Ernst Langthaler/Markus Schermer (Eds.)

Soy and Agro-Food Change

Jahrbuch für Geschichte des ländlichen Raumes/Rural History Yearbook (JGLR/RHY)

Institut für
Geschichte des
ländlichen Raumes

Ernst Langthaler/Markus Schermer (Eds.)

Soy and Agro-Food Change

(Sub-)National Pathways in a Global Perspective

Jahrbuch für Geschichte des ländlichen Raumes/
Rural History Yearbook 2025

StudienVerlag
Innsbruck
Wien

WISSENSCHAFT · FORSCHUNG NIEDERÖSTERREICH
NÖLA NÖLB
JKU JOHANNES KEPLER UNIVERSITÄT LINZ
FWF Österreichischer Wissenschaftsfonds

Redaktionsadresse:
Veronika Helfert und Brigitte Semanek, Institut für Geschichte des ländlichen Raumes, Kulturbezirk 4, 3109 St. Pölten, Österreich
Tel.: +43-(0)2742-9005-12987, E-mail: yearbook@ruralhistory.at, Internet: www.ruralhistory.at

Das *Jahrbuch für Geschichte des ländlichen Raumes/Rural History Yearbook* erscheint jährlich im Umfang von etwa 250 Seiten und seit 2020 neben der Druckversion auch *open access*:
https://journals.univie.ac.at/index.php/rhy/index

Einzelpreis € 34,90/CHF 32,60; Abonnementpreis € 29,90/CHF 27,90; Einzelpreis für Studierende € 27,90/CHF 26,10; Abonnementpreis für Studierende € 23,90/CHF 22,30 (gegen Vorlage einer Inskriptionsbestätigung). Abonnementpreise inkl. 10 % MwSt. zuzüglich Versand. Alle Bezugspreise und Versandkosten unterliegen der Preisbindung. Abbestellungen müssen mindestens drei Monate vor Ende des Kalenderjahres schriftlich erfolgen.

E-mail: order@studienverlag.at, Internet: www.studienverlag.at

Die gedruckte und elektronische Open-Access-Veröffentlichung dieses Bandes wurde durch den Fonds zur Förderung der wissenschaftlichen Forschung (FWF-Projekt P 35531-G), die Johannes Kepler Universität Linz und das Land Niederösterreich (Abteilung Landesarchiv und Landesbibliothek und Abteilung Wissenschaft und Forschung) ermöglicht.

Buchgestaltung nach Entwürfen von himmel. Studio für Design und Kommunikation, Innsbruck/Scheffau – www.himmel.co.at | Satz: Marianne Oppel, Weitra
Umschlag: Studienverlag / Karin Berner | Umschlagabbildung: William J. Morse in einem Soja-Versuchsfeld, Louisiana Experiment Station, 1933. Quelle: William Shurtleff/Akiko Aoyagi, William Joseph Morse: History of his Work with Soybeans and Soyfoods (1884–2017), Lafayette 2017, 449.
Gedruckt auf umweltfreundlichem, chlor- und säurefrei gebleichtem Papier.

Bibliografische Information der Deutschen Nationalbibliothek.
Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://www.dnb.de/ddb abrufbar.
ISBN 978-3-7065-7011-4 ISSN 2523-2185

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Ernst Langthaler/Markus Schermer

Soy and Agro-Food Change

Any assessment of agro-food change faces the challenge of the multiplicity of time, space, and agency. These dimensions are closely interwoven, and each includes multiple scales. Consequently, short-, medium-, and long-term perspectives, spatial formations from local to global as well as various human and even non-human agents need to be considered. Agro-food change is thus characterized by an overwhelming complexity that is difficult to grasp. To reduce this complexity without risking oversimplification, we need a clear research focus. In this special issue of the *Rural History Yearbook*, soy as a commodity provides a lens for assessing agro-food change in the era of globalization since the 1870s. Soy serves best as a marker of agro-food globalization in the 'long twentieth century' because it evolved from being almost exclusively an East Asian food crop until the late nineteenth century to representing the world's biggest agricultural commodity since the early twenty-first century. The lens of soy therefore allows us to comprehend intersections of different scales of time, space, and agency.

The articles of this special issue contribute in one way or another to the multiplicity of time, space, and agency in agro-food globalization. Nearly all of them were initially presented and discussed at the international conference *Agro-Food Change through the Lens of Soy: (Sub-) National Pathways in a Global Perspective*, which took place from 14 to 15 October 2024 at Johannes Kepler University Linz, Austria. The conference assessed agro-food globalization through the lens of soy from a historical social science and humanities perspective, aiming to overcome the methodological nationalism of country-focused agro-food studies as well as certain globalist tendencies in food regime research by emphasizing (sub-)national pathways of agro-food change. International scholars from various disciplines addressed the history of soy in and between Europe, North and South America, Africa, and Asia. They highlighted fundamental continuities and changes, important sites and their connections, as well as more-than-human key actors of the global soy complex – not least in light of the current polycrisis. We will attempt to follow the dimensions of time, space, and agency to provide an overview of the contributions to this volume and make agro-food change more tangible.

The multiplicity of time

The multiplicity of time emerges from intersections of different timescales: short-term (e.g., crop cycles), medium-term (e.g., politico-economic regimes), and long-term (e.g., planetary changes). The example of soy highlights the interplay of these different rhythms, ranging

DOI: 10.25365/rhy-2025-1

Ernst Langthaler, Department of Economic, Social and Environmental History, Johannes Kepler University Linz, Altenbergerstraße 69, 4040 Linz, Austria, and Institute of Rural History, Kulturbezirk 4, 3109 St. Pölten, Austria, ernst.langthaler@jku.at; Markus Schermer, Department of Sociology, University of Innsbruck, Universitätsstraße 15, 6020 Innsbruck, Austria, markus.schermer@uibk.ac.at

from the annual growth cycle of the soybean plant through decades- and centuries-long periods of soy expansion within food regimes all the way to *longue durée* phenomena such as soy-driven planetary change. We can thus distinguish three timescales: first, the *crop scale* of annual soy production and consumption cycles; second, the *regime scale*, which frames the expansion of soy as a sequence of path-dependent periods, each with certain modes of capital accumulation (production, processing, trade, and consumption) as well as regulation (nation states, big companies, social movements, etc.); third, the *planetary scale*, in which natural and human history converge in the Anthropocene, as the Great Acceleration of Earth system trends around 1950 and the soy-driven transgression of planetary boundaries reveal (see *Langthaler* in this volume). These three timescales differ in the ways soy is produced, processed, commercialized, and consumed in various contexts, and they may intersect or act in parallel. The contributions in this volume provide a wealth of examples across five continents.

Crop scale: The annual cycle of production refers to arguments about soy as a "miracle crop." Soy has a unique composition of fat and protein, provides healthy nutrition for humans and animals, and also increases soil fertility through nitrogen fixation in symbiosis with bacteria. This timescale also refers to efforts to adapt soy varieties to local conditions through plant breeding, in connection with changes in production and consumption. The "magic bean" was introduced in Austria-Hungary in the second half of the nineteenth century due to its nutritive value – especially its potential to close the protein and fat gap and to provide a low-cost alternative to meat. But for pioneering producers, yield variation and the availability of adequate varieties posed constant problems (see *Martsch* in this volume). Even after World War II, it still proved difficult to find suitable varieties due to Austria's short growing season and harsh climate. Only in the 1970s did research on photoperiodic behaviour, cold tolerance, and weed control increase soybean cultivation for domestic animal feed sufficiently to reduce the dependence on oilcake imports. Moreover, during the 1980s, tofu, tempeh, and soymilk started to become fashionable foods in the growing community of alternative food networks (see *Tober* in this volume). The government of Taiwan envisioned increasing self-sufficiency in soy through techniques of multiple cropping, intercropping, or crop rotation in the same field within a year. These efforts resulted in labour-intensive, non-mechanized and small-scale, but strongly agrochemical-dependent soy production. Domestic beans predominantly served as materials for tofu, soy sauce, and soymilk, while imported beans were mostly used for oil production (see *Chu* in this volume). In the USA and the USSR, different pathways of soy emerged: In the USA, soy developed from a farm input in the form of seed and animal feed to an output in the shape of soy oil and soy cake as cash crops for domestic and world markets. The USSR was looking for oil crops for various industries as well as protein sources for human and animal nutrition. However, disregard for social and natural conditions in the rural areas contributed to the failure of the "soy revolution" and resulted in the perception of soy as a low-quality food substitute (see *Langthaler* and *Ryzhova* in this volume). In Africa, missionaries and NGOs aimed to use soy to improve nutrition, especially for children. Soymeal was added to the traditional staple foods, but whole soybeans required long cooking times and therefore more fuel, which limited consumer acceptance. Plant breeding supported the expansion of soy cultivation, but production levels remained low (see *Baraibar Norberg* in this volume). In South America, it was genetically engineered herbicide-resistant soy which, in combination with the herbicide glyphosate, propelled the *sojización* of the landscape (see *Baraibar Norberg, Gelabert,* and *Mejía* in this volume).

Regime scale: The annual dynamics of soy are interwoven with expansions (and contractions) of soy cultivation and international trade relations at the food regime scale. Food regimes consist of hegemonic arrangements of agricultural production, agro-industrial processing and distribution, and food consumption coordinated by regulatory institutions at multiple levels. While the literature mostly outlines three global food regimes – the first or British-centred (1870s–1930s), the second or US-centred (1940s–1980s), and the third or WTO-centred (since the 1990s) – a refined periodization distinguishes five regimes (see *Tilzey* in this volume): the "liberal" (1846–1870s), "imperial" (1870s–1930s), "political-productivist" (1930s–1980s), "neoliberal" (1980s–2010), and "neo-imperial" (since 2010) regimes.

From the second half of the nineteenth century up to World War I, soy spread from Northeast China (Manchuria) throughout the Western world, though it remained in an experimental stage with limited production volumes. Various African colonies introduced soybeans from the late nineteenth to the early twentieth century, primarily through experimental stations. Colonial pioneers perceived soy as a valuable source of feed, but also as an answer to the rising European demand for vegetable oils and fats. Soybeans continued to be envisaged as a "future crop" or "food of progress," even when empirical results failed to meet these hopes (see *Baraibar Norberg* in this volume). After World War I, soy flour was propagated as "nutritive, inexpensive food for the starving children of Austria and Central Europe." However, soy and its products did not become part of the food regime in this period, as their introduction in times of scarcity contributed to their negative image as a substitute for animal-based protein (see *Martsch* in this volume). In Taiwan, Japanese colonialism introduced modern processing factories along with large-scale import of soy from Manchuria for fertilizer at the end of the nineteenth century (see *Chu* in this volume).

Between the World Wars, the USA and the USSR announced "soy revolutions." In the United States, extensive European-style mixed farming changed to capital-intensive specialized agriculture with a multi-functional symbiosis between hybrid corn and site-adapted soybeans (see *Langthaler* and *Ryzhova* in this volume). In South America, the colonialism and neo-colonialism of the nineteenth and twentieth centuries introduced or expanded soy monocultures. In the 1940s, farmers from Rio Grande do Sul began to cultivate soy in rotation with wheat production and exported a few tons to Europe (see *da Silva* in this volume).

The era after World War II is characterized by the Green Revolution, a knowledge- and capital-intensive transformation of agricultural production. The technological package of high-yielding seeds, motorized combines, and efficient pesticides made soy the key commodity of the US-centred productivist food regime. Soy oil for human consumption as well as industrial and biofuel use along with soy oilcake for animal feed became the main products. Under the General Agreement on Tariffs and Trade (GATT) of 1947 and the European Recovery Program (ERP) of 1948, the USA exported surplus soy cake at preferential tariffs or subsidized prices (see *Langthaler* and *Ryzhova* in this volume). Austria became a customer for US soy cake as animal feed (see *Tober i*n this volume), and American post-war aid changed beancake from being a fertilizer to serving as animal feed in Taiwan as well (see *Chu* in this volume). Animal feed supported the growing livestock complex in Western Europe and Japan, where middle-class families adopted meat-heavy diets as part of the "American way of life." During the Cold War, cheap soy from North America served as a geopolitical weapon against both world hunger and world communism (see *Langthaler* and *Ryzhova* in this volume). In newly independent African states, governments and aid organizations embraced soybeans

to combat protein malnutrition, reduce dependence on animal-based imports, and promote self-sufficiency (see *Baraibar* Norberg in this volume). In Brazil, shortly after the end of World War II, the increased production of soybeans substituted oil for lard. In the 1970s, Brazilian authorities exploited the danger of African swine fever to propel agrarian modernization and the transition from animal fat to vegetable oil for domestic and international markets (see *da Silva* in this volume).

Over the last 50 years, the neoliberal and the current neo-imperial food regimes have established soy as a flex crop for global markets. Argentina and Uruguay adopted neoliberal reforms, promoting export-oriented agriculture to serve the rising global demand for vegetable oils and animal feed. Argentina became one of the first countries to approve Monsanto's "Roundup Ready" seeds and emerged as a global leader in no-till farming with genetically modified (GM) soy (see *Baraibar Norberg, Gelabert,* and *Mejía* in this volume). By contrast, Austria positioned itself as a producer of GM-free soy. The growing trend towards plant-based diets opened the domestic market for organic and conventional soy foods. Furthermore, EU integration brought an opportunity to sell GM-free soy in international markets – initially to European countries, but recently also to North Africa and the Middle East (see *Tober* in this volume). Taiwan applied a twofold focus by supporting traditional varieties and organic production as well as large-scale mechanized and agrochemical-intensive edamame farming (see *Chu* in this volume). In Africa, the vision for soy changed from direct human consumption to oil extraction and animal feed, often framed in terms of unlocking underutilized land, empowering smallholders, and securing future export markets (see *Baraibar Norberg* in this volume).

Planetary scale: At the planetary scale, the focus lies on the consequences of soy-based commodity chains in the past and present for the sustainable development of the planet in the future. In the current debate, divergent arguments about soy's role in a sustainable transition have emerged: Soy is framed negatively as a "climate killer" as well as positively as a "climate saviour." The negative framing relates to environmental destruction, such as the depletion of the Amazon rainforest and savannahs in Brazil, as well as to the adverse socioecological effects of GM soy: Soy monocultures lead to homogenization of cropping patterns, loss of biodiversity, degradation of soil and water quality, pesticide contamination, and herbicide-resistant "super-weeds" (see *Baraibar Norberg, Gelabert,* and *Mejía* in this volume). The positive framing argues that GM soy allows no-till cultivation and thus reduces carbon dioxide emissions. Moreover, soy provides an alternative to meat as a source of protein, and may thus contribute to reducing the methane emissions of industrial livestock (see *Langthaler* in this volume).

This discussion includes broader visions of low-carbon, "green," and circular-economic development as reaction to the human-driven Earth in the Anthropocene. Societal demands translate into stricter environmental regulations by nation-states and supra-national organizations for firms operating abroad. Some countries, including the EU and China, promote less resource-demanding and more sustainable modes of production. This leads to changes in the hegemonic accumulation strategy: from capital-driven deforestation to state-led "green capitalism." However, the case of Mato Grosso in Brazil shows that the public–private strategy of ecological modernization over the last decades has delivered mixed results: short-term decoupling, but long-term recoupling of soy expansion and deforestation (see *Langthaler* in this volume). Profound sustainability that privileges social and environmental concerns over

corporate interests would require strong institutions backed by a socioecologically responsible state and civil society.

The multiplicity of space

The multiplicity of space emerges from connections linking different spatial configurations. Layers of space – from the local and regional to the national and global – are also transversally linked. The human and non-human relations across space mediated by soy have been extended through scientific improvements such as the exchange of knowledge, appropriation of seed varieties, inoculants to improve nodulation, conventional breeding and genetic engineering, as well as through technological packages of machinery, chemicals, and improved seeds. However, policy programs and market opportunities also played important roles. In the context of the contributions to this volume, two spatial scales are especially relevant: the expansion of frontiers of soy production in certain regions and the extension of transregional teleconnections related to soy.

Regional frontiers: In the USA, soy cultivation increased from the 1930s due to the powerful biotechnological package of hybrid corn and soybeans. The commodity web including beans, oil, and cake spread out from Illinois and proved its viability across the Corn Belt. Initially promoted for hay production or as green manure to support soil conservation, the growing supply of soybeans fuelled demand from the processing industry. Soy oil flowed into the food and other industries; soy cake went to the growing cattle fattening complex. In the USSR, the Bolshevik government's "soy revolution" announced in the late 1920s introduced the crop in suitable territories. Planners envisioned a fourteenfold increase in arable land under soybeans, but the crop failed to become a significant key resource of the Soviet planned economy. A comparison of the USA and the USSR reveals that between the late 1930s and the early 1950s, soybean acreage expanded by 385 per cent in the USA while increasing by only 34 per cent in the USSR, well below the global average of 65 per cent (see *Langthaler* and *Ryzhova* in this volume). In Taiwan, the acreage under soybeans increased by 50 per cent from 1953 to 1958, with production more than doubling due to variety adaptation (see *Chu* in this volume).

The expansion of Brazilian soybeans began in the 1940s, increasing the production area continuously until the 1970s as a result of changes in the production chain, the political preference for processed foods to support the industrialization process, and finally the medical discourse condemning pork lard (see *da Silva* in this volume). Later, the change in market orientation from domestic to export production further fuelled the expansion. In 2024, Brazil accounted for 36 per cent of global soy production and 44 per cent of total soy exports. Within Brazil, Mato Grosso emerged as a hotspot of soy expansion, with a state-led colonization offensive developing settlements and road projects that converted large parts of the savannah and rainforest biomes into cattle pastures and crop monocultures. Here, soy experienced three expansive booms: in the 1980s, production increased 32-fold from a low level; between the mid-1990s and mid-2000s, it grew 3.5-fold from a much higher level; and since the late 2000s, it has further expanded more than twofold (see *Langthaler* in this volume).

In Argentina, the process of *sojización* was a result of the "gene revolution" following the approval of Monsanto's "Roundup Ready" soybeans. Within a few years, 95 per cent of the

grain and oilseed producers adopted transgenic seeds in combination with no-till farming. By 2024, half of the global soybean-growing area (c. 190 million hectares) employed genetically modified seed, concentrated in a few countries including the United States, Brazil, Canada, Argentina, Paraguay, Bolivia, India, and Uruguay (see *Baraibar Norberg, Gelabert* and *Mejía* in this volume).

In Austria, soy cultivation did not gain a significant foothold between its introduction in the 1870s and the postwar decades (see *Martsch* in this volume). Later, however, the renunciation of genetic modification by way of a referendum in 1997 opened up a window of opportunity for the cultivation of GM-free and organic soy. Consumer changes led to increased demand for domestic soy products and an expansion of soy cultivation. Within the European Union, Austrian soy production became second in relation to arable area after Croatia, and fourth in absolute terms. While conventional GM-free soy is mainly used as oil and feed, a growing share is cultivated organically for human consumption (see *Tober* in this volume). In Africa, the recent increase of soy cultivation in some countries (South Africa, Nigeria, Zambia, etc.) is due to increases in domestic meat production and the resulting need for protein-rich concentrate feed (see *Baraibar Norberg* in this volume).

Transregional teleconnections: The term "teleconnection" has been transferred from climatology to history to describe interactions between distant places in the Earth system. These interactions may involve material and immaterial spatial linkages. Perhaps the most obvious material teleconnections are links via intercontinental trade, especially the use of soy cake as protein feed – first from the USA and later from South America – for the meatification of Europe and East Asia. However, soy played a dual role in the Western diet of the postwar decades: Processed soy provided the cake for meatification and oil for oilification, while unprocessed soybeans emerged as an alternative to animal-based food. These opposing yet interlinked nutritional patterns established transnational soy feed trade connections and more nationally-framed soy food networks (see *Tober* in this volume). In Brazil, the state of Mato Grosso was transregionally incorporated into nation-state and global market dynamics via hierarchical commodity chains and other sorts of asymmetrical connections (see *Langthaler* in this volume). However, it is not always concentrate feed and oil that foster teleconnections. In Taiwan, the import of beancake as a fertilizer from Manchuria and Korea initially connected the countries during colonial times (see *Chu* in this volume).

Besides material trade connections, immaterial knowledge transfers on breeding efforts also established soy-related teleconnections. For instance, soy pioneers in the USA and USSR regularly exchanged knowledge on seed varieties and breeding efforts (see *Langthaler* and *Ryzhova* in this volume). In Taiwan, the Asian Vegetable Research and Development Center allied its agenda with the International Rice Research Institute in the Philippines, and the World Bank founded the Consultative Group on International Agricultural Research. This collaboration assisted in boosting soybeans in Indonesia (see *Chu* in this volume). The Soybean Innovation Lab at the University of Illinois, funded by USAID, became a major hub for breeding, agronomy, processing, and training across Africa. Through certification schemes and regional training, it helped to build capacity and link African producers to global markets (see *Baraibar Norberg* in this volume).

The multiplicity of agency

In a comprehensive understanding, agency is the ability of human and non-human actors embedded in hybrid networks to affect somebody or something else more or less strongly, regardless of the degree of intentionality. In the contributions to this volume, we can discern different but closely interwoven forms of agency: Some authors address human agency affecting soy cultivation – for instance, the broad spectrum of breeding efforts ranging from the traditional adaptation of varieties to local conditions to high modern genetic engineering. These activities may result in (often destructive) transformation of natural environments or the establishment of dependencies between governments, breeders, farmers, processors, trading companies, and consumers. Non-human agency related to soy cultivation includes the soybean itself along with other organisms such as companion crops, competing products, or weeds and pests. Animate as well as inanimate entities may exert agency, as the biotechnological package of herbicide-resistant soybeans together with corresponding herbicides and no-till cultivation shows. Finally, human and non-human agency interact in convergent or divergent ways and create more-than-human networks around soy (see *Langthaler* in this volume).

Human agency: Success or failure of human interventions depends on the stability of soy networks, as the Austrian case of early introduction exemplifies. Research-led soy cultivation in the late nineteenth century was shaped by an ever-shifting network of diverse actors including experts, publicists, estate owners, farmers, and the educated public. Early enthusiasm was not supported by sustainable institutions or market links, however. Even after World War I, scientific advancements were undermined by insufficient cohesion and coordination among individual actors, institutions, and state policy (see *Martsch* in this volume).

In the United States, a low-modernist pathway embedded in a state-coordinated yet decentralized knowledge network around the US Department of Agriculture, experimental stations, and the American Soybean Association upscaled soy as a pillar of the US-centred food regime. On the contrary, in the USSR, the disembedded high-modernist pathway with centralized direction by the All-Union Academy of Agricultural Sciences and overambitious five-year plans encountered ecological mismatches, weak knowledge transfer to collective farms, coercive collectivization, and repression of scientific expertise, which repeatedly stalled soy expansion (see *Langthaler* and *Ryzhova* in this volume). Similarly, adoption in Africa was strongest where research, assured markets, and processing capacity aligned (see *Baraibar Norberg* in this volume).

Policy actors played leading roles in different contexts. The USA intervened against Austria's autonomy in terms of oil and protein supply in the 1970s. Most important for the later integration of soy into the Austrian agro-food sector were connections between economic actors, civil society organizations, and state policies (see *Tober* in this volume). The EU is currently imposing stringent sustainability regulations like the Anti-Deforestation Regulation (EUDR) and the Carbon Border Adjustment Mechanism (CBAM), which could complicate market access for soy from Argentina and Uruguay. China's demand for imports surged after its accession to the WTO in 2001 as it opened up its markets and became a major buyer, importing nearly 100 million metric tons of soybeans in 2021, primarily for animal feed and cooking oil. Today, China's increasing emphasis on soybean self-sufficiency poses a potential challenge for global soy exporters (see *Baraibar Norberg, Gelabert,* and *Mejía* in this volume).

Non-human agency: In Brazil, the African swine fever virus played a decisive role in the "battle between lard and soy." The government exploited its spread to favour soy at the expense of pork lard (see *da Silva* in this volume). Ecological responses to soy cultivation provide another example of non-human agency: In Argentina and Uruguay, after decades of expansion, ecological feedbacks such as herbicide and pest resistance coupled with other environmental costs are undermining the economic efficiencies that once stabilized the system. Climate change further increases these pressures, intensifying soil-borne diseases and the vulnerabilities of monoculture systems. As nearly all soy production in the region is rainfed, it is highly vulnerable to precipitation variability. The 2022/23 drought in Uruguay, for instance, led to a drop in yield by 73 per cent, and 23 per cent of the sown area was abandoned (see *Baraibar Norberg, Gelabert,* and *Mejía* in this volume).

The transition from the Holocene to the Anthropocene has produced new forms of human and non-human agency that reinforce each other. There is evidence suggesting that the "Soyacene" can be considered a variety of the Anthropocene. The widening of soy's planetary footprint has driven deforestation and global warming, while its deepening has resulted in herbicide contamination and planetary health issues. While human agency has increased to a point that changes the course of the Earth system, non-human planetary agency may in turn change the course of the human species or even extinguish it – for instance, through an increase in adverse weather phenomena caused by accelerated climate warming (see *Langthaler* in this volume). Managing the Anthropocene to safeguard the habitability of our planet for a broad diversity of species, including humans, is probably the biggest challenge of our times.

We would like to thank all individuals and organizations who contributed to the publication of this volume: the authors, who delivered their manuscripts and revised them according to the reviews; the anonymous reviewers, who provided ample suggestions for improvement; the Austrian Science Fund (FWF) and Johannes Kepler University Linz for their financial support; and, last but not least, the editorial team at the Institute of Rural History in St. Pölten under the direction of Brigitte Semanek – namely Veronika Helfert, who coordinated the communication between the volume editors, authors, and reviewers, and Stephan Stockinger, who undertook thorough copy-editing.

Mark Tilzey

Reconceptualizing Food Regimes from a National (State-Capital Nexus) Perspective

Abstract: This paper undertakes a critique of the previously dominant globalist theorization of food regimes represented by the work of Friedmann and McMichael, especially in their 1989 paper *Agriculture and the State System: The Rise and Decline of National Agricultures, 1870 to the Present.* Given what are considered to be serious theoretical and empirical shortcomings of this work arising from its failure to adequately theorize the nature of capitalism, its relation to the state, and consequently the substance and periodization of food regimes, this contribution presents a significantly revised theoretical foundation for thinking about the political economy dynamics underlying food regimes. The paper then deploys this revised foundation as the basis for proposing a new periodization featuring five international food regimes rather than Friedmann and McMichael's three 'global' regimes. Special attention is devoted to justifying the existence and exploring the character of the proposed first, second, and fifth international food regimes, since the first and fifth have not previously been mooted and the second is, as conceptualized here, substantively different from Friedmann and McMichael's first food regime, with which it broadly coincides chronologically.

Zusammenfassung: Dieser Beitrag unternimmt eine Kritik der bislang dominanten globalistischen Nahrungsregime-Theorie, wie sie im Werk von Friedmann und McMichael zum Ausdruck kommt – insbesondere in ihrem Aufsatz *Agriculture and the State System: The Rise and Decline of National Agricultures, 1870 to the Present* von 1989. Angesichts der als gravierend zu erachtenden theoretischen und empirischen Schwächen des Ansatzes, die aus einer unzureichenden Theoretisierung der Natur des Kapitalismus, seines Verhältnisses zum Staat sowie der daraus folgenden Substanz und Periodisierung von Nahrungsregimen resultieren, präsentiert dieser Beitrag eine maßgeblich revidierte theoretische Grundlage aus der Perspektive der politischen Ökonomie für die Analyse der Dynamiken, die Nahrungsregimen zugrunde liegen. Auf dieser revidierten Grundlage wird sodann eine neue Periodisierung von fünf internationalen Nahrungsregimen an Stelle der drei ‚globalen' Regime von Friedmann und McMichael vorgeschlagen. Besondere Aufmerksamkeit gilt der Begründung und Charakterisierung des ersten, zweiten und fünften internationalen Nahrungsregimes: Das erste und das fünfte wurden in der bisherigen Forschung noch nicht diskutiert, während das zweite in der hier entwickelten Konzeption substanziell von Friedmann und McMichaels erstem Nahrungsregime abweicht, auch wenn es zeitlich mit diesem übereinstimmt.

Keywords: food regime, state-capital nexus, capitalism, state, class, imperium, periphery

DOI: 10.25365/rhy-2025-2

Accepted for publication after external peer review (double-blind).

Mark Tilzey, Independent researcher, UK, rmtilzey@gmail.com

Introduction

In this paper, I undertake a critique of the previously dominant globalist theorization of food regimes, represented perhaps most famously by Harriet Friedmann and Philip McMichael's 1989 article in *Sociologia Ruralis* entitled *Agriculture and the State System: The Rise and Decline of National Agricultures, 1870 to the Present*.[1] Over the years, their paper has become something of an article of faith for scholars researching food regimes, to the extent that its theoretical premises and periodization of food regimes have been accepted and replicated innumerable times without what might be considered due critical (re)appraisal. Being dissatisfied with this situation for well-founded theoretical and empirical reasons, I have previously undertaken such a critical and overdue reappraisal in two peer-reviewed publications: the first in 2018 (*Political Ecology, Food Regimes, and Food Sovereignty*),[2] and the second in 2019 in *Sociologia Ruralis* (*Food Regimes, Capital, State, and Class: Friedmann and McMichael Revisited*),[3] marking the thirtieth anniversary of the 1989 article in the same journal. Since neither of these works has elicited a substantive response from Friedmann or McMichael, it seems opportune to reiterate in this paper the key messages of my 2019 *Sociologia Ruralis* article in particular, especially since they align very well with the underlying theme of the present special issue. Accordingly, the following pages present once again a significantly revised theoretical foundation for thinking about the political economy dynamics underlying food regimes, which is then employed as the basis for proposing a new periodization of food regimes. With respect to the latter, I propose the existence of five *international* capitalist food regimes rather than the three 'global' regimes of Friedmann and McMichael, devoting special attention to delineating the justification for and character of the first ('Liberal'), second ('Imperial'), and fifth ('Neo-Imperial') of these regimes, since none of them has hitherto been hypothesized by Friedmann and McMichael or any other food regime scholars.

As a point of departure, it is perhaps useful to recall what we mean by 'food regimes.' Food Regime Theory (FRT)[4] proposes to found the theoretical conceptualization of food production, distribution, and consumption on a world scale in political economy – in other words, to understand how (and hopefully why) capitalism and the modern state constitute and structure this system. It is important in this context, however, to scrutinize the value of the descriptor 'world' – and, indeed, the term 'political economy.' As we shall see below, there are competing schools of political economy at play in food regime research, with the dominant trend derived from World Systems Theory (WST) using, as I assert, a very imprecise and inadequate definition of capitalism without reference to what we might mean by the 'modern capitalist state.' But if this dominant trend, which numbers Friedmann and McMichael amongst its adherents, has no precise definition of capitalism or the modern capitalist state, then it becomes logically impossible to define on that basis what might be

1 Harriet Friedmann/Philip McMichael, Agriculture and the State System: The Rise and Decline of National Agricultures 1870 to the Present, in: Sociologia Ruralis 29 (1989), 93–117.

2 Mark Tilzey, Political Ecology, Food Regimes, and Food Sovereignty: Crisis, Resistance, and Resilience, London 2018.

3 Mark Tilzey, Food Regimes, Capital, State, and Class: Friedmann and McMichael Revisited, in: Sociologia Ruralis 59 (2019), 230–254.

4 Philip McMichael prefers the term "Food Regime Analysis." See Philip McMichael, Food Regimes and Agrarian Questions, Halifax/Winnipeg 2013, 3.

meant by 'global' or 'world' scale capitalism – the supposed temporal baseline for Friedmann and McMichael's food regimes.

In this paper, I propose a much more precise definition and understanding of capitalism and the modern state, as well as the relation between these two entities, than that offered by Friedmann and McMichael. It comprehends food regimes as arising from the dominance of agrarian capitalist social property relations in one social formation (state-capital nexus), their diffusion to other social formations, and the development of productive and distributive interdependencies between these social formations on a capitalist basis. In other words, the emphasis in this paper is on understanding the agrarian class or social property relations which generate a *national* food regime on a capitalist basis in the first instance, as well as their subsequent diffusion to constitute other national capitalist food regimes, along with the development of symbioses or antagonisms between these national social formations (state-capital nexus) in the form of *international* capitalist food regimes. If we can comprehend the political economy dynamics underpinning this process of national and international food regime formation, it becomes effectively irrelevant whether the scale being addressed is global or less than global – the decisive point is whether the food regime under analysis can be understood as capitalist or not. This is all the more important because I also propose a dialectical and *enduring* relation between capitalism and the modern state as the state-capital nexus, a relation that persists and remains essential to the present day. It is thus the notion of an international rather than a global or world-scale food regime that is of key theoretical significance in the definition and periodization of food regimes. This stands in marked contrast to the globalist conceptualization of this phenomenon on the part of Friedmann and McMichael, for whom the state appears as an essentially ephemeral entity, initially facilitating but then rendered redundant by the rise of a global and putatively post-national capitalism. This is why they place such strong emphasis upon the perceived significance of global food regimes despite offering no adequate definition of what we might mean by 'global' – let alone of capitalism and the nation-state.

We may recall that, according to its co-originators Friedmann and McMichael,[5] FRT proposes three 'global' food regimes: the First (1870s–1930s), Second (1950s–1970s), and Third Regime (1980s–present), with the latter betokened the "corporate-environmental" food regime by Friedmann[6] and the "corporate" food regime by McMichael.[7] Again, however, we are provided with precious little idea of what the authors mean by this 'global' nature. If we interpret the term, using a reasonable definition, to mean the dominance of capitalist social property relations amongst all social formations engaged in interdependent production and consumption (trade) relations at a world scale, then Friedmann and McMichael's definition certainly fails this test with regard to their first and arguably in relation to their second regime as well, and passes it plausibly only with respect to their third regime. This, again, reinforces my argument for defining capitalist food regimes on the basis of national and then international (rather than global) interdependencies, since it is these interdependencies between social formations (the state-capital nexus) subject to capitalist social property

5 Friedmann/McMichael, Agriculture.

6 Harriet Friedmann, From Colonialism to Green Capitalism: Social Movements and the Emergence of Food Regimes, in: Research in Rural Sociology and Development 11 (2005), 227–264, 229.

7 McMichael, Food Regimes, 41.

relations, rather than any arbitrary notion of the 'global', that defines the modus operandi of food regimes within the capitalist mode of production. Friedmann and McMichael go on to suggest that food regimes comprise a series of key relationships enshrined in rulemaking and enforcing institutions, which coalesce to form relatively stable patterns of accumulation over delimited periods before eventually destabilizing and moving into crisis.[8] In addition to WST, Friedmann and McMichael utilize a Regulation Theory (RT) interpretation of capitalist history; they invoke only part of RT, however, much to the detriment of their conceptualization of food regimes (see below).

In this paper, I wish to uphold both the tradition of radical political economy that motivated Friedmann and McMichael's 1989 paper and the value of the food regime concept itself. As suggested above, however, I am critical of the WST school within this tradition, which constituted a major influence on Friedmann and McMichael's development of FRT. While I am supportive of the other main intellectual influence on their formulation of FRT, namely RT, Friedmann and McMichael fail to employ this theory to its full extent, thereby seriously compromising their grasp of the importance of the state in upholding legitimacy functions to embed capitalism *in addition* to its function in supporting capital accumulation. I undertake my theoretical critique of Friedmann and McMichael by drawing on other schools of thinking within radical political economy: so-called Political Marxism, Neo-Gramscian International Political Economy, Poulantzian/Jessopian state theory, and the work of political anthropologist Eric R. Wolf. I also employ RT, but in a way that acknowledges the equal importance of the regime of accumulation *and* the mode of regulation (that is, the legitimation function of the state). I use these theoretical influences to propose a revised ontological basis for food regimes centred around the state-capital nexus, founding them on a more precise definition and understanding of capitalism, its co-evolutionary relation to the modern state, and its tendency towards imperialist relations between an 'articulated' capitalist core and a 'disarticulated' periphery. I then deploy this revised ontological basis to propose a sequence of five international food regimes rather than the three global food regimes suggested by Friedmann and McMichael. In my treatment, food regimes are defined not by whether they function on a putative 'world scale' but rather by whether the co-integration of states via (agri-food) trade relations occurs on the basis of capitalist social relations of production. It is thus the appearance of distinctively capitalist class relations and their co-dependency on the modern state that is crucial in enabling us to identify the first emergence and subsequent expansionary dynamic of capitalist food regimes, and thus to specify the first international capitalist food regime as dating from the 1840s.

Critique of Friedmann and McMichael: Proposing a revised ontological basis for food regimes

In their 1989 paper, Friedmann and McMichael set themselves the principal objective of explaining "the role of agriculture in the development of the capitalist world economy, and

8 Hugh Campbell/Jane Dixon, Introduction to the Special Symposium: Reflecting on Twenty Years of the Food Regimes Approach in Agri-food Studies, in: Agriculture and Human Values 26 (2009), 261–265, 263.

in the trajectory of the state system".[9] Given this objective, any critique of their paper might be anticipated to ask quite reasonably how Friedmann and McMichael define and understand capitalism, the state, the relation between them, and the relations between states as well as between classes – with the latter an issue largely neglected by the two authors. As suggested above, there are also potential questions to be asked about how a capitalist 'world' economy should be defined.[10] We will address each of these key issues below.

With respect to the first issue, Friedmann and McMichael unfortunately offer no explicit definition of the capitalist mode of production. This deficiency is compounded by their reliance on WST, which notoriously conflates capitalism proper with merchant or commercial capitalism, enabling WST proponents such as Wallerstein to speak of "world capitalism" as a phenomenon dating from the sixteenth century.[11] Sadly, Friedmann and McMichael never broach – let alone explain – the discrepancy between Wallerstein's earlier temporal baseline for the emergence of a putative capitalist world system and their own baseline set in the late nineteenth century. However, in order to define capitalism and bring clarity to this issue, we need to differentiate it from merchant or commercial capitalism.

Merchant capitalism is considerably older than capitalism proper and appeared as soon as producers had surpluses available and the social division of labour (social hierarchization) made possible an exchange of products in which this surplus was incorporated. As soon as a substantial part of the surplus produced by pre-capitalist workforces had become centralized in the hands of the members of powerful, privileged classes such as feudal lords and absolutist monarchs, it could then be bartered in long-distance trade, typically in exchange for luxury products originating from other societies. Merchant capitalists then exploited monopoly positions in bringing different societies into trade contact with one another. However, the profit thus derived by merchant capitalists was based on differences in subjective values (social utilities) between the two trading societies, which were essentially ignorant of each other. In other words, societies exchanged scarce products without knowing their respective social costs of production, and merchant capitalists were able to generate profit by buying cheap and selling dear. Contra Wallerstein, this merchant capitalism – not capitalism proper – constituted the basis for the great bulk of profit accumulation until the nineteenth century, with the absolutist, *pre-capitalist* states of Europe (with the exception of Britain) centrally reliant on it in their

9 Friedmann/McMichael, Agriculture, 93.

10 Although Friedmann and McMichael do not use the term 'global food regime' per se, expressions like 'world-scale', 'world price', 'world economy' and cognate terms are clearly key conceptual issues for them. It seems obvious that the key issue for the two authors is one of scale – in other words, that once an ill-defined capitalism achieves a certain critical mass, it may be defined as a 'world-scale' regime. This accords with the quantitative Wallersteinian approach, where modern or 'world-scale' capitalism is simply the result of the progressive accretion of capitalisms that have existed since time immemorial. This contrasts with our own view in which capitalism proper represents a distinct rupture from previous modes, and from mercantile capitalism in particular. The crucial issue is: At what point did these new capitalist social property relations become implanted in a social formation and then proceed to integrate other social formations (states) into this distinctive capitalist dynamic? The primary issue is therefore that of the implantation of this distinctive capitalist dynamic as co-integration of states rather than the scale of an ill-defined entity ("capitalist world economy") whose dynamic remains unspecified.

11 Immanuel Wallerstein, The Modern World System. Capitalist Agriculture and the Origins of the European World Economy in the Sixteenth Century, vol. 1, New York 1974; Immanuel Wallerstein, The Modern World System, vol. 2, New York 1976.

trading relations with other social formations – and indeed their own colonies. There was thus no equalization of the social labour time embodied in commodities through trade, such as would arise through market competition and the free movement of labour under capitalism proper. Rather, profit under merchant capitalism was predicated on very different principles founded on unfree labour and protected markets closely demarcated and patrolled by the pre-modern state in support of revenues and conspicuous consumption by political elites, with the absolutist monarchies of France and Spain perhaps the exemplars here.[12]

By contrast, the capitalist mode of production is identified by three essential features: 1) the entirety of social production takes the form of commodities; 2) labour power itself becomes a commodity, meaning that the producer – now separated from the means of production – becomes a proletarian; 3) the means of production themselves become commodities in which a social relationship is materially embodied, namely that of their exclusive appropriation by a class of capitalists. Following Marx, there is thus a need to specify capitalism proper in terms of class relations comprising owners of the means of production (capitalists) counterposed to an expropriated class (proletarians) now 'free' (from feudal bonds) to sell its labour power to the capitalists.[13] In this way, the separation of producers from their means of production, together with the need for the new capitalists to sell their commodities on the basis of market competitiveness rather than political prerogative, gave rise to Marx's "dull compulsion of the economic" as the essence of capitalism proper. Thus, for the first time in history, power over production in capitalism proper came to be exerted economically (rendered ideologically as the 'self-regulating' market) rather than politically as in feudalism, absolutism, etc. So long as the means of production are owned by capitalists (with absolute or exclusive property rights representing another particularly characteristic feature of capitalism proper) and withheld from producers (proletarians), this "dull compulsion of the economic" obliges the latter to sell their labour power to the former in order to secure the means of survival. Modern capitalism is thus a "*qualitatively* new phenomenon, a new mode of mobilizing social labour in the transformation of nature".[14] This stands in marked contrast to WST, for which – following in the tradition of Weber and Braudel – capitalism is simply a quantitative amplification of relations ('production and trade for profit') already present in pre-capitalist hierarchical modes of production.

Moving to the second issue, if WST – and by extension, Friedmann and McMichael – have no definitive definition of capitalism, then they likewise have no precise conceptualization of the modern state. This is because the newly constituted and institutionally separated spheres of the political and the economic under capitalism proper are *dialectically* cognate and implied, with their 'separation in unity' a consequence of the commodification of labour power and the establishment of absolute property rights in the means of production. The modern state also acquires a strategic political role that the individual capitalist or enterprise cannot attain. The state was initially instrumental in fulfilling the political task of expropriating the peasantry from its means of production, rendering the resulting 'free' labour power

12 Mark Tilzey/Fraser Sugden/David Seddon, Peasants, Capitalism, and the Work of Eric R. Wolf: Reviving Critical Agrarian Studies, London 2023.

13 Karl Marx, Capital, London 1981.

14 Eric Robert Wolf, Europe and the People without History, Berkeley 1982, 85, emphasis in original.

available to agrarian and industrial capitalists.[15] Once capitalism was firmly installed by these means, the state (representing the condensation of dominant class interests in the social formation) further deployed its power to maintain and guarantee the absolute property rights of the capitalist class and to institute and support regimes of work discipline required by this new mode.[16] The modern state also assumed the essential role of arbitrating and managing contestation and collaboration between different fractions of capital, and subsequently between capitalists and their labour forces, as well as the role of representing the interests of capital in the international arena – including by military force if necessary.

One might expect Friedmann and McMichael's acknowledged debt to RT to manifest in some substantive analysis of the modern state. Sadly, this is not the case, and their partial employment of RT only serves to reinforce the deficiencies of their reliance on WST. This relates in particular to their neglect of the two aspects of the relation between capitalism and the modern state that enable us to make sense of both entities in their dialectical co-constitution: the 'separation in unity' of the institutional spheres of the economy and polity referenced above and, relatedly, the complementary accumulation and legitimation functions of the state with regard to capital (and its labour forces) as defined by RT.[17] Apart from almost completely disregarding the legitimation dimension (mode of regulation) of RT, Friedmann and McMichael apply a dichotomous rather than dialectical understanding of the relation between state and capital, with both entities being de-historicized and reified in their treatment.[18] As noted earlier, their modern state consequently appears as nothing more than the contingent and temporally delimited outcome of a sectoral articulation between agriculture and industry. I suggest that a proper understanding of the state-capital relation needs to subvert this dichotomous conceptualization of the two entities.

In addition to a full employment of RT, the work of Poulantzas can help us to achieve this objective.[19] Given the lack of extra-economic influence that individual capitals can exert, the state affords the essential institutional space for the various capitalist class fractions – and under social democracy (Keynesianism), for other non-capitalist class fractions as well – to collaborate and stimulate alliances and strategies while simultaneously co-opting or subverting those non-capitalist classes inclined to follow paths outside capitalism. Not least for legitimation purposes, the state also needs to be relatively autonomous from the interests and influence of particular fractions of capital and, where non-capitalist classes are to be effectively co-opted, even from capital in general. However, when non-capitalist classes become restive and potentially threaten the legitimacy of capitalism, as in the present-day conjuncture, states may become increasingly authoritarian and seek to limit the democratic rights

15 Michael Perelman, The Invention of Capitalism: Classical Political Economy and the Secret History of Primitive Accumulation, Durham 2000.

16 Wolf, Europe, 100.

17 Robert Boyer/Yves Saillard, Regulation Theory: The State of the Art, London 2002.

18 Thus, while they do suggest that "it is possible to see a mutual conditioning of the state system and capital" (Friedmann/McMichael, Agriculture, 112), this is clearly conceptualized as an external relation, as indicated by the following: "In both movements agriculture became incorporated within accumulation itself, and states and national economies became increasingly subordinated to capital. We conclude that the growing power of capital to organize and re-organize agriculture undercuts state policies directing agriculture to national ends, such as food security, articulated development, and the preservation of rural/peasant communities" (ibid., 95).

19 Nicos Poulantzas, State, Power, Socialism, London 1978.

and political influence of such classes while simultaneously attempting to ideologically co-opt selected groups into more restrictive notions concerning who should be the beneficiaries of capitalism and/or state welfare (for example, on the basis of nationality, race, ethnicity, religion, politico-economic allegiance, etc.). As Poulantzas and later Jessop suggest, the state is therefore a social relation constituting the condensation of the balance of class forces or interests in the social formation.[20]

For Friedmann and McMichael, by contrast, capital appears to be a unitary entity lacking any class-fractional differentiation or national affiliation, and featuring a universally kindly disposition towards laissez faire and a 'minimal state.' In their interpretation, it is thus counterposed to an equally essentialized and de-historicized state with a general predisposition towards capital constraint and public control of the means of production. This view is directly opposed to our conceptualization of the state (or better, the state-capital nexus) as a social relation, an arena within which class contestation and compromise are played out – principally to facilitate the accumulation strategies of certain fractions of capital,[21] but also to ideologically embed such strategies amongst the wider citizenry.

Addressing the remaining issues identified earlier, if Friedmann and McMichael have little notion of the specific class configuration of capitalism or of the state as a social relation, it is unsurprising that they apply a deficient class analysis or neglect it entirely, especially in relation to inter-class struggle. From this neglect arise serious shortcomings in their analysis of state-capital dynamics involving class contestation and compromise and, derivatively, inter-state relations. To remedy these shortcomings, I suggest here – building on the schools of Political Marxism and Neo-Gramscian International Political Economy (IPE) in particular – that the prime mover in the formation and reproduction of food regimes derives from the character of capitalist social property relations in the hegemonic state within an international trade regime comprising the articulation of these social property relations with receptive and complementary capitalist class interests in other states.[22] This indicates the pivotal importance of class struggle in the emergence of capitalist social property relations within a given social formation or state, with a social formation being a concrete, organized structure (usually coterminous with the nation or state) marked by a dominant mode of production and the articulation around it of a complex group of other modes which become progressively subordinate to it – and in the case of capitalism, tend to disappear. Capitalist social property relations are defined by the key features identified earlier in this paper, and once these relations become dominant within a social formation, that social formation or state may then reasonably be described as capitalist. The capitalist mode of production, as the outcome

20 Ibid.; Bob Jessop, The State: Past, Present, Future, Cambridge 2016.

21 Peter Taylor, The State as Container: Territoriality in the Modern World-System, in: Progress in Human Geography 18 (1994), 151–162; Bastiaan van Apeldoorn/Nina de Graaff/Henk Overbeek, The Reconfiguration of the Global State-Capital Nexus, Globalizations 9 (2012), 471–486.

22 On Political Marxism, see Robert Brenner, The Agrarian Roots of European Capitalism, in: Trevor Henry Aston/Charles Harding Philpin (eds.), The Brenner Debate: Agrarian Class Structure and Economic Development in Pre-Industrial Europe, Cambridge 1985, 213–328; Colin Mooers, The Making of Bourgeois Europe: Absolutism, Revolution, and the Rise of Capitalism in England, France, and Germany, London 1991; Ellen Meiksins Wood, The Question of Market Dependence, in: Journal of Agrarian Change 2 (2002), 50–87; on Neo-Gramscian International Political Economy, see Andreas Bieler/Adam DavidMorton, A Critical Theory Route to Hegemony, World Order and Historical Change: Neo-Gramscian Perspectives in International Relations in: Capital and Class 82 (2004), 85–113.

of dominant class interests within the social formation, will then become national policy embodied in a particular regime of accumulation. Since capitalism entails, for the first time, the separation of the bulk of the population from its agrarian means of production, therefore implying trade in food staples to feed the newly formed proletariat, this new capitalist regime of accumulation necessarily includes a food regime.[23]

Should this national policy successfully augment the power of the dominant classes and hence the state through expanded capital accumulation, the state may then – through international projection and imposition of its regime of accumulation (subsuming a capitalist food regime) – aspire to the status of hegemon in the inter-state system. In order to compete with this new hegemon, or under duress from it, other states/social formations may then seek to instigate their own transformation to capitalist social property relations. Once the capitalist mode of production becomes dominant within them and they enter into trade with the hegemon, including substantial commerce in food staples, we may then speak of an international – and perforce capitalist – food regime. This process is exemplified by the emergence of the British 'free trade' food regime (1840s–1870s) as the first *international* capitalist regime, accordingly identified in my model as the 'First' or 'Liberal' Food Regime.[24] It is this understanding, I assert, that should form the basis for the definition and periodization of food regimes (see next section) rather than the vague notion of a 'global' food regime deployed by Friedmann and McMichael. To reiterate, according to our definition, the first two of Friedmann and McMichael's regimes should not be defined as global in any case, since many social formations in the Global South in particular did not make the transition to dominant capitalist social property relations until the 1960s or later.[25]

In this way, it is transnational class coalitions and international alliances of capitalists through the medium of the state which act as conduits for the dissemination of a food regime from the hegemon. Class-agential processes of this kind are characteristic even of relations

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23 Tilzey, Political Ecology; Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.

24 Tilzey, Political Ecology.

25 See Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work, and Mark Tilzey/Fraser Sugden, Peasants, Capitalism, and Imperialism in an Age of Politico-Ecological Crisis, London 2023, for details on capitalist transitions. Friedmann and McMichael place a great deal of emphasis on the formation of a putative "world price" as the basis for their definition of the first 'global' food regime. They do not, however, develop an understanding of capitalism that might explain why producers, and subsequently states, enter into competition with one another (the prerequisite for any "world price") and how this differs fundamentally from mercantile capitalism. Again, the issue for Friedmann and McMichael seems to be simply one of scale rather than the emergence of capitalist social property relations predicated on market dependency – the need to reproduce capital and labour power in direct competition with other capitalists and labourers. Market dependency constitutes the fundamental dynamic of capitalism proper. What is key, then, is at what time these new social property relations and this distinctive dynamic first emerged in a social formation and subsequently began to enforce the integration of other social formations into this dynamic. This is why the concept of international capitalist food regimes is more meaningful than the quantitative, scalar concept of "world-price" underpinning food regime definition deployed by Friedmann and McMichael. We assert that the first integration of states on the basis of this new capitalistic dynamic occurred after the abolition of the British Corn Laws in 1846, drawing major grain suppliers in Europe – Germany, Russia, and to a lesser extent France – into its orbit. This same expansionary dynamic later drew in North America, Latin America, India, and elsewhere as cheap suppliers of grain to underwrite British industrialisation. Whether the scale of this process was first regional and subsequently 'world-scale' (with equivalent 'regional prices' and 'world prices') is less important than the specification of the capitalist logic of the dynamic itself.

between a hegemon and a subordinate state, such as between imperial states of the Global North and the so-called periphery of the Global South, in which case imperial transnational class fractions and extraverted peripheral capitalists may forge complementary strategies of accumulation. There may, however, not be a confluence of interest between dominant class fractions in different states, especially when these states are in competition with one another, in which case the aspiring hegemon will be resisted and divergent food regimes may exist concurrently, as was largely the case during the Imperial Food Regime as defined in my model (see below).[26] In this way, we can see that food regimes comprise specific forms of capital accumulation, and these forms reflect the preferred interests of a capitalist class fraction, or coalition of class fractions, within the hegemonic state. These interests are projected beyond the social formation by way of conscious class agency to mould a conformable international regime. Since the intention in this context is to enhance the power and wealth of dominant class fractions – and by extension, that of the hegemonic state itself – this international projection of national interests will tend to generate relations of 'combined and uneven development' (see below) with other social formations. These relations generally take the form of subordination to the hegemon, although they may also result in challenge, competition, and eventual displacement of the hegemonic power.

The above enables us, following van Apeldoorn/de Graaff/Overbeek,[27] to capture the essential internal relations between capital and state which the state-capital nexus deploys to ensure capital accumulation and political legitimation, simultaneously framing the form and function of food regimes. We can identify four key relations:

1. *Market creation*: to engender and ensure the effective functioning of markets, including the structural preconditions for the capitalist mode of production, such as the expropriation of agrarian producers with regard to their means of production (accumulation function);
2. *Market correction*: to mitigate the socially destructive and economically divisive impacts of capital accumulation, to manage the capital-labour relation, and to reproduce the subordination of the labour force to capital and its ideological adherence to capitalism (legitimation function);
3. *Market direction*: to direct and supervise capital accumulation when private capital fails or is unable to secure competitiveness for whatever reason; in other words, state intervention in the economy (accumulation function);
4. *External representation*: to represent the external interests of 'domestic' capital, extending from economic diplomacy to the military protection of business interests abroad (accumulation and legitimation function, the latter elevating the national interest above class interest in the name of nationalism and resulting in what we refer to as 'combined and uneven development').

These key relations constitute the foundation of food regimes as subsidiary elements of accumulation regimes within international political economy. With the first of these relations representing a basic prerequisite of the capitalist mode of production, the relative importance of the relations will vary across space and time according to:

26 Tilzey, Political Ecology.
27 Van Apeldoorn/de Graaff/Overbeek, Reconfiguration, 474.

1. The *class composition* of the respective state-capital nexus;
2. The *hierarchical* or *spatial* location of the state-capital nexus (social formation) within the international state system – core, semi-periphery, or periphery;
3. The *temporal* location of the state-capital nexus within the longer-term trajectory of the capitalist mode of production; for example, the transition from competitive to monopoly capitalism, or the oscillation between 'free trade' liberalism and 'protectionist' mercantilism.

In conclusion of this section, I suggest that capitalism – intimately conjoined with the state – gives rise to food regimes as integral elements of its expansionary dynamic. This arises from a threefold logic connected to both the accumulation and legitimation functions of the state-capital nexus:

1. To supply food on a reasonably cheap and secure basis to its expropriated proletarian labour force, thereby aiming to ensure the relative quiescence of this proletariat (relations 1 and 2 above);
2. To supply this food as abundantly and cheaply as possible in order to exert downward pressure on the socially average wage[28] of labour forces, thereby maximizing surplus value in competitive commodity production and ensuring a transfer of surplus from agriculture to national industries (relations 3 and 4);
3. To create profit-making opportunities for the various class fractions of agrarian capital (relations 3 and 4).

The state-capital nexus employs all four relations identified above to secure this logic. These relations may be complementary, as in socially articulated economies where the labour force is important both as producers and consumers, or antagonistic, as in socially disarticulated economies where producers have no value as consumers and may therefore be subject to super-exploitation (payment of wages below the cost of subsistence).[29]

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28 As defined by Marx, the socially average wage is the amount of money required to sustain a worker at a specific society's average standard of living, reflecting a historically and socially determined level of subsistence, not merely a bare minimum of survival. See Marx, Capital.

29 Copley and Moraitis argue that while capitalist market relations are underpinned by states, they take on an autonomous, dominating logic that constrains states' agency. More concretely, by reproducing international monetary relations, states inadvertently contribute to the establishment of world labour productivity averages that force them to promote national competitiveness in order to keep pace with world market standards. In place of the notion of the mutual constitution of capital and the state, then, they offer Marx's concept of alienation as a theory of a form of social relations that have escaped the control of the institutions producing them. The challenge of state governance, they argue, is to reconcile the impersonal imperatives of market relations with the creation of a legitimate national political project. While correct as far as it goes, this argument fails to recognize that some (imperial) states are the differential authors of such market relations, imposing such relations on other, weaker states and, by the same token, possessing the capacity to mitigate these adverse impacts of the drive for global competitiveness. Moreover, it is important to remember that subordination to the capitalist market (market dependency) is the product of specific social-property relations generated by the separation of the mass of producers from their means of production. Depending on the configuration of social forces in power, states have the capacity to respond to such market dependency by transforming social property relations in such a way as to reunite producers with the means of production, effectively reversing primitive accumulation. See Jack Copley/Alexis Moraitis, Beyond the Mutual Constitution of States and Markets: On the Governance of Alienation, in: New Political Economy 26 (2021), 490–508.

Proposing a new periodization of international food regimes

The revised ontological basis for understanding food regimes set out above enables us to propose a new periodization of *international* rather than the less meaningful *global* or *world-scale* food regimes. These regimes are defined as follows:

- The First International, or *Liberal* Food Regime, 1846–1870s;
- The Second International, or *Imperial* Food Regime, 1870s–1930s;
- The Third International, or *Political Productivist* Food Regime, 1930s–1980s;
- The Fourth International, or *Neoliberal* Food Regime, 1980s–2010;
- The Fifth International, *Neo-Imperial* Food Regime, 2010–Present.

The justification for and detailed characterization of this periodization has been presented in Tilzey (2018), Tilzey (2019), Tilzey et al. (2023), and Tilzey and Sugden (2023).[30] The characterization of my proposed Third and Fourth International Regimes is not drastically different from Friedmann and McMichael's Second and Third Food Regimes – although in my model, the Neoliberal Regime (McMichael's Corporate Regime) retains a central focus on the state-capital nexus as the provider of the key regulatory environment (including through the World Trade Organization – an organization controlled by states) within which transnational fractions of capital are able to thrive. This being the case, the following sections will focus on further detailing and justifying the first, second, and fifth of our international food regimes – in other words, those regimes which Friedmann and McMichael (including in their later work) do not consider at all or which they characterize quite differently.

The First International, or Liberal Food Regime, 1846–1870s

Agrarian capitalism had been emergent in England since the fifteenth century,[31] but it was not until the late eighteenth and early nineteenth century, following the process of widespread parliamentary enclosure and extirpation of peasant common rights (the expropriation of the means of production from the agrarian producers),[32] that the capitalist mode came to dominate the production of food staples for the population as a whole and a national food regime appeared. The capitalist structure of agricultural production and competitive rental agreements with yeoman tenants enforced increasing yields and productivity to meet the new demand for food staples from a burgeoning proletariat and urban middle class. Agrar-

30 Tilzey, Political Ecology; Tilzey, Food Regimes; Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work; Tilzey/Sugden, Peasants, Capitalism, and Imperialism.

31 Spencer Dimmock, The Origin of Capitalism in England 1400–1600, Chicago 2014; Spencer Dimmock, England's Second Domesday and the Expulsion of the English Peasantry, Leiden 2024.

32 The separation of people from their agrarian means of production as a precondition for capitalism is highlighted here because this is how capitalism first began in England – where the first national (capitalist) food regime, and subsequent international (Liberal) food regime, were initiated. This emphasis does by no means preclude other means of implanting capitalism, however, including by dispossessing indigenous people and granting their land to a class of petty commodity producing family farmers, as in the case of the settler states of Canada, the USA, Australia, and New Zealand. Indeed, the author has detailed these various paths of agrarian transition to capitalism elsewhere (see Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work; Tilzey/Sugden, Peasants, Capitalism, and Imperialism).

ian landlords could see clear opportunities for rent increases, and the accompanying age of agricultural improvements was ushered in after 1750. Agricultural prices remained relatively buoyant with the continued movement of people from rural areas to the cities, but the war with France starting in 1793 saw wheat prices accelerate upwards; they would remain high until the repeal of the Corn Laws in 1846. Thereafter, the progressive introduction of an international 'free trade' regime, with the British hegemon at its centre, led to a gradual decline of arable farming in Britain.[33]

What I choose to term the First or Liberal International Food Regime emerged following the repeal of the British Corn Laws in 1846 and was founded on free trade principles designed to allow the export of competitive British industrial goods to other newly capitalist social formations in return for cheap food staples with minimal hindrance in the form of tariff barriers. This may be identified as the first international food regime founded on the integration of imperial or 'core' states (notably France and what was to become Germany) together with certain 'peripheral' social formations like Argentina as (for the first time) predominantly capitalist economies. This international regime arose because the cost of cereals, the principal item in the proletarian diet, became too high in Britain due to the protectionism of the Corn Laws and the progressive inability of the 'organic' four-course rotation system of the 'first' (capitalist) agricultural revolution to sustain output increases over the course of the mid-nineteenth century.[34] This led to a squeeze on profits, and consequently to pressure by industrial capitalists to source cheaper supplies elsewhere. These pressures could be eased by spatio-temporal fixes in the form of bilaterial trade agreements with complementary class fractional interests overseas, thereby exploiting an extractive frontier where labour power and/or the ecological conditions of production were cheaper. Britain thus began to invoke the free trade doctrine of comparative advantage in the first half of the nineteenth century, whereby wage foods should be sourced from wherever they could be produced at the least cost (initially mainland Europe, then North and South America), consequently affording a competitive boost to Britain's preeminent industrial status.

During the mid-nineteenth century, Britain negotiated a series of bilateral trade agreements, among which the Anglo-French (Cobden-Chevalier) Treaty of 1860 was perhaps the most emblematic; its terms were effectively extended to all states in Europe in seven further treaties concluded during the 1860s.[35] Like its successors, the treaty of 1860 facilitated the entry of more competitive agricultural commodities from certain European states into Britain in return for the reciprocal free entry of British industrial goods. These bilateral treaties effectively represented international coalitions between class fractions whose interests happened to be complementary in the historical conjuncture of the mid-nineteenth century. As it was with French agricultural exporters, so it was with Prussian Junkers in relation to British industrialists. In the first decades of the nineteenth century, Prussian agrarian reforms aimed at stimulating a transition to capitalism, and explicitly emulating Britain, liberalized

33 Tilzey, Political Ecology.

34 Mark Overton, The Agricultural Revolution in England 1550–1850, Cambridge 1996.

35 Nik Koning, The Failure of Agrarian Capitalism: Agrarian Politics in the United Kingdom, Germany, the Netherlands, and the USA 1846–1919, London 1994; Stephen David Krasner, State Power and the Structure of International Trade, in: World Politics 28 (1976), 317–347; Bill Winders, The Vanishing Free Market: The Formation and Spread of the British and US Food Regimes, in: Journal of Agrarian Change 9 (2009), 315–344; Tilzey, Political Ecology.

(de-feudalized) the land market and labour relations, leading to an expansion of estate farms and the conversion of Junkers from feudal lords to capitalist farmers. By subjecting the peasantry to heavy burdens of redemption which it could ill afford, these reforms ultimately led to the large-scale transfer of peasant land to the Junkers. From the 1840s, rising agricultural prices and growing demand for agricultural commodities, especially from new importers such as Britain, encouraged Junkers and large domain tenants to develop their farmland along British lines: They enclosed their fields, introduced rotational leys and new fodder crops, and increased livestock numbers, which in turn improved soil fertility, leading to improved arable yields. Such agricultural 'improvement' enhanced the competitiveness of the estate farms, enabling a further expansion of their area from 6.25 to 7.15 million hectares in Prussia between 1851 and 1861.[36]

In this way, the newly capitalist Junkers and a smaller stratum of upper peasants became competitive grain suppliers in international trade over the course of the mid-nineteenth century. German industrial capitalists, however, had not yet attained parity with their British counterparts. The Junkers were therefore advocates of free trade in agricultural commodities along with the industries supplying agricultural machinery, railways, and other industrial infrastructure necessary for the cheap production and distribution of food. By contrast, German industrial class fractions sought protection against their more competitive counterparts in Britain. The political power of the Junkers – and therefore their interests – still prevailed at the level of the state, however, with the result that Prussia eliminated trade barriers for agriculture and retained only a few duties on imported industrial goods.[37]

Despite Britain's status as economic hegemon, other states in the core of the emergent capitalist international system managed to avoid becoming peripheralized – that is, they evaded the fate of dependent or disarticulated development that would become characteristic of the periphery in the Global South. This was due both to their pre-existent strong military infrastructures as a legacy of absolutism, which could effectively resist any British resort to extra-economic measures to enforce market opening (in contrast to the experiences of China, India, Africa, and Latin America), and to the existence of strong nationally oriented bourgeoisies which were reluctant to see emergent national capitalist production subordinated to the economic requirements of an overseas power. For example, Britain had been militarily repulsed by the USA and was only able to defeat Napoleonic France with the assistance of Prussia.[38]

Such was not the case in the emergent capitalist periphery, however. Marini's theory of unequal exchange is highly relevant to understanding the question of the dialectical relation between underdevelopment in the periphery and development in the imperial states of the core, and simultaneously the perpetuation of the peasantry in the former versus its demise and replacement by capitalist farms in the latter.[39] Marini posits the super-exploitation of

36 Koning, Failure.

37 Ibid.; Winders, Vanishing; Tilzey, Political Ecology.

38 It should be noted, however, that the threat of such peripheralization in Germany was not fully repulsed until the power of the export-oriented Junkers in the state was curbed with unification and the adoption of protectionist policies after 1871.

39 Ruy Mauro Marini, Dialéctica de la Dependencia, Mexico City 1974; Ruy Mauro Marini, Plusvalía extraordinaria y acumulación de capital, in: Cuadernos Políticos 20 (1979), 18–39; Ruy Mauro Marini, The Dialectics of Dependency, New York 2022.

labour as the essential factor in capitalist underdevelopment in the periphery, while at the same time viewing the full development of capitalism in Britain as being based on cheap food imports from Latin America (especially Argentina and Uruguay) together with other social formations in an emergent periphery, which allowed extensive specialization in industry, full proletarianization, and the shift from absolute to relative surplus value.[40] This relation established during the Liberal Food Regime, so Marini's argument goes, provided the unacknowledged foundation for the transition of capitalism in Britain to production dominated by large-scale industry during the middle and latter part of the nineteenth century. Marini's theory thus combines the genesis of export-oriented capitalism in the periphery with the development of industrial capitalism in the core of imperial states.

Marini argues that the international market prices of food commodities and other raw materials were below their value because capitalist producers suppressed the wage levels of their workers to below the value of their labour power. This relation was not a result of the deployment of pre-capitalist means of exploitation, he states, but rather a sign of the generation of a *different* type of capitalism *within* the developing capitalist mode of production as a whole. The unequal exchange that emerged within an apparently free trade relation between the periphery and the imperium was not owed to the export of capital, Marini claims, but rather to an emerging capitalist class in the former that was tied to exports as the principal type of commodity production. International trade in turn induced the capital-wage relation under particular conditions in the post-colonial periphery. This is essentially a relation that de Janvry would later term "socially disarticulated" accumulation, whereby workers can be paid below-subsistence wages since they do not represent consumers for the export-bound commodities they produce.[41]

Marini therefore points out that the periphery exhibits deformations when measured against the capitalism of the core states precisely *because of* the relation of dependency between the former and the latter. In his view, the challenge is to explain the particular form of deformed capitalism that came to characterize Latin America and the wider periphery –

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40 It should be noted here that Marini's emphasis on Latin America's cheap exports as undergirding industrialization in Britain appears to be considerably over-stated. During the Liberal Food Regime, imports of food, especially grains, from Germany, Russia, France, Canada, and Ireland were far more important than those from Latin America. Thus, wheat exports from Argentina, the most important Latin American exporter to Britain, did not assume an important role in British imports until later in the century, during the Imperial Food Regime. Nonetheless, Marini's comments concerning the deformation of export-oriented social formations dominated by large landowners and sustaining dependent, disarticulated development as an augmenting factor in the central shift from absolute to relative surplus value appear relevant in relation to Russia, pre-unification Germany (Prussia), and Ireland especially, major exporters of food to Britain. It is also important to note, in arguing the case for the First for Liberal Food Regime, that imports of wheat (the fundamental staple of working-class diet) to Britain rose steadily after the abolition of the Corn Laws – from less than 10% before abolition to nearly 17% by 1850, to 35% by 1870. (Mette Ejrnaes/Karl Gunner Persson/Soren Rich, Feeding the British: Convergence and Market Efficiency in the Nineteenth-Century Grain Trade, in: The Economic History Review 61 (2008), 140–171.) They then continued on this trajectory, established during the Liberal Food Regime, to reach nearly 80% import dependency by 1914. As Bairoch suggested, starting in 1840–1850, Britain began to depend more and more on foreign countries for its subsistence. (Paul Bairoch, Revolución Industrial y Subdesarrollo, Mexico City 1967.) Again, it should be emphasized that it is the cause of this expansionary trajectory of food imports that is important – that is, the new capitalism – not whether it became a notionally 'world-scale' phenomenon by the 1870s.

41 Alain de Janvry, The Agrarian Question and Reformism in Latin America, Baltimore 1981, 27.

and he considers the key to be the super-exploitation of labour, which he characterizes as follows:

> "The intensification of work, the extension of the working day, and the expropriation of part of the necessary labour for the labourer to replace his labour power configure a way of production founded exclusively in the greater exploitation of the worker, and not in the development of his productive capacity."[42]

Marini argues that these mechanisms signify that labour power is paid under its value through depressed wages, and that they thus correspond to the super-exploitation of labour. Significantly for our understanding of the Liberal Food Regime, Marini places the necessity for the super-exploitation of peripheral labour power in the mid-nineteenth century – *before* the appearance of imperialism as portrayed by Lenin as well as what I term the Imperial Food Regime (see below).[43] The transition in Britain from production dominated by methods of absolute surplus to relative surplus value depended on cheap imports of food and raw materials *in addition to* greater productivity. Marini emphasizes this point as follows:

> "Beyond facilitating quantitative growth, the participation of Latin America in the world market would contribute to the axis of accumulation of the industrial economy displacing from the production of absolute surplus value to relative surplus value, that is to say that the accumulation depended more on the increase in productivity of the worker rather than simply on their exploitation. Nevertheless, the development of Latin American production that allowed the region to aid this qualitative change in the central countries was due fundamentally to greater exploitation of the Latin American worker. It is this contradictory character of Latin American dependency that determines the relations of production in the overall capitalist system […]."[44]

While Marini may have seriously overstated the contribution of Latin America to the development of industrialization in Britain, his model nonetheless appears applicable to other peripheral social formations in the mid-nineteenth century as well – notably Russia, Ireland, and pre-unification Germany (Prussia), all of which were major exporters of food staples to Britain and characterized at the time by highly inegalitarian agrarian landlordism. Germany was subsequently able to escape from peripherality and agrarian landlordism through protectionist policies, unification, and increased militarization, while Ireland did the same by embarking on a programme of comprehensive land reform after a period of sustained social unrest which threatened the stability of the British state.

I have demonstrated above the fundamental importance of the Liberal Food Regime of the mid-nineteenth century, firstly in that it embodies the pristine emergence of capitalism proper on the international stage, and secondly in that it signifies the development of capitalism in the core – especially the appearance of 'socially articulated' capitalism there, accompanied by the

42 Marini, Dialéctica, 48.

43 Vladimir Illich Lenin, Imperialism, the Highest Stage of Capitalism: A Popular Outline, Collected Works, London 1964.

44 Marini, Dialéctica, 23.

development of dependent, deformed, and 'socially disarticulated' capitalism in the periphery. It is therefore all the more remarkable that this period – one that set in motion capitalist, intercontinental trade in food commodities – receives no attention at all in the work of Friedmann and McMichael, for whom international trade in food staples began only in the 1870s.

The historical conjuncture of complementarity between class fractions of the core states during the Liberal Food Regime could be sustained only as long as increased consumption of food commodities could support profitable production. This conjuncture began to unravel in the 1870s as continuing and expanding cheap agricultural production in the periphery and in North America combined with increases in farm productivity to generate an over-production crisis with resulting sharp declines in food commodity prices. This sounded the death knell for larger-scale arable farming in Britain, where the government continued to insist on free trade policies and agriculture increasingly concentrated on livestock and dairy production. Agricultural decline and depression in Britain were not considered by British governments to present overriding problems, however: Given that the majority of the population was now engaged in urban industry, agrarian unrest was largely a thing of the past, the agrarian landlord class had diversified its investment portfolios to include non-agrarian interests, and cheap food for the working classes could be readily imported.

This was not the case, however, in the core states of France and Germany. Here, the agrarian question of the peasantry, and the potential for rural unrest, was still very real. Moreover, agrarian capitalists such as the Prussian Junkers, less able than their British counterparts to diversify investment portfolios into what were still nascent industrial sectors, were unhappy to see their domestic and export markets compromised by cheap imports. Additionally, if capitalist agriculture went into decline in these countries, a refocus on industrial development according to free trade principles was perilous given Britain's competitive pre-eminence as 'workshop of the world.' In response to these threats, agricultural and industrial class fractions now demanded protection from the free market, and tariff rates on food imports began to increase in France and Germany. The ruling classes – increasingly comprising domestic alliances between agricultural and industrial class fractions – now sought to develop more nationally based development strategies that were to establish an articulation between agriculture and industry within the national territory. In the cases of France and Germany, this was to be combined with a formal imperialism in the shape of carving out colonies in the periphery, whose function – apart from demonstrating the prowess of the colonizer in this new era of national competition rather than complementarity – was to supply super-cheap raw materials produced by super-exploited labour in order to subsidize industrial development and the shift to the predominance of relative surplus value production amongst a national 'labour aristocracy.'

The Second International, or Imperial Food Regime, 1870s–1930s

The Imperial Food Regime thus saw the widespread adoption of protectionist rather than free trade policies in core states, and a significant political development was the unification of the German state in 1871. These developments coincided with a commodity over-accumulation

crisis, a cyclical tendency that capital could overcome in two possible ways: first, by moving away from an extensive and quantitative regime of accumulation based on absolute surplus value extraction towards an intensive or qualitative one founded on relative surplus value extraction, implying that the working classes needed to be integrated increasingly into a virtuous circle of enlarged, machine-based production and expanded consumption. This aligned well with sectoral articulation and new nationhood (social articulation), so that both accumulation and legitimation needs could be fulfilled in the states of the core. The second means of mitigating over-accumulation lay in supplementing and underwriting qualitative growth by importing super-cheap primary commodities from the periphery (primary means) as well as securing captive markets, in part by destroying local production in those regions (secondary means). Under conditions of rival rather than complementary capitalisms, these means were secured through imperialism. Competitive, protectionist, and nationalist economies, bolstered by racialized ideologies of 'social imperialism', generated an underlying dynamic of mutual aggression that would eventually erupt in the First World War.

Thus, the Imperial Food Regime is defined by the paradoxical reversal in the relation between trade and national development in the core states, away from free trade and towards protectionism – a trend most noticeable in states such as France and Germany, as well as the newly capitalist state of Japan, that could be described as 'late developers.' They now viewed the competitive advantage of Britain in industry and the USA in agriculture as inimical to their own capitalist development and political stability. As we have seen, the preceding Liberal Food Regime had been characterized by a de facto British industrial monopoly in the international arena, with the norm within it being one of assured profits through competition between small and medium-sized enterprises. In stark contrast, the post-liberal or imperial era was characterized by international competition between Britain and the now rival capitalist industrial economies of Germany and the USA in particular.[45] This competition was heightened by the difficulties in realizing sufficient profits for reproduction now faced by capitalist enterprises under conditions of relative depression. In this way, capitalism – embodied in the geopolitical strategies of the core states – entered a period of formal imperialism as understood in the way described by Lenin:[46] that is, in the broad sense of capitalism as now characterized by 'monopoly capitalism', along with the narrower sense of the new and formal integration (colonization) of the periphery as dependencies of the core states – and, as a corollary of this, as competition between these core states.[47]

I suggest, following Lenin, that the major rationale for the adoption of imperialism by the core states after the 1870s was monopolistic control of the sources, and the production through super-exploited labour, of raw materials for subsequent manufacture in the respective imperium.[48] This goal could be met most effectively by means of territorial conquest. The same rationale continues in the neo-imperialism of today (see below) but is complemented, crucially, by the unprecedented relocation of manufacturing itself from the core to selected regions of the periphery, representing an essential investment outlet for imperial capital in

45 Koning, Failure.
46 Lenin, Imperialism.
47 Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.
48 Lenin, Imperialism.

accordance with Lenin's theory.[49] Since it was a necessary factor in counteracting the over-accumulation crisis of the core, Lenin saw the export of capital as generating severe rivalry amongst the imperial states as they strove for access to, and control over, the periphery. He thus perceived a diffusion of capitalism to the periphery and, relatedly, a homogenization of this mode of production between the core and the periphery. In the latter respect, however, Lenin seems to have been incorrect, since he failed to appreciate the dependent and deformed nature of 'development' based on systems of super-exploitation of people and nature that was, and continues to be, characteristic of peripheral subordination to the imperium.

Unlike Lenin, Wolf points to the role of social imperialism in propelling imperialism/colonialism, in effect by fulfilling a legitimacy function of the imperial state.[50] This is a motivation that strives to unify people at home by displacing internal conflicts onto an external enemy, with tangible gains accruing to members of supposed 'master races' from the domination of multitudes of purportedly 'inferior races.'[51] "The spread of imperialism and the extension of outright colonial rule thus appear to be the result of a more complex interplay of social constellations than was allowed for in Lenin's explanation."[52] Aligning with the thinking developed in this paper, Wolf also points to the advantages of conjoining the theories of Lenin and Trotsky:

> "When Lenin characterized Russia as the 'weakest link' in the chain of capitalist domination, he implicitly raised the question of what made some links stronger and others weaker. Trotsky, who attempted an answer, argued that this variability was produced by 'uneven and combined development' – 'uneven' because capitalism encountered extremely diverse conditions produced by uneven development in the past, and 'combined' because capitalism had to combine with these uneven conditions in the very act of permeating them. This answer granted a measure of influence to pre-existing capitalist modes, and recognized that the way capitalism worked depended on this influence. Yet Trotsky still defined capitalism as uniform in its 'law of motion', and therefore uniform in its effects. What, however, if the capitalist mode generated variability and differentiation not only through its combination with other modes but also in the very course of its own operations?"[53]

This quote strongly anticipates our own proposal to reverse Trotsky's terms to produce 'combined and uneven development', meaning that the operation of the capitalist mode in combining actually generates 'uneven' development[54] – for example, through the attempt to perpetuate forms of non-capitalist production underpinning the super-exploitation of peripheral labour forces, even as it takes place *within* the capitalist mode of production.

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49 Tilzey, Political Ecology.

50 Wolf, Europe.

51 If this sounds familiar, it is because we are currently experiencing something very similar in the neo-imperial and ultra-nationalist conjuncture, and for very much the same reasons. Despite inter-imperialist and anti-fascist wars and the loss of untold millions of lives over the last century or more, current trends suggest that we have learnt nothing from history.

52 Wolf, Europe, 302.

53 Ibid., 303.

54 Tilzey, Political Ecology; Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.

The appearance of this combined and uneven development during the Imperial Food Regime had the effect of further entrenching highly inegalitarian and racialized systems of disarticulated accumulation and primary resource extraction, whereby the function of formal colonies and informal dependencies (such as the ostensibly independent Latin American states) alike "was to complement the metropolitan economies and not to compete with them."[55] It must be emphasized again that the capitalism and inter-state relations underlying the Imperial Food Regime were very different from those which had been dominant until the 1870s. Contra the assertions of Friedmann and McMichael, these relations now comprised a plurality of rival national economies 'protecting' themselves against each other.[56] With the breakdown of trade between complementary international class fractions that had typified the liberal era in conformity with the Ricardian ideology of comparative advantage, the need to secure access to key resources under the new conditions of relative depression and the new protectionism seems to have become the key factor driving imperial ambition.[57]

Rather than viewing imperialism simply as an expression of the contradictions of capital accumulation in its new monopoly phase, however, in accordance with our conception of the state-capital nexus, we likewise need to direct our attention to the geopolitical and legitimation dimensions of the capitalist state. As we have seen in reference to Wolf's work, imperialism was also an important means of defusing social tensions within the states of the core. The rise of labour movements that characterized the newly proletarianized and increasingly enfranchised working classes in Europe and North America generated political contradictions for the state-capital nexus which could be ameliorated only partially by means of productivity-related wage increases, important though they were.[58] Ideological incorporation into the nation-state as citizens was equally important – and here imperialism, as social imperialism, could act as a crucial augmenting factor. With the rise of large labour movements and democratic politics, social imperialism – understood as the attempt to use imperial expansion to diminish domestic discontent by economic improvements, social reform, or denigration of other nationalities, races, or ethnic groups to justify their super-exploitation or underpin their casting as scapegoats for capitalism's own ills – became essential for sustaining concord at home. As Hobsbawm has suggested:

> "More generally, imperialism encouraged the masses, and especially the discontented, to identify themselves with the imperial state and nation, and thus unconsciously to endow the social and political system represented by that state with justification and legitimacy."[59]

It is therefore incorrect to suggest, as do Friedmann and McMichael, that mainland Europe was subordinated to a continuing free trade regime from the 1870s onwards.[60] Rather, it was

55 Eric Hobsbawm, The Age of Empire, 1875–1914, London 1987, 65.
56 Friedmann/McMichael, Agriculture.
57 Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.
58 Tilzey, Political Ecology.
59 Hobsbawm, Age, 70.
60 Friedmann/McMichael, Agriculture. Friedmann and McMichael place great emphasis upon the supposed role of 'settler states' – USA, Canada, Australia, New Zealand – in facilitating the development of capitalism in Europe through the export of cheap staples within the context of free trade. While this is true of Britain, it was

only Britain, for reasons unique to its early industrializing experience, that continued with a relatively free trade regime during the imperial era (what I refer to as the Imperial Food Regime) – and this primarily in relation to its colonies and economic dependencies such as Argentina and Uruguay. The principal states of Europe, notably France and Germany, pursued very different agricultural policies best characterized as protectionism rather than free trade.[61] As suggested above, the key dynamics in this process arose from shifting relations between class and class fractional interests within and between the core capitalist states. Where the interests of the major class fractions in each state had been complementary during the Liberal Food Regime, they now became progressively more antagonistic in the Imperial Food Regime. Thus, in the case of Germany – which, as indicated, was a major supplier of wheat to Britain during the mid-nineteenth century – the turn of the latter towards the USA and elsewhere as the cheapest producers of grain had progressively deeper adverse impacts on the incomes of the Prussian Junker capitalists. With foreign sources of income increasingly blocked by cheaper competition, the Junkers began to see a confluence of interest with the nascent industrial bourgeoisies through policies of sectorally and socially articulated and protected national development. The German industrial-capitalist class fraction likewise saw its national, let alone international, expansion thwarted by Britain's predominant industrial prowess, which was now further buoyed by cheap food imports from North and South America and elsewhere.

Meanwhile in Germany, agricultural crisis arising from the capitalization of agriculture and the growing imports of cheaper food staples was generating an ever larger 'surplus' rural population, with the prospect of serious social unrest becoming a progressively more urgent danger to the ruling classes despite the safety valve of emigration. The solution to these concomitant accumulation and legitimation crises was increasingly seen in protectionism, with articulated development affording the means to both absorb labour and augment the power of the nation-state. The state, aided by the process of national unification, assisted the establishment of industrial monopolies, while social unrest could now be dampened through

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not at all true of states such as Germany and France. The reason why we pay relatively less attention to these semi-peripheral settler states compared to states such as Germany during the Imperial Food Regime is therefore to point out Friedmann and McMichael's errors in asserting that: a) this period was a 'free trade' era (it was free trade in food only for Britain); and b) that the settler states were pivotal to the development of capitalism in mainland Europe. This period represented a reaction to free trade in the major states of mainland Europe, with protectionist policies being pivotal in enabling national capitalist development. States like Germany and France sought to stimulate their own national agricultures in articulation with nascent industry against cheap food imports from settler states. This is completely ignored by Friedmann and McMichael and shows, in contrast to their position, the importance of states and nationalism in the dynamics of capitalism. This is by no means to deny the importance of settler states for the British food system during the Imperial Food Regime – Britain continued to pursue a more or less free trade regime in food during this period, and much of this food came from the settler states. Lands expropriated from indigenous people in these settler states could usefully absorb small family farmers surplus to requirements in the UK and Europe, but on the condition that these new petty commodity producers were market-dependent while the industries of the settler states remained largely subordinate to British capital (less so in the case of the USA). The model of 'articulated' national development for these states did not really come to fruition until the Keynesian era (Third International Food Regime). See Koning, Failure; Tilzey, Political Ecology; Tilzey, Food Regimes; Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.

61 Koning, Failure; Marcel Mazoyer/Laurence Roudart, A History of World Agriculture from the Neolithic to the Current Crisis, London 2006.

wage increases in line with productivity enhancements – and social divisions ideologically papered over by means of social imperialism. In Germany as well as in France, which pursued similar policies, significant measures were thus introduced to protect national cereal, meat, and dairy production.[62] This trend was accompanied by a new support for the creation and perpetuation of a class of small commercial farmers over larger capitalist producers, stimulating a 'farmer path' to national developmentalism rather than the 'Junker path' associated with an emphasis on export orientation.[63]

The Imperial Food Regime consequently saw states such as Germany and France renewing efforts to increase productivity of the nation's land, often inspired by anxiety regarding food security. Now that large farms, under conditions of depressed food prices, were in many cases failing to intensify production, intensive land use by small farms assumed a new importance. Of even greater significance were fears that a rural exodus would exacerbate the social disruption engendered by the overall crisis of factory capitalism during this period.[64] These fears triggered a search for means to stem the flight from the land. Since falling output prices made large farms save on labour, small farms and allotments were embraced as a way of keeping people bound to the soil. In this way, land reform measures were advocated by urban liberals and even wealthy rural classes to counter the exodus of farm labour and sustain farm rents as well as the intensification of land use. This contributed to the political desire to create a class of small proprietors as a line of defence against radical socialism, and with it the spectre of the expropriation of private property.[65]

Therefore, agricultural protection was introduced in Germany in the 1880s under Bismarck, moderated in the 1890s, and returned to its former level after the turn of the century. Protectionist farm policy was demanded by a united front of landlords and peasants (now small commercial enterprises) and endorsed by powerful circles in industry and government. These interest groups hoped that farm prosperity would sustain the domestic market, curb a potentially disruptive process of urbanization, secure food security, and make the peasantry a loyal bulwark of the state. Despite increasing industrial exports, the home market remained vitally important for German manufacturers. Furthermore, several enterprises reliant on sales of farm inputs or the processing of agricultural products were prominent in the Central Union of German Manufacturers; they advocated strongly for a rise in agricultural tariffs. These arguments were supported by renowned economists in the Economic Commission established by Chancellor Bülow in 1900 to examine the case for tariff increases. Supported by agri-industrial interests, these economists emphasized the importance of agriculture for the home market as well as for social harmony and food security while stressing the risks of an exclusive focus on industrialization. Consequently, and capturing the essence of the Imperial Food Regime, Bülow's tariff act was passed in 1902.[66]

Thus the Imperial Food Regime, in marked contrast to the laissez-faire of the preceding Liberal Food Regime, saw the introduction of protectionism – especially in France and Germany – tied to calls for land reform to counter the exodus of farm labour and the creation of

62 Mazoyer/Roudart, History.
63 Koning, Failure; Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.
64 Koning, Failure.
65 Ibid.
66 Ibid.; Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.

a class of owner-occupying small proprietors as a bastion against any drift towards socialism. In most European countries that had undergone full capitalist transition, located primarily in the west and north of the continent, farm income support had "become necessary to keep investments in agriculture paying".[67] Britain, however, continued to refrain from such support, retaining its free trade orientation. The proposed introduction of tariffs on agricultural imports by certain agrarian interests during the first decade of the twentieth century was opposed by finance capital, a large segment of industry, and by Britain's large proletariat, all of whom were concerned with keeping food as cheap as possible. The result for British agriculture was prolonged stagnation lasting the next thirty years or so. Unlike other Western European states, which had transitioned to capitalism much more recently and still retained substantial farming populations, Britain was less dependent on the purchasing power of domestic farm incomes – and thanks to the Empire and economic dependencies, it could rely on food imports without compromising food security. In Germany, by contrast, protectionist policy was demanded by a united front of capitalist Junkers and smaller, formerly peasant proprietors. While opposed by commerce, the urban middle class, and urban labour, the combined economic, political, and numerical strength of these classes was lower than in Britain, and they did not find support amongst influential sectors of industry or the government. As noted earlier, farm incomes in Germany were much more important markets for industry than in Britain. In addition, Germany was still geopolitically weaker and more vulnerable than Britain, heightening the importance of domestic agriculture for national food security.[68]

This imperial conjuncture and its anti-liberal sentiments spawned a characteristic ideology of agrarian fundamentalism or populism featuring distinct similarities with the anti-neoliberal and nationalistic movements of today. There were fears that continued rural exodus would engender disequilibrium between agricultural and industrial growth, leading to perilous international dependencies. A wise state would therefore nurture its national agriculture, shielding it from the adverse impacts of free trade and ensuring egalitarian farm structures to retain people in rural areas rather than subordinating everything to the quest for capital accumulation. If necessary, the state should support farm incomes for the purposes of balanced development and social stability. Such beliefs were very strong during the Imperial Food Regime, criticizing orthodox economic liberalism ('Manchesterism') and overlapping noticeably with populist characteristics of ethnocentrism, racism, and nationalism.[69] The competitive, protectionist, and nationalistic economies of this era, bolstered by racialized ideologies of social imperialism, fomented an underlying dynamic of mutual aggression that was to erupt eventually in the First World War. In its aftermath, Germany was effectively destroyed in the short term as a competitor capitalist nation, and a temporary trend away from autocentrism and towards liberalism took hold in the 1920s – until over-accumulation struck again with a vengeance towards the end of the decade, resulting in the Great Depression. This stimulated a return to autocentrism and protectionism during the 1930s in the form of what I have chosen to term the Third International, or Political Productivist Food Regime.[70] This represented a twofold response to the contradictions of the renewed free trade

67 Koning, Failure, 168.
68 Ibid.
69 Ibid.; Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.
70 Tilzey, Political Ecology; Tilzey/Sugden/Seddon, Peasants, Capitalism, and the Work.

interlude of the 1920s: a more market-interventionist stance that could take the form of social democracy (left-wing populism), archetypically displayed in the New Deal policies of the USA, or of right-wing populism, as exemplified by the rise of fascism – notably in Germany and Italy, though also present in many other interwar capitalist states. An important feature of national populisms on both the left and right was (and continues to be, in their current iterations) their continued subordination to capital accumulation despite attempts by both wings to mould its dynamic towards nation-centred legitimation functions.

Final comments: Imperialism resurgent in the Neo-Imperial Food Regime

The world appears to be increasingly embroiled in a conjuncture characterized by a return to heightened inter-state competition and antagonism reminiscent of the Imperial Food Regime. The consensus of the Neoliberal Food Regime that the functioning of the 'soft power' of the market – ostensibly according to the law of comparative advantage – is the optimum means of securing cheap food, energy, raw materials, and employment/affluence for the populations of the Global North appears to be fragmenting. Austerity policies and the migration of labour-intensive manufacturing from the imperium to the periphery under the globalist neoliberal regime have generated considerable social unrest and increasing economic inequality in the core states – though the latter are obviously nothing compared to the precarity endured by the global majority of the South under conditions of disarticulated development. While social democratic left-wing populism is one recurring response, social and economic discontent with neoliberalism is now also being widely captured, as in the 1930s, by a resurgent political right eager to scapegoat recipients of imperial capital and manufacturing – notably China – as one of the primary causes of the imperium's relative decline. The adverse social and ecological impacts of neoliberal globalization on the livelihoods of the precariat in the Global South results in its large-scale displacement in search of employment, or simply as refugees – ironically to the Global North, the source of its impoverishment. The resulting waves of migration from South to North are themselves portrayed by the right as one of the principal causes of economic decline and unemployment in the imperium. At the same time, any effort to address the severe ecological impacts (including climate breakdown) of imperial capitalism is viewed as a cause of unemployment by constraining growth – or more extremely, in the case of the right's ideological 'pushback', the impacts themselves are denied in order to facilitate unbridled resource extraction, especially of fossil fuels.

The contradictions of neoliberal capitalism today are therefore on a far larger scale and more intense than in the 1920s/30s, and moreover have a potentially perilous and unprecedented ecological dimension. Since the beginning of the new millennium, these contradictions have been manifested in three main ways: in terms of capital accumulation, whereby greatly increased wealth disparities in the Global North – especially in the more doctrinaire neoliberal Anglo-Saxon countries such as the USA and the UK – have generated a crisis of commodity under-consumption (over-accumulation), with the financial crisis of 2007 symptomatic of this tendency; relatedly, in terms of greatly increased precarity for the global majority located especially in the Global South, where the resurgence of disarticulated and export-

oriented accumulation by economic elites has generated heightened processes of primitive accumulation and accumulation by dispossession, especially of peasant and indigenous producers, thus creating a huge precariat unable to access even basic necessities. The 2008 food crisis was symptomatic of this trend. The final aspect, as noted, is that of unprecedented and accelerating deterioration in the biophysical fabric of the planet, compromising its continued ability to supply renewable ecosystem services to, and absorb waste from, an ever more profligate capitalism. Climate breakdown, massive loss of biodiversity, and alarming declines in the quality and quantity of soil and water resources are symptomatic of this development.

In order to manage and mitigate these contradictions – but not to resolve them, since that would require the supersession of capitalism itself – states re-emerged from the shadows they had been lurking in during the neoliberal era to once again assume more interventionist roles in seeking to fulfil both accumulation and legitimation functions for the state-capital nexus. As suggested, this movement against market liberalism has tended to assume two forms of national populism – the left-wing populism of social democracy and the right-wing populism of proto-fascism or full-blown fascism. These roles and forms are manifested in a number of ways which, though straddling the global North–South divide, are differentiated according to imperium and periphery. Mercantilism,[71] including the deployment of extra-economic means, is used to secure food, energy, and raw materials for the imperium and the sub-imperium (especially China), wherein land-grabbing and extractivism for energy, raw materials, and plantation crops such as soy have very much become features of the Neo-Imperial Regime. Mercantilism tends to be preferred by left-wing populist imperial regimes, while extra-economic (including military) options are more likely to be deployed by right-wing populist imperial states. Imperial and sub-imperial mercantilism is complemented by a

71 Some may consider the role of mercantilism in the Neo-Imperial Regime to be overstated here. To justify its usage, it is perhaps useful to clarify how we understand the term. Mercantilism entails overt intervention in a nation's economy in order to augment and bolster state power (the state-capital nexus) at the expense of rival powers. High tariffs – particularly on manufactured goods – have historically been a characteristic of mercantilism, and they have made a symptomatic comeback under the current US Trump administration. Mercantilism therefore operates principally through commercial channels, although it does not exclude the use of extra-economic mechanisms (including military compulsion) to reinforce economic interventions. Mercantilism reflects the increased visibility of the role of (imperial) states in serving the interests of 'their' capitalists and, purportedly, of their citizens, regardless of whether this role and the related actions are economic or extra-economic. This (imperialist) activism of states in support of 'their' capitalists gives the lie to the globalist notion that capitalism has transcended the (imperialist) state – or, at a minimum, that it does not require imperialist states to police the world to further its ends. In today's conjuncture of undeniable inter-imperialist rivalry, globalist assumptions that real power has somehow shifted from states to institutions such as the WTO is clearly absurd. It is therefore a mistake to assume that mercantilism involves de-commercialisation; rather, it describes the (imperialist) state manipulation of supply and demand conditions – principally by economic means (e.g. tariffs), but also through extra-economic mechanisms. Perhaps the most important question for characterizing the current moment is that the US state-capital nexus is no longer willing to play by the rules of globalist free trade (if it ever was, since it always manipulated these rules to serve its own ends) and will no longer allow mere comparative advantage to determine the ability of US corporations to dominate any field that they choose. The current conjuncture foregrounds the logic of the imperial state-capital nexus that was always present but rendered temporarily invisible when 'free trade' appeared the best option to serve the capitalist interests of the global hegemon. When the power of the hegemon is threatened by economic rules that no longer serve its purpose, however, politics always 'trumps' economics. The pushback against neoliberalism has been building for some time, but the Trumpian introduction of tariffs perhaps marks the apotheosis of mercantilism in the Neo-Imperial Food Regime.

tendency towards protectionism with regard to domestic agriculture and manufacturing, with the USA, the EU, and China being characteristic in this context. In the periphery, left-wing populism is exemplified by the 'pink tide' states of Latin America, where neo-developmentalist and redistributive policies have been adopted in response to neoliberal contradictions. The revenues these policies depend on, however, the perpetuation and reinforcement of primary resource extractivism, including agro-extractivism, to serve the consumption demands of the imperium and sub-imperium. These regimes therefore remain trapped in the stranglehold of peripheral dependency and deformed development. Right-wing populism in the Global South, exemplified by the regimes of Bolsonaro (Brazil) and Milei (Argentina), simply represents an acceleration of resource extractivism by imperial, sub-imperial, and domestic oligarchic capital, with rhetorical claims concerning the distribution of the benefits of such growth amongst the people having very little substance in reality. The legacy of such rightist regimes is proving to be one of even greater poverty and precarity for the majority, abject dependence on the imperium, and degraded ecosystems whose capacity to support alternative and sustainable agroecological development is seriously compromised.

In the post-neoliberal era, capitalism is again overtly exhibiting its dependence on, and intimate relation to, the state as the state-capital nexus. We have entered a perilous era of heightened inter-state competition and antagonism reminiscent of the Imperial Food Regime, and it is therefore one justly deserving of the title 'Neo-Imperial Food Regime.' As it encounters ever deeper crises defined by spiralling ecological and political turmoil, we can only speculate as to whether this regime may mark the endgame of capitalism.

Ernst Langthaler

From the Anthropocene to the Soyacene

Writing Planetary History through a Commodity Lens

Abstract: This essay addresses a twofold aim: On the one hand, it outlines a research agenda for planetary commodity history, arguing that a commodity lens enables the theoretical claims of planetary history to be put into historiographical practice. In this regard, historians should strive to trace the planetary footprint of a commodity's more-than-human actor network comprising the deepening and widening of commodity chains and their flexible combinations across multiple times and spaces. Soy serves as a key commodity of agro-food globalization in the long twentieth century. Against this backdrop, the universalist notion of the Anthropocene might be specified by the concepts of the Capitalocene or Soyacene. On the other hand, this essay presents a case study of planetary commodity history with a focus on the Brazilian state of Mato Grosso in the Anthropocene since the sixteenth century in general, and in the Soyacene since the late twentieth century in particular. It outlines the widening of soy's planetary footprint with regard to deforestation and global warming, as well as its deepening in terms of herbicide contamination and planetary health. Mato Grosso as a soy hotspot not only reveals the socio-natural dynamics of commodity frontiers but also highlights the transregional incorporation of this region into nation-state and global market dynamics via hierarchical commodity chains and other types of asymmetrical connections. Moreover, this case study provides evidence for a regionally grounded periodization of the Anthropocene.

Zusammenfassung: Dieser Essay verfolgt eine zweifache Zielsetzung: Zum einen entwirft er eine Forschungsagenda für eine planetare Warengeschichte. Dabei wird argumentiert, dass eine warenzentrierte Perspektive es ermöglicht, die theoretischen Prämissen der planetaren Geschichte in historiographische Praxis zu überführen. In diesem Zusammenhang sollten Historiker*innen den planetaren Fußabdruck des mehr-als-menschlichen Akteursnetzwerks einer Ware nachzeichnen – unter Berücksichtigung der Vertiefung und Ausweitung von Warenketten sowie ihrer flexiblen Kombinationen in verschiedenen Zeiten und Räumen. Soja fungiert dabei als Leitware der Globalisierung von Landwirtschaft und Ernährung im „langen zwanzigsten Jahrhundert". Vor diesem Hintergrund lässt sich der universalistische Begriff des Anthropozäns zu dem des Kapitalozäns oder gar des Sojazäns präzisieren. Zum anderen präsentiert der Essay eine Fallstudie planetarer Warengeschichte am Beispiel des brasilianischen Bundesstaates Mato Grosso im Anthropozän seit dem sechzehnten Jahrhundert im Allgemeinen bzw. im Sojazän seit dem späten zwanzigsten Jahrhundert im Besonderen. Dabei wird untersucht, wie sich der planetare Fußabdruck von Soja in Bezug auf Entwaldung und globale Erwärmung ausweitet und im Zusammenhang mit Herbizidbelastung und der planetaren Gesundheit vertieft. Als Soja-Hotspot offenbart Mato Grosso nicht nur die sozio-ökologischen Dynamiken von Warenfronten, sondern verdeutlicht auch die transregionale Einbindung dieser Region in

DOI: 10.25365/rhy-2025-3

Ernst Langthaler, Department of Economic, Social and Environmental History, Johannes Kepler University Linz, Altenbergerstraße 69, 4040 Linz, Austria, and Institute of Rural History, Kulturbezirk, 4, 3109 St. Pölten, Austria, ernst.langthaler@jku.at

nationalstaatliche und globale Marktdynamiken über hierarchische Warenketten und andere Formen asymmetrischer Verflechtungen. Nicht zuletzt liefert diese Fallstudie Belege für eine regional verankerte Periodisierung des Anthropozäns.

Keywords: Anthropocene, soy, Brazil, Mato Grosso, deforestation, contamination

The "shock of the Anthropocene" poses fundamental challenges for history, potentially initiating a planetary turn of historical thought. It questions the constitutive difference between human and natural history, which has legitimized their existence as separate disciplines since the onset of modern scientific thought.[1] According to the foundational myth, the term 'Anthropocene' was spontaneously invented by chemist Paul Crutzen at a conference in 2000. It soon entered the domains of the social sciences and humanities in general and of history in particular. While environmental historians such as John McNeill have picked up the concept in their empirical work,[2] Dipesh Chakrabarty's interventions have been decisive in fuelling the theoretical debate.[3] Accordingly, whereas conventional history rests on the modern dichotomy of humanity and the rest of nature, the history of the Anthropocene as a new epoch of the Earth system – with the human species representing a planetary force – must reintegrate these two domains.[4]

However, the planetary turn seems trapped in the fragmentation between theoretical claims and empirical research. This essay aims to bridge this gap based on the conviction that theory is a tool for historiographical practice rather than a means in itself. It argues that a commodity lens can help to reduce the overwhelming complexity of the planetary turn and operationalize its theoretical claims in empirical research. Moreover, it guides well-grounded stories that add complexity to simplistic notions of grand narratives of the Anthropocene. Soy – meaning the domesticated soybean (*Glycine max*) and its ramified product tree – is employed as a lens for doing planetary commodity history. A regional case study on the Brazilian state of Mato Grosso illustrates how this research agenda might be operationalized.[5]

Planetary commodity history: A research agenda

Bridging theoretical reasoning and empirical research

The debate on the history of the Anthropocene has recently gained comprehensive theoretical reasoning. Most importantly, Chakrabarty's *Four Theses* propose overcoming "global"

1 Christophe Bonneuil/Jean-Baptiste Fressoz, The Shock of the Anthropocene: The Earth, History, and Us, London/New York 2016.

2 John McNeill/Peter Engelke, The Great Acceleration: An Environmental History of the Anthropocene since 1945, Cambridge 2016.

3 Helmuth Trischler, The Anthropocene: A Challenge for the History of Science, Technology, and the Environment, in: NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin 24/3 (2016), 309–335.

4 Dipesh Chakrabarty, The Climate of History: Four Theses, in: Critical Inquiry 35 (2009), 197–222; Dipesh Chakrabarty, The Climate of History in a Planetary Age, Chicago 2021.

5 The first, theoretical part of this essay is an edited version of Ernst Langthaler, Writing Planetary History Through a Commodity Lens, in: Anna-Lena Eick/Achim Landwehr/Tom Vanassche (eds.), Geschichte/n schreiben im Anthropozän, Göttingen 2026, 105–121. The second, empirical part is based on original research.

with "planetary" historical thinking. The first thesis is the most fundamental, arguing that "anthropogenic explanations of climate change spell the collapse of the humanist distinction between natural history and human history."[6] The second thesis claims that "the idea of the Anthropocene, the new geological epoch when humans exist as a geological force, severely qualifies humanist histories of modernity/globalization."[7] It criticizes the hegemonic paradigm of global history, emphasizing the transformation of the human-made world through capitalist globalization since the onset of colonialism around 1500. This negative definition is complemented by the positive one of the third thesis, which states that "the geological hypothesis regarding the Anthropocene requires us to put global histories of capital in conversation with the species history of humans."[8] These two definitions are synthesized by the fourth thesis, which concludes that "the crosshatching of species history and the history of capital is a process of probing the limits of historical understanding."[9] In sum, Chakrabarty argues that a post-anthropocentric history must overcome the anthropocentric dichotomy between the human sphere and the rest of nature, re-integrating these two domains within a planetary perspective of the Earth system that includes the human species as a geological force. Rather than further developing dominant paradigms, this manifesto calls for a paradigm shift in historical thinking: the fusion of human and natural history into planetary history. It remains open how to translate this "well-nigh impossible" theoretical claim into historiographical practice, however.[10]

Beyond the discipline of history, the interdisciplinary field of Earth system science (ESS) stresses historical arguments in data-based analyses of interactions between planetary spheres (atmosphere, hydrosphere, lithosphere, etc.), including the impact of human societies.[11] These approaches mainly relate to the periodization of the Anthropocene: Did this latest geological epoch begin with the European colonization of the "New World" around 1500, the massive burning of fossil fuels during the British Industrial Revolution around 1800, or the use of nuclear energy in the Global North around 1950? A widely acknowledged turning point is the so-called Great Acceleration beginning around 1950, which suggests a human-driven transformation of the Earth system. Accordingly, shifts in socioeconomic trends (population size, petroleum use, fertilizer application, etc.) as well as socioecological trends (surface temperature, carbon dioxide concentration, biodiversity loss, etc.) during the mid-twentieth century indicate a human-driven deviation of the Earth system from Holocene variability. Although a seminal paper identifies factors such as the US-led economic order and the breakthrough of fossil-based technologies,[12] most accounts in ESS build their historical arguments on simplistic descriptions of causally interlinked trends rather than on complex explanations of planetary transformations. A telling example of the integration of social sciences and humanities into ESS and their simultaneous subordination to natural-science hegemony is

6 Chakrabarty, Four Theses, 201.
7 Ibid., 207.
8 Ibid., 212.
9 Ibid., 220.
10 Julia Adeney Thomas/Mark Williams/Jan Zalasiewicz, The Anthropocene: A Multidisciplinary Approach, Cambridge 2020, 130–134.
11 Thomas/Williams/Zalasiewicz, Anthropocene.
12 Will Steffen et al., The Anthropocene: Conceptual and Historical Perspectives, in: Philosophical Transactions. Series A: Mathematical, Physical, and Engineering Sciences 369/1938 (2011), 842–867, 849–852.

the latest model of the Earth system, which extends the former model to include the "anthroposphere" (energy systems, knowledge, science and technology, political economy, etc.).[13]

It seems that the planetary turn in history has got stuck halfway, so to speak: On the one hand, theoretical reasoning by historians is often detached from data-based research on Earth system trends. On the other hand, data-rich empirical analyses by ESS often lack comprehensive explanations of historical dynamics in the human sphere and its interactions with non-human spheres. Planetary history therefore faces the challenge of bridging the gap between theoretical reasoning and empirical research, as well as the one between the natural sciences and the social sciences and humanities. Within multi- and interdisciplinary collaborations, planetary history would assume the role of answering why-questions with fully-fledged explanations linking structural forces and (non-)human forms of agency within the Earth system.[14]

Planetarizing the historical and historicizing the planetary

Taking the planetary turn seriously means considering the Earth system as a whole, including the human species. According to actor-network theory (ANT), the Earth system and its elements are conceived as non-human actors – or "actants" – related to human actors within more-than-human networks.[15] One does not need to be invested in ANT to recognize more-than-human relationships as historical research topics.[16] Planetary history regards not only animals, plants, and inanimate things but also the entire Earth and its parts as actors with agency. Accordingly, the Earth as a differentiated, dynamic, and contingent geopower ("planetary multiplicity") as well as human responses to planetary challenges and opportunities ("Earthly multitudes") come into focus.[17] History consequently extends its scope from anthropocentric notions of the global and sustainable to post-anthropocentric notions of the planetary and habitable.[18] History in a planetary sense would replace the modern dichotomy of culture and nature (the former as active subject, the latter as passive object) with the co-evolution (and eventually co-transformation) of human and non-human – in effect, *hybrid* – actors within the Earth system.[19] The notion of Earth system agency in history does not eclipse (non-)intentional forms of human agency, but instead complements them in complex ways.[20]

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13 Will Steffen et al., The Emergence and Evolution of Earth System Science, in: Nature Reviews Earth & Environment 1/1 (2020), 54–63.

14 Sandra Maß, Zukünftige Vergangenheiten: Geschichte schreiben im Anthropozän, Göttingen 2024, 176.

15 Bruno Latour, Reassembling the Social: An Introduction to Actor-Network-Theory, Oxford 2007.

16 Maß, Vergangenheiten, 113.

17 Nigel Clark/Bronislaw Szerszynski, Planetary Social Thought: The Anthropocene Challenge to the Social Sciences, Cambridge 2021, 8–9.

18 Chakrabarty, Four Theses, 213.

19 Christophe Bonneuil, Der Historiker und der Planet: Planetaritätsregimes an der Schnittstelle von Welt-Ökologien, ökologischen Reflexivitäten und Geo-Mächten, in: Frank Adloff/Sighard Neckel (eds.), Gesellschaftstheorie im Anthropozän, Frankfurt am Main/New York 2023, 55–92, 75.

20 Zoltán Boldizsár Simon/Julia Adeney Thomas, Earth System Science, Anthropocene Historiography, and Three Forms of Human Agency, in: Isis 113/2 (2022), 396–406.

A planetary understanding of history, as outlined before, is only one side of the coin; the other side is the critique of the Anthropocene concept for reintroducing the universalist figure of the *anthropos*, which social sciences and humanities have already dismissed, to highlight human particularities. Accordingly, conceiving humans as an undifferentiated whole – as a species among others – levels out the multiple differences between social groups with regard to class, gender, race, age, religion, and other social contrasts, as well as between the world regions of the Global North and South.[21] This argument is particularly relevant to the debate on the periodization of the Anthropocene and the associated driving forces and responsibilities. Critical scholars argue that not the human species as a whole but only particular social formations – European colonialism in the "New World" from 1500 onwards, fossil-fuel powered industrialization in the Global North beginning in 1800, and capitalist and socialist economic growth in the Global West (and East) from 1950 – have become planetary forces. Consequently, they propose alternative terms to characterize the Anthropocene: Plantationocene, Capitalocene, Technocene, and Chthulucene, to mention only a few.[22] These approaches call for historicization of the planetary – i.e., for identifying, describing, and explaining evolutionary and transformative changes of the Earth system through human action, differentiated by multiple social contrasts (class, gender, race, etc.) and in interaction with more-than-human dynamics.

Historians dealing with the planetary turn face a set of more or less challenging options. Simply relabelling conventional historical approaches, such as environmental history, as "planetary" would miss the point. The opposite strategy, replacing history as we know it with a form of historically informed natural science, would throw the baby out with the bathwater. I therefore argue for a dual strategy of engaging with planetary history that extends the global to the planetary without abandoning it. On the one hand, history should reflexively extend its scope to the more-than-human domains of the Earth system (*planetarizing the historical*), and on the other should critically apply its differentiated toolkit to Anthropocene narratives (*historicizing the planetary*). In short, ESS challenges history, but history also challenges ESS.[23] While most representatives of the former strategy prefer the universalist Anthropocene term, most followers of the latter reject it in favour of more specific terms emphasizing socioecological inequalities. An integrative approach is Jason Moore's "world-ecology," which overcomes the dichotomy of society and nature while avoiding the universalist notion of the *anthropos* by highlighting particular social formations. Accordingly, the limitless exploitation of cheap labour and nature by capital and power groups is key to the transgression of planetary boundaries in the Capitalocene.[24]

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21 Andreas Malm/Alf Hornborg, The Geology of Mankind? A Critique of the Anthropocene Narrative, in: The Anthropocene Review 1/1 (2014), 62–69.

22 Donna Haraway, Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin, in: Environmental Humanities 6 (2015), 159–165.

23 Simon/Thomas, Earth System Science, 400.

24 Jason W. Moore, Capitalism in the Web of Life: Ecology and the Accumulation of Capital, London/New York 2015; Jason W. Moore (ed.), Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism, Oakland, CA 2016.

Accounting for the multiplicity of time, space, and agency

The dual strategy of planetarizing the historical and historicizing the planetary involves at least three conceptual challenges to historical research: the multiplicity of time, space, and agency. The *multiplicity of time* emerges from intersections of planetary timescales measured in thousands, millions, and billions of years with human timescales measured in years, decades, and centuries. Chakrabarty criticizes the tendency of social sciences and humanities dealing with the Anthropocene to eclipse the geological time of Earth history in favour of the human-centred time of global history.[25] However, what initially appears contradictory turns out to be complementary from multi-temporal approaches, new and old.[26] Reinhart Koselleck builds a semantic bridge between geology and history with the notion of overlapping "sediments of time."[27] More systematically, Fernand Braudel's model of multiple layers of time – short-term events, medium-term conjunctures, and long-term structures (*longue durée*) – offers a key to meeting the multi-temporal challenge. Accordingly, a multi-temporal perspective can be achieved by connecting these layers of time through up and down movements: "One could move from the short term to the somewhat less short term and finally to very long time (if this exists, it must be the time of the sages)."[28] This "very long time" – the "time of the sages" – approximates what Anthropocene scholars conceive as geological time. The Braudelian approach of oscillating between human and planetary timescales, thereby reconstructing their interactions transversally – or, more precisely, explaining how they both enable and limit each other – emphasizes the multiplicity of time. This undertaking is all the more obvious as planetary and global history converge in the Anthropocene, as the Great Acceleration around 1950 reveals. It remains to be seen whether the academic and public debate on the Anthropocene will lead to a rearrangement of preceding "regimes of historicity" – premodern, modern, and presentist – or to a different, planetary one.[29]

The *multiplicity of space* emerges from connections, both human and non-human, that link locations of more-than-human encounters across long, even transcontinental distances. Similar to the transversal linkages between layers of time, layers of space – from the global to the local – are also transversally linked. The term "teleconnection" has been transferred from climatology to history to grasp interactions between distant places in the Earth system. There are indications that more-than-human teleconnections have increased in number and strength in the Anthropocene: from transcontinental transfers of animals, plants, and diseases during the European expansion to the "New World" to the recent increase in local adverse weather conditions, droughts, and floods due to the global climate crisis.[30] As a more system-

25 Dipesh Chakrabarty, Anthropocene Time, in: History and Theory 57/1 (2018), 5–32.

26 Achim Landwehr, Zeiten haben: Klimakrise und Endlichkeit, Frankfurt am Main/New York 2025.

27 Reinhart Koselleck, Sediments of Time: On Possible Histories, Stanford, CA 2018, 3–9; Achim Saupe, Zeitschichten: Anmerkungen zur Historisierung und Dynamisierung einer Zeitfigur, in: Achim Saupe (ed.), Zeitschichten und Pluritemporalität in der Geschichtskultur, Göttingen 2026, 21–68.

28 Fernand Braudel, History and the Social Sciences: The Longue Durée, in: Review (Fernand Braudel Center) 32/2 (2009), 171–203, 198 (originally published in 1958).

29 François Hartog, Regimes of Historicity: Presentism and Experiences of Time, New York 2017; Bonneuil, Historiker.

30 John McNeill, The Environment and the World Economy since 1500, in: Tirthankar Roy/Giorgio Riello (eds.), Global Economic History, London 2024, 187–205, 195–201; McNeill/Engelke, Great Acceleration.

atic multi-spatiality, Moore's world-ecology extends human-centred world-systems analysis as pioneered by Immanuel Wallerstein – the bundle of unequal connections between core, semi-periphery, and periphery – further in a more-than-human direction.[31]

The *multiplicity of agency* emerges from interactions between human and non-human actors, differentiated by the degrees, types, and logics of agency, within more-than-human networks. Human history deals with individual and collective agency that also affects parts of the environment: people burn down forests, cultivate fields, build dams, and so on. Vice versa, the non-human agency of the environment may affect people through impacts such as floods, landslides, or diseases.[32] Agency must not be confused with intentionality, however: Even human activity is not necessarily intentional, as the sociology of the habitus reveals.[33] Conversely, non-human activity is not necessarily non-intentional, as human-animal studies on mammals argue.[34] In an ANT-inspired sense, agency is the ability of human and non-human actors embedded in hybrid networks to affect somebody or something else more or less strongly, regardless of the degree of intentionality.[35] This extended notion of agency does not level out differences between actors; on the contrary, as social sciences and humanities highlight internal differences within humanity, they can also differentiate externally between humans and (animate and inanimate) non-humans.[36] With the gradual transition from the Holocene to the Anthropocene, new forms of agency emerge: the human agency to change the course of the Earth system (e.g., by tapping sources and closing sinks of greenhouse gases) as well as the planetary agency to change the course of – and even extinguish – the human species (e.g., through adverse weather caused by accelerated climate warming). One of the challenges of planetary history lies in understanding the complex relationship between multiple forms of human and non-human agency.[37]

Adopting a commodity lens

To operationalize the multiplicity of time, space, and agency with more or less limited resources, historians need a clear research focus such as the commodity perspective. Commodity history has recently established itself as a historical subdiscipline with multi- and interdisciplinary links.[38] The chosen commodity provides a lens through which abstractions such as the Anthropocene can be investigated more concretely. The ANT-inspired leitmotif of the commodity perspective says: "follow the thing."[39] Foundational in this regard was the

31 Moore, Capitalism.
32 Thomas/Williams/Zalasiewicz, Anthropocene, 125–134.
33 Loïc Wacquant, A Concise Genealogy and Anatomy of Habitus, in: Thomas Medvetz/Jeffrey J. Sallaz (eds.), The Oxford Handbook of Pierre Bourdieu, Oxford 2018, 528–536.
34 Chris Pearson, History and Animal Agencies, in: Linda Kalof (ed.), The Oxford Handbook of Animal Studies, Oxford 2017, 240–257.
35 Latour, Reassembling.
36 Alf Hornborg, Artifacts Have Consequences, Not Agency: Toward a Critical Theory of Global Environmental History, in: European Journal of Social Theory 20/1 (2017), 95–110.
37 Simon/Thomas, Earth System Science.
38 Jonathan Curry-Machado/Jean Stubbs, Introduction: Researching Commodity History, in: Jonathan Curry-Machado et al. (eds.), The Oxford Handbook of Commodity History, New York 2024, 1–18.
39 Ian Cook, Follow the Thing: Papaya, in: Antipode 36/ 4 (2004), 642–664.

notion of commodity chains as institutionalized linkages of sites of production, distribution, and consumption across empires and nation-states within the capitalist world-system. Other approaches – most importantly, global commodity chains and global value chains – shift away from this long-term world-historical perspective towards more short-term industry-centred analyses. The scholarship on global production networks emphasizes the multi-spatiality of globalization – that is, the embeddedness of global relations in national, regional, and local contexts.[40] The critique that chain approaches overemphasize the urban centres (compared to the rural peripheries) as well as political and economic aspects (compared to socioecological ones) gave rise to the concept of commodity frontiers.[41] Commodity frontiers are contested zones where new sources of labour and nature are incorporated as "fictitious commodities" into the capitalist accumulation of value. They can be regarded as regional sites functioning as teleconnections within transregional commodity chains. Commodity frontier dynamics comprise phases of expansion and contraction, connected to "double movements" of marketization and socioecological protection in the capitalist world-system.[42] Since the commodity perspective has been widely adopted in global history, there is no reason to assume that it does not work for planetary history as well. However, its anthropocentric legacy needs to be overcome by way of a post-anthropocentric extension that takes into account the agency of commodities as planetary forces.

Soy provides a promising commodity lens for a planetary history of the long twentieth century for several reasons: First, the soybean has developed from an East-Asian food crop in the late nineteenth century to the biggest cash crop of global agro-food capitalism in the early twenty-first century, extracted mainly in South and North America.[43] Second, as a plant with versatile properties, soy is a subject with significant agency that defines the possibilities and limits of its use. Simultaneously, it is an object of techno-scientific manipulation – from conventional breeding to genetic engineering – due to the agency of actors such as plant researchers, commercial breeders, and biotech firms.[44] Third, due to its quantitative and qualitative significance, the more-than-human network around soy has become a planetary force, driving global warming, species extinction, and agrochemical contamination on a massive scale.[45] Soy has thus become a marker of the human-reconfigured biosphere, as has been argued for the broiler chicken.[46] Fourth, soy plays a paradoxical role in the Great Acceleration:

40 Jennifer Bair, Global Commodity Chains: Genealogy and Review, in: Jennifer Bair (ed.), Frontiers of Commodity Chain Research, Stanford, CA 2009, 1–34; Ernst Langthaler/Elke Schüßler, Commodity Studies with Polanyi: Disembedding and Re-embedding Labour and Land in Contemporary Capitalism, in: Österreichische Zeitschrift für Soziologie 44/2 (2019), 209–223; Bernd-Stefan Grewe, Global Commodities and Commodity Chains, in: Tirthankar Roy/Giorgio Riello (eds.), Global Economic History, London 2024, 271–285.

41 Jason W. Moore, Sugar and the Expansion of the Early Modern World-Economy. Commodity Frontiers, Ecological Transformation, and Industrialization, in: Review (Fernand Braudel Center) 23/3 (2000), 409–433; Ulbe Bosma/Eric Vanhaute, Commodity Frontiers: Linking Global Capitalism and Local Resilience, in: Jonathan Curry-Machado et al. (eds.), The Oxford Handbook of Commodity History, New York 2024, 85–101.

42 Langthaler/Schüler, Commodity Studies.

43 Ernst Langthaler, Soy, in: Jeannie Whayne (ed.), The Oxford Handbook of Agricultural History, New York 2024, 304–324.

44 Christine M. Du Bois, The Story of Soy, London 2018.

45 Matilda Baraibar Norberg/Lisa Deutsch, The Soybean Through World History: Lessons for Sustainable Agro-food Systems, Oxon/New York 2023.

46 Carys E. Bennett et al., The Broiler Chicken as a Signal of a Human Reconfigured Biosphere, in: Royal Society Open Science 5/12 (2018), 180325.

On the one hand, as an animal feed for the agro-industrial livestock complex, it is part of the mainstream; on the other hand, as a human food for vegetarian diets, it is allied with alternative and counter-movements.[47] As proposed by Claiton M. da Silva and Claudio de Majo, we can conceive the Anthropocene – or, more precisely, the Capitalocene – as a *Soyacene*.[48]

Following soy through time and space emphasizes the multiplicity of time, space, and agency in planetary history. Regarding the multiplicity of time, soy highlights the intersection of short-, medium, and long-term rhythms ranging from the annual growth cycle of the bean plant through decades- and centuries-long periods of soy expansions to *longue durée* phenomena such as soy-driven ecological change.[49] With regard to the multiplicity of space, soy accentuates teleconnections between regional sites of its production and consumption through transregional trade networks and their institutional arrangements.[50] In terms of the multiplicity of agency, soy underlines interactions with human actors such as nation-states, capitalist enterprises, and social movements as well as with non-human actors ranging from allies such as hybrid corn to opponents such as herbicide-resistant "super-weeds." This perspective even reveals the multiplicity of soy itself – for instance, its paradoxical role as both protagonist and antagonist of the Western nutrition transition to meat-based diets and the associated expansion of the agro-industrial livestock complex.[51]

Tracing a commodity's planetary footprint

The socio-natural footprint of a commodity network indicates the direction, speed, and drivers of planetary change. Anthropocene scholars have developed different socioecological benchmarks including the ecological footprint, the 24 trends indicating the Great Acceleration, and the nine planetary boundaries, to mention but the most important.[52] Since all of these benchmarks build on calculations, they have strengths as well as weaknesses: On the one hand, quantitative indicators provide numeric information from big data about aspects covering long time spans and large spaces; on the other hand, qualitative information – pejoratively referred to as "anecdotal evidence" – is often sidelined or ignored.[53] To include the full account available from historical sources, research needs to combine quantitative and qualitative information on the socio-natural footprint of the commodity network under investigation as an indicator of planetary change. A commodity's footprint thus goes beyond a single indicator expressed by numbers, comprising a complex mosaic of quantitative and qualitative

47 Ernst Langthaler, The Soy Paradox: The Western Nutrition Transition Revisited, 1950–2010, in: Global Environment 11 (2018), 79–104.

48 Claiton M. da Silva/Claudio de Majo, Towards the Soyacene: Narratives for an Environmental History of Soy in Latin America's Southern Cone, in: Historia Ambiental, Latinoamericana y Caribeña (HALAC) 11/1 (2021), 329–356.

49 Baraibar Norberg/Deutsch, Soybean.

50 Ernst Langthaler, Great Accelerations: Soy and its Global Trade Network, 1950–2020, in: Claiton M. da Silva/Claudio de Majo (eds.), The Age of the Soybean: An Environmental History of Soy during the Great Acceleration, Winwick 2022, 65–90.

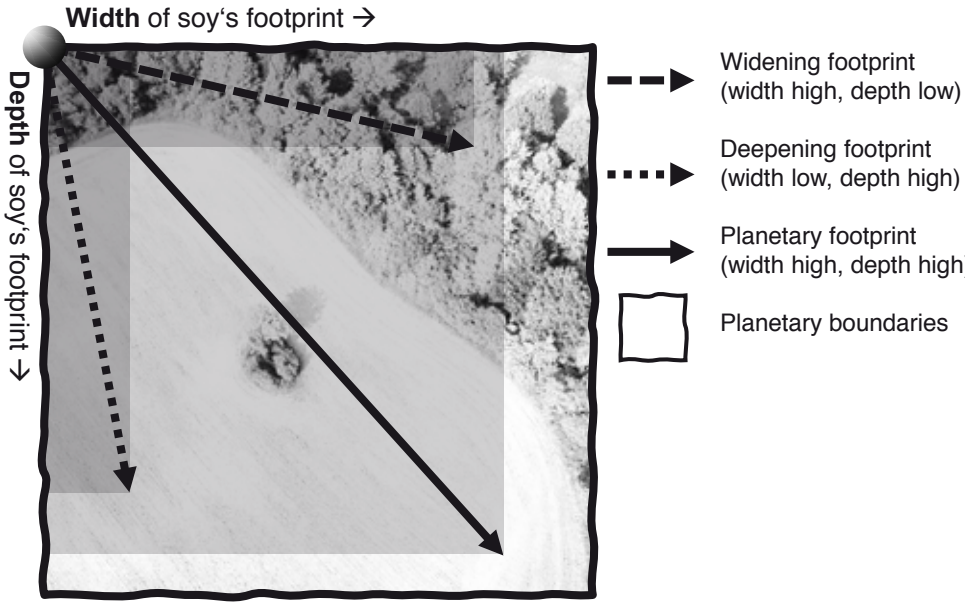
51 Langthaler, Soy Paradox.

52 Erle C. Ellis, Anthropocene: A Very Short Introduction, New York 2018, 103–127.

53 Sean Cubitt, Data/Anecdote, in: John Parham (ed.), The Cambridge Companion to Literature and the Anthropocene, Cambridge 2021, 54–68.

pieces of evidence on the socio-natural dynamics of its entire network. The adequate form of representation is more than a table or diagram – it is the text of a story. A telling example of the content and form of a commodity's footprint is the "ecological hoofprint" of global meatification.[54]

Figure 1: Widening and deepening of a soy's planetary footprint



Source: Design by the author.

The planetary footprint (i.e., the aggregate impact on the Earth system) of a commodity network results from the dynamics of commodity chains and commodity frontiers. Commodity chains act as teleconnections linking sites of frontier expansion (or contraction) within the domains of production and consumption. Power- and capital-driven commodity frontiers can expand *externally* through extensive incorporation of new spaces (*widening*, e.g., conversion of native grasslands into crop monocultures), *internally* through more intensive incorporation of already occupied spaces (*deepening*, e.g., adoption of high-productive technologies), or *flexibly* through combinations of both modes (Figure 1). The conditions and consequences of capital accumulation through frontier expansion, including disruptions of society and nature, are often contested and need to be regulated according to the interests and values of key actors (nation-states, big business, social movements, etc.). From these encounters, a stable regime institutionalizing commodity frontier expansion for a certain period can emerge – before eventually destabilizing again due to external and internal dynamics and transforming into a different regime.[55] In the case of soy, three agro-food regimes have suc-

54 Tony Weis, The Ecological Hoofprint: The Global Burden of Industrial Livestock, London 2013.

55 Ernst Langthaler/Maximilian Martsch/Gabriel Tober, Conceptualizing Historical Commodity Studies: The Case of Soy, in: Juan Carmona-Zabala (ed.), Commodities in History: Theoretical Reflections and Empirical

ceeded one another since the onset of globalization in the 1870s: the imperial, developmental, and corporate regimes.[56]

Transferring the above considerations to the case of soy, the history of the Soyacene explores the contested widening and deepening of soy's planetary footprint in the framework of global agro-food regimes, crises, and transitions since around 1870. The widening of the footprint refers to changes such as the expansion of the soy growing area in Asia and the Americas starting in the early twentieth century, and recently also in Europe and Africa. The deepening of the footprint refers to changes such as the application of the biotechnological package around transgenic soy since the 1990s. How widening and deepening combine in flexible ways becomes evident in South American "soylandia," where the transgenic biotechnology is enabling soy's more-than-human network to expand into near-natural biomes – mainly savannah and rainforest – previously less suited for profitable extraction and marketization.[57] Oscillating between zooming out to the widening and zooming in to the deepening of commodity webs, researchers can trace soy's planetary footprint through time and space.

Deconstructing grand narratives and reconstructing grounded stories

Planetary history – like every form of history – is not only about critical research but also about storytelling. Within the Anthropocene discourse, four grand narratives associated with regimes of historicity about humans' relation to their planet from the past to the future determine academic and public thinking. The dominant *naturalist* narrative claims that the human species has inadvertently altered the Earth system at a geological scale in the past. However, Earth system scientists have made *anthropos* aware of the danger and now provide policymakers with the necessary knowledge and technology to lead humanity towards a sustainable future. The *post-nature* narrative overcomes the division of society and nature by claiming that nature is socially constructed. In contrast to classical modernity in the past, this reflexive-modern spirit might lead humanity to refashion nature technologically and institutionally for a brighter future. The *eco-catastrophist* narrative conceives the past as an unsustainable path transgressing planetary boundaries and pushing the Earth system to irreversible tipping points. If civil society fails to adopt a more participatory politics, a post-growth economy, and a sustainable lifestyle, human life on the planet will be extinguished in the near future. Finally, the *eco-Marxist* narrative argues that capitalism has failed to reproduce labour and nature in the past due to over-exploitation: The elites in the core countries of the world-system have accumulated profit and power through unequal economic and ecological exchange with the peripheries, where the associated social and ecological costs have undermined (non-)human habitability. Avoiding the further transgression of planetary boundaries in the Capitalocene thus requires a radical break with the capitalist growth imperative in favour of a future eco-socialist order.[58] These grand narratives occupy positions in a discursive field structured by

Case Studies, Rethymno 2023, 25–60.

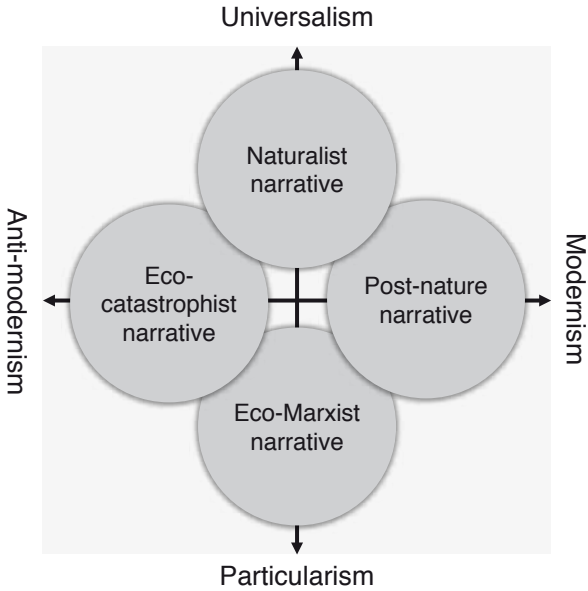
56 Philip McMichael, Food Regimes and Agrarian Questions, Halifax 2013.

57 Langthaler, Soy.

58 Christophe Bonneuil, The Geological Turn: Narratives of the Anthropocene, in: Clive Hamilton/Christophe Bonneuil/François Gemenne (eds.), The Anthropocene and the Global Environmental Crisis: Rethinking Modernity in a New Epoch, London/New York 2015, 17–31.

two dimensions (Figure 2): universalism (naturalist narrative) versus particularism (eco-Marxist narrative), and anti-modernism (eco-catastrophist narrative) versus modernism (post-nature narrative).

Figure 2: Grand narratives of the Anthropocene



Source: Design by the author.

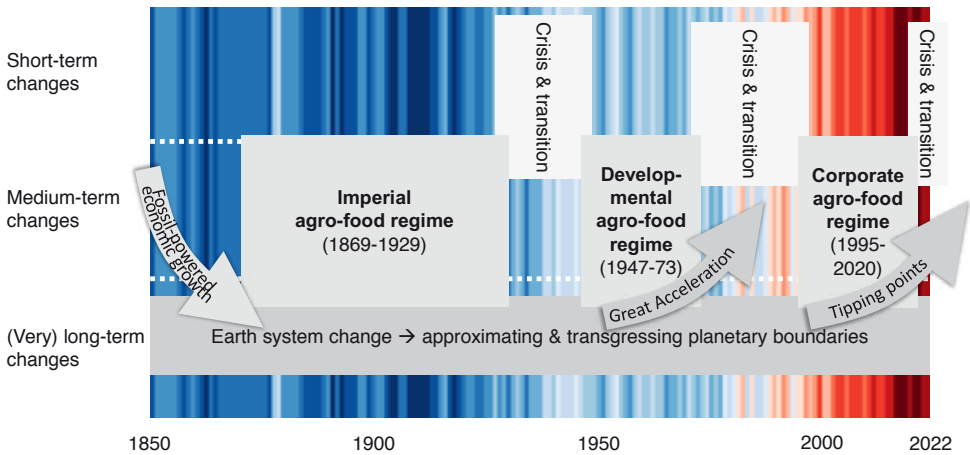
Rather than uncritically adopting or hyper-critically rejecting these grand narratives, planetary history can use them critically as a reflexive framework for creating pluralist stories. It might take from the naturalist narrative the insight that the relation of the human species to the Earth has changed fundamentally in the Anthropocene. However, it can draw on the eco-Marxist narrative to overcome the undifferentiated notion of the *anthropos* by highlighting societal differences such as class, gender, and race as well as unequal political, economic, and ecological structures. Moreover, it acknowledges hybrid assemblages of society and nature as argued by the post-nature narrative. Finally, it takes ecological footprints, planetary boundaries, and tipping points of the Earth system as described by the eco-catastrophist narrative into account.[59]

The deconstruction of these grand narratives is no end in itself, but rather a means to an end – the reconstruction of evidence-grounded stories. Besides space and agency, historical accounts emphasize time in general and periodization in particular. Most grand narratives tend to construct history as a unilinear pathway from one state to another, ranging between stories of failure (e.g., the eco-catastrophist narrative) and success (e.g., the post-nature narrative). Historical evidence often contradicts such simplifications and calls for more complex storytelling. The story of the Soyacene includes periods of path dependencies, when an agro-

59 Bonneuil, Geological Turn.

food regime organizes the expansion of commodity chains and their frontiers according to institutionalized rules of the game, as well as periods of path openness, when a hegemonic regime descends into crisis due to external and internal pressure, alter- and counter-hegemonic alternatives arise from niches, and the old regime transforms into a new one. The succession of periods of path dependency and openness shapes the periodization of the Soyacene into the imperial (1869–1929), developmental (1947–1973), and corporate agro-food regimes (1995–2020), each followed by a period of crisis and transition.[60] These medium-term cycles of regime formation, crisis, and transition interact with other layers of time: The top layer includes short-term events such as military conflicts, economic turbulence, and technological shifts; the bottom layer comprises long-term changes in the Earth system that affect the medium-term (e.g., global warming) and short-term layers (e.g., weather-related disasters) in the Great Acceleration, when planetary boundaries are transgressed and systemic tipping points are approximated. This multi-temporal model provides a heuristic framework for a non-linear, evidence-grounded, and commodity-focused planetary history (Figure 3).

Figure 3: Multi-temporal framework of the history of the Soyacene



The background shows "climate stripes" depicting annual deviations from the average global surface temperature from 1961 to 2010, with blue colours indicating cooler years and red colours indicating warmer years.
Source: https://www.reading.ac.uk/planet/climate-resources/climate-stripes (31 March 2026).
Design by the author.

Planetarizing historical thought

This essay argues that the seemingly impossible project of planetary history could become possible through a commodity lens, as illustrated with the case of soy. But to what extent does such a programme involve a "process of probing the limits of historical understanding,"[61]

60 Langthaler, Soy.
61 Chakrabarty, Four Theses, 220.

as Chakrabarty argues? On the one hand, planetary history goes beyond conventional (i.e., anthropocentric) history. On the other hand, a post-anthropocentric history oriented towards the Earth system, including the human species, is not entirely different from preceding forms of history. For instance, it shares with them the "historical method" comprising heuristics, criticism, and interpretation that lives up to history's scientific aspirations.[62] We can conceive the planetary turn as another extension of history's scope in a long series since the mid-twentieth century: the "social science turn" of the 1960s and 1970s, which focused on society in a comprehensive sense and its class structure; the "cultural turn" of the 1980s and 1990s emphasizing everyday practices of men and women, semiotic and discourse analysis, and the meta-historical reflection of historiography as literature; and the "global turn" of the 2000s and 2010s that highlighted international comparisons and transnational connections, to mention the most important.[63]

Accordingly, the current "planetary turn" is yet another paradigmatic shift that turns attention to the non-human domains of the Earth system as an integral part of a more-than-human history. It goes beyond environmental history, which still – at least rhetorically – stresses the dichotomy of society and nature (i.e., society's "environment"). After having socialized, culturalized, and globalized the discipline, history is now moving towards *planetarizing*. Writing planetary history is a challenging endeavour, but it obsoletes neither the modern historiographical legacy in general nor global history in particular. Planetary history might even become a radicalized form of global history that both concentrates on and de-centres the human impact on the Earth system. The planetary turn does not necessarily require a profoundly shattering revolution or a re-invention of history; a horizon-broadening reform of historical thought to include the more-than-human may suffice.

The research agenda of planetary commodity history outlined above can be summed up in seven theses:

1. The planetary turn in history has not yet bridged the gap between theoretical reasoning and empirical research.
2. Planetary history should adopt the dual strategy of planetarizing the historical and historicizing the planetary.
3. Planetary history must account for the multiplicity of time, space, and agency.
4. The overwhelming complexity of planetary history can be reduced to a manageable degree through a commodity lens.
5. A commodity network's planetary footprint results from the widening and deepening of its frontiers and can be traced by zooming in and out.
6. Planetary commodity history should deconstruct grand narratives and reconstruct evidence-grounded stories.
7. Since the planetary turn continues the series of history's paradigmatic shifts, it leads to a reform rather than a revolution of historical thought.

62 Jörn Rüsen, Evidence and Meaning: A Theory of Historical Studies, New York/Oxford 2017, 125–144.

63 Georg G. Iggers/Q. Edward Wang/Supriya Mukherjee, A Global History of Modern Historiography, London/New York 2017, 204–263, 310–345.

Planetary commodity history: The case of Mato Grosso

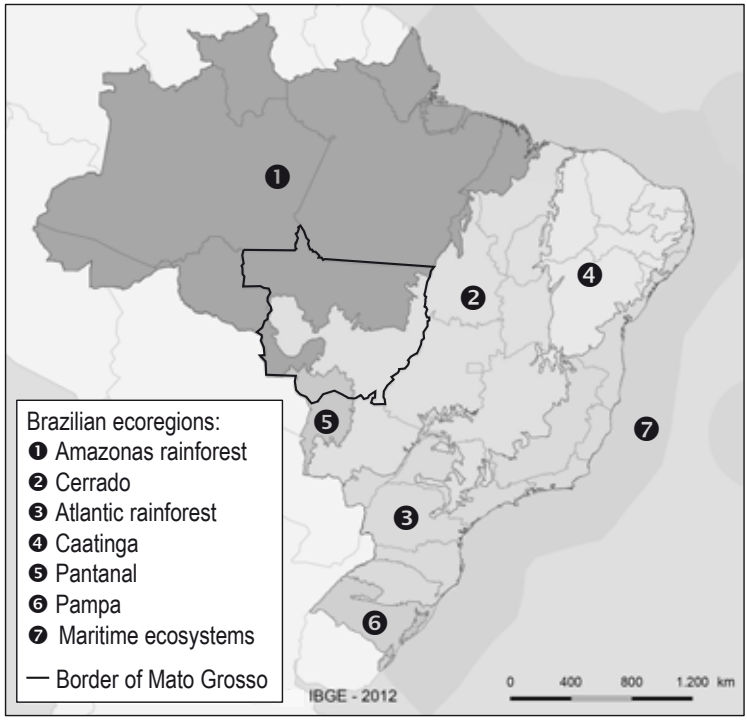
Sediments of time

As argued above, planetary commodity history combines zooming out to the level of a commodity network as well as zooming in on its individual nodes. The following section addresses soy's commodity web and its planetary footprint from the perspective of nodes (or commodity frontiers) rather than arrows (or commodity chains).[64] The Brazilian state of Mato Grosso has been chosen as a focus region of planetary dynamics at soy frontiers for two reasons: First, Mato Grosso has emerged as a hotspot of soy expansion in Brazil, the world's leading soy powerhouse with shares of 36 per cent of total production and 44 per cent of total exports in 2024.[65] Second, the state is located at the intersection of the two Brazilian ecoregions ("biomes") most important for soy expansion: the savannah (Cerrado) and the Amazon rainforest (Figure 4). To fully understand Mato Grosso's socio-natural transformation as a soy frontier, we should also consider the region's colonial legacies. Accordingly, four overlapping sediments of time have been identified: The first extends from the sixteenth to the early twentieth centuries, when Mato Grosso was represented by white colonizers as a "wilderness" on the fringes of the Anthropocene triggered by the European conquest of the "New World" after 1500 as well as the fossil fuel-powered industrialization of the West after 1800 (*colonial Anthropocene*); the second lasts from the 1930s to the 1980s, when authoritarian regimes opened the remote region to state-led capitalist modernization (*authoritarian Capitalocene*); the third extends from the 1980s to the 2000s, when soy fields expanded rapidly into the savannah and rainforest biomes (*unleashed Soyacene*); and the fourth emerges since the 2000s, when contradictory effects of the socio-natural crisis triggered public-private management of the ongoing soy expansion (*organized Soyacene*).

Colonial Anthropocene (16th–20th centuries): From around 1500, the Amazonian Basin played an ambivalent dual role in the European expansion to the "New World": On the one hand, the tropical rainforest with its diverse communities of indigenous peoples, animals, and plants appeared to the colonial gaze as an isolated "wilderness." On the other hand, the Amazon River and its branching tributaries opened up routes of expansion for European "civilization." In the sixteenth century, political control and economic exploitation of the new colony were initially limited to the narrow strip of land along the Atlantic coast. It was only when land reserves and forced labour became scarce, and the greed for precious stones and metals grew, that the extraction front advanced from the "civilized" coast into the "wild" interior. The Portuguese invaders repelled the claims of the rival colonial powers – Spain, England, France, and the Netherlands – and established a province in the seventeenth century that encompassed large parts of the Amazonian Basin. It was primarily diamond and gold prospectors who sought to realize their dreams of wealth in Mato Grosso. Economic and religious penetration was followed by bureaucratic integration from the eighteenth century onwards: Mato Grosso became a captaincy in 1748, a province in 1822, and a state in 1889. After Brazil declared its independence from Portugal in 1822, the young nation-state sought to assert its territorial integrity amid internal uprisings and external attacks. In the national

64 For an analysis of soy's global commodity chains since the 1950s see Langthaler, Great Accelerations.
65 Source: FAOSTAT, https://www.fao.org/faostat/en/#home (9 March 2026). Calculation by the author.

Figure 4: Location of Mato Grosso in the Brazilian ecoregions



Source: Design by the author.

context, Mato Grosso was a geopolitically vulnerable border region on the sidelines of the rubber and coffee extraction booms, which integrated other parts of the country into global commodity markets at the turn from the nineteenth to the twentieth century. Soybeans were already acclimatized in Brazil around 1900, but only in the South. While fossil fuel-powered economic growth – that is, the Anthropocene in the form of the Capitalocene – had already been unleashed in the industrial centres of the capitalist world-system, Mato Grosso remained a resource-rich but barely accessible periphery within the periphery.[66]

Authoritarian Capitalocene (1930s–1980s): After the commodities boom had broken down during the Great Depression, the Amazonian Basin became a target region for capitalist development by the interventionist nation-state. In 1938, the authoritarian Vargas regime launched the "March to the West" – a state-led development program which initiated expert assessments, road construction projects, land purchases, and investment incentives. In 1964, the military leadership responded to escalating social tensions with a coup supported by the United States. Through a "conservative modernization" under bureaucratic-technocratic auspices, the military regime sought to contain class conflicts without altering the politi-

66 Antonio Augusto Rossotto Ioris, Frontier Making in the Amazon: Economic, Political and Socioecological Conversion, Cham 2020, 31–35.

cal and economic balance of power.[67] According to the logic of the developmental agro-food regime, the state launched a large-scale colonization program to integrate the Brazilian Midwest, including Mato Grosso, both geopolitically and geoeconomically. While public colonization – often accompanied by chaos, corruption, and failure – primarily attracted settlers from impoverished regions, affluent families from the South responded more eagerly to private projects.[68] The state-led colonization offensive included the construction of highways connecting Mato Grosso to the country's administrative and economic centres.[69] The colonization and infrastructure projects of Brazilian high modernism radically reshaped the state's socio-natural landscape: Settlements and road projects displaced the indigenous population from their ancestral living spaces and converted the species-rich vegetation of the savannah and rainforest into cattle pastures and crop monocultures. From 1960 to 1988, 57 per cent of the savannah and 12 per cent of the rainforest in Mato Grosso were cleared.[70] The accelerated expansion of the agricultural frontier created a niche for a stable network around soy consisting of three elements: first, new methods of mineral fertilization to make the nutrient-poor and acidic soils fertile for crop production; second, new plant varieties that could tolerate poor soils, longer days, and the tropical climate of the savannah region; and third, new styles of farming that combined technological enthusiasm, market orientation, and pioneering spirit. This assemblage received institutional and financial support from the agricultural research agency EMBRAPA, which established a soybean centre, as well as from PRODECER, a Japanese-Brazilian development program for the savannah region, in the 1970s.[71]

Unleashed Soyacene (1980s–2000s): The coalition between the two newcomers from the South – adapted plant varieties and white settler families – unleashed an unprecedented expansion of the soy frontier in Mato Grosso from the 1980s onwards (Figure 5). This more-than-human power couple conquered the region so forcefully that the resident indigenous and smallholder population pejoratively labelled them "grasshoppers."[72] The immigrant soy farmers established a politically well-connected and economically prosperous class with common features – large holdings, cutting-edge technology, and innovative spirit – and a shared pioneer identity. Their entrepreneurial style of farming differed both from peasant farming (due to strict market orientation) and capitalist farming (due to strong cooperative

67 Ioris, Frontier Making, 35–38, 52–54; Gerd Kohlhepp, The Brazilian Amazonia in Change II: Five Decades of Exploitation, Deforestation and Attempts at Sustainable Development, Bielefeld 2025, 227–228.

68 Lisa Rausch, Convergent Agrarian Frontiers in the Settlement of Mato Grosso, Brazil, in: Historical Geography 42 (2014), 276–297, 280–285; Wendy Jepson/Christian Brannstrom/Anthony Filippi, Access Regimes and Regional Land Change in the Brazilian Cerrado, 1972–2002, in: Annals of the Association of American Geographers 100/1 (2019), 87–111.

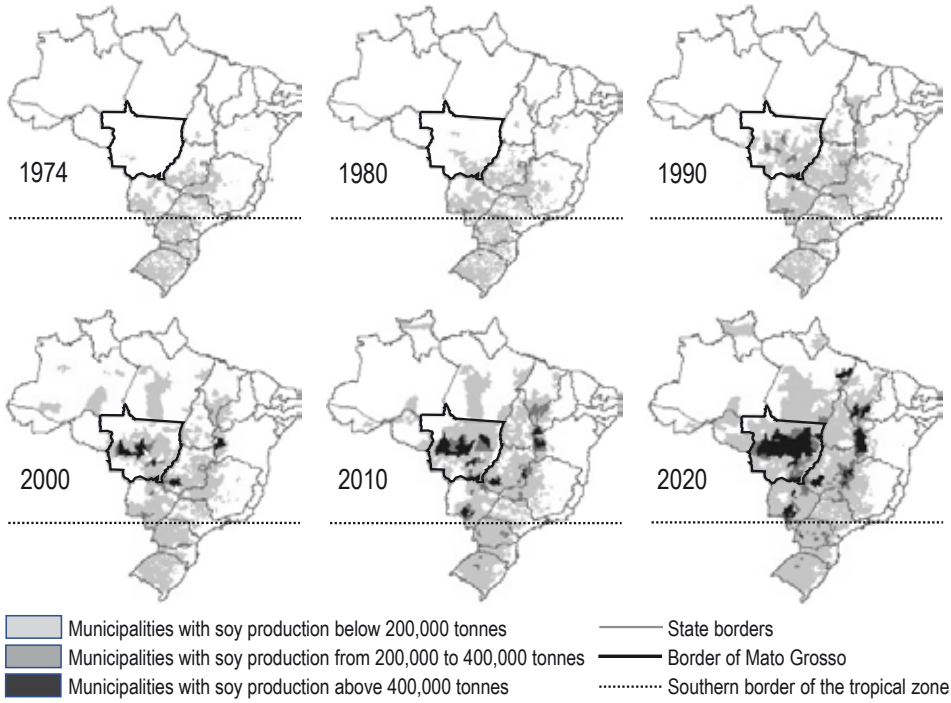
69 Kohlhepp, Amazonia, 249–250.

70 Freg J. Stokes et al., Tropical Deforestation and Indigenous Resistance over the Longue Durée in South America, in: Journal of Global History 20/2 (2025), 121–142; Philip M. Fearnside, Deforestation in Brazilian Amazonia, in: George M. Woodwell (ed.), The Earth in Transition, Cambridge 1990, 211–238.

71 Claiton Márcio da Silva, Between Fenix and Ceres: The Great Acceleration and the Agricultural Frontier in the Brazilian Cerrado, in: Varia Historia 34 (2018), 409–444; Cassiano Brito Rocha/Claudio de Majo/Sandro Dutra e Silva, A Geo-historical Analysis of Expanding Soybean Frontiers in the Brazilian Cerrado, in: HALAC 12/2 (2022), 217–252.

72 Da Silva, Fenix, 426.

Figure 5: Soy expansion in Brazil, 1974–2020



Source: Fábio Pitta/Maria Luisa Mendonça, Industrial Soy Expansion in Brazil: Financialization, Deforestation, and Dispossession in the Birthplace of Waters, n.p. 2022, 18. Design by the author.

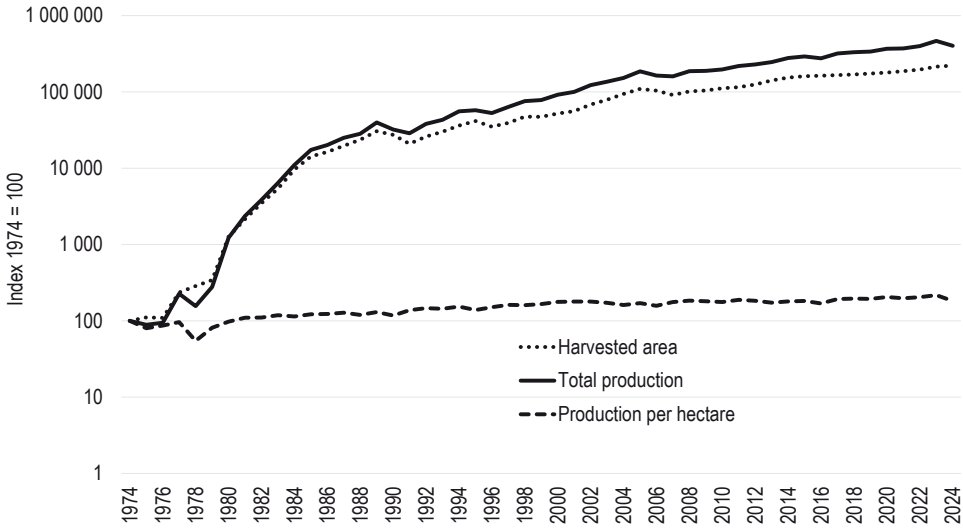
attitudes).[73] Mato Grosso experienced two soy booms (Figure 6): the first in the 1980s, with a 32-fold growth of production from a low level, and the second from the mid-1990s to the mid-2000s, with a 3.5-fold increase from a much higher base. Both were mainly due to the enlargement of the harvested area. The stagnation between these booms reflected the shaky transition from state-protected to market-oriented development after the shift from military dictatorship to liberal democracy in 1985. Due to its neoliberal agenda, the government began during the 1990s to improve the transport infrastructure and open the national market to transnational agribusiness companies ("ABCDs"), which gained control over the commodity chain as creditors, processors, and traders. This politico-economic constellation derived its legitimacy from hegemonic media discourses that attributed technological, administrative, and managerial efficiency to the soy business. Growing demand from the European Union and China as well as the liberalized framework of the World Trade Organization in the corporate agro-food regime fuelled Mato Grosso's export-oriented soy expansion.[74] While agribusiness firms and growth-oriented farmers accumulated profits, indigenous and smallholder

73 Herbert S. Klein/Francisco Vidal Luna, Feeding the World: Brazil's Transformation into a Modern Agricultural Economy, Cambridge 2019, 263–264; Kohlhepp, Amazonia, 230–237; Ioris, Frontier Making, 57.

74 Klein/Luna, Feeding the World, 247–248; Ioris, Frontier Making, 56.

communities as well as near-natural biomes were displaced at a large scale by the expanding soy monoculture.[75] Whereas the first boom was confined to the savannah region, the second boom also encroached on the rainforest along the newly paved highways. However, soy acted as an indirect rather than a direct driver of deforestation: Initially, lucrative soy fields displaced less profitable cattle pastures from the savannah into the rainforest; a few years later, they eventually followed them again.[76]

Figure 6: Soy expansion in Mato Grosso, 1974–2024



Source: IBGE, SIDRA, Tab. 1612, https://sidra.ibge.gov.br/Tabela/1612 (22 March 2026). Calculation by the author.

Organized Soyacene (2000s–2020s): At the turn of the millennium, Mato Grosso consisted of a patchwork of "modernized" and neglected places and regions: On the one hand were affluent neighbourhoods, thriving soy and cattle farms, and designated nature and indigenous reserves; on the other were urban slums, struggling family farms, and devastated rainforest and savannah areas.[77] The period of left-wing governments starting with the Lula da Silva administration in 2003 was characterized by ambivalence: On the one hand, the socio-natural destabilization through commodity frontier expansions continued. On the other hand, state, corporate, and civil society engaged in restabilization through 'sustainable' governance. Besides the tightening of the Forest Code in 2012, combined with monitoring and enforcement

75 Philip M. Fearnside, Soybean Cultivation as a Threat to the Environment in Brazil, in: Environmental Conservation 28 (2001), 23–38.

76 Elizabeth Barona et al., The Role of Pasture and Soybean in Deforestation of the Brazilian Amazon, in: Environmental Research Letters 5/2 (2010), 24002.

77 Ioris, Frontier Making, 57–61; Mariano Turzi, The Political Economy of Agricultural Booms: Managing Soybean Production in Argentina, Brazil, and Paraguay, Cham 2017, 83–100; Martin Coy/Frank Zirkl/Tobias Töpfer, Peripher und doch global vernetzt: Das brasilianische Agrobusiness und seine Folgen für räumliche Prozesse und Arbeitswelten, in: WSI-Mitteilungen 72/1 (2019), 31–38.

measures, the Soy Moratorium of 2006 and the associated Roundtable on Responsible Soy, negotiated by agribusiness firms, state agencies, and environmentalist NGOs, aimed to contain soy-driven rainforest loss due to consumer concerns.[78] This case of "ecological modernization" promoting the market-induced decoupling of soy expansion and rainforest loss delivered mixed results: During the first years, deforestation rates declined and expansion shifted to the savannah biome. From the 2010s onwards, deforestation increased again and expansion shifted back to the rainforest biome, peaking during the right-wing Bolsonaro administration, albeit on a smaller scale than in the early 2000s. Simultaneously, a third soy boom, starting in the late 2000s and combining extensive and intensive growth, more than doubled production from an already high level.[79] However, the application of the biotechnological package of herbicide-resistant transgenic seeds and the herbicide glyphosate from the mid-2000s onwards failed to achieve the promised yield increases.[80] Capitalist farming styles by speculative financial investors from other Brazilian states and foreign countries competed with the entrepreneurial farming styles of regional soy farmers.[81] However, the largest profits were made by transnational trading and processing companies, which exploited an increasing share of Mato Grosso's soy acreage (2004: 69 per cent, 2020: 83 per cent) as 'ghost acres' used by overseas countries, among which Western Europe slowly gave way to East and Southeast Asia.[82]

Widening soy's planetary footprint: The example of deforestation

Among the varieties of the widening of soy frontiers, and thus soy's planetary footprint, the deforestation in the Amazonian Basin stands out with regard to destabilization of the Earth system: "Of the nine processes identified as critical for Earth system stability, five with the most critical status, namely climate change, biosphere integrity, land system change, freshwater change, and biogeochemical flows, are significantly influenced by the Amazonian Basin, particularly at regional to continental scales."[83] The strength of corporate-driven soybean expansion, exacerbated by the weakness of national environmental policies under neoliberal governments, decimated large swaths of rainforest and savannah vegetation in Mato Grosso. Of the forests existing in 1970, excluding the extremely species-rich bush and grassland areas, 2.7 million hectares, or 5 per cent, had already been cleared by 1978. During the first soy boom lasting

78 Damien Arvor et al., Combining Socioeconomic Development with Environmental Governance in the Brazilian Amazon: The Mato Grosso Agricultural Frontier at a Tipping Point, in: Environment, Development and Sustainability 20/1 (2018), 1–22, 11–16.

79 Carlos A. Silva/Mendelson Lima, Soy Moratorium in Mato Grosso: Deforestation Undermines the Agreement, in: Land Use Policy 71 (2018), 540–542.

80 Cleiva Schaurich Mativi et al., The Use of Glyphosate and RR Soybean Productivity in Brazil from 2009 to 2018, in: Revista Ibero Americana de Ciências Ambientais 13/11 (2022), 129–138.

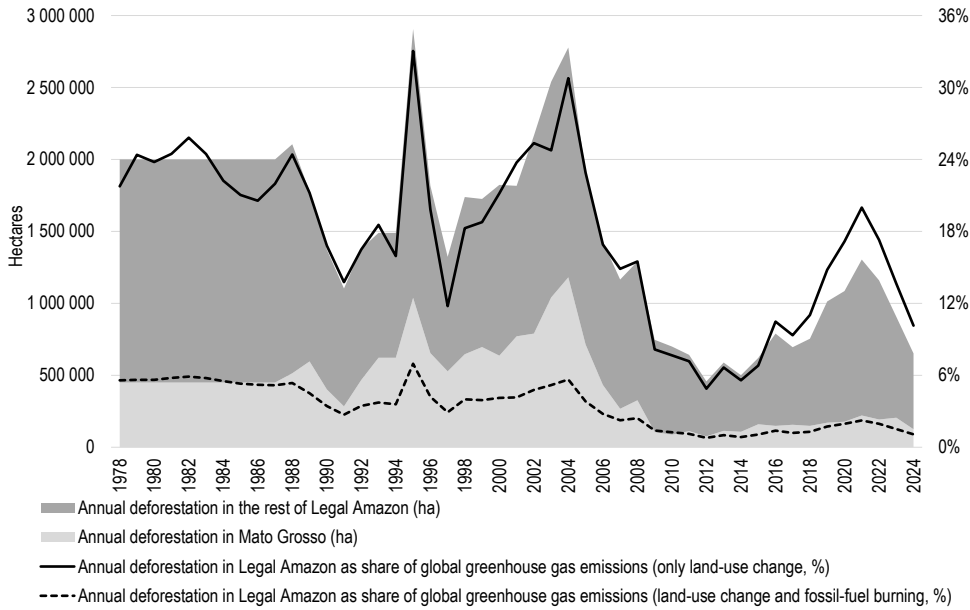
81 Mateo Mier y Terán Giménez Cacho, Soybean Agri-food Systems Dynamics and the Diversity of Farming Styles on the Agricultural Frontier in Mato Grosso, Brazil, in: The Journal of Peasant Studies 43/2 (2015), 419–441; Andrew L. Ofstehage, Financialization of Work, Value, and Social Organization Among Transnational Soy Farmers in the Brazilian Cerrado, in: Economic Anthropology 5/2 (2018), 274–285.

82 Source: TRASE, https://trase.earth/ (22 March 2023). Calculation by the author.

83 Marco A. Franco et al., How Climate Change and Deforestation Interact in the Transformation of the Amazon Rainforest, in: Nature Communications 16 (2025), 7944, 2.

until 1988, an average of 0.45 million hectares of forest, or 23 per cent of the total deforested area in the Legal Amazon, fell victim to clearing fires and chainsaws each year.[84] After a decline in the late 1980s and early 1990s, deforestation gained momentum once again during the second soy boom. Annual deforestation reached a first peak in 1995 at 1.04 million hectares and a second peak in 2004 at 1.18 million hectares. During this decade, Mato Grosso's share of deforestation in the Amazonian region skyrocketed from 35 to 43 per cent (Figure 7).

Figure 7: Deforestation and greenhouse gas emissions in Mato Grosso and the rest of the Legal Amazon, 1978–2024



Source: Fearnside, Greenhouse Gases (deforestation 1978–1988 and greenhouse gas emissions 1990 in the Legal Amazon); Instituto Nacional de Pesquisas Espaciais (INPE), Terra Brasilis, PRODES, https://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates (21 February 2026, deforestation since 1988 in the Legal Amazon); Global Carbon Project, Global Carbon Budget 2025, https://globalcarbonbudget.org/download/2341/?tmstv=1762815901 (21 February 2026, global greenhouse gas emissions since 1978). Calculation by the author.

The obligatory and voluntary measures for forest protection under the "post-neoliberal" left-wing governments significantly loosened the coupling of the third soy boom with deforestation. In 2010, the annual area cleared fell below the 100,000-hectare threshold for the first time since recording began. Deforestation later accelerated again and exceeded the 200,000-hectare mark in 2021 during Brazil's right-wing intermezzo, but remained well below the levels seen up until the mid-2000s. Between 2001 and 2016, 6 per cent of the deforestation in the Amazon rainforest and 17 per cent in the Cerrado were attributable to soy expansion.

84 Philip M. Fearnside, Greenhouse Gases from Deforestation in Brazilian Amazonia: Net Committed Emissions, in: Climatic Change 35/3 (1997), 321–360, 324–326.

Not included in these figures are the pastures on deforested land before 2001, which soy conquered, nor the newly established pastures that eventually became soy fields after 2016. In the rainforest biome, which was protected by the reformed Forest Code and the Soy Moratorium, deforestation declined more sharply than in the less protected savannah biome. As overall deforestation increased once again, the focus shifted back in the opposite direction.[85]

Soy-driven deforestation is not a phenomenon limited to the territory of Mato Grosso and the rest of the Legal Amazon, but it had – and continues to have – a planetary impact. In addition to the displacement of indigenous communities and the loss of animal and plant species, many of which were endemic, the greenhouse gas effect caused by deforestation is particularly significant. Based on a detailed calculation for 1990, greenhouse gas emissions from the Legal Amazon since the 1970s have had a significant impact on the global climate balance up to the mid-2000s. The share of Amazonian deforestation in global land use-related greenhouse gas emissions into the atmosphere fluctuated between 21 and 26 per cent during the first soy boom in the 1980s, peaking at 33 per cent in 1995 and 31 per cent in 2004 during the second soy boom; for Mato Grosso alone, the range was 5 to 7 per cent, with peak values of 12 and 13 per cent. Measured against global anthropogenic greenhouse gases in total, including emissions due to land use change and fossil fuel burning, the Legal Amazon accounted for 3 to 7 per cent and Mato Grosso alone for 1 to 2 per cent in this period. During the third soy boom, when losses of rainforest became a matter of international concern, its climate-related impact had already considerably declined. However, most of the deforestation-related carbon dioxide and other greenhouse gases since 1970 (Legal Amazon: 79 per cent, Mato Grosso: 82 per cent) had already been emitted into the atmosphere in the three and a half decades until 2004, and will remain there for centuries and millennia.[86] Soy-driven deforestation in the Amazonian Basin affected not only the regional climate by raising surface temperatures and reducing rainfall.[87] It has also been a significant driver of the planetary climate crisis – and, thus, of the Anthropocene.

Deepening soy's planetary footprint: The example of contamination

Whereas the widening of soy's planetary footprint, as indicated by deforestation-driven greenhouse gas emissions, peaked in the early Soyacene (until the mid-2000s), its deepening – as exemplified by herbicide contamination – was most prevalent in the late Soyacene (from the mid-2000s onwards). The third soy boom not only displaced species-rich grasslands,

85 Xiao-Peng Song et al., Massive Soybean Expansion in South America Since 2000 and Implications for Conservation, in: Nature Sustainability 4 (2021), 784–792; Erasmus K. H. J. zu Ermgassen et al., Using Supply Chain Data to Monitor Zero Deforestation Commitments: An Assessment of Progress in the Brazilian Soy Sector, in: Environmental Research Letters 15/3 (2020), 35003; R. D. Garrett et al., Intensification in Agriculture-Forest Frontiers: Land Use Responses to Development and Conservation Policies in Brazil, in: Global Environmental Change 53 (2018), 233–243; C. A. Silva/Mendelson Lima, Soy Moratorium in Mato Grosso: Deforestation Undermines the Agreement, in: Land Use Policy 71 (2018), 540–542.

86 Source: Fearnside, Greenhouse Gases. Accordingly, the clearing of one square kilometre of Amazon rainforest caused 71,388 tonnes of greenhouse gas emissions (CO2-equivalent) in 1990. Calculation by the author.

87 Rafaela Flach et al., Conserving the Cerrado and Amazon Biomes of Brazil Protects the Soy Economy from Damaging Warming, in: World Development 146 (2021), 105582.

shrublands, and forests, but also led to a socio-natural shift on the fields, where transgenic soy varieties replaced conventional ones. The U.S. biotech company Monsanto, which had been marketing the broad-spectrum herbicide glyphosate under the brand name "Roundup" since the 1970s, developed the "Roundup Ready" soybean variety, whose genetically engineered bacterial DNA confers glyphosate resistance, in the 1990s. The biotechnological package consisting of herbicide-resistant seeds and a matching herbicide promised a patent-protected solution to a major problem in commercial soybean cultivation: the labour- and capital-intensive weed control required during the early, slow growth phase of the plants. In addition to the economic arguments of simplification and cost reduction, product marketing also brought ecological arguments to the fore: protection against soil erosion through no-till cultivation and the reduction of herbicide use through increased efficiency. In short, transgenic soy embodied the logic of "ecological modernization." Following Monsanto's international market launch in 1996, a political controversy erupted in Brazil, with a coalition of technology corporations, government agencies, farmer lobbies, agricultural research institutions, and the mass media pushing through the legalization of transgenic soy – which was already being grown illegally in the southern areas of the country – temporarily in 2003 and permanently in 2005 despite strong resistance from civil society movements.[88]

The ambivalence surrounding "green genetic engineering" soon became apparent in the soybean fields of Mato Grosso. Following the approval of the new technology, the share of transgenic soybean varieties in the total acreage surged from 31 per cent in 2005/06 to 83 per cent in 2012/13 and peaked at 97 per cent in 2021/22.[89] At the same time, herbicide use exploded, with a significant turning point emerging in the early 2010s: The initially rising proportion of glyphosate use stabilized near the 50 per cent mark and eventually began to decline. Behind this lay a more-than-human dynamic beyond farmers' control: The excessive use of glyphosate in soy fields over several years created selective pressure for glyphosate-resistant "super-weeds," which farmers combated by using increasingly more and stronger herbicides such as the defoliant 2,4-D used by the U.S. Army during the Vietnam War (Figure 8).[90] The anticipated increases in land productivity to reduce deforestation pressure also failed to materialize.[91] Contrary to the promised simplification and cost reduction, transgenic soy cultivation became increasingly complicated and expensive. The fact that most soy farmers – with the few exceptions within non-transgenic supply chains – nevertheless clung to this contradictory technology illustrates the strong path dependence of the "transgenic treadmill." The increasing contamination of air, soils, and water in Mato Grosso's soy-growing regions has sparked numerous protests by adversely affected civil society groups in recent years. They criticize not only the scientifically proven increase of diseases among the rural population but also the deliberate use of herbicides as a weapon by soy farmers to drive

88 Renata Motta, Global Capitalism and the Nation State in the Struggles over GM Crops in Brazil, in: Journal of Agrarian Change 16/4 (2016), 720–727.

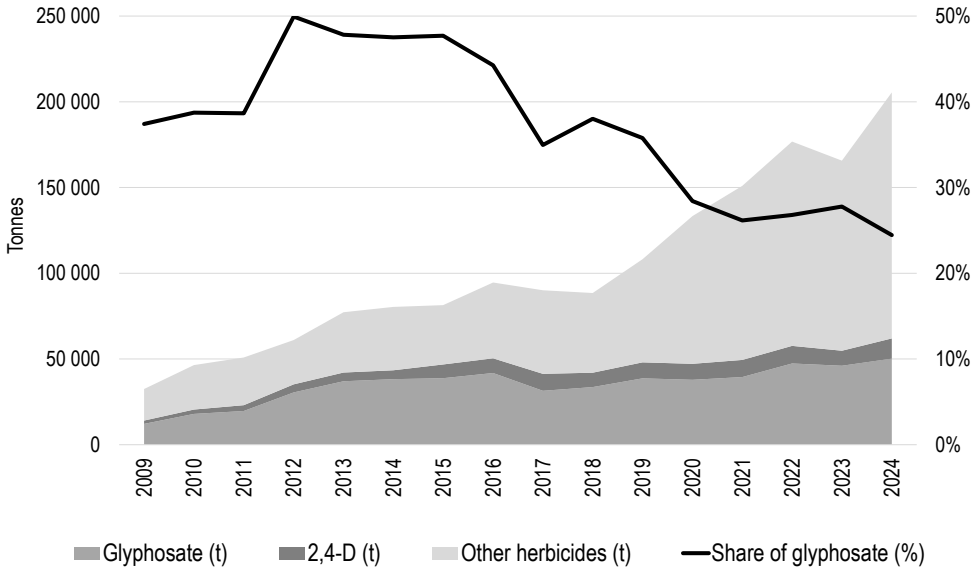
89 Source: Soja Livre Institute, https://sojalivre.com.br/ (22 March 2026). Calculation by the author.

90 Sergio de Oliveira Procópio et al., Impacts of Weed Resistance to Glyphosate on Herbicide Commercialization in Brazil, in: Agriculture 14 (2024), 2315; Vicente Eduardo Soares de Almeida et al., Use of Genetically Modified Crops and Pesticides in Brazil: Growing Hazards, in: Ciencia & Saude Coletiva 22/10 (2017), 3333–3339.

91 Sergio de Oliveira Procópio et al., Impacts of Weed Resistance; Vicente Eduardo Soares de Almeida et al., Use of Genetically Modified Crops; Mativi, Use of Glyphosate.

out small-scale farmers and indigenous residents living nearby.[92] The ecological-modernist utopia of soy-related biotechnology has turned into a socio-natural dystopia of planetary health – not only in Mato Grosso, but also in other regions within the global countryside.[93]

Figure 8: Herbicide application in Mato Grosso, 2009–2024



Source: IBAMA, Relatórios de comercialização de agrotóxicos, https://www.gov.br/ibama/pt-br/assuntos/quimicos-e-biologicos/agrotoxicos/relatorios-de-comercializacao-de-agrotoxicos (22 March 2026). Calculation by the author.

Conclusion

This essay addresses a twofold aim: On the one hand, it outlines a research agenda for planetary commodity history. It argues that a commodity lens enables the theoretical claims of planetary history to be put into historiographical practice. In this regard, historians should trace the planetary footprint of a commodity's more-than-human actor network, which comprises the deepening and widening of commodity chains and their flexible combinations, through multiple times and spaces. Soy serves as a key commodity of agro-food globalization in the long twentieth century. Against this backdrop, the universalist notion of the Anthropocene

92 Global Atlas of Environmental Justice, Pesticide Poisoning Linked to Agribusiness in Mato Grosso, Brazil, https://ejatlas.org/print/soy-expansion-and-pesticide-contamination-in-sorriso-mato-grosso-brazil (20 March 2026).

93 Federico Maggi et al., The Global Environmental Hazard of Glyphosate Use, in: Science of the Total Environment 717 (2020), 137167.

might be specified as a Capitalocene or even Soyacene. On the other hand, this essay presents a case study of planetary commodity history with a focus on the Brazilian state of Mato Grosso in the Anthropocene since the sixteenth century in general, and in the Soyacene since the late twentieth century in particular. It outlines the widening of soy's planetary footprint in terms of deforestation and global warming as well as its deepening with regard to herbicide contamination and planetary health. Mato Grosso as a soy hotspot reveals not only the socio-natural dynamics of commodity frontiers but also the transregional incorporation of this area into nation-state and global market dynamics via hierarchical commodity chains and other asymmetrical connections. Moreover, this case study provides empirical evidence for a periodization of the Anthropocene, one of the theoretical key challenges: colonial Anthropocene (16th–20th centuries), authoritarian Capitalocene (1930s–1980s), unleashed Soyacene (1980s–2000s), and organized Soyacene (since the 2000s). This periodization does not claim universal validity; rather, it is grounded in the particular regional trajectory of Mato Grosso. In comparison with further case studies in other regions, this bottom-up approach might offer a more convincing solution to the periodization problem than the prevailing top-down approach in Anthropocene history.

Maximilian Martsch

Why Soy Failed

Austria in Its Transnational Setting, 1870–1950

Abstract: This paper examines why soy was not successfully integrated into the Austrian agro-food system until the 1950s despite numerous attempts. The failure is framed as a 'bottleneck' issue in that the transfer of knowledge from the soy niche to the broader agro-food regime was impeded. Emerging from late nineteenth-century agronomic research, the soy niche became a space for experimentation fuelled by diverse actor networks of experts, publicists, and the general public. The bottleneck occurred in the early 20th century when soy was reintroduced as a potential substitute for scarce oils and foods during the First World War. However, conflicting views and insufficient coordination between institutions, policies, and actors stifled its widespread adoption. Efforts to promote soy cultivation and its use in food products failed largely because of ideological divisions and the contrast between agrarian autarky policies and market-oriented ventures. Although the Nazi regime temporarily expanded the bottleneck by incorporating soy into the war economy, postwar socioeconomic shifts led to its regression. As the economy recovered, soy was increasingly stigmatized as an inferior substitute, and meat reclaimed its dominant role as the preferred source of protein. This paper highlights how agro-food transitions are shaped by local conditions and complex, non-linear dynamics, underscoring the idiosyncrasies of national and regional development paths.

Zusammenfassung: Dieser Beitrag untersucht, warum Soja trotz zahlreicher Versuche bis in die 1950er Jahre nicht erfolgreich in das österreichische Agrar- und Ernährungssystem integriert werden konnte. Dieses Scheitern wird aufgrund des strukturell beeinträchtigten Wissenstransfers von der ‚Soja-Nische' in das breitere Agrarregime als *bottleneck*-Problem konzeptualisiert. Aus der agrarwissenschaftlichen Forschung des späten 19. Jahrhunderts hervorgegangen, entwickelte sich die Soja-Nische zu einem Experimentierraum, der von Akteursnetzwerken bestehend aus Experten, Publizisten und der allgemeinen Öffentlichkeit getragen wurde. Der *bottleneck* entstand zu Beginn des 20. Jahrhunderts, als Soja im Ersten Weltkrieg als potenzieller Ersatz für knappe Öle und Lebensmittel wieder ins Blickfeld rückte. Widerstreitende Positionen und mangelnde Koordination zwischen Institutionen, politischen Akteuren und Maßnahmen verhinderten jedoch eine breite Durchsetzung. Bemühungen, den Sojaanbau und die Verwendung von Soja in der Lebensmittelproduktion zu fördern, scheiterten vor allem an ideologischen Gräben sowie am Gegensatz zwischen agrarautarkistischen Politiken und marktorientierten Initiativen. Obwohl das NS-Regime diesen ‚Flaschenhals' vorübergehend ausweitete, indem es Soja in die Kriegswirtschaft eingliederte, führten die sozioökonomischen Verschiebungen der Nachkriegszeit

DOI: 10.25365/rhy-2025-4

Accepted for publication after external peer review (double-blind).

Maximilian Martsch, Department of Economic, Social and Environmental History, Johannes Kepler University Linz, Altenberger Straße 69, 4040 Linz, Austria, maximilian.martsch@gmail.com

The research for this article was funded by the Austrian Science Fund, Grant DOI: 10.55776/P35531, 2022–2026.

zu einem Rückgang. Mit der wirtschaftlichen Erholung wurde Soja zunehmend als minderwertiger Ersatzstoff stigmatisiert, während Fleisch seine dominante Rolle als bevorzugte Proteinquelle zurückgewann.

Keywords: soy, crisis, agricultural change, agro-food transitions

Introduction

In this paper, I attempt to answer the question why soy failed in Austria – or more precisely, why soy and its products did not become part of the agro-food regime despite numerous attempts to establish the East Asian cultigen.

Failure is a temporary assessment in this case, since soy has become an integral part of the Austrian agro-food system in recent decades – one could say that soy seems to be a success story in Austria after all. But from a historical perspective, it took more than a hundred years from the first large-scale field trials to a fully integrated field crop. However, I argue that until the end of the Second World War, there were many attempts to introduce soy and soy products as an innovative solution to regime-related problems. This raises the question of the factors behind the initial failure – a question often neglected by historical research, which tends to favour success stories of commodities, especially those with global implications like sugar, cotton, meat, or corn.[1] The issue that remains is how to frame failure. I propose a network-oriented approach taking into account the contingencies, relationships, actor agency, trends, and crises that affect the adoption of crops and thus the restructuring of the agro-food regime. This study therefore employs an integrative theoretical framework that brings together food regime analysis, transition theory, and commodity studies to investigate agro-food change. Food regime analysis situates agricultural development within shifting configurations of capital accumulation, regulation, and socio-natural relations. Transition theory explains how systemic crises open windows for innovation and regime transformation through the interaction of niches, incumbent regimes, and landscape-level pressures. Commodity studies operationalize these dynamics by tracing how specific goods such as soy embody and mediate broader structural changes over time. To investigate these processes empirically, the study draws on a wide range of archival sources, including over 1,500 contemporary newspaper articles, trade statistics, and administrative records from national and regional archives. A combination of qualitative and quantitative discourse analysis – including techniques such as principal component analysis – is used to examine the interplay between actors, institutions, and materialities across multiple scales. Together, these approaches offer a multi-dimensional perspective on both continuity and rupture in agro-food regimes, shedding light on how global and national dynamics, actor coalitions, and material constraints interact to shape the trajectories of crop adoption and agro-food change.[2]

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1 Sven Beckert, Empire of Cotton: A Global History, New York 2014; Ulbe Bosma, The World of Sugar: How the Sweet Stuff Transformed Our Politics, Health, and Environment Over 2,000 Years, Cambridge 2023; William Cronon, Nature's Metropolis: Chicago and the Great West, New York 1991; Arturo Warman, Corn and Capitalism: How a Botanical Bastard Grew to Global Dominance, 2nd ed., Chapel Hill 2003.

2 Ernst Langthaler/Maximilian Martsch/Gabriel Tober, Conceptualizing Historical Commodity Studies: The Case of Soy, in: Carmona-Zabala et al. (eds.), Commodities in History: Theoretical Reflections and Empirical Case Studies, Crete 2023, 59 f.

In his 2018 book *The Magic Bean*, Matthew Roth argues that the success of the soybean in the United States was the cumulative result of a combination of long- and short-term contingencies that ultimately created a coordinated network of institutional, private, governmental, and entrepreneurial actors in a multi-step process that established a certain path dependency, which Roth calls the "soybean pipeline." This pipeline illustrates the dynamics of spatial and functional networking that enabled the transfer of knowledge from the niche to the regime – or, geographically speaking, from one end of the world to the other.[3] The process began with the involvement of the US Department of Agriculture in the early 1900s and ended with the anchoring of the soybean pipeline in the New Deal programmes of the 1930s.[4]

Building on Roth's analysis of the US soybean pipeline, I argue that a combination of political regulation, knowledge and technology, and commodification created a bottleneck in Austria that prevented the long-term adoption of soy in agriculture and industry. Although the bottleneck was temporarily widened under the authoritarian war economy of the Nazi regime, soy's socioeconomic embeddedness was insufficient to maintain its status during the postwar renewal.

A bottleneck is a narrowing that impedes flow from one side to the other. It symbolizes an overbalance of negative, constricting forces over positive, expanding forces. Moreover, the bottleneck metaphor also signifies the existence of a diverse public and scientific discourse at the base of the bottle, where ideas about socioeconomic change and innovation associated with the diverse potential of the soybean and its products circulate. At different points in time, these ideas gained sudden popularity and attention but ultimately failed to be integrated into the existing agro-food regime.

The paper is divided into four episodes, each representing a distinct period in which soy was embedded in processes of restructuring and transitional change.

First episode: The allure of the unfamiliar (1873–1880s)

The first episode focuses on early soy research in the Austro-Hungarian Empire and the formation of an initial niche network of experts. It identifies scientific and agronomic curiosity, along with the effects of the ongoing agrarian crisis, as the main drivers of soy's introduction to the West and brief popularity. However, weak links between the niche and the dominant regime, a lack of commercial outlets, and a general reluctance to make long-term commitments and investments were the main constricting forces that caused the initial 'soy craze' to lose momentum quickly.

3 Matthew Roth, Magic Bean: The Rise of Soy in America, Lawrence 2018, 7.

4 This article does not offer a symmetrical comparison but instead employs the comparative perspective as a pragmatic entry point and narrative device. A more systematic analysis of soybean development in the United States is provided elsewhere in this volume (see the contribution by Ernst Langthaler and Natalia Ryzhova).

Early soybean research – Friedrich Haberlandt

Starting points are not always easy to determine for historical studies, but in the case of soy it is rather evident. The pivotal event for soy research in Austria was the Vienna World's Fair of 1873. Among its many visitors was Friedrich Haberlandt, a 46-year-old botanist and agronomist from Pressburg/Bratislava who had recently accepted a position in Vienna as a professor of botany at the newly founded *k. k. Hochschule für Bodenkultur*. As he toured the exhibition grounds, he came into possession of different varieties of the soybean or 'Chinese oil bean', as the plant was commonly referred to at the time due to its East Asian origin.[5] This visit marked the beginning of Haberlandt's soybean research, which he would continue until his death in 1878. It is no coincidence that Haberlandt is regarded as one of Europe's soy pioneers, since his research laid the foundation for what I will call the *soy niche*.[6]

In 1875, Haberlandt planted the seeds he had acquired in the experimental garden of the *Hochschule für Bodenkultur*. The trials delivered promising results, and by using a relatively simple form of empirical breeding, he succeeded in isolating early-maturing varieties that performed well under the local climatic conditions.[7] Encouraged by the healthy growth of the early-maturing plants, he decided to continue his trials in the following years.

The second phase of field trials facilitated the creation of an expert network driven by scientific curiosity and the potential of agricultural modernization. In 1876, Haberlandt sent seeds of his successfully grown brown-red and yellow-coloured varieties to eight agronomists in different parts of the Habsburg Monarchy and beyond: Hungary, Moravia, Banat, Styria, Bohemia, Bukovina, and Prussian Silesia.[8] Among these eight participants were two estate owners, one head gardener, one estate administrator, one professor, two economists, and one senior official (*Hofrat*).

The dominance of estate owners and state-funded agricultural colleges highlights the importance of established regime actors in the initial formation of the soy niche. The aristocratic Attems family was one example of the involvement of distinguished regime players in its development, while another central actor was at the spearhead of state-funded research in Hungary: the Hungarian Royal Agricultural Academy located in the small town of Ungarisch-Altenburg [*Magyaróvár*]. The academy was involved in the field trials from the very beginning and formed an important node in the nascent soy network. Not only was it the former workplace of Haberlandt and several of his colleagues at the *Hochschule für Bodenkultur,* but it also had close ties to the Hungarian Ministry of Agriculture.[9]

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5 During his visit, Haberlandt acquired 20 samples of late- and early-maturing soybean varieties from China (13), Japan (4), Transcaucasia (1), and Tunisia (1). Friedrich Haberlandt, Die Sojabohne: Ergebnisse der Studien und Versuche über die Anbauwürdigkeit dieser neu einzuführenden Culturpflanze, Vienna 1878, 6.

6 It is likely that Haberlandt was already familiar with soy at this time, as he mentions a publication discussing the chemical composition of 'Chinese oil beans' dating back to 1872: A. Stöckhardt/Emmanuel Senff, Untersuchung chinesischer Oelbohnen, in: Central-Blatt für Agrikulturchemie 1/3 (1872), 348 f.

7 Haberlandt, Sojabohne, 6.

8 Ibid., 19.

9 The only participating state institution outside the Austro-Hungarian Empire was the Agricultural Academy in Proskau [*Prószków*], Prussian Silesia (which was later incorporated into the Agricultural University of Berlin), which already implied the transnational ambition of Haberlandt's soy research at this early stage.

Each of the trial participants was given detailed instructions by Haberlandt, ranging from sowing and care to the final harvest of the beans. Even though Haberlandt did not personally supervise the field trials, he passed along his practical knowledge and was constantly updated on their progress. In this way, he transferred his knowledge and methods to the estates of his collaborators. Haberlandt and his fellow campaigners were especially interested in the agricultural potential of soy. Hence, the involved actors meticulously recorded the number and variety of the planted seeds as well as their reproduction rate. In addition, they also commissioned chemical analyses of specific seeds.[10]

Chemical analysis was deliberately employed to enhance the scientific credibility of the research. Agronomists and botanists worked with organic chemists to improve seed selection and breeding, seeking varieties with high protein and fat content. The nutritional value of soy was a compelling argument for its integration into farming systems. Haberlandt himself was convinced that this integration would have positive effects on national welfare. He poetically called the soybean the "miraculous stranger," emphasizing the unmatched nutritional value of the legume while also hinting at the allure of the unfamiliar.[11]

The third round of agronomic trials starting in 1877 was the most extensive yet. Seeds were now also sent to Germany, Switzerland, the Netherlands, and the Croatian coast. The vast scale of the experiments was aimed at incorporating international scholars into the research network. At the same time, efforts were made to disseminate knowledge about the soybean through regional channels. Agricultural schools played a crucial role in linking institutional research to practical application. These schools were also involved in agricultural extension, educating the rural population about the latest farming practices, machinery, and crops.[12] The state school for agriculture in Kotzobendz [*Chotěbuz/Kocobędz*] participated in Haberlandt's field trials, distributing yellow soybeans and cultivation manuals among 191 primary schools across Silesia. The acclimatization attempts carried out by these schools were ultimately intended to encourage regional farmers to adopt soy cultivation on their lands.[13] State-funded institutions such as agricultural schools were the testing grounds for agricultural innovations. Through these channels, the soy debate gained momentum, and knowledge began to spread independently in regional circles among experts, extension agents, small farmers, and laypeople. The regional establishment of small-scale soy research signifies that the soy niche had become increasingly diversified and heterogeneous.

During this time, the soy debate reached a climax; one might speak of a short-lived 'soy craze'. Scientists and the public seemed extremely enthusiastic about the soybean's nutritional and economic potential and predicted a glorious future. The *Neue Freie Presse* hailed soy as "a highly remarkable plant, which by all accounts will soon take its seat among our cultivated crops."[14]

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10 Haberlandt, Sojabohne, 30. In *Die Sojabohne*, Haberlandt mentions an analysis of harvested soybeans conducted by K. Zulkovski, a professor at the chemical laboratory at the Technical University in Brünn [*Brno*], which certified a high content of natural fats and proteins.

11 Ibid., 113.

12 Jonathan Harwood, Europe's Green Revolution and Others Since: The Rise and Fall of Peasant-friendly Plant Breeding, London 2012, 17.

13 Wiener Landwirtschaftliche Zeitung, 24 May 1879, 218.

14 Neue Freie Presse, 3 April 1877, 4. This and all further translations of quotes into English are by the author.

In 1878, Haberlandt published the results of the large-scale trials in his magnum opus *Die Sojabohne*. Sadly, he did not live to see the success of his work, as he passed away the same year. With his death, the soy debate shifted to a more economic focus. The appeal of the unfamiliar – the botanical curiosity – was replaced by a more pragmatic, rational attitude.

The agricultural crisis as a catalyst of innovation pressure

Austria-Hungary was deeply affected by the onset of the agricultural crisis in the 1870s, which brought about a sharp decline in the global market price for cereals. The global grain market was oversaturated by rising exports from the settler colonies during the first food regime.[15] Estate owners – especially in Hungary, the breadbasket of the empire – were confronted with a downward price spiral and fierce international competition that threatened to impinge on their economic lifeline.[16] The need to diversify agricultural production to offset missing revenue therefore became more urgent than ever. The agrarian crisis thus provided an unprecedented chance to convince farmers and estate owners who were desperately looking for alternative cash crops of soy's adaptability and profitability. There was a certain pressure to modernize and innovate, reflected in the soy advocates' tendency to stress the "glorious" and "miraculous" potential of the exotic cultigen.[17]

One of the most energetic soy propagandists in the early 1880s was Count Josef Attems, whose Styrian family was among the largest landowners in the Austrian half of the empire. Attems was convinced that the 'Chinese oil bean' had a great future in Austria. In an article in the *Wiener Landwirtschaftliche Zeitung* from March 1881, he reported on his success with soybean cultivation.[18] The experiments had begun on a small field on the family's seed breeding estate in St. Peter near Graz. Encouraged by the positive results, the cultivated area was expanded year by year to a maximum of one hectare. The harvest amounted to 1,030 kg of brown and 1,840 kg of yellow soybeans, a remarkable yield confirming Josef Attems' assessment that the soybean was suitable for cultivation in Styria and all other regions where maize could be grown. Particularly interesting is the rational tone of Attems' cultivation report in which he tried to evaluate soy's economic potential. Due to their high protein content, he estimated that soybeans should fetch a significantly higher market price than potatoes and corn. Considering the need for protein-rich crops in livestock farming, soy certainly had the economic potential to push back starchy forage plants.

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15 Harriet Friedmann/Philip McMichael, Agriculture and the State System: The Rise and Decline of National Agricultures, 1870 to the Present, in: Sociologia Ruralis 29/2 (1989), 93–117, 101; Mark Tilzey, Political Ecology, Food Regimes, and Food Sovereignty, Cham 2018, 99.

16 Harwood, Revolution, 21; Roman Sandgruber, Die Agrarrevolution in Österreich: Ertragssteigerung und Kommerzialisierung der landwirtschaftlichen Produktion im 18. und 19. Jahrhundert, in: Alfred Hoffmann (ed.), Österreich-Ungarn als Agrarstaat: Wirtschaftliches Wachstum und Agrarverhältnisse in Österreich im 19. Jahrhundert, Vienna 1978, 195–271, 250.

17 Haberlandt, Sojabohne, 113; Ernst Wein, Ueber den Anbau der rauhharigen Sojabohne in Bayern, Munich 1879, 50.

18 Wiener Landwirtschaftliche Zeitung, 16 March 1881, 160.

Estate owners' interest in soybeans led to a significant increase in seed stock. By 1878, seed availability had surged from 500–600 kg in 1877 to an estimated 50,000–60,000 kg.[19] In 1880, sixteen traders advertised soybean seed for sale, but its high cost – between 16 and 24 florins (fl.) per 100 kg – made it unprofitable as animal feed, especially since there was no established method of blending soy with other forage crops like clover or corn.[20]

For farmers, switching to a new crop was associated with high risks and costs. Not only was purchasing seed a major investment, it was also a bet on the future of the crop. The final yield of a new crop such as soy was impossible to calculate, not to mention whether a buyer could be found for the harvest. When using the harvest directly on the farm, for example as animal feed, the basic economic consideration was whether other fodder plants might offer the same utility at a lower cost.

Even though early soy proponents such as Haberlandt and Attems were eager to emphasize that soybeans were low-maintenance and resistant to pests and heat, and that the early-maturing yellow- and brown-seeded varieties were fully acclimatized to the wine and maize growing regions of the Austro-Hungarian Empire, acceptance among farmers and landowners remained low. This was primarily because the question of utilization remained unresolved.

For this reason, farmers initially only cultivated soy in smaller areas on a trial basis to better assess its properties and economic viability. The consistent result was that none of the farmers who experimented with soybeans in the late nineteenth century decided to adopt large-scale soybean cultivation on their farms. The soy debate thus went on until the participants could eventually decide on the future viability of the crop.

Although the summary of Attems' experimental soybean cultivation was consistently positive and the crop was predicted to have a bright future, the Attems family subsequently withdrew completely from the soy debate, with no evidence of their cultivation continuing. This example is indicative of the first phase of soy research and experimental growing: Even though the plant was considered suitable for cultivation, at least in the southern parts of the empire, there was one crucial element missing – the sales market.

Although the agricultural crisis prompted landowners to experiment with new crops and seek opportunities for diversification, it also limited their room for investments and their willingness to take risks. Most large landowners therefore eventually withdrew from soy experiments – at the very latest when the economic situation improved in the 1890s and agricultural prices stabilized once again. The supply of soybean seed on the market was correspondingly short-lived, and by 1890 only three commercial suppliers were left in business. The lack of a selling market was a clear obstacle to farmers' endorsement of the plant and one of the major reasons why the interest in soy faded, leaving it confined to a niche at the turn of the century. It is not surprising, however, that the soy debate would eventually resurface when the industry faced a scarcity of a vital component making up one-fifth of the soybean: oil.

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19 Wiener Landwirtschaftliche Zeitung, 1 March 1879, 84.

20 Edmund von Blaskovics, Die Sojabohne: Etwas über deren Cultur, Verwendbarkeit und Werth als Futtermittel, Vienna 1880. According to von Blaskovics, a major constraint on soy's use as animal feed was its price. The small cultivation area of soy resulted in a much higher market price compared to common forage like clover. Von Blaskovics therefore suggested adding soy as a high-energy supplement to more readily available types of forage. It could also present an alternative for regions with a shortage of inexpensive feedstuff rich in nitrogen and fats. Ultimately, the use of soy as forage for animal fattening never extended beyond experimental status in the Habsburg Monarchy.

Weak alliances and fading interest

After Haberlandt's death, his colleague at the *Hochschule für Bodenkultur*, Wenzel Hecke, continued his research as a "duty of friendship."[21] Hecke was a professor of agricultural economics and later appointed dean of the university. He coordinated and evaluated the next phase of cultivation trials with soybeans. In an open letter, Hecke called on all farmers who had carried out trials with soybeans to submit their reports to him. Just one year later, he summarized the results in a series of three articles in the *Wiener Landwirtschaftliche Zeitung*.[22] Hecke was also a consultant for the Imperial–Royal Ministry of Agriculture. In his dual function as a scientist and political advisor, he played a connecting role between niche scientific research and potential areas of practical application within the agricultural regime.

A key characteristic of the soy niche was that although it emerged at the fringes of the agro-food regime, it was supported and promoted by regime actors from the very beginning. These established regime actors had been involved in practical soy research on the side as a kind of intellectual hobby.

This loose connection between the actors began to falter when soy increasingly lost its novelty and was progressively demystified: Agrochemistry unravelled all its chemical components, numerous field trials made farmers familiar with the foreign crop, and botanists and agronomists even declared that the soybean was already fully acclimatized to parts of the Austro-Hungarian Empire.

The resulting question was what could be done with the soybean, and who would benefit from the introduction of the plant. The soy niche had to forge alliances with other academic fields and interest groups to emphasize its socioeconomic significance. A central argument in the publications by Haberlandt and his successors was that the consumption of soybeans could significantly improve the diet of rural and urban populations, especially the working class and the poor. Soy had the potential to close the protein and fat gap, which was a common feature of malnutrition resulting from a one-sided diet based on cheap carbohydrates. Furthermore, the increasing number of labourers in the industrial regions had high calorie requirements due to the physical strain of their work. Only very few working-class families could regularly afford to consume meat, which was considered the main source of quality protein at the time.[23]

Soy was presented as an ideal source of vegetable protein. Nevertheless, the scientific debate on soy was reduced to the areas of plant breeding and botany. There was no connection to the protein debate, which at the same time was playing an increasingly promi-

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21 Hecke was born in Reichenberg [*Liberec*], Bohemia, in 1824. He studied at the Agricultural College in Ungarisch-Altenburg [*Mosonmagyaróvár*] and was appointed as professor of agricultural economics at the *Hochschule für Bodenkultur* in 1872.

22 Wiener Landwirtschaftliche Zeitung, 1 March 1879, 84; Wiener Landwirtschaftliche Zeitung, 8 March 1879, 97–98; Wiener Landwirtschaftliche Zeitung, 15 March 1879, 109.

23 By the end of the nineteenth century, meat consumption was increasing, especially in cities. However, the lower classes mostly consumed low-quality cuts and cheap meat products. Roman Sandgruber, Die Anfänge der Konsumgesellschaft: Konsumgüterverbrauch, Lebensstandard und Alltagskultur in Österreich im 18. und 19. Jahrhundert, Vienna 1982, 153–171; Clara Nagele/Till Uschmann, Der Wiener Fleischkonsum 1830–1913, in: Friedrich Hauer (ed.), Die Versorgung Wiens 1829–1913: Neue Forschungsergebnisse auf Grundlage der Wiener Verzehrungssteuer, Vienna 2014, 51–70.

nent role in the emerging discipline of nutritional physiology.[24] In particular, the research by German nutritionist Carl von Voit made a significant impact in the academic community of the 1870s. At a physicians' congress in Munich in 1875, Voit presented a study in which he advised a daily protein intake of no less than 118 grams for a male labourer, half of which should be derived from animals, preferably through meat consumption.[25] The protein debate would have been a logical extension of the soy niche to expand the reach and connectivity of its research and agenda. However, the fact that this did not occur was characteristic of the nascent soy niche, which developed more in depth (regional embedding) than in breadth (scientific and social connectivity).

Furthermore, the links between the actors in the niche were relatively weak and underdeveloped. We can observe a high turnover of individuals and institutions joining and leaving the network. These fluctuations indicated unstable niche-regime alliances that impeded the development of a long-term agenda for soybean adoption.

The formation of the soy niche

The soy niche emerged in the late nineteenth century as a protected space. The actors involved were either scientists employed by state-funded institutions or estate owners and managers who could experiment with new crops as a secondary activity. The niche offered the setting for learning and experimentation in a supportive community.[26] Within it, knowledge about the soybean was circulated and multiplied through independent follow-up studies, correspondence, and publications.

This success was nevertheless temporary, since soy actors did not receive the acknowledgment and support of interest groups and scientific disciplines which were also concerned with matters of public nutrition at the time. Even though the soy network expanded and diversified, it remained relatively homogeneous at its core. Nearly all participants were active in the domains of agriculture or botany, and scientific debates mostly revolved around issues of cultivation and breeding. Ideas for practical applications such as troop provisioning, dietary supplements for the working class, or animal feed remained underdeveloped. This meant that the potential of soy remained largely unrecognized by fellow scholars and social activists. Although knowledge was constructed and circulated within the soy niche, it eventually dissipated due to the lack of perspective and outside support.

Furthermore, the economic potential of the bean was not pursued: Farmers who grew soybeans on a trial basis quickly abandoned their experiments because there was no market. Commercial processing and on-site use on farms were not explored. Although the agricultural crisis incentivized experimental cultivation, it limited the availability of capital and the willingness of entrepreneurs and estate owners to take risks.

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24 Kenneth J. Carpenter, Protein and Energy, Cambridge 1994, 77; Corinna Treitel, Eating Nature in Modern Germany: Food, Agriculture, and Environment, c. 1870 to 2000, Cambridge 2017, 96.

25 Carl Voit, Über die Kost in öffentlichen Anstalten, Munich 1876, 25; Carpenter, Protein, 89.

26 Julie Ingram, Framing Niche-Regime Linkage as Adaptation: An Analysis of Learning and Innovation Networks for Sustainable Agriculture Across Europe, in: Journal of Rural Studies 40 (2015), 59–75, 61.

Second episode: The rediscovery of soy – from a curiosity to a crisis product (1908–1920s)

The second episode is structured into three intertwined phases during which the soy question was revived under the prevailing issue of scarcity. The debate initially centred on a shortage of oils and fats for the industry; with the outbreak of the First World War, it increasingly became a matter of food shortages and self-sufficiency. Only after food security slowly began to improve in the early 1920s did public interest in soy and soy foods begin to fade again.

The oils and fats crisis as the catalyst of soy's revival

By the turn of the century, discourse around the soybean had gone relatively quiet even in scientific circles. The first flicker of renewed interest came in the wake of the Japanese victory in the war against Russia in 1905.[27] This outcome not only caused a geopolitical stir but also raised questions among nutrition scientists about the provisioning of the Japanese army. After the end of the war, the Austrian chemist Emanuel Senft published a widely noticed, three-part study on the rations of Japanese soldiers in the Viennese specialist journal *Pharmazeutische Post*. Senft analysed a large variety of Japanese army rations in terms of their nutritional value and ingredients, paying particular attention to foods containing processed soybeans. The idea of using soybeans to supply the army due to their high protein content and storability was not completely new; Haberlandt had previously already floated the same idea. But the Japanese victory against a major Western power framed soybeans in the context of military modernization. In addition, its success in the war secured Japan's influence over Manchuria, which facilitated the implementation of an imperial export-oriented expansion strategy for soybeans.[28]

Interest in Senft's study, however, was primarily fuelled not by jingoism or imperialism but by a global supply crisis in cottonseed oil. Soybeans offered a viable alternative for European oil producers, resulting in a first test shipment of Manchurian soybeans to Great Britain in 1907.[29] The key driver of this development was the industry's growing demand for oils and fats, particularly for the production of soap, paints, and margarine. Austria-Hungary experimented with soybean oil only a short time later, with the first deliveries arriving in the port of Trieste consisting of pressed soybean oil from British manufacturers. The Austrian media soon recognized the rising trade in soybean oil and acknowledged that the soybean

27 Christine M. Du Bois, The Story of Soy, London 2018, 46.

28 Carl Fruwirth, Die Sojabohne, in: Fühlings landwirtschaftliche Zeitung 64/3–4 (1915), 65–96, 65–66. Before the Russo-Japanese War, soybeans from Manchuria only went to Japan, but since then, through Japanese brokers, they were also shipped to North America and Europe. Hiromi Mizuno/Ines Prodöhl, Mitsui Bussan and the Manchurian Soybean Trade: Geopolitics and Economic Strategies in China's Northeast, ca. 1870s–1920s, in: Business History (2019), 1–22, 5. The ongoing economic struggle between Russia and Japan was reflected in the phenomenon of 'railway imperialism'.

29 Du Bois, Story, 46; Roth, Bean, 44; Mizuno et al., Mitsui Bussan, 11. The first test shipment of 100 tonnes reached Liverpool in August 1907, and just one year later, exports from Manchuria to Europe had grown to well over 1 million tonnes.

had become a serious competitor for established oilseeds on the global market due to its low price and ample supply.[30] What made soy appealing was its compatibility with existing cottonseed processing infrastructure, its relatively low price, and its versatility across multiple industrial applications.[31] The import of soybean oil led to a debate about customs duties in Austria, as domestic oil producers were afraid of being at a disadvantage due to competition from England. In the summer of 1909, Austrian oil producers wrote a memorandum to the Ministry of Trade expressing their concern about the growing sales of foreign soybean oil.[32] In the memorandum, the oil producers, led by Trieste-based cottonseed oil manufacturers, demanded an increase in import duties for soybean oil in order to mitigate the "danger of soybean oil for domestic oil production." The similarity between cottonseed oil and soybean oil, which resulted in analogous areas of use and made them direct competitors, was also noted. The manufacturers emphasized the outstanding properties of soybean oil:

> "Like cotton oil, it [soy oil] is above all an excellent cooking oil, which should also be suitable for the production of artificial butter and cooking fat, it provides a very good fuel oil and is perfectly suited for lubrication purposes due to its neutrality. Soap manufacturers also hope to obtain a cheap raw material from it."[33]

The memorandum eventually prompted the Ministry to conduct a special inquiry into the tariff classification of soybean oil. Due to its similarity to cottonseed oil, the proposal was to equalize the respective import duties. The customs issue remained unresolved, however, and the first soybean oil soon arrived from England. In 1909, there were at least two trial shipments of soybean oil from the port of Hull.[34]

Import volumes of raw soybeans via the port of Trieste were comparatively low and inconsistent. The Imperial–Royal Consulate General in Shanghai recorded a total export volume of 62 tonnes of soybeans to Austria-Hungary in 1910. In the following year, the volume dropped to near zero before rising to 102 tonnes in 1912.[35] The consulate's final assessment was nonetheless pessimistic: "For the Monarchy, the import of this promising product [soy] still seems unfeasible because of the high duty on legumes."[36] While soybeans were reclassified as oilseeds in Germany in 1910 and could thus be imported duty-free, they continued to be subject to the import duty for legumes in Austria-Hungary.[37]

The example of the fat and oil crisis shows how the inertia of the Ministry of Trade with regard to adjusting trade regulations and taxation prevented the import and thus the domestic processing of soybeans into oil. Although the oil-producing industry was keenly interested

30 Drogisten Zeitung, 23 July 1909, 264.
31 Ines Prodöhl, "A Miracle Bean:" How Soy Conquered the West, 1909–1950, in: Bulletin of the German Historical Institute Washington 46 (2010), 111–129, 119.
32 Drogisten Zeitung, 27 August 1909, 299–300. Soybean oil was subject to a lower duty rate than cottonseed oil (7.5 crowns per 100 kg compared to 40 crowns per 100 kg).
33 This and the preceding quote: Neue Freie Presse, 8 August 1909, 17.
34 William Shurtleff/Akiko Aoyagi, History of Soybeans and Soyfoods in Austria and the Austro-Hungarian Empire (1781–2020): Extensively Annotated Bibliography and Sourcebook, Lafayette 2020, 302.
35 Jahresbericht des k. u. k. General-Konsulates in Shanghai, für das Jahr 1912, Shanghai, 166.
36 Jahresbericht des k. u. k. General-Konsulates in Shanghai, für das Jahr 1911, Shanghai, 186.
37 Fruwirth, Sojabohne, 5; Prager Tagblatt, 22 July 1910, 10.

in the possibilities offered by soy, legal obstacles hampered the plant's establishment. Rather than a lack of industrial interest or technical feasibility, it was the absence of clearly defined and supportive institutional frameworks that impeded the formation of stable demand. Without tariff reforms or regulatory incentives, the potential uses of soy could not translate into broader market uptake. This tension between material potential and structural constraints on demand points to a recurring dynamic in the early history of soy in Austria-Hungary.

The soybean becomes a matter of sustenance – the First World War

With the outbreak of the First World War, imports of raw soybeans from the Far East were no longer an option for Austria-Hungary. After Italy joined the war on the side of the Entente, the subsequent naval blockade of the Adriatic Sea put a complete halt to the empire's maritime trade.

The soy debate was not settled but instead shifted to another area, since the question of economic independence was now much more pressing. The supply of everyday foodstuffs in general and stimulants such as coffee in particular became a growing problem as the war progressed.

Initially, soy was advertised as a substitute for coffee. Near Prague, the company Santosa produced a bean coffee made from soy, which it sold by mail throughout the monarchy. The company's advertising changed significantly during the war, and in one of its last newspaper campaigns, soy coffee was advertised as "war coffee."[38]

The tone of the soy debate also transformed in 1915: Soy was now increasingly associated with self-sufficiency and food security. It was also at this time that the debate split into two mostly separate camps: the popular camp, which considered soy to be the immediate solution to food shortages, and the scientific camp, which doubted the short-term impact of soybean adoption and questioned its general viability.

The contrast is manifest in two figureheads of the contemporary discourse. One was a leading expert in the field of plant breeding, Carl Fruwirth, while the other, Maurice Fürstenberg, was an amateur botanist and publicist from Styria.[39] Fürstenberg was the central figure of the populists proclaiming soy as the solution to all nutritional problems caused by the war. The global conflict was the catalyst that enabled the revival of the miraculous stranger: "The soybean was awakened from its slumber to new life – it is the World War that allows it to green and bear fruit again."[40] The foreword to Fürstenberg's 1916 booklet was written by none other than Gottlieb Haberlandt, son of Friedrich Haberlandt and professor of botany in Berlin. His appeal would end up becoming the guiding principle of the soy niche during the First World War: "The calm explanations of the man of science must find their echo in the loud call of the educated layperson."[41]

38 Prager Abendblatt, 3 March 1915, 8.

39 Fürstenberg even published two short booklets on the soybean during the war, one in 1916 and the other in 1917.

40 Maurice Fürstenberg, Die Einführung der Soja, eine Umwälzung der Volksernährung, Berlin 1916, 22.

41 Ibid., 1.

The basis of the popular camp within the soy debate consisted of small farmers and allotment gardeners who had little interest in macroeconomics or agrarian policy and were primarily interested in self-sufficiency and subsistence strategies. The actors involved were educated laypeople who acquired their knowledge through a trial-and-error approach and interpersonal exchange of know-how. This was not a centralized, unified organization, but rather a set of small regional groupings that communicated with each other through public lectures, articles in regional newspapers, and discussion groups. One of the most active regional actors was Edmund Pasternek, a teacher from Maxglan in Salzburg. From 1916 onwards, Pasternek wrote numerous articles, gave specialist lectures, carried out cultivation trials with soy, distributed seeds, and issued cultivation instructions.[42] The popular soy debate was mainly confined to the daily press and strongly inspired by the optimistic rhetoric of Fürstenberg's publications.

In contrast to the popular discourse, the scientific debate on the soy question continued to be largely concentrated in specialist journals, most notably the *Wiener Landwirtschaftliche Zeitung*. The most prominent actor in the scientific camp was Carl Fruwirth, who was not only a leading expert in legumes but had ample experience with soybean cultivation as well.[43] Fruwirth published several studies between 1914 and 1915 in which he discussed the use of soybeans.[44] He was less than enthusiastic about the propaganda writings of Fürstenberg, and his scientific assessment was much more cautious. In his review of Fürstenberg's soy booklet, Fruwirth taunted it as a "waste of paper" given the ongoing scarcity of resources.[45]

In a 1915 article in the *Illustrierte Landwirtschaftliche Zeitung*, Fruwirth argued against the expansion of soybean cultivation in Austria. The more northerly regions of the monarchy were generally unsuitable for cultivation, and the seed offered by the large European nurseries was not acclimatized for cultivation in Austria-Hungary. Nevertheless, he recognized the nutritional value of soybeans and suggested using existing stocks to offset the impact of food shortages in the short term.[46] Despite Fruwirth's active involvement during the war years, his scientific contributions were largely overlooked in the public discourse. Furthermore, his expertise also went unrecognized by the Ministry of Agriculture, which failed to consult him.

The government was the third player to engage in the soy question in the background. Driven by the dispute over soybean oil in the years before the war and the increasing supply shortages, the Ministry of Agriculture decided to intervene for the first time and carry out large-scale field trials with soybeans. The Committee for the Promotion of Medicinal Plant Cultivation was commissioned to carry out the trials. The leading committee members had backgrounds in medicine and pharmacology; none of them were involved in applied agriculture or had hands-on experience with soybean cultivation. The scientist in charge was

42 Salzburger Volksblatt, 15 November 1916, 5; Salzburger Volksblatt, 21 March 1917, 5. Pasternek gave several lectures on the cultivation of soybeans and overcoming food shortages in Salzburg and the surrounding region, e.g. in Hallein, Neumarkt, and Saalfelden in 1917.

43 Fruwirth had already carried out experiments with soybeans at the Agricultural College in Hohenheim and then continued his field trials at his farmstead near Amstetten.

44 Carl Fruwirth, Anbau der Hülsenfrüchte, 2nd edn., Berlin 1914; Carl Fruwirth, Hülsenfruchterbau, Friedrichswerth 1914; Carl Fruwirth, Oelfruchtbau, in: Wiener Landwirtschaftliche Zeitung 65/92 (1915), 681–683; Fruwirth, Sojabohne.

45 Wiener Landwirtschaftliche Zeitung, 20 February 1918, 103.

46 Carl Fruwirth, Die Sojabohne – jetzt, in: Illustrierte Landwirtschaftliche Zeitung 35/3 (1915), 13–14.

Emanuel Senft, who had caused a commotion in academic circles just before the war with his study on Japanese army rations. The field trials were carried out between 1914 and 1916, reaching their peak in 1916 with a total of 241 test locations spread across the Empire – except for Hungary. In the final report published in 1917, Senft concluded that "all excessive praise of soybeans and urgent recommendations for increased cultivation in Austria must be firmly rejected." This was a clear renunciation of the hopeful narrative of popular soy advocates. Senft further elaborated that these advocates "raise hopes in the widest circles that the plant is not yet able to fulfil." In summary, most field trials delivered mixed results or failed entirely. As a consequence, the committee reached the verdict that "soybeans can hardly be expected to bring about any changes or radical successes in Austria in the foreseeable future."[47] This clear statement put an end to the state's involvement in soybean research for years to come.

However, the field trials initiated by the Ministry of Agriculture during the First World War had two fundamental problems. Firstly, the seed sample was too small, with only two soybean varieties initially being tested: One yellow-seeded Manchurian variety from the Dresden nursery Gehe & Co., and a second yellow-seeded variety from northern China, which came from a soy food factory near Paris.[48] The selection of only two as yet untested soy varieties created a genetic bottleneck from the outset.[49] Secondly, the majority of the test fields were located north of the Danube in the Czech crown lands. Hungary did not participate in the field trials at all – an indication the growing dispute between the two parts of the empire.[50] This meant that there was a surplus of cooperation partners from areas that had already been classified as climatically unsuitable for soybean cultivation by nineteenth-century agronomists such as Friedrich Haberlandt, or more recently by Carl Fruwirth.[51]

These examples show that the soy question enjoyed a certain revival in the shadow of the war, though it did not produce a coordinated niche with a common agenda; rather, it generated a fragmented collection of several camps with different narratives and comparatively low levels of cohesion and cooperation. For the most part, popular discourse, scientific debate, and state involvement were completely separate from each other.

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47 This and the preceding quotes: Rudolf Kuraž, Anbauversuche mit gelbsamiger Sojabohne in Österreich. (Mit 10 Tafeln), Mitteilungen des Komitees zur staatlichen Förderung der Kultur von Arzneipflanzen in Österreich, in: Zeitschrift für das landwirtschaftliche Versuchswesen in Österreich 20 (1917), 177–211, 184. A lecture given by the chemist Leimdörfer on 20 March 1914 about the importance of oil cultivation for the national economy at the beginning of the war is highlighted as particularly influential in the report; for the text of the lecture, see Unsere Fettversorgung, in: Österreichische Chemiker Zeitung, 15 April 1915, 63–67.

48 Kuraž, Anbauversuche, 185–186. The factory near Paris was most likely Li Yu-ying's *Caséo-Sojaïne* in La Garenne-Colombes. William Shurtleff/Akiko Aoyagi (eds.), History of Soybeans and Soyfoods in France (1665–2015). Extensively Annotated Bibliography and Sourcebook Including Monaco, Li Yu-Ying (Li Shizeng), Society of Acclimatization, Lafayette 2015, 6.

49 Erich Stietz, Die Soja in der Weltwirtschaft: Ein Beitrag zur Ernährungs- u. Rohstoffwirtschaft der Erde, doctoral dissertation, University Gießen 1931. The ongoing war complicated the procurement of suitable seed material, which also indicates that no sufficient stockpile from previous cultivation trials existed in Austria-Hungary.

50 Ernst Langthaler, Dissolution before Dissolution: The Crisis of the Wartime Food Regime in Austria-Hungary, in: Richard P. Tucker et al. (eds.), Environmental Histories of the First World War, Cambridge 2018, 38–61, 50.

51 Later publications also criticized the conditions and methods of the cultivation trials. Wiener Landwirtschaftliche Zeitung, 9 March 1932, 113–114.

Enduring food shortages as a testing ground for soy foods

After the end of the First World War, the issue of shortages and food insecurity dominated the newly proclaimed Republic of (German-)Austria. Especially alarming was the shortage of much-needed coal and basic foods. Austerity and rationing remained the reality of life for most parts of the population even years after the end of the war. Food stamps, which were introduced during the war to manage shortages of essential commodities such as bread, flour, sugar, potatoes, milk, and fat, were issued by the state until the early 1920s. Only once the availability of consumer goods slowly began to improve was the use of ration cards gradually phased out.[52]

During this period of economic uncertainty and social hardship, a Hungarian food chemist developed an improved milling process for soybeans that opened up new avenues of commercial exploration. This invention solidified the re-evaluation of soy as a human food, causing other aspects of utilization to fade into the background. The creator behind this invention was László Berczeller, a 30-year-old nutritional chemist from Budapest.

In 1921, Berczeller developed a novel production method for a wholesome soy flour that retained the full fat content of the bean.[53] Berczeller soon found a strong financial investor in the Scottish chemist and entrepreneur Robert Graham, who was prepared to turn his invention into a product. Graham was already an experienced entrepreneur in the food business, having established the Veda Bread Company in 1900.[54] He and his staff were experimenting with the development of soy foods in Vienna to find a "nutritive, inexpensive food for the starving children of Austria and Central Europe", as Graham himself framed it in a letter printed in the *London Times*.[55]

The collaboration between Berczeller and Graham soon yielded its first results. In an article in the London Times on 28 September 1921, Berczeller reported on his soy research and introduced a range of soy-based products (bread, flour, and milk) to be launched under the biblical brand name 'Manna'.[56] The telling label represented the company's ambition to bring a revolutionary popular food to market that might help to fight hunger worldwide. In the article, Berczeller specifically claimed that soy products could be exported in large quantities from the production facility in Vienna to Russia to ease the hardship of the famine raging

52 Neues Wiener Journal, 15 January 1921, 3.

53 In January 1921, Dr. Ladislaus Berczeller applied for his first patent for a *Verfahren zur Veredelung von Sojabohnen* (process for improving soybeans) in Austria. He developed a process to remove "rancid and noxious substances" from the beans by treating them with steam before drying: Soaked or germinated soybeans are treated with saturated steam at 100 C for 10 to 20 minutes. They absorb only small amounts of water and should be dried before being processed as a whole into flour. The gentle distillation process preserved the albuminous constituents of the bean while greatly improving digestibility and taste. Nevertheless, the approval process dragged on for years, and the patent was not granted until 15 January 1926. It was filed under Patent No. 106346 and guaranteed legal protection for 15 years.

54 Veda produced an enriched bread made with malted wheat that resulted in a sweet flavour. It was quite popular at the time and is still sold in Northern Ireland today. Graham's influence and entrepreneurial background were clearly evident, as Berczeller's soy bread likewise contained malted grain and was described as having a slightly sweet taste similar to Veda bread.

55 London Times, 29 September 1921, 11. The letter was a response to a previously published article in the September issue of the same newspaper entitled *Manna*.

56 London Times, 28 September 1921, 11–12. In the Bible, *manna* was the food sent from God to save the starving Israelites on their march through the desert.

there.[57] This lofty promise must be dismissed as a publicity stunt, however, for at the time Berczeller and Graham were far from having an efficient facility to implement large-scale production of soy foods in Vienna. Moreover, all the required soybeans would have had to be imported, since there was no domestic cultivation in Austria.

Manna bread was launched in 1921 and could be bought without rationing cards.[58] The price was initially set between 40 and 50 crowns per loaf (320 grams). The food factory *Stumpf & Söhne* in the Vienna district of Hietzing produced the bread on commission for the *Mannabrotgesellschaft* established by Robert Graham. The key selling point of Manna bread was that it delivered higher nutrient content for a competitive price.[59] Yet the product was unable to fulfil this promise, as it was around 50 per cent more expensive than regular bread due to rising inflation.[60] Even though it had a higher nutritional value, it ultimately failed to win over consumers.

Overall, the success of Manna bread seems to have been short-lived, since there are no references to the company's operation or newspaper advertisements to be found after 1922. The commercial failure of Manna bread as well as legal and interpersonal disputes appear to have been the reason why Berczeller and Graham eventually decided to go separate ways.

One plausible explanation for the product's lack of success may have been the traumatic experiences of war food shortages and rationing. Since bread and flour had been subject to rationing measures from 1915 and the supply situation continued to deteriorate until the end of the war, a wide variety of substitute products were introduced to the market. Under the name *Kriegsbrot* (war bread), scarce cereal flours were replaced by surrogates such as corn, potatoes, or – during the worst times – sawdust.[61] The memory of austerity and inferior substitutes continued to affect the collective consciousness even after the war, and a new food product using an exotic bean as an additive to bread thus likely held little appeal for consumers. Even though the high nutritional value and wholesomeness of soy flour as a low-cost meat substitute were advertised, Manna bread was burdened with the stigma of an ersatz product.[62] Another factor was the dire economic situation in postwar Austria and the increasing devaluation of the crown currency. The inflation rate reached a high point between the summer of 1921 and 1922. During this time, monthly consumer price increases reached

57 William Shurtleff/Akiko Aoyagi, Laszlo (Ladislaus) Berczeller – History of His Work with Soyfoods and Edelsoja Whole Soy Flour (1871–2020): Extensively Annotated Bibliography and Sourcebook, Lafayette 2020, 23. Interestingly, Ukraine is one of the main producers of soybeans in Europe today.

58 Christian Mertens, Die Auswirkungen des Ersten Weltkriegs auf die Ernährung Wiens, in: Alfred Pfoser/Andreas Weigl (eds.), Im Epizentrum des Zusammenbruchs: Wien im Ersten Weltkrieg, Vienna 2013, 162–171, 163. Due to its soy content, Manna bread could be sold freely and was not affected by the rationing measures. At the time, food stamps regulating the distribution of bread were still being issued in Vienna. Ration cards were introduced in the Austro-Hungarian Monarchy as early as 1915 to manage supply problems caused by the war.

59 Wiener Allgemeine Zeitung, 16 November 1921, 9. The first mention of *Manna Brot* came a few weeks earlier: Reichspost, 23 October 1921, 9; Deutsches Volksblatt, 23 October 1921, 7.

60 Deutsches Volksblatt, 22 January 1922, 9.

61 Langthaler, Dissolution, 52–53.

62 J. Fiehe, Über Sojabohnen und Sojabohnenbrot, in: Zeitschrift für Untersuchung der Nahrungs- und Genußmittel (1925), 45–51, 51.

a peak of 38 per cent. Food was especially affected, highlighted by the fact that food price subsidies constituted up to 55.6 per cent of government spending.[63]

The creation of the soybean bottleneck

The three phases outlined above illustrate the revival of the soy question and the soy niche. It is evident that new actors and institutions were embracing soy and discussing it as a solution to the growing supply crisis. Soy was first integrated into a global trade market as a source of oil and fat and then re-evaluated as a human food during the war. However, the intensive debates by various interest groups did not lead to the formation of a clear development path by which soy found its way into the agro-food regime. Rather, there were numerous setbacks and inhibiting factors that contributed to the formation of a bottleneck preventing the widespread adoption of soy.

The first of these was the reluctance of the Austro-Hungarian government to act during the global oils and fats supply shortage. The unresolved issue of customs clearance for raw soybeans and soybean oil was a source of uncertainty for the domestic oil industry and discouraged entrepreneurial initiatives to explore the industrial use of soybeans as an alternative source of oil. The result was that other European countries such as England, France, and Germany were able to develop a competitive advantage over Austria-Hungary. Secondly, although the division of the soy debate into different camps ensured widespread exposure among the public as well as among experts, it resulted only in limited cohesion and coordination between the actors. Thirdly, the postwar collaboration between Berczeller and Graham is a concrete example of a failed regime-niche alliance. It was the first time that a marketable soy product was introduced in Austria, but the commercialization attempt ended in a dispute between the two involved parties, who could not agree on the direction and profitability of the company. Over the next few years, Berczeller continued to try to capitalize on his soy patents and find new investors, while Graham withdrew from the Austrian soy business.

Third episode: Renewed state involvement and commercialization attempts – *Edelsoja* (1924–1930s)

The drivers behind the soy debate in the late 1920s were the quest for national independence in the oilseed and animal feed sectors on the one hand and the rising cost of living in the wake of the 1930s economic crisis on the other. These factors once again provided a window of opportunity for soy.

63 Peter Eigner (ed.), Österreichs Wirtschafts- und Sozialgeschichte im 19. und 20.Jahrhundert: 175 Jahre Wiener Städtische Versicherung, Munich 1999, 144.

The introduction of the state soybean breeding program

In 1924, soybeans were included in the state breeding program for special crops. This meant that the acclimatization trials with soy were now supervised by the Federal Institute for Plant Cultivation and Seed Testing in Vienna under its head commissioner, Dr. Fritz Drahorad.[64] The chief plant breeder became Anton Brillmayer, who had been conducting trials with soybeans on a farm in Platt, Lower Austria, since 1920 and had successfully isolated high-yielding varieties.[65] After the Lower Austrian Chamber of Agriculture became aware of Brillmayer's promising work, he was approached by Drahorad. Their combined efforts facilitated the expansion of experiments, which resulted in the registration of several acclimatized soybean varieties by the end of the 1920s.

A major advance in Brillmayer's cultivation trials was the large variety of cultivars. Seeds from different regions were tested, including American and Chinese varieties.[66] Brillmayer even exchanged ideas with Chinese experts on breeding methods and varieties.[67] In Austria, cultivation was considered viable in all regions where maize reaches maturity. Extremely early-maturing varieties and varieties for green fodder production were also tested in harsher conditions and at higher altitudes. By 1928, a network of 20 soybean seed propagation stations in Lower Austria, Upper Austria, and Styria had been established. The breeding stations affiliated with the Federal Institute for Plant Cultivation and Seed Testing also transitioned to growing only yellow-seeded varieties suitable for industrial utilization.[68] By 1933, the institute had supplied soybean seed to 609 farmers, and a range of 102 soy varieties was subject to continuous testing.[69] The institute had apparently learned from the mistakes of the soybean cultivation trials during the First World War and concentrated its efforts on climatically suitable growing locations and marketable cultivars.[70]

In 1929, Brillmayer and Drahorad published an informative soy booklet containing all necessary practical information for farmers and interested laypeople. In the foreword, the authors stated that the circulating misinformation about the plant and the large number of inquiries they received from farmers over the years had prompted them to write the book. Accordingly, the focus was less on scientific completeness and more on compiling a practical guide informing readers about care, benefits, and potential uses of the plant.[71] This was a general trend; in the course of the 1920s, the soy debate gradually shifted in the direction

64 Fritz Drahorad was the former assistant to Tschermak von Seysenegg at the *Hochschule für Bodenkultur*, and worked intensively with soybeans himself. Franz Anton Brillmayer, Die Kultur der Soja in Österreich, Vienna 1947, 13.

65 The origin of the seeds with which Brillmayer began his experiments in Platt in 1920 is curious. According to his statement, the seeds were the contents of a matchbox he received from a prisoner of war returning from Siberia after World War I. Ibid., 12.

66 Fritz Drahorad/Franz Anton Brillmayer, Die Sojabohne, ihre Bedeutung, Kultur und Verwendung, Vienna 1929, 46.

67 Brillmayer, Kultur, 13.

68 Österreichisches Staatsarchiv (ÖSTA), Archiv der Republik (AdR), Bundesministerium für Land- und Forstwirtschaft (BM.f.Land.u.Forstw.), 1187 c, 1717/1933. Black and brown varieties were excluded from breeding for industrial purposes because they led to an unwanted dark colouring of the flour after milling.

69 ÖSTA, AdR, BM.f.Land.u.Forstw., 1187 c, 1717/1933.

70 Drahorad/Brillmayer, Sojabohne, 39.

71 Ibid.

of market utilization and economic benefits, while the primarily scientific aspects of soy research remained confined to academic circles. The aim was to convince farmers and industrialists of the economic and nutritional benefits of domestic soybean cultivation.[72]

The Federal Institute for Plant Cultivation and Seed Testing worked in close cooperation with the Ministry of Agriculture and Forestry; archival records document a lively interinstitutional exchange. The profitability of soybean cultivation in Austria in particular was a constant topic of discussion.[73] Expert assessments regarding soybean cultivation were now consistently positive, emphasizing the economic benefits for farmers since plant protein had a very high market price and could also be used as a feed additive on farms. Soybeans provided the greatest possible amount of high-quality nutrients per area without degrading the soil and without adding additional labour and machinery costs. The institute's soy promotion campaign was particularly successful with small farmers in the lower Alpine regions who tried growing soy on a small scale for green fodder and protein feed – though the success rate was rather mixed.[74] Small-scale soy farming in Upper Austria was finally abandoned completely in 1934, as it was impossible to consistently achieve reliable harvests.[75]

Since yields were inconsistent, many farmers decided against storing part of their soybean harvest as seed and instead sold it on the market for a high price. Selling it as animal feed was not lucrative since Austria was flooded with cheap soybean meal from abroad at the time, making it economically unviable to compete on that market. The practice of using dried soybeans as animal feed was not widespread in Austria either: As early as the late 1920s, soybean meal was one of the cheapest protein feeds available on the market.[76] For this reason, the soybean breeding operation in Platt was scaled back, as there was little demand for seed. Only around 1,000 kg of soybean seed could be sold each year.[77]

Besides its use as protein feed, Brillmayer and Drahorad argued that it would be even more efficient to use soy directly as human food than to "send it through the animal body." [78]

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72 Ibid., 11.

73 ÖSTA, AdR, BM.f.Land.u.Forstw., 1187 c, 1717/1933, 1–2.

74 Drahorad/Brillmayer, Sojabohne, 83. Some experiments were carried out with black-seeded soybean varieties, which were particularly suitable for green fodder production in the low mountainous regions of the Alpine foothills due to their bushy growth. In contrast to the USA, the use of green soy plants for silage was not field-tested in Austria. Only a few feeding trials were carried out over the years, and even at the end of the 1920s, von Blaskovics' study from 1880 was still regarded as the reference work.

75 Heinrich L. Werneck, Die naturgesetzlichen Grundlagen der Land- und Forstwirtschaft in Oberösterreich: Versuch zu einer Pflanzengeographie und -Ökologie, in: Jahrbuch des Oberösterreichische Musealvereines (1934), 165–440, 304; Arnold Kornfeld, Die Ölbohne oder Soja, Hamburg 1935, 22. In addition, many soy plants were affected by a bacterial disease.

76 Ernst Langthaler, Die beschleunigte Modernisierung. Österreichs Agrarentwicklung zwischen Krise und Boom (1930–1960), in: Hannes Stekl (ed.), Österreich – was sonst? Ernst Brückmüller zum 70. Geburtstag, Vienna 2015, 204–228, 209. Since 1922, Austrian agricultural policy has pursued a course of moderate agricultural tariffs. The specific import numbers for soybean meal and cake are not available for Austria since animal feed and oilcakes were each summarized in a single category. What can be deduced from the figures, however, is that imports of feed meal and oilcake far exceeded exports, and that the import figures increased annually. Bundesministerium für Handel und Verkehr (ed.), Statistik des auswärtigen Handels Österreichs im Jahre 1929, Vienna 1930, 61.

77 Brillmayer, Kultur, 14–15.

78 Drahorad/Brillmayer, Sojabohne, 61–62.

Brillmayer was one of the advocates of Berczeller's full-fat soy flour, as it contained all the valuable nutrients of the soybean, including not only fat but also important vitamins and lecithin. The other option was the milling of oil extraction residue into so-called vegetable protein flour. This soy flour had a lower nutritional value and calorie count, but the previously extracted oil could be used for various industrial purposes, making its use more flexible.[79] Austria ultimately took the path to commercial use of full-fat soybean flour, with the processing of soybeans into two different raw materials, oil and cake, assuming a subordinate role.[80]

Drahorad published a two-part article on soybean cultivation in Austria in the *Wiener Landwirtschaftliche Zeitung* in April 1932. Although he maintained a positive attitude towards the expansion of soybean cultivation in Austria, he nevertheless concluded that "[…] considering the current agricultural crisis and the low price of foreign soy, large-scale cultivation can only be advised if the yields per hectare warrant profitability."[81]

Profitability was the biggest obstacle, as the yields per hectare and the lack of domestic selling opportunities made farmers reluctant to adopt soy. The Federal Ministry of Agriculture and Forestry therefore concluded that soy only had a chance in Austria if its oil could be processed and utilized domestically.[82] From 1925 onwards, Austria imported an increasing amount of soybean oil.[83] Throughout the 1920s, soy oil could be purchased via the commodity exchanges in Hamburg and Trieste.[84] The import figures more than tripled within a few years, from 891 tonnes in 1925 to 3,788 tonnes in 1928. Soy oil imports even surpassed those of coconut oil and palm oil for several years. The constant supply of Manchurian soybeans kept global market prices low. Moreover, production was able to meet the rising global demand: Until 1928, Austria did not import notable amounts of raw soybeans, which also indicates the lack of a domestic processing industry. Drahorad was convinced that the best way to overcome the agricultural crisis was the "conquest of the domestic market", which included breaking away from import dependencies.[85] Striving for national autarky was a programmatic demand that derived from the experience of hunger during the First World War and gained popularity during the interwar period. The aim was not to increase competitiveness on the world market but to protect domestic agriculture from excessive dependency on external suppliers and thus strengthen the national economy.[86]

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79 Ibid., 19.

80 Ibid., 28. By contrast, oil extraction played an important role in Germany. The *Hansamühle* in Hamburg, the largest soybean-processing oil mill, was able to process around 300 to 400 tonnes of raw beans a day. The extracted oil was mainly used in soap and margarine production, while the meal was sold as animal feed for the dairy industry and pig fattening.

81 Wiener Landwirtschaftliche Zeitung, 9 April 1932, 114.

82 ÖSTA, AdR, BM.f.Land.u.Forstw., 1187 c, 1717/1933, 2.

83 Stietz, Soja, 38–39. By the late 1920s, Germany had transitioned from being a net importer of soy oil and meal to becoming a net exporter and one of the main suppliers of soybean products in Central Europe. Already by 1927, soy cake was the most-fed oilcake in Germany's livestock industry.

84 William Shurtleff/Akiko Aoyagi, History of Soybeans and Soyfoods in Italy (1597–2015): Extensively Annotated Bibliography and Sourcebook, Including Soyfoods in Italian-Style Products from Other Countries, Lafayette 2015, 116. Soybeans were directly processed in the oil industry in Trieste. Italy was one of the main suppliers of soybean oil and cake for Austria, as the foreign trade records show.

85 Wiener Landwirtschaftliche Zeitung, 16 April 1932, 123.

86 Frank Uekötter, Die Wahrheit ist auf dem Feld. eine Wissensgeschichte der deutschen Landwirtschaft, 2nd edn., Göttingen 2012, 190–191; B. Heinze, Die Entwicklung der Sojabohne oder Kaffeebohne (Soja hispida Mönch) und ihre Verwendung, in: Naturwissenschaften 4/32 (1916), 478–480; Susanne Heim, Forschung für die

Although the cultivation of oilseeds and animal feed was to be increased in Austria, no incentive program for soybean cultivation was introduced to offset market disparities in the form of direct subsidies or fixed purchase prices. The development of the soybean cultivation area was correspondingly modest: Brillmayer spoke of around 5 hectares in 1928, including small farms and breeding stations in Lower and Upper Austria as well as Styria.[87] The International Institute of Agriculture in Rome estimated a total area of 64 hectares by 1930 for Austria.[88] The problem was not the lack of tested quality seed but the missing incentives for small farmers to switch to the new crop.

Kupelwieser's Edelsoja

The failed market launch of Berczeller's soy flour put a stop to further commercialization attempts with soybean products in Austria for the time being. Berczeller himself sought success abroad, travelling through Europe in the mid-1920s and trying to convince policymakers and entrepreneurs of his manufacturing process. He went to London, where he met Winston Churchill at a soy foods dinner, and made his first trip to the Soviet Union. He was also welcomed personally by Benito Mussolini, who hosted a soybean dinner and was captivated by the idea of substituting wheat with soybean flour to ease supply shortages.[89] In the end, Berczeller did not have to travel far to find a new business partner with whom to revive his soy endeavours in Austria. More precisely, his new associate turned out to be a long-time colleague at the Physiological Institute of the University of Vienna, Dr. Ernst Kupelwieser.

Berzceller's Austrian patent for the production of full-fat soy flour was legally approved in 1926 and immediately sparked brisk academic interest. Several scientific papers dealing with the potential of soy flour from a nutritional and economic point of view were published. One of the hot spots of research was the Physiological Institute of the University of Vienna. Besides Berczeller and Kupelwieser, the institute's director Prof. Dr. Arnold Durig and Dr. Helene Wastl were among the first to write about the possibilities of soy flour.[90] In a 1926 article, Wastl endorsed the introduction of soy flour as a public food with economic reasoning.

> "Since Austria's domestic production of foodstuffs is far from sufficient, imports play an important role. In particular, animal products with their high prices are one of the largest items in our negative trade balance since the war. At the same time, the peace-

Autarkie: Agrarwissenschaft an Kaiser-Wilhelm-Instituten im Nationalsozialismus, in: Susanne Heim (ed.), Autarkie und Ostexpansion: Pflanzenzucht und Agrarforschung im Nationalsozialismus, Göttingen 2002, 145–179, 147. In the German agricultural policy of the interwar period, the demand for autarky in the oilseed and animal feed sector was supported by similar arguments.

87 Drahorad/Brillmayer, Sojabohne, 13.

88 Institut International D'Agriculture, Le soja dans le monde, Rome 1936, 263.

89 Shurtleff/Aoyagi, Berczeller, 7.

90 A. Durig wrote an unpublished article in December 1926 entitled *Soya als Nahrungsmittel*. Helene Wastl, Das Sojamehl als Nahrungsmittel, in: Fritz Löw (ed.), Arbeiten ueber das Berczeller'sche Sojamehl, Vienna 1928, 1–7.

time standard of living in Austria for the majority of the population is still inadequate, and this is especially true for the protein standard."[91]

Wastl's emphasis on a rational economy highlighted the importance of a balanced trade regime to maintain a well-fed population and improve economic output. Consumption of soy flour could improve people's nutrition thanks to its wholesomeness and high nutritional content (protein, fat, lecithin, vitamins, etc.). This applied especially to financially disadvantaged social strata, which were more severely affected by the economic problems after the First World War. In this context, Wastl stressed the significant price advantage of soy over meat as a protein source. She therefore saw the greatest potential of soy flour as an additive in bread, the most important popular food.[92] Yet even if soy flour could address this nutritional gap, its acceptance depended on whether consumers and institutions recognized it as a viable and desirable substitute. Demand was therefore not only economically but also culturally constrained.

In 1926, Wastl and Berczeller jointly published an article in the *Wiener Medizinische Wochenschrift* entitled *On the Nutritional Question of Europe*.[93] In its very first sentence, they tellingly defined national nutrition as a "border area between nutrition physiology and economics."[94] The overall goal was to combine scientific knowledge from both research areas to optimize the diets of the general population in both economic and nutritional terms. While the joint publication did not focus on the use of soy flour, it provided statistical evidence that the nutritional situation in Europe had barely improved since the end of the First World War. The solution, the authors argued, could only be a general reduction in the cost of wholesome basic nutrition.

Scientific study of the soybean convinced Ernst Kupelwieser that the commercial development of soy products and their sale had enormous potential. He met with Berczeller several times to explore the possibility of entrepreneurial collaboration.[95] After securing the patent rights for Austria from Berczeller and meeting with various potential investors, Kupelwieser finally managed to strike a preliminary deal with the Viennese food manufacturer Wetzler & Co. in August 1927. The agreement set the terms for the foundation of the *Österreichische Soja-Ges.m.b.H.*[96]

The new product would be called *Edelsoja*, with this name deliberately chosen to counteract the war stigma of soy flour as a substitute commodity. The prefix '*edel*' (noble) signified the premium and refined quality of the new product. The Austrian Soybean Association

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91 Helene Wastl, Das Sojamehl als Nahrungsmittel, in: Wiener Medizinische Wochenschrift 76/41 (1926), 1209–1214, 1213.

92 Ibid., 1213.

93 Ladislaus Berczeller/Helene Wastl, Zur Ernährungsfrage von Europa: Separatdruck aus der "Wiener Medizinischen Wochenschrift" 1926, Nr. 48 und 49, Vienna/Leipzig 1927. The article was republished as a booklet in 1927.

94 Berczeller/Wastl, Zur Ernährungsfrage, 3.

95 Kupelwieser Privatarchiv (KPa), Letter from Ernst Kupelwieser to Franz and Marianne Kupelwieser, 21 September 1926. At the time, Ernst Kupelwieser was in a financial predicament. He came from one of the great business families of the Austro-Hungarian Empire, but the end of the monarchy ushered in the family's financial decline. This placed additional pressure on Ernst to support his parents financially and try to preserve the family wealth. His employment as an assistant and lecturer at the Physiological Institute gave him a secure basic income. However, Kupelwieser was not particularly interested in a scientific career and therefore in search of alternative sources of income.

96 KPa, Letter from Ernst Kupelwieser to Franz Kupelwieser, 12 August 1927.

advertised for it with the slogan "The soybean, boneless meat and milk of the Far East for 4,000 years. Adapted to European taste, *Edelsoja* is a new food for us."[97]

The product launch was accompanied by a large-scale media campaign.[98] Kupelwieser was also able to secure the support of the Union of Austrian Women's Associations (*Bund Österreichischer Frauenvereine*) and the Federal Cooking Academies (*Staatliche Kochlehranstalten*) with the intent to appeal to the primary consumer group: housewives. The strategy was not to establish *Edelsoja* as a direct competitor to meat, eggs, or dairy products, but rather to promote soy flour as a nutrient-rich and cheap supplement. The packages sold in stores were therefore accompanied by small recipe booklets explaining how to use *Edelsoja* to refine well-known dishes, ostensibly enabling housewives to save money without any of the family members noticing a difference in taste.[99]

Overall, the market launch of *Edelsoja* did not generate the sales that Kupelwieser and his partners had hoped for. Although the women's associations in particular beat the advertising drum for the new product, the response from private customers was mixed. Availability was also a significant problem affecting sales figures, since only a few stores in Vienna carried the product. The company remained in business, however, and by 1933 a new factory was opened south of Vienna in Schwechat: the so-called *Edelsoja-Werke*.[100] It is confirmed that *Edelsoja* was continuously available on the market, as indicated by numerous mentions and recipes in newspapers. It is nevertheless difficult to assess how successful the product really was. Sources suggest that soy flour was used primarily in public institutions, hospitals, and communal kitchens, with little evidence of significant demand among private households.[101] This lack of private consumption illustrates the structural limits of demand that persisted despite nutritional promise and institutional support – limits shaped not only by economic conditions but also by cultural preferences and ingrained food habits.[102]

The divided soy niche

One major constraint for the introduction of soybean cultivation and processing in Austria were differing views on the right path to success. The Federal Institute for Plant Cultivation

97 KPa, Inscription on the photograph of the Austrian Soybean Association's exhibition booth.

98 From the beginning of November 1928, the same advertising text was placed in numerous daily newspapers. Die Edelsoja: Ein neues Nahrungsmittel, in: Tagblatt, 11 November 1928, 9; Ein neues Volksnahrungsmittel, in: Neue Freue Presse, 1 December 1928, 12.

99 Neue Edelsoja-Gesellschaft G.m.b.H. (ed.), Das kleine Edelsoja-Kochbuch, Munich 1937. After the product was launched in 1928, the cookbook was published in multiple editions. Soja-Vertriebs G.m.b.H. (ed.), Wiener Voll-Soja Rezepte, Berlin 1939.

100 After negotiations with Wetzler Co. broke down, Kupelwieser signed a partnership agreement with the German industrial group Schneider in late 1928. This partnership not only increased the capital of the *Edelsoja* company but also financed its move to a new factory.

101 KPa, Letter from Ernst Kupelwieser to Franz Kupelwieser, 19 February 1928. There is no reliable information regarding the production capacity of the *Edelsoja* plant. Taking the old plant in Leobersdorf as a benchmark, the maximum production capacity would have been in the range of 3,000 kilograms of soy flour per day, assuming the new facility was still operating with a single steamer and mill. Despite the increased production capacity provided by the new factory in Schwechat, sales were likely well below capacity.

102 Uwe Spiekermann, Twentieth-Century Product Innovations in the German Food Industry, in: Business History Review 83/2 (2009), 291–315, 295.

and Seed Testing was the institutional embodiment of agrarian state policy, which held that domestic production should be encouraged through a continuous cycle of seed improvement by way of systematic field testing along with agricultural extension based on economic rationality. Farmers were to be convinced that integrating soybeans into their crop rotation and using them as an alternative source of protein feed was a sensible way to increase soil productivity and counterbalance the financial pressure of the agrarian crisis by reducing dependence on volatile international markets. Interventions by the state in the form of direct cultivation subsidies and fixed sales prices were not part of this approach, and the growing debate about national self-sufficiency in the oils and fats sector was not yet translated into a concrete action plan for agrarian policy. State interventionism in the agricultural sector did not begin until 1931 with the introduction of Dollfuß's "agrarian course."[103]

Kupelwieser with his *Edelsoja* brand envisioned a very different approach, focusing less on self-sufficiency and more on market-oriented demand, especially for processed foods. In fact, the *Edelsoja* company imported nearly all of its resources, at least in its early years. The first deliveries of soybeans were procured through the Hamburg-based company *Kunerol* and transported to Vienna. Kupelwieser was confident that domestic cultivation would eventually follow suit with growing demand. Planning ahead, he began collaborating with regional farmers to test soybean varieties suited for flour processing, offering them a guaranteed sales outlet. In this regard, he clashed with the systematic and considerate approach of the Federal Institute for Plant Cultivation and Seed Testing.

In 1932, Kupelwieser submitted two memoranda to the Ministry of Agriculture and Forestry presenting his commercial plans and vision for Austria's soy future.[104] In them, he justified the import of raw soybeans by stating that "domestic agriculture did not grow the varieties that are suitable for industrial processing." He thereby indirectly criticized the government's soybean research program for not responding to economic interests.

To verify and evaluate Kupelwieser's statements, the Ministry asked Drahorad for commentary – and in his reply, the disparities between the two parties became apparent. Drahorad questioned Kupelwieser's credibility by exposing his misinformation and salesmanship. He also criticised the reliability of Kupelwieser's cultivation trials, even calling them "primitive." In his opinion, they did not reflect common agricultural practice, as they were not carried out systematically and merely based on single-year results.[105] In Drahorad's opinion, Kupelwieser's actions significantly undermined the work of his institute by favouring imports and distributing unsuitable foreign seeds.

In addition, attached to Drahorad's written commentary was a confidential side note in which he disclosed Kupelwieser's business ties to Yugoslavia. Many of the cultivation tests for the *Edelsoja* product were being conducted using the variety Reiner 17, which originated in Manchuria and was cultivated on the family estate of Fritz Reiner near Osijek. The

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103 Ernst Langthaler, Der gespaltene Bauernstand – Bruchzonen von Landwirtschaft, Agrarpolitik und ländlicher Gesellschaft, in: Stefan Karner (ed.), Die umkämpfte Republik: Österreich 1918–1938, Innsbruck 2017, 259–268, 261. With the end of the postwar crisis economy in 1922, Austria adopted a liberal trade policy with moderate tariffs, which was also intended to mitigate the poor performance of domestic agriculture.

104 Unfortunately, the original memoranda dated 31 July 1932 and 4 December 1933 are lost. However, a comprehensive account by Kupelwieser from 24 October 1933 has survived in which he summarized his concerns. ÖSTA, AdR, BM.f.Land.u.Forstw., 1187 c, 31534-36.

105 ÖSTA, AdR, BM.f.Land.u.Forstw., 1187 c, 1717/1933, 4

Edelsoja company had supply contracts for soybeans with the Reiner estates in Yugoslavia. Furthermore, Fritz Reiner's son Hellmuth was a shareholder in Kupelwieser's enterprise, which constituted a clear conflict of interest in Drahorad's eyes.[106] The result of the dispute was that Kupelwieser had to agree to cultivate yellow soybeans from the breeding facility in Platt on his contract estates.

The consolidation of the soybean bottleneck

The consolidation of the soybean bottleneck occurred because of two critical constricting factors. Firstly, intense international competition from inexpensive soybean oil and meal made it impossible for domestic production to compete with global market prices. Farmers were not offered alternative outlets for soy products in the form of green fodder or soybean meal for livestock production or the option of selling soybeans to the domestic oil industry. Secondly, the large-scale introduction of *Edelsoja*, the first commercial full-fat soybean flour in Austria, was not successful. The reasons for its failure were complex, but once again, fragile regime-niche alliances ultimately led to unstable corporate governance and market strategy. The product failed to win over its key consumer group – housewives – and alternative market sectors proved equally unable to generate the desired sales figures.

Fourth episode: The rise and fall of the 'Nazi Bean' – Wehrmacht to UNRRA (1935–1950)

With the annexation of Austria by Nazi Germany, soy became an important fuel for the German war machine. However, the foundations for its adoption had already been laid in the prewar period with Kupelwieser's *Edelsoja* and the state's breeding program. During the National Socialist era, the soy bottleneck widened, and the bean temporarily moved from the niche into the regime.

The integration of the soybean into the Nazi war economy

Kupelwieser worked as a private entrepreneur until 1935. During this time, the German chemical company *I.G. Farben* started its soy program and experimented with soybean cultivation in the Balkans.[107] The German management was looking for factories that could process these soybeans, initially as subcontractors. Ernst Kupelwieser entered into negotiations with *I.G. Farben* no later than 1935. He initially became an external consultant and then an employee of the company, with the German corporation paying him RM 1,000 per month

106 ÖSTA, AdR, BM.f.Land.u.Forstw., 1187 c, 1717/1933, 7.

107 Joachim Drews, Die "Nazi-Bohne:" Anbau, Verwendung und Auswirkung der Sojabohne im Deutschen Reich und Südosteuropa (1933–1945), Münster 2004, 168; Ines Prodöhl, Globalizing the Soybean: Fat, Feed, and Sometimes Food, c. 1900–1950, Abingdon/New York 2023, 101.

for his collaboration. From 1935, Kupelwieser regularly travelled between Berlin and Vienna on business, exchanging information with representatives of the *I.G. Farben* group.[108] The company was deeply entrenched in the economic plans of the Nazi regime. Development of an exploitable and reliable source of fat and protein was a top priority in the National Socialist supply system, not least with regard to the war economy. The fact that these plans had been pursued for a long time is evident in the speed with which they were implemented after the annexation of Austria by Nazi Germany. Only a few days after the *Anschluss* in March 1938, the first purchase order from the German Army High Command arrived in Vienna: On 18 March, just seven days after the German troops crossed the border into Austria, the *Wehrmacht* ordered 400 tonnes of whole soy flour and 500 tonnes of soybeans for the year 1938.[109] A fixed purchase price of 460 schilling per tonne of soybeans and about 1,000 schilling per tonne of flour was agreed upon, and the order volume thus amounted to 230,000 schilling for the soybeans and 400,000 schilling for the soy flour, a total of 630,000 schilling. The delivery deadline for the beans was set between the harvest and the end of February 1939. The soy flour was to be delivered between January and the end of March 1939, with a minimum of 50 tonnes per month.[110] Considering the scarce documented production numbers of *Edelsoja*, it seems plausible to say that the magnitude of this German order easily surpassed all previous sales figures.

In addition, the *Wiener Edelsojawerk G.m.b.H.* was founded with a share capital of RM 200,000. The new company was now an official subsidiary of *I.G. Farben*, which sent Dr. William Bening from Berlin to Vienna to act as managing director together with Ernst Kupelwieser.[111] The entry in the commercial register lists "manufacture and distribution of soy products" as the company description. The date of 9 December 1938 is provided for the company's foundation, and its articles of association were concluded on 28 November.[112]

The integration of Kupelwieser's soy project into the *I.G. Farben* group can be explained in the context of the reorganization of the Southeast European economic zone since the 1930s.[113]

Austria's role in supplying the Wehrmacht

The so-called *Ostmark* was one of the expansion territories for soybean cultivation. An article in the supplement of the *Neuigkeits-Weltblatt* in December 1939 was entitled *The Ostmark, the soy basket of the German Reich*.[114] It mentioned the organized expansion of soybean cultivation in the *Ostmark* as a cornerstone of the Reich's fat and protein strategy. Within two years, the cultivation area was expanded from 70 hectares in 1937 to 800 hectares in 1939,

108 KPa, Written statement by Ernst Kupelwieser, 5 April 1946.
109 KPa, Purchase order German Army High Command, 18 March 1938.
110 KPa, Purchase order German Army High Command, 25 March 1938.
111 Neues Wiener Tagblatt, 21 December 1938, 16.
112 Wiener Stadt- und Landesarchiv, Sig.: 2.3.3.B78.27.237.
113 Drews, "Nazi-Bohne", 204–205. Particularly important is the establishment of the Central European Economic Forum (MWT) as a German trade association with the aim of creating a unified economic area in Eastern and Southeastern Europe. *I.G. Farben* assumed a leading position in the MWT.
114 Neuigkeits Weltblatt, 17 December 1939, 29. The article is signed "Ing. R.", most likely referring to Ing. Rossek, head of the Viennese *Sojaring*.

and the harvest was used almost exclusively to produce soy flour for human consumption. The *Neuigkeits-Weltblatt* article also emphasized the soy plant's capacity for nitrogen fixation, which greatly improves soil quality. The argumentation therefore not only focused on financial incentives but also included sustainable aspects of soil management. How could farmers disagree when soy cultivation was both good for the wallet and good for the soil?

A major difference in the organization under the National Socialists was that cultivation contracts guaranteed farmers fixed purchase prices for their harvests. This system was managed by *Sojaring* in Vienna, a central organization installed in 1937 which took over the function of promoting and organizing soybean cultivation and processing in Austria. *Sojaring* was also responsible for the testing and distribution of seeds; its director, Ing. Friedrich von Rossek, described the organization as the "single agency between producer and buyer."[115]

Soybean processing would become even more important for Austria than cultivation. Vienna developed into a hub for soybean deliveries from the Balkan states. Large silos were built in Austria to store the beans, which arrived by ship via the Danube or by train from the Balkan countries, especially Romania.[116] They were then processed into whole soy flour and soybean oil directly in Vienna in two large factories: the aforementioned *Edelsoja* factory and a second plant established on the southern outskirts of Vienna in 1937 under the name *Dr. Winkler*.[117]

Although there are no documented import figures for Austria after the start of the war, the few national trade records published after the *Anschluss* reveal the shift of foreign commerce to the Balkans. Between January and March 1939, 689 tonnes of soybeans were imported to Austria, all of them coming from Romania.[118] This represented a significant increase in raw soybean imports from before the National Socialist takeover: In 1937, only 179 tonnes had reached Austria over the border. The importance of the *Edelsoja* company and Ernst Kupelwieser's affiliation with *I.G. Farben* was already tangible in that the soybeans came exclusively from Yugoslavia.[119] Furthermore, *Wiener Edelsojawerk G.m.b.H.* and *Sojaring* reached an initial agreement under which the processing company agreed to purchase the entire domestic soybean harvest at fixed prices in 1937.[120] This agreement established the system of cultivation contracts in Austria, which would become the central instrument of agricultural policy under the Nazis.[121]

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115 Völkischer Beobachter, 21 February 1943, 6.

116 A Vital German Supply. The Magic Bean, in: London Times, 23 April 1940; Ortrun Veichtlbauer, Braune Donau: Transportweg nationalsozialistischer Biopolitik, in: Christian Reder/Erich Klein (eds.), Graue Donau – Schwarzes Meer, Vienna/New York 2008, 226–245, 234. Under the Nazis, the Viennese Danube port of Albern was developed into a transshipment hub for agricultural goods from Southeastern Europe. Ina Markova/Stefan Wedrac, "Hamburg des Ostens"? Der Ausbau des Wiener Hafens in der NS-Zeit, Vienna 2023, 68.

117 Pharmazeutische Post, 7 August 1937, 366; ÖSTA, AdR, BM.f.Land.u.Forstw., 1187 c, 18073 – II/1/39.

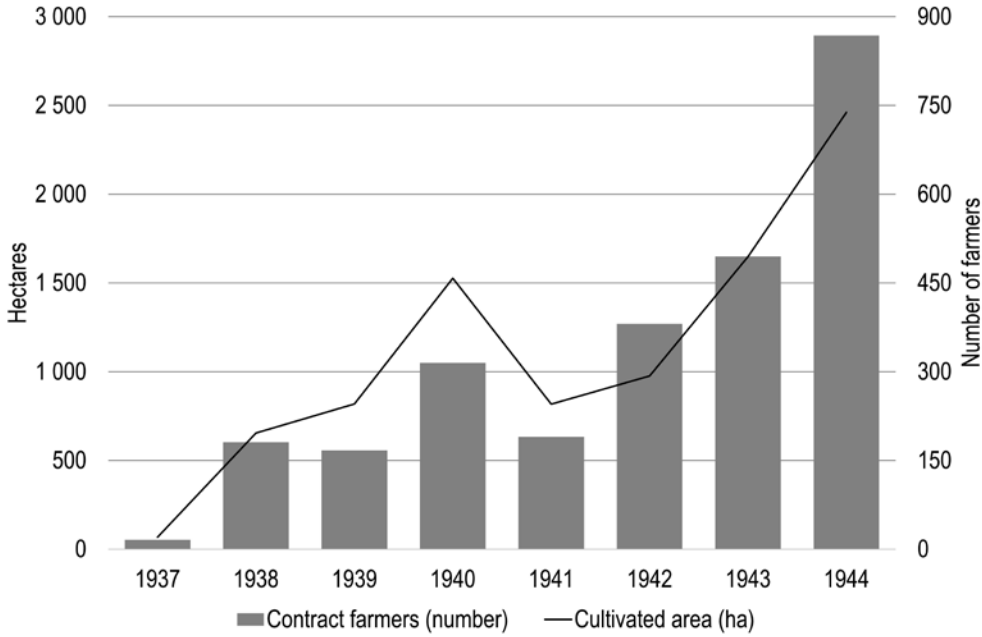
118 Ministerium für Wirtschaft und Arbeit (ed.), Monatshefte der Statistik des Außenhandels Österreichs, März 1939, Vienna 1939, 60. In addition, 15 tonnes of soybean oil were directly imported from Manchukuo.

119 Bundesministerium für Handel und Verkehr (ed.), Monatshefte der Statistik des Außenhandels Österreichs, Dezember 1937, Vienna 1938, 27. At this time, Austria still imported a considerable amount of 7,006 tonnes of soybean oil per year, nearly 90 per cent of which came directly from China. Denmark contributed 577 tonnes.

120 Neues Wiener Tagblatt, 6 August 1943, 4.

121 Farmers who wanted to grow soy had to register with *Sojaring* in order to enter into a cultivation contract. Once registered, the contract farmer would receive the necessary seeds, inoculant, and cultivation instructions. This system remained in place until the end of the war. Völkischer Beobachter, 12 January 1945, 3.

Figure 1: Soybean cultivation area and number of contract farmers, 1937–1944



Source: Brillmayer, Kultur, 1947, 17.

Under the heading *A Vital German Supply. The Magic Bean*, the *London Times* reported in April 1940 that "the soya has become vitally important to Germany from the food, the economic, and the military standpoints." The newspaper specifically mentioned the widespread use of *Edelsoja*, further writing that "at the end of the Polish campaign, Nazi official circles were boasting in Berlin that without the soya it would not have been possible for the German Army to advance so quickly as it had done."[122]

Whole soy flour became an integral part of institutional provisioning. The *Wehrmacht* was the main recipient, but the DAF, the German Labour Front, likewise relied on soy flour to feed workers and forced labourers.[123]

The army used soy flour mostly as an additive in field kitchens to reduce the need for meat, similar to the legume-based *Bratlingspulver*. On long campaigns, it proved especially effective due to its storability.[124] A report in the *Badener Zeitung* from November 1942 described the supply of Rommel's Afrika Corps, stating that soy flour was one of the concentrated supplements carried by the army on its campaign.[125]

A high-level functionary at *Sojaring,* chief agricultural advisor Hans Kusatz, did not miss the opportunity during a workshop with representatives from the oil and fat sector in Vienna

122 A Vital German Supply: The Magic Bean, in: London Times, 23 April 1940.
123 Völkischer Beobachter, 1 March 1941, 9; Prodöhl, Globalizing, 104.
124 Völkischer Beobachter, 6 June 1944, 6; Drews, "Nazi-Bohne", 185.
125 Badener Zeitung, 4 November 1942, 2.

in early 1943 to proudly announce that Austria's flourishing soybean cultivation was "completely bought up by the Wehrmacht."[126] Kusatz continued to be a key factor in the organization of soy cultivation in Austria under the Nazi regime until the end of the war. In the final months of fighting, he appealed to farmers to "plant soybeans" (*bauet Sojabohne!)* as a "decisive contribution" to the final *Kriegserzeugungsschlacht* (war production battle).[127]

The graph in Figure 1 shows the strong expansion of soybean cultivation under the administration of *Sojaring* in Austria, which reached its peak in 1944.[128]

Soy products in the postwar food aid program by UNRRA

Immediately after the Second World War, soy came to the attention of the public media once more, and the soy question briefly flared up again. The *Wiener Zeitung* even spoke of a "new soy craze."[129] However, most of the production facilities were destroyed during the war, including the *Edelsoja* plant, which was hit during an air raid.

Just a few months after the end of the war, the *Sojaring* organization resumed its work to strengthen soybean cultivation as a crucial factor of the nutrition economy.[130] Under the slogan "Grow soybeans", it attempted to persuade farmers to sign new cultivation contracts.[131] In general, the Federal Ministry of Agriculture and Forestry sought to secure the population's fat supply as quickly as possible by promoting the cultivation of oilseeds. To this end, producer prices were fixed and an oil premium was introduced in combination with the return of oilcake for the livestock industry.[132]

Anton Brillmayer, who had worked as an agricultural advisor in the south of France for some time during the war, also returned as a supporter of the continuation of soybean cultivation. To this end, he wrote three popular books about the bean, all richly illustrated with drawings to familiarize readers with every aspect of soy in an accessible fashion.[133] Scarcity and rising food prices were the dominant issues during the immediate postwar period. The overall food situation in Austria was appalling, and Austria was therefore included in the aid program of the United Nations Relief and Rehabilitation Administration (UNRRA) as early as 22 August 1945. The first UNRRA aid shipment arrived in April 1946, containing 1,026 tonnes of soy flour from the USA along with other foodstuffs, clothing, and medical supplies.[134] Soy flour continued to be an essential part of the relief food shipments over the

126 Neues Wiener Tagblatt, 21 February 1943, 6. Johann Kusatz was a former department head of the regional farmers' association (*Landesbauernschaft*) of *Donauland* in Linz.

127 Völkischer Beobachter, 12 January 1945, 3.

128 For brief context illustrating the success of soy in the USA, soybean cultivation had already reached roughly 4 million hectares there by 1942: Roth, Bean, 2018, 122. For a detailed comparison with the US figures, see the contribution by Ernst Langthaler and Natalia Ryzhova in this volume.

129 Wiener Zeitung, 6 June 1946, 4.

130 Arbeiter-Zeitung, 4 September 1945, 3.

131 Agrarische Post, 20 December 1947, 2.

132 Niederösterreichischer Grenzbote, 21 September, 4.

133 Franz Anton Brillmayer, Die Bedeutung der Soja für die Ernährung Österreichs, Vienna 1947; Brillmayer, Kultur; Franz Anton Brillmayer, Wunderpflanze Soja, Vienna 1947.

134 Arbeiterwille, 14 April 1946, 2.

following months, and the *Wiener Zeitung* strove to avoid stigmatizing it as a substitute, instead promoting its wholesomeness.[135]

With soy rice, a new refined product was introduced to the market that mixed soy flour with rice flour, resulting in a starchy product that was more suitable for soup garnishes and the production of various types of pasta and baked goods. Although most newspapers tried to emphasize its positive cooking properties, one paper ran the headline "We'd rather have pork."[136] This title encapsulates the acceptance of soy products during the postwar period: As long as no alternative products were available, people consumed soy – but as soon as the food and supply situation improved, meat was back on the table.

The *Dr. Winkler* soy factory in Vienna resumed limited operations after the war, launching an appeal to the population to deliver soybeans to designated exchange points and have them ground into soy flour.[137] In contrast to Winkler's production facilities, however, the *Edelsoja* factories had been destroyed during the fighting. Kupelwieser attempted to revive the company, but struggled to secure the necessary investments and retrieve the remaining machines and assets from the Soviet-occupied zone.[138]

In 1949, the Federal Ministry of National Nutrition announced that the supply situation in Austria had eased considerably, partly owing to the steady provision of fats and oils from the USA.[139] This is evident in the decline of the public soy debate. From 1949, the use of soy flour and the cultivation of soybeans were no longer a topic in the newspapers. The soy debate thus flared up for only a few years after the war in response to the protein and fat supply crisis before subsiding again as the socioeconomic situation steadily improved.

The widening of the bottleneck

During the years preceding the war and the German annexation of Austria, we can observe a widening of the soybean bottleneck. With the expansion of domestic cultivation in the *Ostmark* and the development of Vienna as a processing and transport hub, soybeans became an integral part of the Reich's war economy and agro-food regime.

The transformation of soy from a niche crop to a staple was facilitated by a concentrated effort by the Nazi regime that involved centrally managed distribution of certified quality seed and the introduction of cultivation contracts with price guarantees. This system both incentivized and pressured farmers into growing soybeans, as the goals of agricultural production were set by the planned economy. The second factor contributing to the widening of the bottleneck was the fact that the *Wehrmacht* became the primary consumer of soy products. In military rations, factors like smell, taste, and appearance were of secondary importance while price, nutritional value, and shelf life were the key considerations. *Edelsoja* did not have to

135 Wiener Zeitung, 6 June 1946, 4; Wiener Zeitung, 13 June 1946, 4.

136 Neue Zeit, 17 January 1947, 3.

137 Neues Österreich, 19 October 1947, 6.

138 KPa, Letter from Ernst Kupelwieser to Hertha Sprung, 19 February 1951. In personal letters, Kupelwieser accused Winkler of being entrusted with the administration of the "soy matter" by Krauland's Ministry for Asset Protection and Economic Planning after the war, and claimed that his company thus received preferential treatment. Kupelwieser also asserted that a large part of the oil industry was in "Eastern hands."

139 Vorarlberger Nachrichten, 3 February 1949, 1.

compete for the favour of consumers in the free market but was integrated into institutional provisioning as an efficient and rational hidden food.

After the war, the bottleneck narrowed again relatively quickly. Although soy became an important source of fat and protein during the supply crisis, particularly in the context of UNRRA aid deliveries, it was once again stigmatized as a substitute product once the food supply steadily improved by 1950. Meat would become the driver of the postwar consumer society.

Conclusion: Framing soy's failure as a bottleneck issue

This paper assesses why soy was not integrated into the Austrian agro-food system until the 1950s despite multiple efforts. The failed adoption of this Far Eastern crop is framed in terms of a 'bottleneck' that impeded the flow of knowledge from niche to regime, and thus the formation of a coherent development pathway. The bottleneck was not purely technological or institutional; it was equally one of demand, which remained fragmented and culturally constrained across three distinct use cases: human consumption, livestock feed, and industrial processing.

Emerging from late nineteenth-century agronomic research, the soy niche developed into a dynamic experimental space shaped by an ever-shifting network of diverse actors including experts, publicists, aristocrats, and the general public. The niche served as a breeding ground where soy was cultivated as a novel solution to regime problems and periods of crisis. However, the fluidity of the actor network highlights the inherently experimental and unstable nature of the niche, where innovation thrived but lacked strategic anchoring. These niche dynamics also reveal that early enthusiasm was not supported by sustainable institutional or market structures, exposing the vulnerability of innovation driven primarily by novelty rather than by sustained alignment with consumer preferences or practical end-use demand.

The second episode highlights how conflicting views and expectations surrounding the soybean contributed to the formation of the bottleneck. In the years preceding the First World War, soy was rediscovered amid the oils and fats crisis, with soybean oil regarded as a substitute for scarce cottonseed oil. The war itself further emphasized soy's nutritional value as a food source during growing supply shortages. This phase illustrates how crises can act as short-term catalysts for innovation uptake, albeit without leading to lasting systemic change.

The third episode outlines the consolidation of the soybean bottleneck. Scientific advancements were undermined by insufficient cohesion and coordination among individual actors, institutions, and state policy. The absence of a coherent coalition or strategy meant that soy remained a fragmented innovation shaped more by reactive than proactive logic. Even amidst the economic crisis, soy advocates struggled to find a unified direction – a challenge amplified by the misalignment of state and private economic interests. The push towards autarky and increased agricultural regulation contrasted sharply with the entrepreneurial endeavours of Kupelwieser's soy foods company *Edelsoja*, which targeted budget-conscious housewives but failed to achieve market acceptance. *Edelsoja* exemplifies the disconnect between top-down economic goals and bottom-up consumer practices, a major obstacle to reframing soy foods as a premium supplement rather than a mere substitute product.

The fourth episode explores the temporary widening of the soybean bottleneck under the Nazi regime's drive for national autarky. Soybeans were integrated into the National Socialist economy as part of the *Erzeugungsschlacht* for fat and protein, reflecting regime interventionism tailored to the specific demands of wartime mobilization with limited social embeddedness. The expansion of soy was thus contingent on a narrowly defined political-economic context and lacked resilience beyond the conditions of scarcity and mobilization.

After the war, deliveries of soy products through the Allied food aid programme helped alleviate humanitarian hardship, but soy foods once again failed to gain acceptance among the population. They were widely stigmatized as relief food and regarded as inferior substitutes. As the economy recovered and purchasing power rose, soy fell out of favour while meat reclaimed its status as the preferred protein source. This negative consumer perception further tightened the bottleneck, pushing soy back into niche status. It is a reversal that highlights the symbolic dimension of food choices: Associated with hardship and deprivation, soy struggled to establish cultural legitimacy as a desirable protein source in times of prosperity – a central pattern in the early history of soy foods in Austria.

Overall, the study illustrates the complex dynamics of agro-food transitions through the lens of a single crop. The introduction of new crops into agro-food regimes is rarely a straightforward or clearly defined process. The case of soy in Austria highlights how the processes of regime transition create critical junctures where innovations must become anchored within existing structures to avoid being sidelined or rejected. Without such anchoring, innovations remain fragile and prone to failure even if their initial reception seems promising. The 'success' of a crop depends not only on its functional benefits but also on sustained demand across sectors, cultural acceptance, institutional support, and coherent coordination among societal actors. It results from a shifting interplay of facilitating and impeding factors that manifest in diverging policies, agendas, strategies, and narratives. These combinations give rise to distinct developmental trajectories that can vary significantly between countries. The soybean was successfully integrated into the US agricultural system in the first half of the twentieth century; it also became an essential commodity for the German oil industry during the interwar period. In Austria, however, although there were glimpses of a breakthrough, it ultimately remained a failure story of untapped potential – at least until the second half of the twentieth century.

Gabriel Tober

Why Soy Succeeded

Austria in Its Transnational Setting, 1950–2020

Abstract: This article explores the driving and impeding forces behind the rise of soy as feed, food, and arable crop in Austria between around 1950 and 2020. Drawing on the food regime approach, transition theory, and commodity chain analysis, it investigates the formation of soy networks in Austria and their transnational connections. Using qualitative and quantitative data, it illustrates three periods: *hidden beans* (1948–1973), *contested beans* (1973–1995), and *flexible beans* (1995–2020). In the 1950s and 1960s, introducing soy cake as animal feed marked Austria's integration into the US-centred regime. During the 1970s and 1980s, several attempts to establish domestic soy cultivation denoted a shift towards a more nationally framed food regime. From the 1990s to the 2010s, a new wave of globalization, Europeanization, and regionalization of soy (GM-free and organic seeds) occurred. Austria became part of the dominant WTO-centred regime as well as the emerging EU-centred regime, combining domestic production and international trade in flexible ways. Key factors behind the Austrian soy expansion include state actions, international agreements, initiatives by business and civil society, and broader nutritional and ecological questions. The article's empirical evidence contributes to theoretical debates on food regimes with regard to transitional periods and multiscalar structures.

Zusammenfassung: Dieser Artikel untersucht die treibenden und hemmenden Kräfte hinter dem Aufstieg der Sojabohne als Futter- und Lebensmittel sowie Ackerkulturpflanze in Österreich zwischen etwa 1950 und 2020. Die Herausbildung von Soja-Netzwerken in Österreich und deren transnationalen Verflechtungen werden unter Bezugnahme auf den Food Regime-Ansatz, Transition Theory und die Analyse von Warenketten untersucht. Anhand qualitativer und quantitativer Daten werden drei Phasen in der Entwicklung des Sojaanbaus herausgearbeitet: „versteckte Bohnen" (1948–1973), „umstrittene Bohnen" (1973–1995) und „flexible Bohnen" (1995–2020). In den 1950er und 1960er Jahren markierte die Einführung von Sojakuchen als Tierfutter die Integration Österreichs in das US-zentrierte Regime. In den 1970er und 1980er Jahren deuteten mehrere Versuche, einen heimischen Sojaanbau zu etablieren, auf ein stärker national geprägtes Nahrungsregime hin. Die Zeit von den 1990er bis zu den 2010er Jahren war von einer neuen Welle der Globalisierung, Europäisierung und Regionalisierung von Soja (GVO-freies und Bio-Saatgut) geprägt. Österreich wurde sowohl Teil des dominanten WTO-zentrierten als auch des aufkommenden EU-zentrierten Regimes und verband dabei heimische Produktion und internationalen Handel auf flexible Weise. Zu den Schlüsselfaktoren hinter der österreichischen Sojaexpansion zählen staatliche Maßnahmen, internationale Abkommen, Initiativen aus Wirtschaft und Zivilgesellschaft sowie übergeordnete ernährungsbezogene und

DOI: 10.25365/rhy-2025-5

Accepted for publication after external peer review (double-blind).

Gabriel Tober, Department of Economic, Social and Environmental History, Johannes Kepler University Linz, Altenberger Straße 69, 4040 Linz, Austria, gabriel.tober@jku.at

The research for this article was funded by the Austrian Science Fund, Grant DOI: 10.55776/P35531, 2022–2026.

ökologische Fragen. Die empirischen Befunde des Artikels leisten einen Beitrag zu theoretischen Debatten über Nahrungsregime mit einem Fokus auf Übergangsphasen und multiskalare Strukturen.

Keywords: Austria, soybean, oilseed, food regime, transition, cultivation

Introduction

This article traces agro-food change through the lens of soy in Austria, from the abandonment of domestic soy cultivation and its introduction as imported animal feed after the mid-twentieth century to its establishment as a significant arable crop with multiple uses in the twenty-first century. It tells the story of soy's transition from an exclusively imported commodity to domestic production and differentiated consumption.[1] This was not a linear development but rather a long and challenging journey with ruptures and setbacks. The 'success' of soy is understood here in analytical rather than normative terms; that is, as the emergence and consolidation of domestic and transnational relations constituting a relatively stable commodity network, along with the associated set of institutionalized rules. These relationships are indicative of soy being integrated into food regime mechanisms. This applies to the entire commodity chain of production, processing, and trade as well as consumption as feed, food, or for other purposes. However, soy has not been completely integrated into all facets of the food regime – nor was this integration uncontested. For this reason, this article focuses on the emergence of a partially integrated and contested domestic soy cultivation.

It builds on the food regime approach, highlighting stable periods of capital accumulation and regulation of agriculture and food.[2] However, this structuralist concept is complemented with transition theory to emphasize the multi-actor interplay of top-down and bottom-up dynamics in regime crises and transitions, as well as with interdisciplinary commodity studies. Taken together, these three perspectives illuminate the emergence of the soy commodity network, including its human and non-human actors.[3] For the period under study, the formation of the US-centred regime (1950s–1970s) as well as the following crisis and transition to a more multipolar food regime (1990s–2010s), sometimes referred to as 'WTO-centred' or 'corporate', are of interest.[4] The article thus contributes to the refinement of the food regime approach in terms of spatiality (from global to national) and temporality (from stable phases to transitions). In particular, it engages in the ongoing controversy in food regime scholarship

1 The soybean is a leguminous plant whose beans contain protein (around 37 per cent), oil (around 20 per cent), and other components such as isoflavones. This versatility translates into a wide range of products including soy cake, flour, and oil. The term 'soy' is used in this article to refer to the plant as well as the products derived from it.

2 Harriet Friedmann/Philip McMichael, Agriculture and The State System: The Rise and Decline of National Agricultures, 1870 to the Present, in: Sociologia Ruralis 29/2 (1989), 93–117.

3 These theoretical concepts provide a framework for exploring the history of capitalism through the lens of a specific commodity, explaining the techno-scientific, economic, and political dynamics of agro-food changes from local to global. See Ernst Langthaler/Maximilian Martsch/Gabriel Tober, Conceptualizing Historical Commodity Studies: The Case of Soy, in: Juan Carmona-Zabala (ed.), Commodities in History: Theoretical Reflections and Empirical Case Studies, Crete 2023.

4 Philip McMichael, Global Development and the Corporate Food Regime, in: Frederick Buttel/Philip McMichael (eds.), New Directions in the Sociology of Global Development, Amsterdam/London 2005, 265–299, 273.

about the (non-)existence of a third food regime after its first (British-centred) and second (US-centred predecessors), along with the modality of food regime transitions.[5]

My analysis is based on four types of sources: expert interviews, contemporary literature, foreign trade statistics, and archival material. The latter consists mainly of files from the Austrian State Archives (ÖSTA), the Provincial Archive of Lower Austria (NÖLA), the Parliamentary Archives (ParA), and the Kreisky Archive (StBKA). The interviews were conducted between 2022 and 2024 with Austrian soy pioneers and other relevant actors in the field, and primarily cover the period from the 1980s onwards. To reconstruct the emergence of soy in Austria, I analyse key commodity networks, regulatory institutions, and transfers of knowledge and technology from around 1950 to 2020, covering the political, economic, and societal reconstruction after the Second World War up to the recent polycrisis escalated by the Covid-19 pandemic. This large timeframe is divided into periods that can be defined on the basis of economic cycles and political shifts.[6]

In the main part of the article, I explore the driving and impeding forces affecting the formation of a soy commodity network in Austria. I argue that the rise of soy was mainly driven by political, economic, and civil society forces. To trace the changing configurations in the adoption of soy, I distinguish between three periods: The first period (1948–1973) covers the postwar reconstruction focused on supplying the population with basic foodstuffs and increasing the level of agricultural self-sufficiency. Agricultural productivity grew through intensification, with imports of protein-rich soy cake as animal feed for livestock production within the US-centred food regime playing an important role.[7] In the 1960s, Austria shifted from undersupply to structural agricultural surpluses. The 1973 protein crisis initiated the descent of the preceding regime and its gradual transition to a different regime. The second period (1973–1995) saw various state- and business-initiated efforts to reduce dependence on protein and vegetable oil imports. During the 1970s and 1980s, agricultural policy by a series of social democratic governments in conjunction with initiatives by agrobusiness firms aimed to establish domestic oilseed production. Following the return of the conservative party to government as a coalition partner in 1987, so-called eco-social policies including organic farming and subsidies for alternative crops gained ground, leading to an initial soy cultivation boom.[8] Austria's accession to the European Union (EU) in 1995 marks the beginning of the third period characterized by the stabilization of a different food regime. Austria's current position is distinguished by the coexistence of imports and exports, with soy representing a diversified and flexible product satisfying various demands.

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5 André Magnan, Food Regimes, in: Jeffrey Pilcher (ed.), The Oxford Handbook of Food History, New York 2012, 370–388, 381–383.

6 The periodization should not be understood as clear-cut demarcations, but rather as overlapping periods that share certain events and developments.

7 In this article, oilcake refers to protein-rich products from oil mills and oil extraction (extraction meal, press cake, and other residues). Oilcake is the main category. The type of oilseed (e.g. soybean, rapeseed, sunflower) defines specific sub-categories of oilcake (e.g. soy cake).

8 Gerhard Hovorka/Josef Hoppichler, Agrarpolitik, in: Herbert Dachs et al. (eds.), Politik in Österreich: Das Handbuch, Vienna 2006, 701–710, 703–704; Ernst Hanisch, Die Politik und die Landwirtschaft, in: Franz Ledermüller (ed.), Geschichte der österreichischen Land- und Forstwirtschaft im 20. Jahrhundert: Politik, Gesellschaft, Wirtschaft, Vienna 2002, 15–189, 161.

Hidden beans: Austrian soy under the US-centred regime (1948–1973)

In the period after the Second World War, Austria became integrated in the emerging US-centred hegemony in the agro-food domain. The developing postwar order emphasized national food security as the key political and economic concern. Both domestic production and trade, including food aid, served this purpose. After the end of the war, cultivation of soy in Austria was initially promoted as a possible contribution to easing the dramatic food shortage, but it soon turned out to be unsuitable.[9] According to Friedrich Drahorad, a leading Austrian soybean breeder during and after the Second World War, it was

> "clearly visible that despite local successes in soybean cultivation, its general incorporation as an agricultural crop in Austria was probably out of the question. The reported successes are not real in economic terms and can be explained by the lack of raw materials at the time and the price support via public funds."[10]

Domestic soy cultivation declined due to unsuited varieties and increasing international dominance. Following a brief revival immediately after the war, the area planted with soybeans declined steadily. By the 1950s, soy breeding and cultivation no longer played a role in Austrian agriculture (Figure 1).

Despite not being locally grown, soy entered the Austrian agro-food sector in two forms: soy oil as a fat-rich food supply and soy cake as protein-rich animal feed. Direct imports of manufactured goods and foodstuffs were key means to stabilize basic supplies after the war. In the European Recovery Program (ERP, also known as the Marshall Plan) of 1948/49–1951/52, the US government aimed to boost Austrian agricultural production from 55 to 75 per cent of domestic demand. This increase was to be achieved by "greater use of fertilizer; use of higher quality seeds; the reestablishment and development of indigenous seed-growing plants; imports of animal feeds; increased mechanization; and the rationalization of agricultural holdings."[11] The technological intensification and state regulation of agriculture thus aimed at increasing self-sufficiency and securing the food supply for the Austrian population by importing feed for the livestock sector.

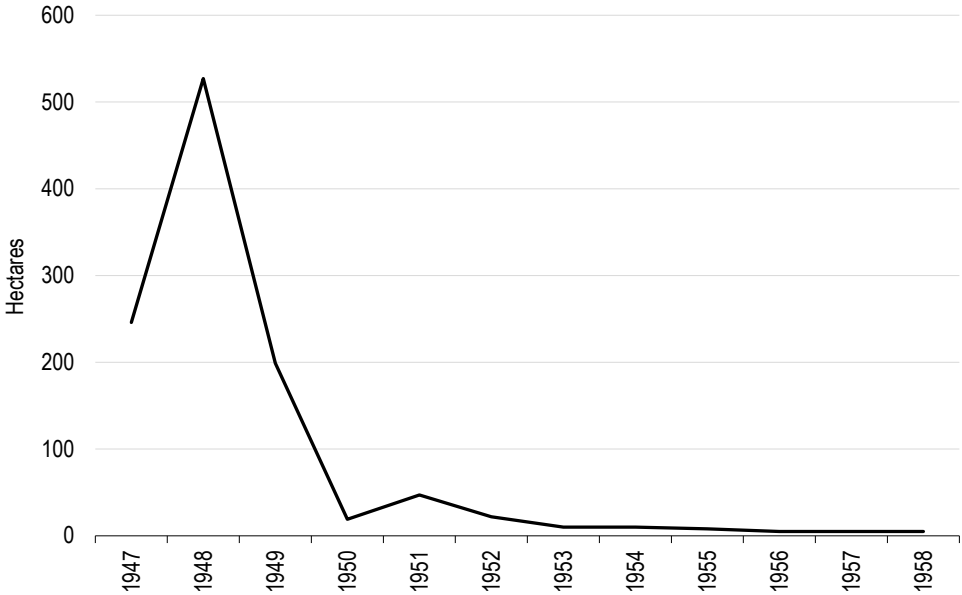
Imports of soy cake began in 1948 under the ERP with 1,288 tonnes. However, during the ERP period, soy cake accounted for only a small proportion of the total oilcake imports for feed (between 2 and 32 per cent). Other important products were peanut, coconut, linseed, and sesame oilcake. It was not until the late 1950s that soy cake increased in importance compared to other oilcakes (Figure 2). Initially, direct and indirect imports of soy cake came from

9 Franz Anton Brillmayer, Die Bedeutung der Soja für die Ernährung Österreichs, Vienna 1947; Franz Anton Brillmayer, Die Kultur der Soja in Österreich, Vienna 1947.

10 Friedrich Drahorad, Phänologische und morphologische Beobachtungen an Soja hispida Moench: Ein Beitrag zur Frage des Anbaues und der Akklimatisation in Österreich, in: Die Bodenkultur 6: Sonderheft (1955), 71–91, 89. This and all further translations of quotes from interviews and other sources into English are by the author.

11 Economic Cooperation Administration, Austria: Country Study. European Recovery Program (ERP), Washington, D.C. 1949, 44.

Figure 1: Soybean cultivation in Austria after the Second World War, 1947–1958



Source: Österreichisches statistisches Zentralamt, Bodennutzungserhebung, in: Statistische Nachrichten, years 1947–1958, Vienna. Compiled by the author.

different countries including the USA, Argentina, Brazil, Yugoslavia, Italy, and the Federal Republic of Germany.[12]

The share of food aid was significant. Between 1948 and 1950, food imports within the ERP framework amounted to $198 million, compared with $134 million for manufactured goods.[13] These deliveries accounted for over 20 per cent of the total value of goods and services imported during these years.[14] In particular, bread, cereals, fats, and oils – together accounting for more than 80 per cent of all foodstuffs – were imported as food aid.[15] A closer look at 1948, the first year of the ERP, reveals that some 28,600 tonnes of edible oils and fats came to Austria as aid, with soy oil from the United States accounting for 5,183 tonnes. Although wheat and wheat flour made up the bulk of the shipments (almost 70 per cent of the total), the 8,348 tonnes of soy flour delivered from the United States were a significant figure.[16] The

12 Österreichisches statistisches Zentralamt, Statistik des Außenhandels Österreichs, yearbooks 1948–1960, Customs No. 1399/555, 2304. Due to the source data, only direct imports are considered in this article. It should be noted that certain countries of origin (e.g., Germany, the Netherlands, or Denmark) are not soybean-producing countries but instead act as intermediaries (re-exporters) or first processors of soybeans. Austrian exports may also include products that have been imported and subsequently re-exported, known as re-exported imports.

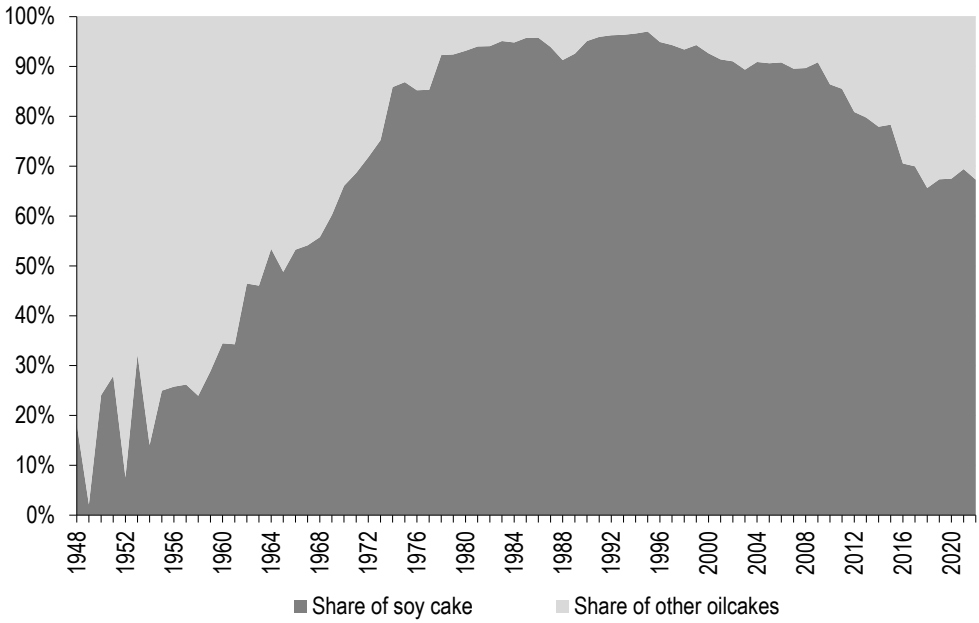
13 Hannes Hofbauer, Westwärts: Österreichs Wirtschaft im Wiederaufbau, Vienna 1992, 151.

14 Hans Seidel, Österreichs Wirtschaft und Wirtschaftspolitik nach dem Zweiten Weltkrieg, Vienna 2005, 306.

15 Österreich und der Marshall-Plan: Eine Zusammenstellung der wichtigsten Dokumente des europäischen Wiederaufbauprogrammes, Mit einer Gesamtdarstellung der Marshall-Plan-Hilfe in Österreich, Vienna 1950, 123.

16 Österreichisches statistisches Zentralamt, Die Hilfslieferungen an Nahrungsmitteln im Jahre 1948, in: Statistische Nachrichten, Vienna 1949, 151–152.

Figure 2: Share of soy cake in total oilcake imports in Austria, 1948–2022



Sources: Österreichisches statistisches Zentralamt, Statistik des Außenhandels Österreichs, yearbooks 1948–1994, Customs No. 1399, 2304, 2305, 2306; Statistik Austria, Statcube, years 1995–2022, 2304, Combined Nomenclature: 2305, 230650, 230620, 230630, 230610, 230660, 230690. Compiled by the author.
Other oilcakes refers to oilcakes made from peanuts, coconuts, pumpkin seeds, linseeds, rapeseeds, sesame seeds, sunflower seeds, cottonseeds, and palm nuts.

quantity of imported soy oil increased throughout the duration of the ERP, reaching around 7,000 tonnes in 1953. The countries of origin for soy oil included the USA as well as the Netherlands, the Federal Republic of Germany, and Belgium.[17]

These data indicate that the ERP laid the foundations for long-term transcontinental commodity chains for soy oil and soy cake. For the first time, the ERP linked (American) soybean producers, international and domestic traders and processing companies, and Austrian consumers. The federal government regulated and supported the import of soy oil to alleviate the shortage of edible oils and fats. As part of the ERP, it organized calls for offers for certain volumes, to be decided upon by an award commission. The resulting offers show how Austrian importers interacted with American and international trading and processing companies to submit suitable proposals. The successful bidders imported soy oil and other ERP goods to Austria via the port of Trieste in Italy as well as by rail. Distribution and consumer prices in

17 Österreichisches statistisches Zentralamt, Statistik, yearbooks 1948–1958, Customs No. 160 e/75, 179/83.

the country were regulated by the Austrian government. The soy oil went to processing plants in the soap, oil, and margarine industries, where it was turned into marketable products.[18]

The procedure for soy cake was similar, except that no further processing was carried out in Austria and the products were sent directly to the farmers via so-called receiving stations, i.e. warehouses and national traders.[19] An interviewee from an agricultural trading company recalled the process as follows: "We have had soy cake since the 1950s […]. It used to come in sacks. It arrived in sacks, in railway wagons […] And then it went by truck, in sacks, to the farms. To the warehouses and us."[20] This underlines that the ERP directly linked Austrian agriculture to the US-centred agricultural trade network. Even if the quantities of soy cake were relatively small at first, it shows the formation of an initial soy commodity chain. The need for exports of agricultural surpluses on the supply side and imports of food and feed on the demand side, supported by the US and Austrian governments, connected the Austrian agro-food sector to the US-centred regime via flows of soy cake and oil.

From the 1950s onwards, imports of animal feed for livestock production enabled both the intensification of agricultural production and a shift towards a more animal-based diet (meat, milk, eggs) in the context of economic growth. This contributed to the decoupling of animal production from domestic agricultural land, as well as to sectoral and spatial specialization.[21] Trade policy also played a key role in this development. Austria's accession to the General Agreement on Tariffs and Trade (GATT) in 1951 led to deeper integration with the US-centred regime.[22] In the course of the Kennedy Round (1964–1967) of GATT negotiations, Austria made a binding commitment to duty-free treatment for oilcake in return for US concessions involving reduced duties on cheese, ski equipment, and gemstones. This decision was also supported by interest groups such as the Chamber of Agriculture and the Chamber of Commerce.[23] However, a low tariff of 12 per cent was imposed on soy oil.[24]

Soy oil and soy cake continued to be imported after the end of the ERP. In the case of soy cake, import volumes remained stable in the 1950s and only began to increase in the 1960s. While annual imports amounted to around 15,344 tonnes in 1960, they reached the 50,000 tonne mark in 1966 and grew to just under 100,000 tonnes in 1970. During this period, the USA emerged as a direct supplier, steadily increasing its share until 1972. The Federal Republic of Germany supplied an increasing quantity starting in 1953, with a sharp rise in the 1970s. Small quantities were also imported from the Netherlands. Meanwhile, direct imports from Brazil and Argentina played no role (Figure 3). The trend for soy oil was different, however: Imports increased until 1960, then declined until 1969. The main exporting

18 Österreichisches Staatsarchiv (ÖSTA), Archiv der Republik (AdR), GZ: 652.886-ERP 5/51, ECA-Autorisation 31-0504-00-3547.

19 ÖSTA, AdR, GZ: 751.022-ERP 5/52, Zl. 80.341-III/8/51.

20 Interview no. 28/2, segment 36 (male, agricultural trading company), 16 November 2023.

21 Norbert Ortmayr, Überschusskrisen in der europäischen Landwirtschaft: Österreich 1970–1994 als Fallbeispiel, in: zeitgeschichte 34/3 (2007), 162–178, 165–168.

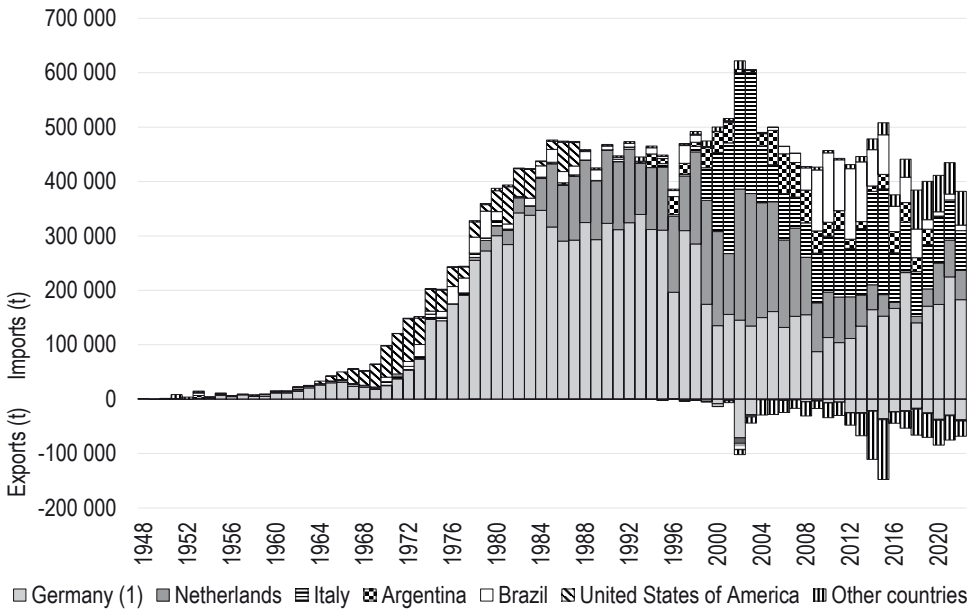
22 Due to a veto by the Soviet Union, Austria's accession did not take effect until 1955.

23 Kreisky-Archiv (StBKA), shelfmark VI.1, box 61: Landwirtschaftliche Spezialprobleme. Ölkuchen Importabgabe. Informationen für den Bundesminister, 8 January 1969, Zl.: 77.658-I/68; Walter Tausch, Sind die Alternativen Alternativen?, in: Gerhard Steger (ed.), Grünbuch: Krise und Perspektiven der österreichischen Landwirtschaft, Vienna 1988, 192–199, 193.

24 GATT, Results of Negotiations under Article XXYIII for the Modification, or Withdrawal of Concessions in the Schedule of Austria Initially Negotiated with the United States of America, Geneva 19 September 1955, 10.

countries were the USA, Germany, the Netherlands, Denmark, and Hungary.[25] This means that Austria's integration into the US-centred regime occurred primarily via trade in soy cake and only secondarily via soy oil trading, both initiated by the ERP but only reaching significance in the 1960s. In this respect, the ERP acted as a door opener allowing the US to seize its opportunity by introducing soy to Austrian farmers, creating demand, and selling in significant quantities. During this period, soy occupied a hidden but nonetheless relevant position in the Austrian agro-food sector.

Figure 3: Soy cake trade in Austria, 1948–2022



Sources: Österreichisches statistisches Zentralamt, Statistik, yearbooks 1948–1994, Customs No. 1399/555, 2304; Statistik Austria, Statcube, years 1995–2022, Combined Nomenclature: 2304. Compiled by the author.
(1) Until 1991: West and East Germany.

Contested beans: Austrian soy in the regime crisis and transition (1973–1995)

In the second period, the established commodity network of feed imports entered a crisis, as a result of which the cultivation and processing of soy and other oil and protein crops within Austria became a hotly contested solution. The instability of the oil and protein supply pro-

25 Österreichisches statistisches Zentralamt, Statistik, yearbooks 1948–1970, Customs No. 160 e/75, 179/83, 150787, 150737, 150797.

vided via imports triggered political and economic reactions to deal with its consequences. Three successive efforts to develop domestic oilseed production and processing emerged during this period: a political planning project by the social democratic government, a civil society and economic niche development, and a political undertaking within the framework of eco-social policy by the coalition of social democrats and conservatives.

The Oilseed Project (1973–1981)

From the end of the 1960s, contradicting effects of economic growth began to be felt in Austria. In the agro-food sector, a transition from shortages to surpluses became evident. During the 1960s, surpluses began to appear in the dairy and livestock (cattle) sectors, which were sold abroad. By the mid-1970s, cereal production had also reached a level that surpassed domestic consumption. Over time, these grain surpluses could also be exported.[26] By contrast, the demand for protein feed – particularly soy cake – continued to grow in the 1970s (Figure 3). A global shortage of protein feedstuffs, especially fishmeal from Peru and soy from the US, further exacerbated by a one-week US export embargo on soy in June 1973, drove up prices.[27] This period of scarcity was framed by contemporaries as a 'protein crisis'.[28] Political decision-makers in Austria interpreted the protein shortage as a twofold problem: On the one hand, the country was dependent on foreign deliveries of vegetable oils and protein feed. On the other hand, Austria produced agricultural surpluses in other areas, which were exported with state support and thus burdened the federal budget.[29]

Political debates about oilcake imports had begun at the end of the 1960s, before the protein crisis. In fact, as early as 1958, the National Assembly had passed a federal law allowing the Ministry of Finance (BMF) to impose licence fees on the import of protein feed (including oilcake). In the event of surplus milk production, imported protein feed used for milk production would be taxed, with the generated revenue used to promote milk sales.[30] In 1968, the BMF issued such an executive order for oilcake.[31] In the subsequent GATT consultations, the US announced retaliatory measures against Austrian products (cheese, fruit juices, wine, clothing).[32] Following this objection, the Austrian authorities decided to withdraw the order.[33]

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26 Ortmayr, Überschusskrisen, 163; Alois Posch, Österreichs Landwirtschaft – von der Unter- zur Überversorgung, in: Steger (ed.), Grünbuch, 31–43, 33.

27 Matthew Roth, Magic Bean: The Rise of Soy in America, Lawrence 2018, 196–199.

28 Gerhard Rupp, Weltweite Futtereiweißkrise, in: Agrarische Rundschau 2 (1973), 27–28.

29 BMLF, Grüner Bericht 1973: Bericht über die Situation der österreichischen Land- und Forstwirtschaft, Vienna 1973, 12.

30 Bundesgesetz über die Einhebung einer Lizenzabgabe anläßlich der Einfuhr bestimmter eiweißhaltiger Futtermittel vom 16. Dezember 1958, Bundesgesetzblatt (BGBl) 283/1958.

31 Verordnung des Bundesministeriums für Finanzen über die Einhebung einer Lizenzabgabe anläßlich der Einfuhr von Waren der Zolltarif-Nummer 23.04 vom 26. Juni 1968, BGBl 252/1968.

32 GATT, Article XIX – Austria: Action on Oilcakes. Retaliatory Measures by the United States, L/3046/Add.1, 20 November 1968.

33 GATT, Article XIX – Austria: Action on Oilcakes. Restoration of Concession, L/3046/Add.3, 24.12.1968; Verordnung des Bundesministeriums für Finanzen vom 20. Jänner 1969, mit der die Verordnung vom 26. Juni 1968, BGBl. Nr. 252, über die Einhebung einer Lizenzabgabe anläßlich der Einfuhr von Waren der Zolltarif-Nummer 23.04 aufgehoben wird, BGBl 40/1969.

In addition, this so-called 'action on oilcakes' led to an important agreement between the USA and Austria: The conservative government promised not to introduce a domestic consumption tax or similar measures for oilcakes in the future.[34] The attempt to defend Austria's autonomy in trade policy thus failed due to the hegemonic position of the USA in the food regime. This would shape developments in the years that followed.

During the protein crisis of 1973, the Austrian government debated stockpiling oilseeds, animal by-products, and protein feeds such as fishmeal and soy cake to ensure short-term food security.[35] Domestic production of oil and protein crops was also discussed as a means of securing oil and protein supplies in the longer term. According to the Minister of Agriculture, Oskar Weihs, it was necessary to make cultivation more attractive for producers, establish a permanent processing facility, and ensure that local products (fat, oil and oilcake) were competitive with imported goods.[36] These three aspects formed the cornerstones of a diffuse state-led 'Oilseed Project' involving actors from different sectors.

Renewed interest in oilseed and protein crops including soy led public and private agricultural research institutions to address related cultivation and breeding questions. The University of Natural Resources and Life Sciences (BOKU) established a soy research programme as early as 1969. Mutation breeding was initiated to establish the soybean as a legume in crop rotation.[37] The introduction of soy as a crop in Austria faced many challenges, however, with scholars identifying three main problems in 1976: Firstly, it was difficult to find suitable varieties due to Austria's short growing season and climate. Trialling varieties thus became a crucial step in scientific research. For the BOKU studies, around 150 genetic lines from nine countries were tested. The second challenge was the yearly variation in yield per hectare: Growing soy was only profitable for producers if they could achieve both high and stable yields. Lastly, the seed quality of the selected varieties needed to be high to meet industrial and legal requirements in Austria.[38] In the 1970s, BOKU researchers carried out further investigations on aspects including the photoperiodic behaviour of soy plants, the cold tolerance of soybeans, and weed control in soybean cultivation. These studies reflect that university research was coordinated with government institutions and breeding companies and even received state funding.[39]

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34 StBKA, shelfmark VI.1, box 61: Landwirtschaftliche Spezialprobleme, Österreich Beschluß bezüglich Ölkuchen. Beratung zwischen Österreich und den Vereinigten Staaten, 22 January 1969, L/3046/Add.4.

35 StBKA, Josef Staribacher Diaries. Digital edition, 22 November 1973, 18-1307–18-1309.

36 Parlamentsarchiv (ParA), Beantwortung der schriftlichen parlamentarischen Anfrage 1420/J betreffend Eiweißfuttermittelmarkt, 1328/AB, Beilagen zu den stenographischen Protokollen des Nationalrates, 27 July 1973, scanned original.

37 Ralph Gretzmacher, Sojaanbau in Österreich?, in: Agrarische Rundschau 1 (1974), 55–58.

38 Ralph Gretzmacher/Laila Tanasch, Research Notes. Soybean Breeding in Austria, in: Soybean Genetics Newsletter 3 (1976), 7–11.

39 Peter Liebhard, Untersuchungen über den Einfluß der Tageslänge und der Temperatur auf Wachstum und Entwicklung verschiedener Sojabohnensorten im Freiland und unter kontrollierbaren Klimabedingungen, doctoral thesis, University of Natural Resources and Life Sciences, Vienna 1979; Herbert Oberecker, Untersuchung über Keimung bei tiefen Temperaturen sowie der Frostresistenz bei Sojabohnen als Grundlage für eine Auslesemethode bei der Sojazüchtung, diploma thesis, University of Natural Resources and Life Sciences, Vienna 1976; Johann Glauninger, Unkrautbekämpfung in Sojabohne, doctoral thesis, University of Natural Resources and Life Sciences, Vienna 1978.

The Federal Institute for Plant Production and Seed Testing (BAP) was responsible for state-funded field trials and variety registration. It received a direct mandate from the Ministry of Agriculture and Forestry (BMLF) to deal with oil and protein crops. In 1974, the department for forage crops was expanded to include grain legumes and oilseeds, and it began testing soybeans in plot and large-scale trials. Two years later, these trials were integrated into the European Soybean Research Project of the Food and Agriculture Organization (FAO). This platform facilitated obtainment of seed varieties and the sharing of results with partners abroad.[40] In 1982, after eight years of research, department head Dietrich Wolffhardt concluded: "Trials with soybeans should not be ignored in the future, even if this crop is unlikely to become established in practical agriculture at the present time."[41] While his research showed that soybean cultivation was possible in Austria, he delivered a negative outlook for extensive soy cultivation. Soybean variety testing continued after 1982, but on a smaller scale.

The Provincial Chambers of Agriculture (LWK) in eastern Austria, especially those of Lower Austria, Burgenland, Vienna and Styria, carried out state-sponsored large-scale cultivation trials advised by the BAP to gain practical experience. The LWK took on a mediating role between government agencies and farmers in promoting agricultural research and applied knowledge.[42] The Chambers in Lower Austria and Burgenland ran large-scale cultivation trials between 1974 and 1976, but this first phase of trials produced unsatisfactory results with fluctuating yields and difficulties regarding weed control. In total, around 10 hectares of soy were tested each year. In 1977 and 1978, only the Styrian Chamber carried out trials on a small scale (Figure 4).

A twofold change occurred in 1979: Firstly, the LWK once again increased the number of trials performed on behalf of the BMLF. The government also offered incentives to growers by way of fixed prices and sales volumes. This arrangement lasted only a single year, however.[43] Secondly, *Sojaring,* the Austrian Soybean Farmers' Association, was founded in 1979 to establish and promote soybean cultivation in Austria.[44] Its pioneer, Anton Wolf, was a senior scientific advisor at the research department of the Central Institute for Meteorology and Geodynamics (ZAMG). He had been investigating the climatological conditions for soy cultivation in Austria since 1975.[45] Unlike Wolffhardt, he was convinced that soy cultivation not only could be established in the future but should be started immediately. As a producer organization, *Sojaring* concerned itself with the entire production chain from seed to harvest,

40 Bundesanstalt für Pflanzenbau (ed.), Jahrbuch der Bundesanstalt für Pflanzenbau 1984, Vienna 1985.

41 Dietrich Wolffhardt, Anbauversuche mit Sojabohnen in Österreich, in: Fette, Seifen, Anstrichmittel 84/3 (1982), 92–101, 101.

42 Interview no. 20, segment 7 (male, Chamber of Agriculture), 13 June 2023.

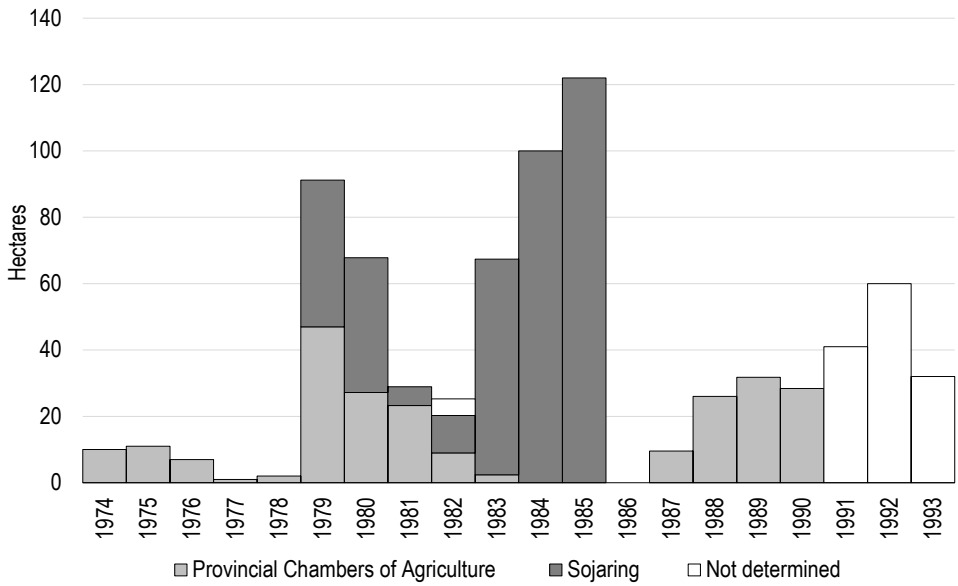
43 Österreichische Vereinigung für Agrarwissenschaftliche Forschung, Bericht über Erfahrungen beim Anbau von Sojabohne (Glycine max) im Bundesland Niederösterreich. Im Auftrag des Bundesministeriums für Wissenschaft und Forschung, Vienna 1981, 14–15.

44 An agricultural co-operative named *Sojaring* already existed during the Second World War and was dissolved in 1959. See Zentralblatt für die Eintragungen in das Handelsregister der Republik Österreich 58/50 (16 December 1959), 836.

45 Anton Wolf, Vorläufige Ergebnisse klimatologischer Untersuchungen über den Sojaanbau in Österreich, in: Wetter und Leben: Zeitschrift für angewandte Meterologie 32/2 (1980), 88–92.

emphasizing knowledge generation and transfer.[46] As a scientist and representative of *Sojaring*, Wolf lobbied for soy and liaised with many political and economic actors.[47] *Sojaring*'s large-scale cultivation trials began in 1979 in cooperation with the BAP as advisory body and financed by the BMLF. The cooperation was suspended in 1981 and not resumed until 1982, however.[48] From 1979 to 1982, *Sojaring* complemented the trials directed by the LWK, and after 1982 became the central player in the soy trial programme (Figure 4, next subchapter).

Figure 4: Large-scale soybean cultivation trials by Provincial Chambers of Agriculture and *Sojaring*, 1974–1993



Sources: BMLF, Tätigkeitsbericht, years 1973–1990; BMLF, Grüner Bericht, years 1991–1993; ÖSTA, AdR, GZ 26.006/03/82 (1981), GZ 26.006/04/82 (1982), GZ 26.006/24/84 and GZ 26.006/26/84 (1983), GZ 26.006/31/85 (1984). Compiled by the author.

Alongside the cultivation trials, considerations regarding the processing of oilseeds began. The political decision-makers and scientific advisors realized that domestic cultivation of oil and protein plants needed to be combined with domestic processing (separation of their components in an oil mill or extraction plant), since there were no large processing plants for oilseeds in Austria at the time. Such plants existed in other European countries such as Switzerland or Germany, from where Austria imported both soy oil and soy cake

46 Zentrales Vereinsregister (ZVR) der Landespolizeidirektion Wien, ZVR-Zahl 727023127, legal records of Sojaring, 20.03.1979–27.01.2023.

47 Anton Wolf, Endbericht des Soja-Rohstoff-Forschungsprojektes 1980. Untersuchung über das Gedeihen von Sojabohnensorten in Abhängigkeit von naturräumlichen Faktoren, 1. Phase Datenerhebung, Vienna 1981; Wolf, Ergebnisse.

48 Bundesanstalt für Pflanzenbau und Samenprüfung, Jahrbuch der Bundesanstalt für Pflanzenbau und Samenprüfung, years 1979, 1980, 1981, Vienna 1980, 1981, 1982.

(Figure 3).[49] In 1974, Josef Staribacher (SPÖ), Federal Minister for Trade, Commerce, and Industry (BMHGI), initiated negotiations with representatives from the oil and fat processing industry in collaboration with the BMLF. In this context, two groups of actors came together: On the one hand, the multinational corporation Unilever was contemplating the establishment of an oil mill in Switzerland and expressed interest in procuring oilseeds from Austria. When the Swiss project failed, Staribacher attempted to promote Austria as an alternative location for the facility.[50] On the other hand, Heinrich Wohlmeyer, Director of the Austrian Agricultural Industry, advocated founding an Austrian consortium to establish an oil extraction plant.[51] Eventually, a three-party consortium comprising the Austrian Agricultural Industry, the Austrian Consumer Cooperative, and the Eisenberg Group – an internationally operating company that was to construct the mill – was registered in 1977 under the name *Olioprot*.[52] This consortium constituted the economic core of the so-called Oilseed Project or Oil Mill Project.

The project faced internal challenges and conflicts of interest, however. The relationship between Unilever and the Austrian consortium was initially characterized by a lack of trust and accusations by the latter that the former was only participating to impede Austrian developments. These differences led to the formulation of two project plans and the exchange of mutual statements. During a meeting, Staribacher presented his views on the matter: "I have not yet decided in favour of either project, but I am waiting to see who comes up with the better proposal. A certain amount of external protection will be necessary. […] We need the oil extraction plant and that is my conviction."[53] Apart from economic representatives, the involvement of workers' representatives (Chamber of Labour, Austrian Federation of Trade Unions) in the project was important to the government.[54] At the end of 1977, the involved actors agreed to set up working groups. Their results served as a basis for further steps in the political decision-making process.[55] Details of the Oilseed Project were first presented to the public in 1977 at a special conference as well as in journal articles.[56]

In April 1978, the federal government submitted a bill for a vegetable oil tax law (Pflanzenölabgabegesetz) to the National Assembly. It was based on the Swiss and Swedish market organizations for oilseeds and strove to create a framework for the cultivation and processing of oilseeds for vegetable oils and protein feed. The bill proposed a tax on all vegetable oils, fats, and residues (oilcake) produced in Austria or imported into Austria.[57] This policy move represented a second attempt to address the inadequate market protection for oilseeds in Austria and promote domestic oilseed production.

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49 BOKU, Projektstudie für die Errichtung einer Ölsaatenverarbeitungsanlage in Österreich. Memorandum für die österreichische Bundesregierung, Vienna 1974, 6–12.

50 StBKA, Diaries, 28 November 1974, 23-1435–23-1436.

51 StBKA, Diaries, 30 September 1974, 22-1163.

52 Zentralblatt für die Eintragungen in das Handelsregister der Republik Österreich 76/20 (18 January 1977), 791.

53 StBKA, Diaries, 27 April 1977, 36-0477–36-0478.

54 StBKA, Diaries, 29 March 1977, 35-0367, 35-0369–35-0370.

55 ÖSTA, AdR, Bundesministerium für Handel, Gewerbe und Industrie (BMHGI), records of negotiations between Unilever and Olioprot, 14 November 1977, GZ 4315.18/29-IV/5a-77.

56 Hans Köttl, Die volkswirtschaftliche Rentabilität eines konkreten Projekts zur Erzeugung und Verarbeitung von Ölsaaten in Österreich, in: Agrarische Rundschau 4/5 (1977), 6–14.

57 ParA, Regierungsvorlage Pflanzenölabgabegesetz vom 22.5.1978. 907 der Beilagen zu den stenographischen Protokollen des Nationalrates XIV.GP, scanned original.

Opposition to the proposed law was immediate and intense. On the one hand, established Austrian companies trading in animal feed (especially soy cake) reacted, as domestic production and processing of oilseeds were seen as competition for the lucrative import business. On the other hand, US diplomacy sprang into action on behalf of American soybean farmers, processors, and agricultural traders. The US National Soybean Processors Association (NSPA) learned of the Austrian plan in the spring of 1978 and intervened with the US Secretary of Agriculture, Robert Bergland.[58] The US authorities considered the law a violation of existing agreements, including the one concluded after the 'action on oilcakes', and again enacted retaliatory measures.[59] This strong US reaction towards Austria can also be interpreted as an example of deterrence vis-à-vis the European Community (EC), which was much more important for US soy exports. However, another potential line of resistance to the Austrian proposal came from the EC itself (Germany was a major supplier of soy cake) as well as from the soy-producing countries of South America, especially Brazil.[60] This situation also led to broader media coverage of the Oilseed Project.[61] A subcommittee of the parliamentary Finance Committee examined the bill and concluded that it should not be passed.[62] Accordingly, the bill's GATT conformity was never resolved, since it was not pursued further following the US objection.[63]

By the end of the 1970s, it became clear that the original idea of the Oilseed Project with a large oil extraction plant, protection against cheap imports, and promotion of oilseed cultivation was falling apart. Instead, Minister Staribacher urged gradual action: "We will now […] build up soy production in Austria in small steps."[64] Initially, the idea was to slowly increase the area under oilseed cultivation at the expense of the fat industry without subsidies, and subsequently increase VAT on vegetable oils and fats from 8 to 18 per cent, using the generated funds to finance the cultivation of oilseeds.[65] In the end, neither financing option was implemented. The situation on the processing side changed as well: The *Olioprot* consortium began to fall apart in 1978 and was finally dissolved in 1980.[66] Unilever and other oil processing companies continued to play an important role, however. As buyers, they negotiated with the BMHGI as well as with farmer and worker interest groups on quantities, prices, and state support for oilseeds.[67] The Oilseed Project gave way to isolated meetings focusing on rapeseed as the central raw material for the oil and fat processing industry.

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58 Sheldon J. Hauck, Protectionism in Trade – Expansion in oilseeds, in: Frederick Corbin (ed.), World Soybean Research Conference II: Proceedings, Boca Raton 1980, 801–806, 804–805.

59 StBKA, shelfmark VII.1, USA, box 16: Korrespondenz der US-Botschaft in Österreich (1978), letter no. 63, 21 June 1978.

60 ÖSTA, AdR, BMHGI, Information für den Bundesminister betreffend GATT, Ölsaatenprojekt, Zl. 27.629/48-II/7/78.

61 Soja in Österreich: Der zähe Kampf gegen den Wolf, in: Trend: Das österreichische Wirtschaftsmagazin, May 1981, 176–181; Agraraffäre: Das Sojawunder vom Marchfeld, in: Trend: Das österreichische Wirtschaftsmagazin, September 1978, 42–51; Als Abschreckung gedacht, in: Die Zeit, 1 December 1978, 21.

62 Nicholas M. Thuroczy, Austrian Parliament Lays Aside Plan to Boost Oilseed Output, in: Foreign Agriculture 16/40 (1978), 14–15.

63 Wolfgang Benedek, Handbuch zur österreichischen GATT-Praxis: Einführung zu den Artikeln des Gatt 1994. Die österreichische Praxis zum Gatt, Nationale und europäische Rechtsquellen, Vienna 1998, 36.

64 StBKA, Diaries, 11 December 1978, 45-1457.

65 StBKA, Diaries, 30 June 1978, 43-0765–43-0766; Geld für Ölsaatenprojekt, in: Kurier, 19 July 1980, 6.

66 Zentralblatt für die Eintragungen in das Handelsregister der Republik Österreich 80/17 (29 April 1981), 935.

67 StBKA, Diaries, 21 June 1981, 60-0772; 9 July 1981, 60-0875–60-0876.

At the same time, there were loud calls to continue the (large-scale) project. These came from the traditional agricultural sector as well as from provincial governments. For instance, the Deputy Governor of Lower Austria, Erwin Pröll (ÖVP), called for production alternatives in agriculture and forestry at a symposium on the subject: "The implementation of the Oilseed Project is a matter of state policy, just like the State Treaty [1955] was at the highest level. Austria's permanent neutrality requires a secure supply in the event of a crisis."[68] A parliamentary resolution also urged the social democratic federal government to continue its efforts in the oilseed sector.[69] This was partially achieved through the implementation of subsidies for the cultivation of rapeseed from 1981 and for broad beans and peas from 1982.[70]

Reviewing the 1970s reveals a curious inconsistency. Despite concerted political and economic initiatives to reduce reliance on oil and protein feed imports, as exemplified by the Oilseed Project, the 1970s witnessed a surge in imports of soy oil and soy cake accompanied by a concomitant increase in dependency. The imports of soy oil increased from approximately 17,600 tonnes in 1970 to almost 43,000 tonnes in 1982, while soy cake imports quadrupled during the same period, reaching over 400,000 tonnes in 1982. Germany was the most significant exporter ahead of direct imports from the USA. However, Germany acted as an intermediary, importing soybeans and processing them into oil and oilcake which were then exported to other European countries. Italy, the Netherlands, Argentina, and Brazil were additional suppliers of soy cake (Figure 3).[71] The consequence of the global protein crisis was a diversified trade, with the USA beginning to lose its unique position as an agro-food superpower. Austria attempted to increase local soy expertise and establish a domestic soy commodity chain, including the necessary regulatory framework. These efforts can be seen as a plan for a more nationally framed regime in the oilseed and protein sector. It did not result in a reduction in trade volume, however, and the Austrian attempt to secure more autonomy failed due to the still strong position of the USA in international regulatory institutions.

The soy food niche network (1980–1987)

In the early 1980s, a commodity-based niche network around soy emerged between economic and civil society actors. It built upon the previous rise of soy cake as animal feed and the handling of the crisis by a network composed of state, science, and enterprises. The absence of a larger processing plant for oilseeds (oil and protein feed) resulted in the establishment of two smaller areas of soy processing for food products in the 1980s: Firstly, grain mills sought new processing and marketing options, intending to diversify their activities away from the milling of wheat, which was subject to strict market regulations. The introduction of soy to this sector constituted a novel and innovative development. At least four mills in Upper and Lower Austria commenced soy milling operations during the 1980s. The initial purchasers

68 Ernst Scheiber (ed.), Produktionsalternativen für die Land- und Forstwirtschaft in Niederösterreich, Vienna 1981, 85.

69 ParlA, Entschließung des Nationalrates vom 6. Oktober 1981 betreffend Verwirklichung des Ölsaatenprojektes, 65/E XV. GP, scanned original.

70 BMLF, Grüner Bericht 1989, 63–64.

71 Österreichisches statistisches Zentralamt, Statistik, yearbooks 1970–1982, Customs No. 150787, 150737, 150797, 1399/555, 2304.

of the soy flour and soy flakes produced there were primarily the food industry along with companies in the baking and confectionery industry (biscuits and wafers).[72]

At first, imported soybeans were processed, but the increasing availability of soybeans from experimental soy cultivation forged links between Austrian farmers and processing companies. Anton Wolf, managing director and later chairman of *Sojaring* from 1982 onwards, facilitated cooperation between producers and processors. According to Wolf, in 1982, *Sojaring* farmers cultivated approximately 100 hectares, exported 20 tonnes of soybeans, marketed 15 tonnes to Austrian processing companies, and sold 12 tonnes directly from their farms.[73] A soy farmer recalls this period:

> "We finally had success with the soybean. […] We cleaned the soybeans at our place […] and packed them in 25-kilo sacks. And that then went to various customers […] that made soy milk or tofu. We delivered it there in small batches. And we got good money for it."[74]

This passage underlines the profitability of soy in conjunction with post-harvest processing on the farm. Furthermore, it reveals the second area of soy processing: the newly founded processing companies for alternative soy foods including tofu, tempeh, miso, and soy milk.[75] The first Austrian company to commence production of tofu and miso was established in 1980. Others emerged in the following years, and after several reorganizations and mergers, there were eventually three major tofu processing companies. Since the early 1980s, tempeh was also produced from soybeans in Austria. At the time, soy food products were distributed through specialized health food and organic food shops.[76] These sales enabled *Sojaring* to increase its cultivation area in the first half of the 1980s (Figure 4).

Nevertheless, this soy food network was not a standalone entity but instead connected with other actors in the agro-food sector. On the one hand, *Sojaring* received funds from government agencies for cultivation experiments between 1979 and 1985.[77] Yet the association complained about the inequitable treatment of soybeans given that the BMLF provided subsidies for rapeseed, broad beans, and grain peas as alternative arable crops. Conversely, soy was not only excluded from subsidies but also met with resistance from powerful agricultural lobbying organizations. This clash of interests became obvious in the context of frequent damage caused to soy fields by wildlife, which led to extensive discussions with hunting

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72 Interview no. 6, segment 2 (male, soy mill), 14 September 2022.

73 ZVR, legal records of Sojaring; William Shurtleff/Akiko Aoyagi, History of Soybeans and Soyfoods in Austria and the Austro-Hungarian Empire (1781–2020). Extensively Annotated Bibliography and Sourcebook, Lafayette, CA 2020, 654; Sojaring, 4. Aussendung an Mitglieder, Vienna, 1 March 1983, letter. As there is no official data on soy production in Austria from 1959 to 1986, this self-reported data serves as an initial estimate.

74 Interview no. 36, segment 4 (male, soy farmer), 7 February 2024.

75 Soy foods are soy-based products for direct human consumption, including tofu (soybean curd), tempeh (fermented soybeans), miso (fermented soybean paste), and soy milk (liquid extract of soybeans). These are protein-rich, plant-based foods consumed as meat or dairy substitutes.

76 Shurtleff/Aoyagi, History, 656, 665, 688.

77 BMLF, Tätigkeitsbericht, years 1973–1990; BMLF, Grüner Bericht, years 1991–1993; ÖSTA, AdR, GZ 26.006/03/82 (1981), GZ 26.006/04/82 (1982), GZ 26.006/24/84 and GZ 26.006/26/84 (1983), GZ 26.006/31/85 (1984).

organizations regarding compensation.[78] On the other hand, there were international connections. *Sojaring* procured soy seed directly from the USA and Canada, as conventional seed trade companies in Austria would not provide it. The cost of this procurement from abroad was an incentive for using farm-saved seeds. Furthermore, German processing companies purchased Austrian soybeans, and members of *Sojaring* interacted with agronomists around the world and applied US quality standards for soy cultivation for food.[79]

In the second half of the 1980s, plant breeding and seed companies showed increasing interest in oil and protein crops. After more than a decade of (scientific) field trials and political discussions about the need for an Austrian oilseed and protein crop production, the engagement of commercial and cooperative breeders was a further step. International and Austrian experts discussed seed breeding for rapeseed, broad beans, sunflowers, and peas at a symposium at the sixth International Trade Fair for Seed (IFASA) in September 1985. Soybeans were not explicitly discussed, however.[80] Even at this time, they were still dismissed by established experts as a "small market niche" and not competitive with other oil and protein crops.[81] On the one hand, this indicates that niche networks around soy had been established by the 1980s, with farmers gaining experience and some consumers deciding to opt for alternative food products. At the same time, however, cultivation of soy and its processing as a food were not considered worthwhile in the established agro-food sector.

The Soybean Campaign (1987–1995)

At the end of the 1980s, a significant shift in agricultural policy regarding soy cultivation became apparent. It represents an example of efficient state-led crisis management. In 1986, Erich Schmidt, the newly appointed Minister of Agriculture, increased the subsidies for oil and protein crops – but soybeans were still not included.[82] One year later, following sixteen years of social democratic leadership, the Ministry of Agriculture was taken over by the conservative party (ÖVP) under Josef Riegler. The reduction of grain surpluses and the substitution of protein feed and vegetable oil imports, together with the greening of agriculture, became the central focus of eco-social agricultural policy.[83] The experiences of the previous decade and renewed consultations with the USA revealed that no trade policy measures were possible in the oilseed sector. This left the government with the exclusive option of providing subsidies from the state budget.[84]

The subsidies were thus further increased – and finally also extended to soybeans and sunflowers – with the aim of facilitating a transition in agricultural production from cereals

78 Sojaring, 1. Aussendung an Mitglieder, Vienna, 20 January 1985, letter.

79 Sojaring, 3. Aussendung an Mitglieder, Vienna, 1 February 1983, letter; Sojaring, 4. Aussendung an Mitglieder, Vienna, 1 March 1983, letter.

80 Saatbau Linz, 6. Internationale Fachmesse für Saatgut (IFASA '85), in: Inform: Zeitschrift für Pflanzenzüchtung und Saatgutproduktion 2 (1985), 3.

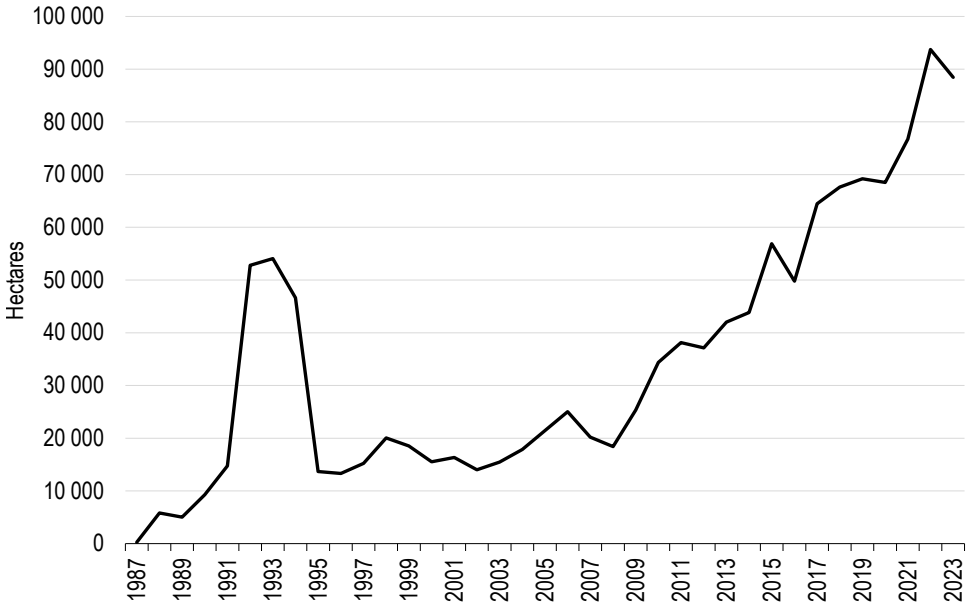
81 Dietrich Wolffhardt, Erfahrungen im Anbau von Öl- und Eiweißpflanzen in Österreich, in: Inform: Zeitschrift für Pflanzenzüchtung und Saatgutproduktion 2 (1985), 9–10, 9.

82 Ernst Bruckmüller/Wolfgang Werner, Raiffeisen in Österreich: Siegeszug einer Idee, St. Pölten 1998, 204.

83 Josef Riegler, Neugestaltung der österreichischen Agrarpolitik, in: Der Förderungsdienst 35/4 (1987), 90–91.

84 Tausch, Alternativen, 194.

Figure 5: Soybean cultivation in Austria, 1987–2023



Sources: BMLF, Grüner Bericht 1989, 64; Statistik Austria, Statcube, years 1990–2023, Feldfruchtproduktion, Sojabohnen. Compiled by the author.

to alternative arable crops. This was due to high federal expenditure for supporting grain exports, one-sided crop production, and the dependency on protein feed imports.[85] The state subsidy system for soy between 1988 and 1994 (referred to as the 'Soybean Campaign') comprised an area bonus and a product bonus (a guaranteed purchase price).[86] The LWK were responsible for issuing authorization certificates to farmers. To qualify for the subsidy, farmers were required to reduce their area devoted to grain and grain maize by the amount of land on which they cultivated subsidized soy. Furthermore, it became mandatory to purchase original seeds from a selection of authorized varieties. In essence, the subsidy scheme can be characterized as contract farming, since farmers were required to arrange a cultivation and supply contract with purchasers.[87] In effect, the Soybean Campaign supported the cultivation of soybeans with favourable contribution margins, promoting the position of soy in comparison to other arable crops. This state support led to an expansion of soy cultivation. In 1987, for the first time since the postwar period, the BMLF designated soy as a specific crop with a total growing area of 250 hectares. During the campaign, soy reached its peak in 1993 with cultivation on over 50,000 hectares (Figure 5). The associated financial outlay amounted to

85 Oliver Auer, Land der Bohne? Über das soziale System und die kulturellen Praktiken hinter der österreichischen Körnerleguminosenproduktion, master thesis, University of Klagenfurt 2015.

86 BMLF, Grüner Bericht,1994, 122.

87 Niederösterreichisches Landesarchiv (NÖLA), Bezirksbauernkammern, BBK Baden, box 65: NÖ Landes-Landwirtschaftskammer Schreiben bezüglich Sojabohnen – Anbauaktion 1988, 10 March 1988, administrative record.

approximately 186 million euros.[88] Nevertheless, it resulted in a reduction in expenditure for the support of grain sales.[89]

The incorporation of soy into the state subsidy programme led to a resurgence in research activity. In 1987, the LWK resumed large-scale cultivation trials with state support (Figure 4). Furthermore, state-funded scientific research was conducted in conjunction with the cultivation of soybeans, encompassing areas such as soybean breeding, irrigation techniques for soybeans, agrometeorological concerns, and potential applications for animal feed.[90] The largest research project was a soybean breeding programme at BOKU.[91] Between 1987 and 1992, cross-breeding trials were conducted and approximately 100 soy varieties tested at thirteen locations in collaboration with LWK, technical colleges, and breeding companies.[92] Additionally, breeding companies had commenced the introduction of novel soybean varieties to Austria for evaluation purposes. At this time, two cooperative companies dominated the soybean seed market: *Raiffeisen Ware Austria* (RWA) with its subsidiary *Saatzucht Gleisdorf,* and *Saatbau Linz*. Soy cultivation in Austria was contingent upon the availability of suitable early-maturing varieties. The expansion of acreage went hand in hand with an increase in the number of available varieties: While Austrian farmers had previously been limited to five soybean varieties imported from Canada and the USA, the market expanded to encompass 25 varieties by 1994.[93]

The eco-social shift of agricultural policy impacted other established players in the agro-food sector as well. Despite the absence of external protection for oilseeds, the increased state support for the cultivation of oil and protein crops was a strong economic incentive to invest in the processing sector. Support for a new oil mill project came from the *Raiffeisen* co-operatives, the LWK, and other economic actors such as agricultural trading companies. In 1989, an oil mill commenced operations, with a producers' cooperative assuming responsibility for supplying approximately 50,000 tonnes of oilseeds. The establishment of the oil mill contributed to reducing Austria's reliance on imported vegetable oils.[94] However, the project once again excluded soy, with the mill designed exclusively for processing rape and sunflower

88 Author's calculation based on: BMLF, Grüner Bericht, years 1989–1994. Exchange rate: 1 euro = 13.7603 schilling.

89 Rechnungshof, Nachtrag zum Tätigkeitsbericht des Rechnungshofes: Verwaltungsjahr 1994. Produktionsumlenkende Förderungsmaßnahmen zur Einschränkung des Getreideanbaus, Vienna 1994.

90 H. Supersperg/Peter Cepuder/Andreas Klik, Abschlußbericht: Beregnung von Sojabohnen, Forschungsprojekt L 561/89, Vienna 1991; Walter Schneeberger/Rudolf Leitgeb/Emmerich Berghofer, Endbericht zum Projekt ND 45. Kosten-Nutzen-Analyse der verschiedenen Verwertungsmöglichkeiten für Sojabohnen im Futtermittelbereich, Vienna 1991; Ralph Gretzmacher, Endbericht über das Projekt Nr. 474: Aufbau einer österreichischen Sojabohnenzüchtung und Erarbeitung optimaler pflanzenbaulicher Maßnahmen, Vienna 1991; Inge Dirmhirn et al., Endbericht für das Projekt Nr. L 569/89: Agrarmeterologische Untersuchungen an Mais, Sojabohne und Pferdebohne, Vienna 1992.

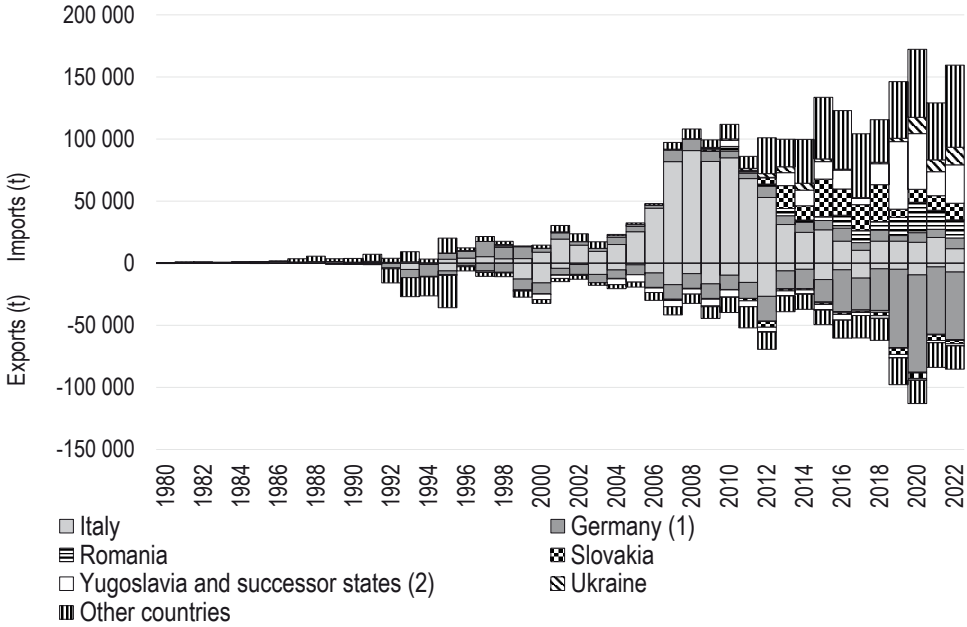
91 ParA, Bericht des Bundesministeriums für Wissenschaft und Forschung über die Forschungsförderungen 1990, III-30 der Beilagen XVIII. GP, report.

92 Gretzmacher, Endbericht; Ralph Gretzmacher, Abschlußbericht über das Forschungsprojekt Nr. L 719/92: Weiterführung einer österreichischen Sojabohnenzüchtung und der begleitenden produktionstechnischen Untersuchungen, Vienna 1992.

93 Kundmachung des Sortenverzeichnis und Zuchtbuchs, in: Amtsblatt zur Wiener Zeitung, 10 February 1994, 14–15.

94 Stefan Pinterits, Markt für pflanzliche Öle und Fette, in: Günter Breuer et al. (eds.), Agrarvermarktung in Österreich: Von der Marktordnung zum Marketing, Vienna 1991, 333–337, 334–335; Bruckmüller/Werner,

Figure 6: Soybean trade in Austria, 1980–2022



Sources: Österreichisches statistisches Zentralamt, Statistik, yearbooks 1980–1994, Customs No. 120120, 12010010, 12010090; Statistik Austria, Statcube, years 1995–2022, Combined Nomenclature: 12010010, 12010090. Compiled by the author.
(1) Until 1991: only West Germany, no trade with East Germany; (2) Since 1991/92: Bosnia and Herzegovina, Kosovo, Croatia, North Macedonia, Serbia, Montenegro, Slovenia.

seeds. This may have been due to the relatively new and still unstable soy cultivation sector and the additional equipment that would have been required.[95]

Processing of the Austrian soy harvest therefore still had to occur via alternative routes. On the one hand, soy was processed in large quantities by compound feed mills in full-fat form for animal feed.[96] The requisite pre-treatment (degradation of trypsin inhibitors) resulted in the establishment of processing facilities capable of thermally treating (toasting) soybeans.[97] Meanwhile, the transition to domestically produced animal feed was facilitated by the support of traditional agricultural cooperatives such as *Raiffeisen*.[98] Conversely, a minor proportion of the soybean yield was absorbed by food processing companies for soy-based

Raiffeisen, 204; Commission of the European Communities, Regulation (EEC) No. 4064/89: Merger Procedure. Case No IV/M.866 – CEREOL/ÖSAT-Ölmühle, Luxembourg 1997; BMLF, Grüner Bericht 1989, 63.

95 Walter Schneeberger/Franz Raab, Sektorplan-Grundlagen für Getreide, Ölsaaten und Hülsenfrüchte, Saat- und Pflanzgut, Stärke und Alkohol, Vienna 1993, 61.

96 Walter Schneeberger/Rudolf Leitgeb/Emmerich Berghofer, Einsatz von Sojabohnen im Futtermittelbereich: Kosten-Nutzen-Analyse der verschiedenen Verwertungsmöglichkeiten, in: Der Förderungsdienst 40/8 (1992), 53–60, 53.

97 Interview no. 28/2, segment 10-26 (male, agricultural trading company), 16 November 2023.

98 Bruckmüller/Werner, Raiffeisen, 312.

mill products and alternative foods, as previously outlined. A limited quantity was also utilized in specialized facilities for soy oil and exported.[99] In 1993, soybean exports amounted to approximately 27,000 tonnes (Figure 6). In summary, the incorporation of soy into the subsidized alternatives scheme resulted in an expansion of the production network, with an increase in the number of soy farmers and the emergence of new sectors including animal feed production and seed breeding. Austrian soybeans, formerly a niche product, became more and more incorporated into the established agro-food sector, indicating a nationally framed (sub-)regime. However, soy cake imports were still the main source of protein for animal feed (Figure 3), highlighting Austria's continued dependence on a global – though no longer solely US-centred – food regime.

Flexible beans: Austrian soy between WTO- and EU-centred regimes (1995–2020)

From the mid-1990s onwards, the Austrian-centred commodity network around soy was stabilized by the European integration. Simultaneously with the first soy boom, Austrian politicians decided to set a course for EU accession in response to increasing international competition in the context of the GATT's Uruguay Round. Austria applied for membership in 1989, accession negotiations began in 1993, and the country became a member of the EU in January 1995. The accession process marked a pivotal moment for the agricultural sector given the necessary adaptations to the notable discrepancies in pricing and quality within the framework of the EU's Common Agricultural Policy (CAP). Concerning agricultural subsidies, Austria managed to ensure degressive payments to producers for a transitional period of four years. Furthermore, the possibility of an agro-environmental policy within the context of the CAP was established. This was subsequently implemented in the Austrian agro-environmental programme ÖPUL.[100] Moreover, international treaties signed by the EU also became binding for Austria. These included the Blair House Agreement concluded between the EU and the USA in 1992 to settle the oilseeds dispute. It stipulated that the EU was permitted to promote a maximum of 5,128,000 hectares of oilseeds, with Austria assigned a maximum of 147,000 hectares.[101] The agreement enabled the conclusion of the GATT Uruguay Round and thus the transition to the World Trade Organization (WTO) in 1995.[102] This suggests that the USA retained a dominant position in the European oilseed market even during the 1990s, with Austria being further integrated into transnational agro-food commodity chains.

99 Schneeberger/Raab, Sektorplan, 5, 56, 65.

100 Andrä Rupprechter, Agrar- und Agrarstrukturpolitik, in: Waldemar Hummer/Walter Obwexer (eds.), 10 Jahre EU-Mitgliedschaft Österreichs: Bilanz und Ausblick, Vienna 2006, 455–460, 455–456; Schneeberger/Raab, Sektorplan, 18; BMLF, Jahresbericht 1993, 57–60; BMLF, Jahresbericht 1994, 73–80.

101 Austria never reached this level. See ParA, Beantwortung der schriftlichen parlamentarischen Anfrage betreffend Auswirkungen des "Blair House Agreement", 2290/J, 10 November 2004, scanned original.

102 Glenn Ames/Lewell Gunter/Claudia Davis, Analysis of USA-European Community Oilseeds Agreements, in: Agricultural Economics 15/2 (1996), 97–112, 100–101; Michael T. Herlihy/Joseph W. Glauber/James G. Vertrees, U.S.–EC Blair House Agreement, in: International Agriculture and Trade Reports Europe: Situation and Outlook Series/RS-93-5 (1993), 45–52, 49.

Austria's EU accession resulted in a reduction of the high state subsidies for soy cultivation, which subsequently led to a significant decline in harvested area. Until the 2000s, the area under soy cultivation ranged between 13,000 and 25,000 hectares (Figure 5). Nevertheless, the continuation of direct payments was a factor that contributed to the persistence of soy cultivation. Soy was subsidized with an area compensation as an oilseed in the so-called Crop Compensation Scheme (1995–2005), which also included rapeseed and sunflowers.[103] Starting in 2000, the level of support for oilseeds decreased continuously. The ÖPUL also created an indirect incentive to cultivate oil and protein crops from 1995 onwards. This was achieved by promoting crop rotation as part of the incentives for eco-friendly farming. The soybean, which acts as a nitrogen collector in symbiosis with bacteria, benefited from this measure in the long term.[104]

In addition to these institutional changes, public discourses affected the role of soy in the agro-food domain from the 1990s onwards. The socio-ecological discourse centred on organic farming versus genetically modified organisms (GMOs) in agriculture generated distinct public notions of 'good soy' versus 'bad soy'. The debate about GMOs began relatively late in Austria when the harmonization of the EU's legal system culminated in the Austrian Genetic Engineering Act of 1995. A significant and emotional debate commenced in 1996, coinciding with the prospective release of genetically modified potato and maize plants. Genetic engineering was perceived as a potential threat by many consumers, especially those from the middle classes with higher income and education. A heterogeneous coalition from different areas of society (organic farmers' associations, food traders, environmental NGOs), supported by certain mass media, emerged. Due to this civil society resistance, experimental cultivation of GMOs never started in Austria. In 1997, a referendum calling for the prohibition of genetic engineering in food, agriculture, and patents was initiated. The petition was signed by over 20 per cent of the Austrian electorate. The demands were gradually incorporated into the Austrian and EU regulatory framework through revised authorization procedures for the release of GMOs and food labelling. In Austria, opponents of genetic engineering joined forces in the platform *ARGE Gentechnik-frei* (GM-free) and established the label *Gentechnik-frei hergestellt* (produced without GMOs).[105]

The use of soy as food and feed has been a key issue in the debate on GMOs, resulting in a gradual restructuring of the established commodity network. The broad rejection of GMOs in Austria on the demand side was perceived by companies in agricultural trade, animal husbandry, processing, and retail as an incentive to supply GM-free products. This led to two significant changes: Firstly, a new commodity chain for GM-free soy emerged alongside the well-established imports of North and South American GM soy (Figure 3, Figure 6).[106] Secondly, the controversial debate around GMOs promoted the value of GM-free soybeans cultivated in Austria. According to a representative of a compound feed company, the GMO issue "then […] improved a bit the competitiveness of our GM-free soy, GM-free soy by

103 BMLF, Grüner Bericht 1995, 148.

104 Auer, Land, 73.

105 Petra Grabner/Helge Torgersen, Gentechnik in Österreich: Technikkritik versus Modernisierung, in: Christine Wächter et al. (eds.), Technik gestalten: Interdisziplinäre Beiträge zu Technikforschung und Technologiepolitik, Munich 1998, 209–223, 215–217; Franz Seifert, Demokratietheoretische Überlegungen zum österreichischen Gentechnik-Konflikt, in: SWS-Rundschau 43/1 (2003), 106–128, 108–109 and 120–121.

106 "Da läuft generell etwas falsch:" Interview mit Karl und Andreas Pilstl, in: Schweineprofi, n.d., 11–12.

nature, right. So, there was a price difference […], and then it became more valuable."[107] As a reaction to the end of direct subsidies, soy cultivation initially declined. Starting in 2009, however, a combination of factors including the upvaluation of GM-free soy in the value chain led to a steady increase in soy cultivation until recently (Figure 5).

A further alternative to genetic engineering besides GM-free soy was organic soy. Representatives of organic farming successfully positioned organic (and therefore also GM-free) products as an even better alternative to GMOs.[108] Exploiting this market opportunity, a group of entrepreneurs comprising food processors, breeders, and farmers founded the *Soja aus Österreich* (Soy from Austria) association in 2008 with the aim of raising awareness of soy as a sustainable foodstuff and promoting GM-free and organic soy cultivation in Austria.[109] This civil society initiative was in part a continuation of the now-defunct *Sojaring*. In particular, several *Sojaring* farmers joined the new association, and their focus on soy food remained a priority. Food processing companies played a more important role, however.[110] The soy commodity network was reinforced and expanded around this association, including scientific soy research at BOKU, commercial breeding with a specific focus on varieties for soy food, plant cultivation advice, soy farmers, specialized agricultural trade, large-scale soy food processing (tofu, soymilk, soy flour, soy snacks) and retail (private labels and special brands). A central element highly valued by discerning consumers was the organic and regional origin of soybeans. With the growing trend towards plant-based diets, the importance of soy in human nutrition has increased, resulting in a wide range of organic and conventional soy food products and soy derivatives (for example, lecithin and isoflavones) available to food processors, restaurants, and consumers.[111] As a consequence – and in contrast to most other countries – approximately one-third of the soybean harvest in Austria is organic.[112]

Another key feature of soy's commodity network is its transnational connectedness. Austria's integration into the Single European Market has resulted in intensified competition and significant adaptations in specific sectors, for example dairies and mills. However, EU integration has also presented opportunities for Austrian companies to sell their products abroad.[113] In this market integration, the distinguishing feature of GM-free soy was essential, as it facilitated the competitiveness of Austrian companies with suppliers of GM soy and thus

107 Interview no. 22, segment 28 (male, compound feed company), 19 October 2023.

108 Josef Hoppichler, Biolandbau und Gentechnik: Von der Unmöglichkeit eines Nebeneinander, in: Michael Groier/Markus Schermer (eds.), Bio-Landbau in Österreich im internationalen Kontext: Zwischen Professionalisierung und Konventionalisierung, Vienna 2005, 139–154, 140; Helge Torgersen, Austria and the Transatlantic Agricultural Biotechnology Divide, in: Science Communication 24/2 (2002), 173–183, 180.

109 Matthias Krön, Produktion und Vermarktung von Soja-Lebensmitteln in Österreich, in: Verein Soja aus Österreich (ed.), Tagungsband: 1. Österreichisches Soja-Symposium. 135 Jahre Sojabohne und Sojaforschung, Vienna 2008, 11–13.

110 Interview no. 31, segment 4-19 (male, NGO), 30 November 2023.

111 Angela Mörixbauer/Elisabeth Fischer, Projektbericht: Marktübersicht gastronomiegeeigneter verfügbarer Sojaprodukte aus der Region, Vienna 2019.

112 2023 bisher größte Sojaernte in Österreich, in: Austria Presse Agentur, Originaltext-Service (APA-OTS), 5 December 2023.

113 Josef Hoppichler, Was brachte der EU-Beitritt der österreichischen Landwirtschaft?, Vienna 2007; Matthias Schneider, Österreichs Landwirtschaft unter EU-Bedingungen, in: WIFO Monatsberichte 3 (1997), 155–170, 160.

generated added value. This includes soy products like soy milk, tofu, soy snacks, soy seeds, and soy mill products.

In contrast to soy cake, which is mainly imported, Austrian soy mill products are export products. Since 1995, soy flour exports and trade links have been increasing, peaking at around 16,800 tonnes in 2014. Initially, Austria exported soy flour primarily to European countries, but over the past decade there has been a notable shift towards non-European regions such as North Africa and the Middle East. For instance, approximately one-sixth of the export volume was directed to non-European countries in 2019. By contrast, imports only played a significant role between 2000 and 2007.[114] These developments highlight the steadily growing importance of Austrian soy in the agro-food sector after its downturn in the mid-1990s, complemented by key export links to the EU and beyond.

A transnational linkage similar to soy flour has emerged in the domain of soy seeds. While Austria depended on foreign soy varieties for a long time, a coexistence of foreign and domestic varieties has emerged over the last fifteen years. Austrian soy breeding achieved national approvals for early-maturing, food-grade soy varieties in 2015. With these domestic varieties, Austrian breeders not only transformed the domestic soy seed market but also expanded their supply chains in the international GM-free seed market. In 2020, around 30 per cent of registered soy varieties in Austria were from domestic breeding.[115] Saatzucht Donau, a major Austrian breeding company, registered 74 soy varieties in fourteen foreign countries within seven years.[116] A representative of the company mentions a "relatively large geographical radius of action. So, the easternmost cultivation area of our varieties is in the very east of Russia […] and the westernmost distribution is in the Toronto area."[117] The commercial success of companies stabilized the domestic connections between interest groups, producers, and processors in the soy commodity network.

In the 2010s, the network around Austrian soy underwent expansion in two directions: Central and Eastern Europe as well as the livestock complex. In 2012, members of the *Soja aus Österreich* organization founded the association *Donau Soja* (Danube Soy – DS). In contrast to the former, the latter identifies as an international non-governmental organization (NGO) representing the entire soy value chain in Europe. DS asserts that Europe's dependence on soy imports from socio-ecologically problematic extraction in South and North America represents a sustainability issue. The DS initiative therefore promotes a more sustainable, GM-free and purely European supply chain of plant protein as human food and animal feed, referred to as the 'protein transition'. To this end, it propagates the expansion of soy cultivation and other protein crops in Central and Eastern Europe. DS established the labels *Donau Soja* and *Europe Soja* to guarantee consumers assured origin, production without GMOs, glyphosate, and deforestation, and fair labour standards. Certification charges in addition to membership fees and public funding are the crucial financial sources for DS.[118] The number of

114 Statistik Austria, Statcube, years 1995–2022, Combined Nomenclature: 120810.

115 Bundesamt für Ernährungssicherheit, Österreichische Sortenliste 2023, Vienna.

116 Saatzucht Donau, Sortenzulassungen, https://www.saatzucht-donau.at/sorten/ (10 September 2024).

117 Interview no. 14, segment 45 (male, breeding company), 4 May 2023.

118 Donau Soja Association, Donau Soja 10 Years Anniversary & Annual Report 2022, https://www.donausoja.org/wp-content/uploads/2022/09/DonauSoja_AnniversaryReport2022-1.pdf (30 August 2024); Matthias Krön/Ursula Bittner, Danube Soya: Improving European GM-free Soya Supply for Food and Feed, in: OCL-Oilseeds and Fats, Crops and Lipids 22/5 (2015), 1–10.

members increased from 34 in 2012 (mainly from Austria, Switzerland, and Germany) to over 200 from nearly 30 European countries by 2020. The list of members includes agrobusiness companies, lobbying and research organizations, farmers' associations, agricultural traders, food and feed processors, and retailers.[119] The DS association and its transnational activities signify the emergence of a soy commodity network with an ambivalent character: On the one hand, it represents a European and sustainable counterweight to the dominance of American soy-exporting countries and transnational agrobusiness in agro-food globalization; on the other hand, it also adopts parts of the expansionist and agro-industrial agenda and includes traditional national and global actors.

As *Donau Soja* was founded, the first extraction plant for soy oil commenced operations in Austria. It processes soybeans originating from Austria and its neighbouring countries according to the DS standard, with most of the oil sold to the domestic biodiesel industry. The remaining soy cake is sold to the feed industry in Austria and abroad.[120] While these activities have only slightly reduced the import volumes of soy cake, the share of soy in oilcake imports has dropped significantly from around 90 per cent in 2010 to 67 per cent in 2020 due to the increase in rapeseed and sunflower oilcakes (Figure 2). Furthermore, the countries of origin for soy cake and soybeans have diversified, with soy cake now also being imported from Eastern Europe (Poland, Serbia, Hungary, Ukraine, and Romania). Similarly, soybeans are imported from Eastern Europe for further processing (Figure 3, Figure 6). Austrian soybeans are also exported to Germany due to the shift of Archer Daniels Midland's oil mills in Straubing and Mainz to GM-free soy.[121] This strategy illustrates that key players in the global agrobusiness respond to European developments by diversifying their value chains in both the GM and GM-free sectors.

By the 2020s, the soy commodity web in Austria was significantly diversified. The joint efforts of anti-GM activists and GM-free marketing had reinforced a distinction in the public discourse on soy: Whereas imported products were perceived as 'bad' soy (i.e., genetically modified, industrialized, and foreign), Austrian soybeans were viewed as 'good' soy (GM-free, organic, and regional). Currently, imported soy – grown almost entirely from GM seeds – continues to play a role as 'food from nowhere', while GM-free conventional and organic soy is represented in product marketing as 'food from somewhere' for human consumption and animal feed.[122] The fact that both notions of soy exist side by side demonstrates that elements of the previous US-centred regime continue to exist even though new elements have been introduced by overlapping WTO- and EU-centred regimes. The Austrian position in the global food regime has shifted from that of a strongly dependent importer of transatlantic soy to that of a producer and exporter of domestic soy in the European common market with increased – though still limited – autonomy.

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119 Author's calculation based on: Donau Soja Association, List of members 2024.

120 Interview no. 21, segment 43-59 (male, soy oil mill), 16 October 2023.

121 Ölmühle Mainz: Verarbeitung von GVO-freiem Soja, in: agrarzeitung, 8 April 2022.

122 Hugh Campbell, Breaking New Ground in Food Regime Theory: Corporate Environmentalism, Ecological Feedbacks and the 'Food from Somewhere' Regime?, in: Agriculture and Human Values 26/4 (2009), 309–319.

Conclusion

This article highlights agro-food change through the lens of soy in the age of globalization. It concentrates on national developments and their transnational connections in the establishment of soy as an arable crop, feed, and food in Austria between around 1950 and 2020. Austria is now an important soy producer and exporter within the EU. It is the second largest producer of soy in relation to arable land after Croatia, and the fifth largest producer in absolute terms behind Italy, France, Romania, and Croatia.[123] The long and challenging journey of soy in Austrian agriculture comprises three partly overlapping periods: *hidden beans* (1948–73), *contested beans* (1973–95), and *flexible beans* (1995–2020). In the first period, Austria dealt with political and economic reconstruction after the Second World War by boosting food supply and agricultural self-sufficiency. Soy cake imports from overseas for livestock production facilitated agricultural intensification, supplying the increasing consumption of meat and dairy products. Through these commodity flows and associated institutions, Austria became integrated in the US-centred food regime. By the 1960s, the country transitioned from food scarcity to agricultural surpluses, while its dependence on vegetable oil and protein imports persisted. The 1973 global protein crisis marked the beginning of a second period characterized by state- and business-initiated efforts to reduce dependence on feed imports, representing a move towards a more nationally framed food regime. However, US pressure forced the Austrian government to abandon its plans for strengthening food autonomy. Despite this failure, a commodity-based network around soy food emerged and successfully established a vegetarian niche within the 'meatified' regime. During the third period, which was shaped by Austria's accession to the EU, the niche network relating to soy expanded and benefited from both material and symbolic diversification between conventional (mostly GM) and organic (GM-free) soy. In the context of the high-productivist WTO-centred regime, the EU regulations opened up room for manoeuvre for 'post-productivist' activities such as organic agriculture and regional food. Within the WTO- and EU-centred regimes, Austria's position shifted from that of a pure (and therefore dependent) feed importer to an importer, producer, and exporter of diverse products with more (albeit still limited) autonomy.

The actors involved in the emerging soy commodity web in Austria dealt with various driving and impeding forces. Most important for the integration of soy into the Austrian agro-food sector were the connections between initiatives by economic actors and civil society organizations on the one hand and state policies on the other. For instance, state regulation and support promoted the establishment of a network for soy cake and oil in the first period and enabled the soy food network in the second and third periods. This development was not linear, however, but rather a step-by-step journey of trial and error to explore a suitable path. A further facilitating factor was the connection between soy and nutritional changes in large segments of Austrian society. Soy played a dual role in human nutrition: On the one hand, processed soy provided the ingredients for the meatification and oilification of the Western diet in the postwar decades. On the other hand, unprocessed soybeans emerged as a "whole food" for a more plant-based diet representing an alternative to animal-based food.[124] These

123 Author's calculation based on: Eurostat, apro_cpsh1: arable land (ARA), soya (I1130), year 2019.

124 Ernst Langthaler, The Soy Paradox: The Western Nutrition Transition Revisited, 1950–2010, in: Global Environment 11/1 (2018), 79–104, 102–103.

opposing, yet interlinked nutritional patterns initially formed different commodity networks: transnationally embedded soy cake flows and more nationally framed soy food networks. While these networks have largely converged over time, their driving forces have remained powerful. The emergence of soy in Austria was driven not only by demand but also by supply due to its material and symbolic features. In both organic and conventional farming, soybeans were a means of expanding crop rotation, thereby diversifying and ecologizing one-sided agro-ecosystems. The discursive association of GM soy with unsustainable agro-extractivism in the Americas worsened its public image in Austria. In the long term, the soy commodity network benefitted from the distinction between 'good' and 'bad' soy.

Besides these driving forces, Austrian soy also faced obstacles and restraints. Most importantly, institutional barriers inhibited the emergence of a competitive Austrian-based soy network for some time. During the first and the beginning of the second period, US producer and trader interests institutionalized in the food regime played a central role in maintaining the status quo. During the third period, Austria's EU integration enabled more leeway in the institutional framework for the Austrian soy network. In addition to institutional barriers, soy's biological properties such as the its dependence on day length posed challenges as well. Soy cultivation demanded specialized knowledge and practices, and its processing required adequate equipment and technical expertise – and in the culinary realm, it competed with traditional dishes. Nevertheless, the driving forces gradually overcame these impeding factors.

Although this article has an empirical ambition with a limited temporal and spatial focus, its findings also contribute to temporal and spatial aspects of food regime theory. Firstly, it contributes to the periodization of food regimes by emphasizing the periods of crisis and transition. The Austrian case shows that the transition between the US-centred regime and its successor regime extended over a relatively long period from the 1970s to the 1990s. It can be argued that such periods of crisis and transition are at least equally crucial for food regime analysis as the more stable regime periods. Although the periodization of food regimes can build on single moments such as the 1973 protein crisis, it must also take into account the gradual overlaps of elements of previous and subsequent regimes – be they regulatory institutions, commodity networks, or socio-technical innovations. Secondly, the Austrian case highlights the need to reassess food regimes in a multiscalar perspective. The integration of a national agro-food sector into a global food regime is always only partial, leaving room for national, regional, and even local agency in organizing agriculture and food. Therefore, describing the successor of the US-centred regime as a 'WTO-centred' and 'corporate' regime does not adequately reflect the multiscalar diversity. The EU's Common Agricultural Policy as well as (sub-)national agro-food policies, commercial projects, and social movements add complexity to the simplistic notion of a uniform global regime. Country-focused case studies may provide a fruitful approach to analysing agro-food change adequately with a view to the multiplicity of time and space.

Matilda Baraibar Norberg

Soy in Africa

A Perpetual Promise since the Late Nineteenth Century

Abstract: This article traces the changing place of soybeans in Africa from the late nineteenth century to the present, arguing that the continent's modest material uptake contrasts with a remarkably persistent 'soy promise.' Using a discourse-historical approach and a food regime framework, African trajectories are situated within wider transformations of the global agri-food system. In the Colonial Experimental Regime (1880s–1930s), soy was cast as a crop of scientific modernity, yet it remained largely confined to trials and station fodder. In the Cold War Developmentalist Regime (1950s–1970s), it re-emerged as a nutritional technology and aid commodity within U.S.-led architectures of food aid and market development. In the Corporate-Neoliberal Regime (1990s–present), soy is reframed as a flexible frontier commodity embedded in liberalised value chains and feed complexes, with post-2010 output growth concentrated in a few countries. The article argues that the durability of the 'soy promise' reflects the interplay of imaginaries, institutions, and uneven material outcomes; it also considers whether regional markets, continental trade initiatives, and climate pressures might shift soy's role beyond its predominantly feed-centred footprint.

Zusammenfassung: Der Artikel zeichnet die Veränderungen in der Bedeutung der Sojabohne in Afrika vom späten 19. Jahrhundert bis heute nach und argumentiert, dass die bescheidene materielle Verbreitung auf dem Kontinent im Kontrast zu einem bemerkenswert hartnäckigen ‚Soja-Versprechen' steht. Mittels eines diskurshistorischen Ansatzes und einer Nahrungsregime-Rahmung werden die Entwicklungen in Afrika in den Kontext umfassenderer Veränderungen des globalen Agrar- und Ernährungssystems eingeordnet. Im kolonial-experimentellen Regime (1880er–1930er Jahre) wurde Soja als Kulturpflanze der wissenschaftlichen Moderne konzipiert, blieb jedoch weitgehend auf Versuchsanbau und Viehfutter beschränkt. Im entwicklungspolitischen Regime des Kalten Krieges (1950er–1970er Jahre) trat Soja als Technologie zur Verbesserung der Ernährungssituation und als Hilfsgut im Rahmen der von den USA angeführten Nahrungsmittelhilfe und Marktentwicklung wieder auf; die Verwendung von verarbeitetem Soja stand stärker im Fokus als die Ausweitung des Anbaus. Im kapitalgesellschaftlich-neoliberalen Regime seit den 1990er Jahren wird Soja als flexible Pionierware umgedeutet, eingebettet in liberalisierte Wertschöpfungsketten und Futtermittelkomplexe, wobei sich das Produktionswachstum seit 2010 auf wenige Länder konzentriert. Der Artikel argumentiert, dass die Beständigkeit des ‚Soja-Versprechens' das Zusammenspiel von Projektionen, Institutionen und wechselnden Produktionsergebnissen widerspiegelt. Er untersucht zudem, inwieweit regionale Märkte, kontinentale Handelsinitiativen und der Druck des Klimawandels die Rolle

DOI: 10.25365/rhy-2025-6

Accepted for publication after external peer review (double-blind).

Matilda Baraibar Norberg, Department of Environment, Development and Sustainability Studies, School of Natural Sciences, Technology and Environmental Studies, Södertörn University, 141 89 Huddinge, Sweden, matilda.baraibar@sh.se

der Sojabohne über ihren vorwiegend auf Futtermittel ausgerichteten Fußabdruck hinaus verschieben können.

Keywords: Africa, food regimes, agrarian political economy, agricultural imaginaries

Introduction

"With its vast arable land, Africa has the potential to develop a strong soybean industry to increase food security, create employment opportunities, and position itself as a key exporter to China."[1] Although this statement was published only last year, such claims are far from new. In fact, as early as the late nineteenth century, soybeans were framed as a legume of exceptional promise for Africa. In 1898, French botanist Louis Trabut wrote of soy's potential in Algeria:

> "Very remarkable for its richness in nitrogenous materials and fat, it can be very useful in the feeding of animals, for fattening and for the production of dairy milk. Its role in the human diet is less evident, however the indigenous people might find a precious resource in this legume."[2]

Comparable assessments circulated widely across colonial Africa. In 1908, E. R. Sawer of South Africa's Cedara Agricultural Station described soy as "the richest of all grains in albuminoids," arguing that "even a crop of half the standard yield is well worth growing. […] As grain, hay, or ensilage, it is well adapted for admixture with maize to counteract the deficiencies of the latter crop."[3] Such arguments have proven remarkably durable, with contemporary policy actors and agribusiness consultants continuing to reiterate many of the same claims. As Brivery Siamabele concluded in 2021:

> "[I]ncorporating soybeans as a major cash crop and animal-feed protein in African production systems is cost-effective and can address the dual challenges of malnutrition and climate change resilience that small-scale farmers are faced with. The paper also argues that Africa needs soybeans production more now than ever before because the continent at large has the potential to be a world leader in the production of soybeans as well as other key grain legumes."[4]

1 Vincent Ninkuu/Tianfu Han/Felix D. Dakora, Development of the Soybean Industry in Africa: Safeguarding Food Security in Africa and China. A Perspective, in: Engineering 49/6 (2025), 272–278.

2 Louis Trabut, Le soja, in: Informations Agricoles, Service Botanique, Algérie, Bulletin 16/7 (1898), n.pag.

3 E. R. Sawer, The Place of Legumes in Our Agricultural System, in: Natal Agricultural Journal 11/6 (1908), 685–692, 688–690, https://hdl.handle.net/10520/AJA0000009_1349.

4 Brivery Siamabele, The Significance of Soybean Production in the Face of Changing Climates in Africa, in: Cogent Food & Agriculture 7/1933745 (2021), 1–16, 12.

Investor discourse echoes this optimism. In June 2024, the online business magazine *Capmad* predicted annual growth rates of over 20 per cent for Africa's soybean agri-food sector in the coming years.[5]

For more than a century, actors ranging from colonial officials to contemporary agribusiness consultants have imagined Africa as a 'latent soybean frontier,' consistently projecting a transformative future. Yet its materialisation has remained elusive: Africa accounted for only roughly 1.5 per cent of global soybean output in 2024,[6] a modest increase from 0.27 per cent in 1961[7] and well below its demographic share (c. 19 per cent)[8] and estimated share of global arable land (c. 20.3 per cent).[9] This persistent gap between projection and production – the paradox of a crop long promoted but never fully realised – lies at the heart of this article.

Rather than explaining soy's limited expansion primarily through agronomic or economic constraints, it focuses on how the future of soy has been imagined, narrated, and mobilised across different historical contexts. Why has the narrative of untapped potential endured despite modest production outcomes? What broader visions of development, modernisation, and geopolitical positioning does the soybean come to embody?

This article scrutinises how soybeans in Africa have been represented in policy, scientific, and development-oriented texts since the late nineteenth century, tracing continuities and shifts in how both the crop and the continent have been positioned within global agri-food debates. These imaginaries vary across colonial territories, postcolonial states, and agro-ecological zones. Accordingly, Africa is not treated as a homogeneous space but rather as a historically fragmented terrain of imperial, postcolonial, and corporate interventions.

The article follows a longue durée structure organised around three periods used as heuristic, relational frameworks rather than rigid, self-contained blocks. First, the Colonial Experimental Regime (1880s–1930s) situates soy as a crop of projection in the context of imperial science and commodity frontiers. Second, the Cold War Developmentalist Regime (1950s–1970s) examines soy as a nutritional and feed technology within U.S.-led food aid and market-building architectures. Third, the Corporate-Neoliberal Regime (1990s–present) traces the repositioning of soy within liberalised value chains, investment frontiers, and shifting geopolitical partnerships. Across all three periods, soy is treated not only as a botanical object but as a vehicle of projection through which changing technocratic and geopolitical visions of African development were articulated. A final comparative section relates the third

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5 Capmad, Africa's Soybean Sector Takes the International Market by Storm, in: Capmad (21 June 2024), https://www.capmad.com/post/africas-soybean-sector-takes-the-international-market-by-storm (13 January 2026).

6 Total global production of soybeans (2024/2025) was 427.15 million metric tons. U.S. Department of Agriculture/Foreign Agricultural Service, Production Data for Soybeans (2024/2025), https://www.fas.usda.gov/data/production/commodity/2222000 (14 January 2026).

7 FAOSTAT, Crops and Livestock Products, Production Quantity (Soya beans), Africa (Total) and World (Total), 1961–2024, Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/ (14 January 2026).

8 Africa's estimated total population was 1,568,885,679, as of 13 January 2026 at 08:33 PM (CET; UTC+01:00). Worldometer, Africa Population, https://www.worldometers.info/world-population/africa-population/ (13 January 2026).

9 Africa's total land area is approximately 11,724,000 square miles (30,365,000 square km), and the continent measures roughly 5,000 miles (8,000 km) from north to south and 4,600 miles (7,400 km) from east to west. Africa, in: Encyclopaedia Britannica online, https://www.britannica.com/place/Africa (13 January 2026).

regime back to the first two, identifying continuities and divergences in projection, power, and material outcomes.

Soy in global history and Africa's marginal position

The historical literature on soybeans has focused predominantly on East Asia,[10] the U.S. Midwest,[11] and South America.[12] An expanding body of scholarship situates these histories within global perspectives, tracing soy's entanglement with agri-food globalisation, capitalist transformation, and successive food regimes.[13] To date, however, this global historiography has rarely incorporated Africa as a site of historical production, experimentation or developmental projection, even though soy has figured prominently in agricultural interventions on the continent since the late nineteenth century.

Research explicitly addressing soy's history in Africa is limited, though scattered studies examine specific regions or national contexts at specific periods.[14] For longer historical perspectives, the most extensive – yet largely unanalysed – body of material is found in the archive of the SoyInfo Center, which offers a rich source for encyclopaedic documentation. Alongside this, a growing body of contemporary literature frames soy as a "Cinderella crop" capable of addressing food insecurity, economic diversification, and agricultural modernisation, often emphasising Africa's presumed abundance of uncultivated arable land.[15]

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10 Midori Hiraga, A Business History of Soy: Japan's Modernization and the Rise of Soy as a Global Commodity, New York 2024; Brian Lander/Thomas David DuBois, A History of Soy in China: From Weedy Bean to Global Commodity, in: Claiton Marcio da Silva/Claudio de Majo (eds.), The Age of the Soybean: An Environmental History of Soy During the Great Acceleration, Winwick 2022, 46–65.

11 Matthew Roth, Magic Bean: The Rise of Soy in America, Lawrence 2018.

12 Matilda Baraibar Norberg, The Political Economy of Agrarian Change in Latin America: Argentina, Paraguay, and Uruguay, Cham 2020; Matilda Baraibar Norberg, Sojización as a New First Movement: A Polanyian Analysis of the South American Soybean "Boom", in: da Silva/de Majo, The Age of the Soybean, 91–114; Mariano Turzi, The Political Economy of Agricultural Booms: Managing Soybean Production in Argentina, Brazil, and Paragua*y*, Cham 2017; Pablo Lapegna, Soybeans and Power: Genetically Modified Crops, Environmental Politics, and Social Movements in Argentina, Oxford 2016.

13 Baraibar Norberg, The Political Economy; Matilda Baraibar Norberg/Lisa Deutsch, The Soybean Through World History: Lessons for Sustainable Agrofood Systems, New York/London 2023; da Silva/de Majo, The Age of the Soybean; Christine M. Du Bois/Chee-Beng Tan/Sidney Mintz (eds.), The World of Soy, Urbana/Chicago 2008; Theodore Hymowitz, The History of the Soybean, in: Lawrence A. Johnson/Pamela J. White/Richard Galloway (eds.), Soybeans: Chemistry, Production, Processing, and Utilization, Urbana 2008, 1–31; Ernst Langthaler, The Soy Paradox: The Western Nutrition Transition Revisited, 1950–2010, in: Global Environment 11/1 (2018), 79–104; Ines Prodöhl, Globalizing the Soybean: Fat, Feed and Sometimes Food, c. 1900–1950, London 2023.

14 Dalia Mohamedkheir Khojely et al., History, Current Status, and Prospects of Soybean Production and Research in Sub-Saharan Africa, in: The Crop Journal 6/3 (2018), 226–235; Sudarshna Kumari et al., Introduction, History, Geographical Distribution, Importance, and Uses of Soybean (Glycine max L.), in: Krishna Pratap Singh/N. K. Singh/Aravind Thangavel (eds.), Soybean Production Technology: Physiology, Production and Processing, Singapore 2025, 1–17; Brian Diers/Andrew Scaboo, Soybean Breeding in Africa, in: African Journal of Food, Agriculture, Nutrition and Development 19/5 (2019), 15121–15125; Abuli S. Jackson, A Brief History of Soybean Production in Kenya, in: Research Journal of Agricultural and Environmental Management 5 (2016), 58–64.

15 Christine H. Foyer et al., Modelling Predicts that Soybean Is Poised to Dominate Crop Production across Africa, in: Plant, Cell & Environment 42/1 (2019), 373–385; Muhyidiyn Islam et al., Soybean and Sustainable

Reports and development documents from the Food and Agriculture Organization (FAO) and other international organisations further illuminate how soy has been positioned within agricultural policy and aid strategies, especially during the post-independence period and the Green Revolution. Much of this literature remains descriptive and technical, paying limited attention to the historical continuity and transformation of the 'soy promise.' This article seeks to fill that gap – it foregrounds the continent as a recurring site of projection, experimentation, and developmental imagination within global soybean histories.

Sources, methods, and a discourse-historical approach

The core empirical foundation of the study comes from the SoyInfo Center, a digital archive curated by William Shurtleff and Akiko Aoyagi since the late 1970s. Created to document the global diffusion of soy foods and soybean technologies, the archive now contains more than 94,000 digitised documents covering soybean cultivation, processing, consumption, and promotion worldwide. Particularly useful here are the regionally focused Africa sourcebooks, which compile material from the late nineteenth century to the present and bring together otherwise scattered references to soybeans in colonial agricultural trials, missionary nutrition programmes, postwar development planning, and contemporary sustainability debates.[16]

While uniquely rich, the SoyInfo Center archive poses methodological challenges. The chronologically compiled PDF volumes have uneven metadata and limited thematic indexing; also, the collection largely reflects the viewpoints of actors promoting soy, including scientists, missionaries, development agencies, industry associations, and state institutions. The perspectives of African farmers, labourers, and consumers typically appear only indirectly, and critical or failure-oriented accounts are less consistently represented. To triangulate, I draw on additional digitised repositories: CGIAR/IITA collections, the UK National Archives' Discovery platform, USDA FAS, *Soybean Digest*, FAO repositories, and Sabinet/AJA for historical African journals.[17] These sources broaden regional coverage and allow cross-checks on yields, adoption, and policy rationales. At the same time, they share a predominantly development- and state-centred vantage point, reinforcing the need for a critical reading of the source base as a whole.

Agriculture for Food Security, in: Takuji Ohyama et al. (eds.), Soybean – Recent Advances in Research and Applications, London 2022, 1–16, DOI: 10.5772/intechopen.104129; Michael Morris et al., Awakening Africa's Sleeping Giant: Prospects for Commercial Agriculture in the Guinea Savannah Zone and Beyond, Washington, D.C.: World Bank 2009, http://documents.worldbank.org/curated/en/312591468004457911 (13 January 2026); T. R. Sinclair et al., Soybean Production Potential in Africa, in: Global Food Security 3 (2014), 31–40.

16 William Shurtleff/Akiko Aoyagi, History of Soybeans and Soyfoods in Africa (1857–2019): Extensively Annotated Bibliography and Sourcebook, Lafayette 2019.

17 CGIAR Central Library, https://cgspace.cgiar.org/ (10 January 2026); International Institute of Tropical Agriculture (IITA), Knowledge Center, https://www.iita.org/knowledge/knowledge-center/ (10 January 2026); UK National Archives, Discovery Catalogue (search: soya, 1870–1960), https://discovery.nationalarchives.gov.uk (10 January 2026); FAO Knowledge Repository, https://openknowledge.fao.org/home (10 January 2026); U.S. National Archives, Catalog (search: soybean Africa), https://catalog.archives.gov/search?page=1&q=soybean%20Africa (10 January 2026); Soybean Digest (Archive), Internet Archive collection, https://archive.org/ (10 January 2026); Sabinet African Journals, together with the African Journal Archive (AJA), https://www.ajarchive.org/ (7 February 2026).

As is often the case in historical agrarian research, quantitative data prior to around 1960 are sparse, inconsistent, and often methodologically opaque. Production figures, acreage estimates, and adoption rates vary widely across sources and are frequently embedded in advocacy-driven reports rather than standardised statistical systems.[18] Accordingly, this study does not seek econometric precision but instead prioritises qualitative, interpretive, and contextual analysis.

Building on these sources, the article traces both the material trajectories of soybean production, consumption, and trade as well as the shifting meanings, institutional pathways, and contested outcomes of soybean promotion in Africa over the past 150 years. To examine the persistent gap between discursive promise and material realisation, it adopts a discourse-historical approach, analysing how soybeans have been framed across periods, places, and actors. Imaginaries are understood here as historically situated, collectively produced visions of desirable futures that organise knowledge, justify intervention, and orient political and economic action. Unlike isolated ideas or rhetorical claims, imaginaries link scientific expertise, policy rationales, and material expectations, shaping how agricultural futures are anticipated even when past interventions have repeatedly fallen short.

Agrarian political economy and food regimes

To situate these narratives materially, the analysis draws on African agrarian history and agrarian political economy. Scholarship in this field shows how African agriculture has been shaped by incorporation into the global capitalist economy, from colonial land regimes and post-independence development strategies to neoliberal restructuring and the contemporary climate crisis.[19] From this perspective, agrarian change is analysed through processes of commodification, differentiation, and dispossession, foregrounding the contradictions and class dynamics of rural transformation.[20] This literature encourages us to read soybean initiatives (colonial, postcolonial, and contemporary) not as isolated technical projects but as moments within longer struggles over land, labour, and development authority. It also underscores the value of longue durée perspectives for understanding how external interventions intersect with state-building as well as with broader patterns of agrarian transformation.

To connect these trajectories to the political economy of global agriculture, the article draws on food regime theory. Food regimes conceptualise food systems as historically specific configurations of power, production, and consumption that underpin successive phases of

18 Giovanni Federico, Feeding the World: An Economic History of Agriculture, 1800–2000, Princeton 2010; Kent Deng/Patrick O'Brien, Establishing Statistical Foundations of a Chronology for the Great Divergence: A Survey and Critique of the Primary Sources for the Construction of Relative Wage Levels for Ming-Qing China, in: The Economic History Review 69/4 (2016), 1057–1082.

19 Henry Bernstein, Considering Africa's Agrarian Questions, in: Historical Materialism 12/4 (2004), 115–144, DOI: 10.1163/1569206043505158; Henry Bernstein, Agrarian Questions Then and Now, in: The Journal of Peasant Studies 24/1–2 (1996), 22–59; Archibald Mafeje, The Agrarian Question, Access to Land, and Peasant Responses in Sub-Saharan Africa, UNRISD Programme Paper 6, Geneva 2003; Amanda Hammar (ed.), Displacement Economies in Africa: Paradoxes of Crisis and Creativity, London/New York 2014; James C. McCann, Agriculture and African History, in: The Journal of African History 32/3 (1991), 507–513.

20 Bernstein, Considering, 115–117.

capitalist development.[21] Each regime reflects a particular configuration of geopolitical, institutional, and economic relations coordinating the roles of states, firms, and farmers; it persists until internal contradictions and external shocks precipitate its destabilisation and reconfiguration.[22] Following McMichael, three major food regimes are commonly distinguished:[23]

- *First food regime (1870s–1930s):* British-led; centred on imperial trade, European industrialisation, and colonial provisioning; unravelled with interwar crisis and depression.
- *Second food regime (1950s–1970s):* U.S.-led; state-centred and embedded in Cold War geopolitics; structured by surplus grain production, food aid (e.g., PL 480), and the rise of industrial feed markets. During this regime, soy became a major U.S. surplus crop.
- *Third food regime (1990s–present):* Corporate-neoliberal; characterised by transnational agri-food value chains, financialisation, proprietary technologies, and increasingly 'meatified' diets. Soy expanded dramatically during this regime, with South America challenging U.S. dominance.[24]

In this article, I align Africa's soy history with these global regimes while adapting the respective labels to the continent's empirical trajectories:

- *Colonial Experimental Regime (1880s–1930s): Soy as a promise and projection,* when experimentation became systematic across Africa and agronomists expressed high expectations for the crop amidst the Scramble for Africa.
- *Cold War Developmentalist Regime (1950s–1970s): Soy as a nutritional technology and aid commodity* in the context of Africa's long decolonisation moment, during which most nations gained independence and began refashioning agricultural institutions. Many soybean experiments unfolded at the interface between late colonial governance and early postcolonial state-building, shaped by Cold War agricultural aid, technical assistance, and U.S.-led food diplomacy.
- *Corporate-Neoliberal Regime (1990s–present): Soy as a flexible frontier commodity,* when soybean production finally expanded, though more slowly than anticipated and outpaced by consumption.

Throughout the text, I provincialise these regimes by foregrounding Africa's recurrent position as a 'latent soy frontier,' with anticipatory narratives often outpacing material incorporation. The periodisation aligns with the African regional context and soy's specific empirical history while remaining consistent with global regime dynamics. Across all three periods, soy is examined not only as a crop but as a vehicle of projection through which shifting technocratic and geopolitical visions of African development were articulated. Food regimes are treated as heuristic and relational frameworks rather than rigid, self-contained blocks.

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21 Philip McMichael, A Food Regime Genealogy, in: Saturnio Borras Jr. (ed.), Critical Perspectives in Rural Development Studies, London/New York 2013, 129–158; Philip McMichael, Food Regimes, in: A. Haroon Akram-Lodhi et al. (eds.), Handbook of Critical Agrarian Studies, Cheltenham/Northampton 2021, 218–231; Jostein Jakobsen, New Food Regime Geographies: Scale, State, Labor, in: World Development 145 (2021), 105523, DOI: 10.1016/j.worlddev.2021.105523.

22 Gerardo Otero, Review of Philip McMichael's *Food Regimes and Agrarian Questions*, in: Journal of World-Systems Research 22/1 (2016), 299–305; Philip McMichael, Critical Agrarian Studies and Crises of the World-Historical Present, in: The Journal of Peasant Studies 50/2 (2023), 725–757.

23 McMichael, A Food Regime Genealogy, 131–132.

24 Baraibar Norberg/Deutsch, Soybean, 166–168.

Colonial Experimental Regime (1880s–1930s): Soy as a promise and projection

Soy reached Europe in the late eighteenth century. By the late nineteenth century, botanists and agronomists in France, Germany, Britain, and Switzerland promoted it as a 'crop of the future.' Seeds circulated through scientific societies; hundreds of trials were established in Europe and selected colonies, and their results appeared in an expanding botanical and agronomic press. Yet yields were often disappointing, and farmer uptake in Europe remained limited.[25]

African references (Egypt 1857; Algeria 1863; Tunisia 1873) remain isolated until the 1880s, when experimentation became systematic amidst the Scramble for Africa.[26] Between 1876 and 1900, European powers extended formal colonial rule from roughly 10 to 90 per cent of the continent, a shift codified at the Berlin Conference of 1884–1885.[27] Imperial rivalry, techno-scientific optimism, and rising industrial demand for oils and protein converged.[28] The second industrial revolution intensified the search for vegetable oils and protein-rich feedstuffs, stimulating oilseed trials across colonial territories. Soy entered this milieu as an experimental commodity championed by scientists, administrators, missionaries, and commercial actors.[29]

Agronomic trials, production, and the making of a colonial soy network

Auguste Paillieux's *Le Soya* (1880) synthesised two decades of reports from the *Bulletin de la Société d'Acclimatation*. It summarised 27 trials in France, Switzerland, and Algeria and promoted soy for both metropolitan and colonial agriculture, suggesting it could "grow reasonably well" under semi-arid conditions.[30] Medical interest accompanied agronomic trials: In 1888, Dr M. Egasse reported that diabetic patients at Algiers' Dey Hospital who received soybean porridge showed a "considerable decrease in sugar in their urine" and improved wound healing.[31] This was an early sign of soy's multivalent promise across agronomy and

25 Baraibar Norberg/Deutsch, Soybean, 131.

26 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 15–30.

27 It came to symbolise the beginning of the Scramble for Africa, the final large-scale territorial partition in world history. See Carlos Ramirez Faria, The Historical Dictionary of World Political Geography: An Encyclopaedic Guide to the History of Nations, Basingstoke/New York 2001; M. E. Chamberlain, The Scramble for Africa, 3rd ed., Abingdon 2013; Ellen Hillbom/Erik Green, Afrika: En kontinents ekonomiska och sociala historia, Stockholm 2010, 107; Henry Bernstein, Class Dynamics of Agrarian Change, Halifax/Winnipeg 2010, 41.

28 Chamberlain, The Scramble for Africa, 38.

29 Jean Suret Canale, French Colonialism in Tropical Africa 1900–1945, London 1971; K. E. Giller/K. E. Dashiell, Glycine max (L.) Merr., in: M. Brink/G. Belay (eds.), Plant Resources of Tropical Africa 1. Cereals and Pulses, Wageningen/Leiden/Wageningen 2006, 76–82.

30 Nicolas Auguste Paillieux, Le soya: Sa composition chimique, ses variétés, sa culture et ses usages, in: Bulletin de la Société d'Acclimatation 27 (1898), 414–471, 538–596, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 22–25.

31 M. Egasse, Le soja et ses applications économiques et thérapeutiques, in: Bulletin Général de Thérapeutique Médicale, Chirurgicale, Obstétricale et Pharmaceutique 115 (1888), 433–448. English translation by the author.

Figure 1: Louis Trabut (from his 1929 obituary)

Source: Maire René, Notice nécrologique, in: Revue de botanique appliquée et d'agriculture coloniale 9/98 (1929), 613–620, 617.

therapy. From the 1890s, the Algerian government stations at Rouiba and Maison Carrée led by Louis Charles Trabut emphasised the legume's drought tolerance, high protein and fat content, and value for animal feed and dairy.[32] Trabut acknowledged soy's green-manure potential as well, but concluded that it was "more useful for the production of seed and a rich summer forage" while also cooking soybeans for local populations and framing the crop as a tool to "reform indigenous diets."[33]

Parallel initiatives emerged across the British Empire. In southern Africa, the *Transvaal Agricultural Journal*[34] and the *Natal Agricultural Journal*[35] became key venues for soybean advocacy. Articles praised the crop as fodder: "Cattle and mules took to it at once, and looked for more."[36] Joseph Burtt-Davy, Transvaal's agrostologist and botanist, positioned soy in rotations, recommending legumes (soy, peanuts, sugar beans) to "add nitrogen as well as humus to the soil, particularly stressing the fruitful combination with maize."[37] Although industrial

32 Louis Trabut, Le soja, in: Informations Agricoles, Service Botanique, Gouvernement Général de l'Algérie 16 (1898), 7, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 31–32.

33 Louis Trabut, Rapport à M. le Gouverneur Général sur les études de botanique agricole entreprises en 1898, in: Informations Agricoles, Service Botanique, Gouvernement Général de l'Algérie 19 (1899), 83, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 32.

34 This journal was published quarterly between 1902 and 1911 "to assist the farming population with expert advice, to record and adapt to this country's requirements the known successful methods of the farming communities of other countries." Department of Agriculture (South Africa), Rural Notes, in: Transvaal Agricultural Journal 1/1 (October 1902), 1–8.

35 In 1911, it was superseded by the *Agricultural Journal of the Union of South Africa*, created as part of the political unification of South Africa in 1910.

36 G. Lewis, The Soy Bean in the Transvaal, in: Transvaal Agricultural Journal 1/4 (July 1903), 40–41, 41.

37 Joseph Burtt-Davy, Botanical Section: Wheat Growing in the Western Transvaal, in: Transvaal Agricultural Journal 6/22 (January 1908), 250–264, 253; Joseph Burtt-Davy, Botanical Section: Soy-Beans, in: Transvaal Agricultural Journal 9/33 (October 1910), 41–42; Joseph Burtt-Davy, Botanical Section: The Planting and Cultivation of the Maize Crop, in: Transvaal Agricultural Journal 8/29 (October 1909), 60–76, 61 and 74–75.

oil and soap prospects were discussed, Burtt-Davy stressed soy's principal value as protein-rich stock feed and green manure – "a more profitable rotation crop" than those which can only be ploughed under "because there is no use for the by-products", while emphasising that wider adoption required local trials and varietal adaptation."[38]

At Cedara Experiment Station (founded in 1902), director E. R. Sawer emerged as a leading advocate, calling soy the "principal grain-producing leguminous crop" for the province. Based on repeated station trials, he argued that grain legumes were essential but demanding components of Natal's agricultural system, requiring careful experimentation, suitable soils, and appropriate moisture and fertilisation rather than simple transfer of practice. While peas and cowpeas proved useful under specific climatic conditions, Sawer concluded that soybeans stood out as the most promising legume for commercial cultivation at Cedara: soy combined high protein and oil content, strong responsiveness to fertilisers, and particular suitability for rotation with maize, making it economically worthwhile when properly managed.[39] Cedara trials reported yields up to 1,252 lb/acre (using Chinese seed), and Sawer shipped seed to the United States Department of Agriculture (USDA).[40]

Trials soon spread across Mauritius, Nigeria, Malawi, Tanzania, the Gold Coast (Ghana), Egypt, Sudan, Gambia, and Rhodesia (later Zimbabwe and Zambia). A 1909 report from the Institute of Commercial Research in the Tropics at Liverpool University deemed soy likely viable "in most of the African colonies," especially in rotation with maize.[41] German botanists trialled soy at Amani (Tanzania); Belgians did so in the Congo. Catholic missions promoted soymilk for malnutrition.[42] Portuguese agronomists hailed the crop as "invaluable" for Mozambique's Zambezia province for enriching coconut plantations, feeding draft animals, supplying local food, and enabling surplus sales to South Africa. They further wrote that "great progress has been made in the cultivation of Soya Bean" in West Africa, and that there was "no reason why Portuguese East Africa should not do just as well."[43] The trials were often described as promising a "great future" for growers in West and South Africa.[44] Beyond experimental stations, officials sought to popularise soy among settler farmers. In 1908, H. J. Choles (Department of Agriculture of the Natal Colony) addressed "progressive farmers," portraying soy as an overlooked but highly promising crop. He praised its nutritional profile – "above all other pulses as an albuminous food" – and its agronomic resilience, stating

38 Joseph Burtt-Davy, Botanical Section: The Soy-bean (Glycine Hispida), in: Transvaal Agricultural Journal 8/32 (July 1910), 620–633, 625.

39 Sawer, The Place of Legumes.

40 E. R. Sawer, Cedara Memoirs on South African Agriculture, vol. I, Pietermaritzburg 1909; E. R. Sawer, Cedara Memoirs on South African Agriculture, vol. II, Pietermaritzburg 1911; E. R. Sawer, Studies in Agriculture. Series 2: The Soya Bean, Natal 1910; USDA, Bureau of Plant Industry, Inventory. Washington, D.C. 1911, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 52–55, 77–78.

41 E. S. Edie, Cultivation and Uses of Soya Beans, in: Bulletin: Institute of Commercial Research in the Tropics 1/1 (1909), 1–7, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 45; Cultivation and Utilisation of Soy Bean II, in: Bulletin of the Imperial Institute 8/1 (1910), 40–42, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 52.

42 Khojely, History, 227.

43 E. H. Heron, O feijão soya e os seus usos, in: Boletim da Repartição de Agricultura de Moçambique 5 (1911), 12–14, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 72–73.

44 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 56.

that it "stands drought well and is not easily injured by excess moisture."[45] Drawing on scientific analyses from Europe, East Asia, and USDA, Choles presented soy as a globally validated solution to fodder shortages, soil depletion, and dietary deficits.[46] In his vision, adopting soy meant joining the world of modern, science-guided farming.

Demand, trade, and persistent projection

European demand for fats and oils surged in the early twentieth century. Scientific knowledge transformed the fat market, expanding the range of raw materials and end products. New techniques for hydrogenation, refining, deodorising, winterising, and solvent extraction turned vegetable oils into cheaper substitutes for animal fats.[47] The *Manchester Guardian* hailed soy's "manifold uses" including yielding oil, feed, bread, soap and "milk substitutes," and discussed integrating African production into British supply chains. Oil was the prime product, but protein-rich meal (the by-product of oil extraction) fuelled pork and dairy.[48]

Prices for soybeans and other oilseeds began to rise around 1910, conjuring up the prospect of remunerative African production in addition to rotation benefits with maize in Natal's upland, midland, and coastal districts and throughout the Gambia, Sierra Leone, Nigeria, and the Gold Coast.[49] Large volumes of Manchurian soy were already being imported into Liverpool and Hull since late 1908, and unprocessed beans were traded widely across Europe.[50] These cheap Manchurian supplies did not dampen the hopes for African production, however: Trial harvests from Africa were shipped to Liverpool for oil analysis, and the continent ("West, East, and South") was repeatedly cast as suitable for soy, with some even suggesting African experience could inform U.S. Cotton Belt expansion.[51] At the same time, bottlenecks including low seed viability and the absence of satisfactory harvesting methods impeded diffusion.

Imperial entrepreneurs followed: Seeking low-cost oils for soap, paint, explosives, confectionery and margarine, shippers scanned the tropics. Sir Alfred Lewis Jones teamed with seed broker A. Grenville Turner to promote soy across British West Africa.[52] Turner's 1909 tour reported rapid germination and early maturity in Nigeria and the Gold Coast, as well as promising prospects in East Africa, Rhodesia, and the Cape (including a variety yielding 513 lb of seed per acre at Cedara).[53] Commissioned by Lever Brothers, Turner distributed seed and bulletins in South Africa (1910–1911). Despite the prevailing drought, soy report-

45 Herbert John Choles, The Soy Bean: A Valuable Fodder Plant and Its Cultivation, in: Natal Agricultural Journal 11/11 (1908), 1411–1423.

46 Ibid.

47 Prodöhl, Globalizing the Soybean, 43.

48 Baraibar Norberg/Deutsch, Soybean, 134.

49 Charles V. Piper/William J. Morse, The Soybean, New York 1923, 49–54.

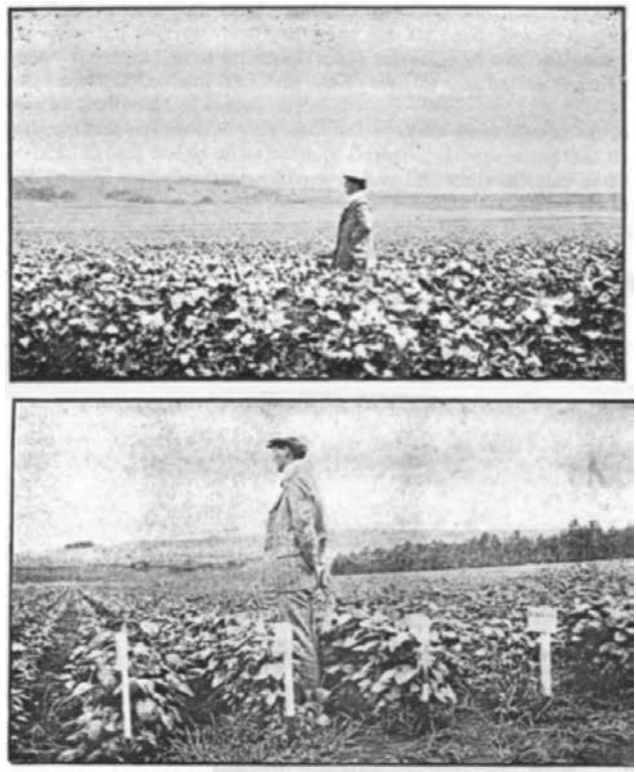
50 Prodöhl, Globalizing the Soybean, 16; A. Grenville Turner, The Soy Bean, in: Agricultural Journal of the Union of South Africa 7/1 (January 1914), 67–77.

51 Grenville Turner, The Soy Bean, 71.

52 Sir Alfred Jones was a British shipping magnate, often called the "Uncrowned King of West Africa," who built a vast commercial empire spanning shipping, banking, cold storage, commodity trade and tourism. See Alan Hay Milne, Sir Alfred Lewis Jones, K. C. M. G.: A Story of Energy and Success, Liverpool 1914.

53 Grenville Turner, The Soy Bean, 71.

Figure 2: E. R. Sawer in a field of soybeans, Cedara, c. 1910



Source: Sawer, Cedara Memoirs, vol. II, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 80.

edly withstood conditions "too severe for even maize." [54] Turner forecast European demand "up to ten million tons per annum," envisioning South Africa shipping "all the beans she can produce."[55] He further argued that soy had the potential to provide wealth across a wide range of colonial industries and services, from railways to farm co-operatives.[56]

Early issues of the *Agricultural Journal of the Union of South Africa* claimed local soybeans averaged about 20 per cent oil (and were thus worth "£8 per ton more" than German or Manchurian beans), with lower freight costs to England than from Manchuria.[57] Researchers at USDA echoed that beans grown in South Africa yielded 20 to 22 per cent oil, as against 15 to 16.5 per cent for the same varieties grown in Manchuria.[58] Sawer likewise championed South

54 Ibid., 71.

55 Ibid., 68–72.

56 Ibid., 74–75. Turner continued to advocate for soy for many years, see Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 148.

57 This journal superseded the Transvaal Agricultural Journal and the Natal Agricultural Journal, see Rural Notes: Soy Beans, in: Agricultural Journal of the Union of South Africa 2/1 (January 1911), 126–127, https://hdl.handle.net/10520/AJA0000021_450; Erwin Thompson, Soya Beans in South Africa, in: Daily Consular and Trade Reports, 21 November 1913, 955, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 88.

58 Piper/Morse, Soybeans in Africa.

African soy as commercially superior due to its high oil content and favourable freightage to England.[59]

A few years later, another agriculturalist wrote that "there can be no doubt about the great future of the Soya Bean industry, in the many parts it takes in commerce," hoping to spur farmers to "continue their experiments and carry them to a successful issue."[60] Commercial and diplomatic actors from the United States also showed interest, showcasing African soy at fairs in Calabar and Lagos and exhibiting oil, flour, biscuits, and coffee substitutes to encourage local cultivation for export.[61] World War I disruptions intensified these trans-imperial initiatives, framing Africa as a potential site for both production and consumption. On paper, the case for an African soy frontier appeared technically and commercially sound.

Persistent limitations and the collapse of the colonial soy project

Despite early optimism, many trials disappointed. In the Gold Coast, director of agriculture W. S. D. Tudhope judged soy "unsatisfactory," stating that its seed lost "vitality in a few weeks" and calling it "unlikely that it will ever be largely grown here."[62] Similar verdicts came from German East Africa,[63] Mauritius,[64] Rhodesia,[65] Uganda,[66] Algeria,[67] Zanzibar, and Portuguese East Africa.[68] The cited constraints included poorly adapted varieties, lack of inoculants, pests, harvesting difficulties, and the absence of processing infrastructure. Even in South Africa, Burtt-Davy conceded in 1913 that soy was "too uncertain" for silage and less satisfactory than velvet beans or cowpeas.[69] In Southern Rhodesia, J. A. T. Walters reported that while early experiments had been promising, later trials failed to increase yields regardless of the

59 Sawer, Cedara Memoirs, vol. II, 79–80.

60 J. A. Y. Walters, Dhal or Pigeon-Pea (Cajanus indicus), in: Rhodesia Agricultural Journal 11/8 (1914), 1137–1140, 1138.

61 U.S. Bureau of Manufactures, Soya Bean Growing for Africa, in: Daily Consular and Trade Reports, 19 November 1909, 4; The Soya Bean, in: London and China Telegraph, 6 December 1909, 1086; Bulletin of the Imperial Institute, 7/3 (1909), 308–314, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 48–56.

62 W. S. D. Tudhope, Agricultural Department, Aburi, in: Government Gazette (Accra) 8 (1912), n.pag., in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 81–82.

63 A. Eichenger, Über Leguminosenanbau und Impfversuche, in: Pflanzer 8/4 (1912), 190–219, in: Shurtleff/Aoyagi, History of Soybeans and Soyfoods in Africa, 87–8.

64 P. Boname, Soja, in: Île Maurice Station Agronomique, Rapport Annuel 1911 (1912), in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 84–85; Piper/Morse, Soybeans in Africa.

65 J. A. T. Walters, New Crops for Rhodesia: Results of Experiments, in: Rhodesia Agricultural Journal 11/2 (December 1913), 217–219.

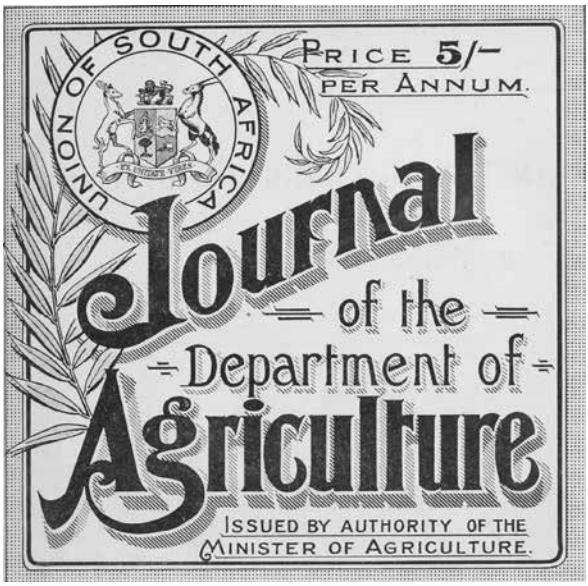
66 J. D. Tothill, Agriculture in Uganda, London 1940, 104–182, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 93–98.

67 Joseph Crèpin, Séance générale du 7 avril 1919, in: Bulletin de la Société d'Acclimatation 66 (1919), 289–296, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 111–112.

68 Chemist and Druggist (London), Soya-Bean Cultivation, in: India and the East, 6 September 1913, 383.

69 Joseph Burtt-Davy, The Preservation and Use of Maize for Stock Feed, in: Agricultural Journal of the Union of South Africa 5/4 (1913), 75–88.

Figure 3: Journal of the Department of Agriculture, Union of South Africa (1920)



Source: Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Journal_of_the_Department_of_Agriculture,_Union_of_South_Africa_(1920)_(14767397285).jpg (30 June 2026).

seed varieties used.[70] By the early 1920s, most publications reported low seed yields (forage excepted), high uncertainty, and negligible commercial production.[71]

Even where trials proved successful, production did not take off. Egypt is an illustrative example: Soybeans performed well there due to lower water requirements compared to cotton and a short growth cycle, yet farmers preferred other crops, notably maize. Promising trials were seldom followed by larger-scale tests.[72] Agronomists in Southern Rhodesia (today's Zimbabwe) likewise complained that farmers found it easier to produce other crops such as maize, and that encouraging experimental results did not translate into broader adoption.[73] By the 1920s, soy experiments had been abandoned at many stations; elsewhere, however, cultivation persisted but remained largely confined to research stations, missions, and smallholder pockets (for example, Nigeria's Tiv Division), without expanding into large-scale production.[74]

USDA reports noted occasional successes (for example, hay yields in Egypt), but also mentioned recurring obstacles including storms, bird damage, harvesting bottlenecks, and

70 J. A. T. Walters, New Crops for Rhodesia, in: Rhodesia Agricultural Journal 15/6 (December 1918), 529–534.

71 Pierre Crèpin, Extraits des procès-verbaux des séances de la société: Séance générale du 4 décembre 1922, in: Bulletin de la Société d'Acclimatation 70/2 (1923), 17–23.

72 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 97–101.

73 H. C. K. Fynn, Statistics of Crops Grown by Europeans in Southern Rhodesia for the Season 1920–21, in: Rhodesia Agricultural Journal 19/2 (1922), 29–36; Dorothy Margaret Adkins, The Soya-Bean Problem, in: Science Progress (London) 15/59 (January 1921), 445–451.

74 L. Pynaert, Le soja, in: Bulletin Agricole du Congo Belge et du Ruanda-Urundi 11/1–2 (1920), 151–186, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 74–98.

unreliable nodulation.[75] Agronomists struggled to find varieties whose vegetative cycles were "in sync with the cosmic environment," meaning aligned with local day lengths, temperatures, and seasonal rhythms.[76]

At the same time, agricultural science increasingly recognised that low yields were often caused by the absence of appropriate soil microbes required for nitrogen fixation. An influential article in the *Bulletin de la Société d'Acclimatation* reported that soy "only succeeded on land where soil from the country of origin had been spread," since such soil contained the necessary root-nodule bacteria (Bradyrhizobium).[77] This practice was soon replaced by seed inoculation with selected strains. Trials at Cedara in 1921–1922 showed that inoculated plants produced abundant nodules and markedly higher yields, whereas uninoculated ones produced none.[78] Agronomists emphasised that when the correct bacteria were present, legumes such as soybeans enriched the soil with nitrogen – thus explaining why farmers often saw little soil improvement in early, uninoculated trials.[79]

Even as technical knowledge improved, market and policy conditions shifted in ways that disadvantaged African soy cultivation. Production expanded rapidly in Manchuria and Japan, and in the United States by the end of the period as well, while European demand proved insufficient to sustain African exports. Prices fell below competitive levels. Soybeans no longer seemed likely to play a significant role in African commercial agriculture, whereas palm oil and cotton continued to underpin several colonial economies. Amid recurring warnings of raw-material 'crises,' firms increasingly pivoted toward tropical concessions in palm, copra, and kernels, aligning production with metropolitan industrial needs.[80] Many stations that had launched soybean trials eventually abandoned them.[81] This marked the decline of the enthusiastic Colonial Experimental Regime.

Analytical reflection: Soy and the first food regime

In the late nineteenth century, amid imperial expansion and scientific optimism, soy entered Africa as an experimental crop of promise. Colonial soybean initiatives in Africa unfolded during the first food regime (1880s–1930s), a period defined by British imperial hegemony, global grain circuits linking settler agriculture to European industrialisation, and expanding imperial transport and finance infrastructures. Within this system, Africa occupied a peripheral position: It was incorporated not as a supplier of staple grains – as in the settler-colonial

75 Piper/Morse, Soybeans in Africa.

76 See Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 121–127.

77 Extraits des procès-verbaux des séances de la Société. Botanique (Mr. Rouest), in: Bulletin de la Société d'Acclimatation 68 (February 1921), 138–139, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 117.

78 Department of Agriculture (South Africa), The Schools of Agriculture and Experiment Stations, in: Journal of the Department of Agriculture 7/1 (July 1923), 13–16, 14–15.

79 Farming in South Africa (Pretoria), in: Bacterial Co-operation 4/45 (December 1929), 457, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 155–156.

80 Grenville Turner, The Soy Bean, 74.

81 D. Kaltenbach/J. Legros, Soya: Selection, Classification of Varieties, Varieties Cultivated in Various Countries, in: Monthly Bulletin of Science and Practical Agriculture, International Institute of Agriculture 27/8 (1936), 291T–295T.

regions of North America, Australia, and Argentina – but instead as a source of raw materials, labour, and extractive agricultural potential.

From an agrarian political economy perspective, early soy interventions were not merely technical experiments but rather part of broader efforts to commodify African land and labour, restructure rural production, and consolidate developmental authority over colonised agrarian systems.[82] Imperial planners imagined that Africa could contribute to global oilseed markets – supplementing or even substituting for Asian sources such as Manchuria – and thereby deepen the continent's integration into imperial trade networks. Soy was thus integrated into wider agendas of agricultural modernisation. These agendas were not uniform, however; they comprised interlinked ideas about productivity, order, revenue, and control. The establishment of botanical gardens and agricultural research stations, the proliferation of trial plots for cash crops (cotton, coffee, groundnuts, and later soybeans), the promotion of 'scientific agronomy' through crop rotation, fertilisers, and varietal selection, and the push for permanent farming under private or individualised tenure formed part of a broader project to remake African agriculture. These interventions rested on the belief that scientific knowledge, commercial integration, and moral discipline could transform land, labour, and diets into productive components of the imperial economy while leaving existing social and ecological systems subordinate to external control.[83] Soy was promoted as a technical solution to multiple perceived crises – soil exhaustion, protein scarcity, and rising demand for industrial oils. Yet these framings also helped to legitimise more far-reaching projects of agrarian reorganisation: the expansion of research institutions, the entrenchment of new property regimes, and the remaking of local cultivation systems according to imperial developmental logics.

Material outcomes, however, were limited. Despite numerous trials, soybeans failed to scale. Agronomic constraints (poorly adapted varieties, lack of inoculants, uncertain yields, and inadequate processing capacity) intersected with structural limits of the first food regime, which did not position Africa as a major oilseed supplier. China dominated global production by 1910 (roughly 71 per cent), with Manchuria adding another 16–17 per cent.[84] Yet soy in Africa played a significant symbolic role: Colonial documents repeatedly framed it as a crop of modernity capable of improving soils, supplying protein, reforming diets, and supporting industrial production. It became a 'future crop,' a speculative horizon of agrarian modernity that justified new forms of land control, scientific authority, and institutional expansion despite negligible material results.

In sum, early soy initiatives reveal contradictions at the heart of the first food regime. They sought to reorganise African agrarian systems in line with imperial priorities, reflecting ambitions of productivity, order, revenue extraction, and civilisational pedagogy even as they collided with ecological and socio-economic constraints. Soy functioned less as a realised commodity than as an anticipatory project, invoked as a promise of progress but rarely produced at scale.

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82 Sara Berry, Struggles over Land and Authority in Africa, in: African Studies Review 60/3 (2017), 105–125; Samir Amin, Neo-Colonialism in West Africa, London 1972; John Iliffe, The African Poor: A History, Cambridge 1983.

83 Bernstein, Class Dynamics, 61–65.

84 Baraibar Norberg/Deutsch, Soybean.

Although the Colonial Experimental Regime eroded during the 1930s owing to the rise of cheap soy from Manchuria and the United States along with ongoing underperformance in Africa, soy remained present in the intervening phase of reorganisation before the second regime. It continued to be praised as forage (notably for pigs and cattle in Algeria), used as green manure (e.g., in the Congo), and occasionally included in crop rotations in South Africa.[85] South Africa also had two factories crushing soybeans for oil – though most soy oil was imported, since foreign oil was significantly cheaper than the domestic production.[86] Imports of soy oil also rose in Egypt and Portuguese East Africa, reflecting external rather than domestic supply dynamics.[87]

During this period, concerns over food shortages once more drew attention to soy as a potential emergency crop. One report noted: "The soybean has once again come into the limelight because of food shortages in West Africa. […] Soy flour is excellent for fortification of breads, and it blends well with cocoa or chocolate."[88] Soy was mentioned as a possible famine-relief food in Ruanda, and a Congolese report described how it could contribute to "improving the diet of the indigenous people."[89] These short-lived revivals foreshadowed soy's later role as a food-aid commodity in the Cold War Developmentalist Regime. At the same time, older colonial imaginaries of Africa as a laboratory and soy as a speculative future crop would reappear in postwar developmental agendas – reframed in the contexts of nutrition, food aid, and Cold War geopolitics.

Cold War Developmentalist Regime (1950s–1970s): Soy as a nutritional technology and aid commodity

In the postwar decades, a new geopolitical and economic order emerged. The United States consolidated hegemony within the Bretton Woods framework; development planning, food aid, and technical assistance became central instruments of global governance.[90] This developmentalist imaginary converged with the rapid transformation of soy in the United States. After decades of varietal adaptation and agronomic research, soy became a major Midwestern crop; production rose sharply as industry bodies such as the American Soybean Association (ASA) and the National Soybean Processors Association (NSPA) gained influence, and protectionist measures underwrote a powerful domestic complex around oil and meal crushing.[91]

85 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 141–154.

86 Soya Bean as an Alternative Summer Legume, in: Farming in South Africa 2/21 (December 1927), 497–498, 148.

87 Ivan Grinenco/Giorgio Capone (eds.), Produits oléagineux et huiles végétales: Étude statistique sur leur production et leur mouvement commercial, Rome 1921.

88 Soya Bean Culture and Consumption, in: Tropical Life (England), 25/288 (June 1929), 104.

89 L. Tihon, À propos d'une variété nouvelle de soja O-too-ton, in: Bulletin Agricole du Congo Belge 22/1 (1931), 120–123.

90 Philip McMichael, Food Regimes and Agrarian Questions, Winnipeg 2013, 14.

91 Baraibar Norberg/Deutsch, Soybean, 139–143. See also the contribution by Langthaler and Ryzhova in this volume.

U.S. policy linked surplus management to foreign policy, using agricultural exports, concessional sales, and food aid to advance wider strategic aims.

Across Africa, protein-energy malnutrition, ecological limits to livestock production (not least due to tsetse), and urban food insecurity rose to prominence in national and international agendas. Against this backdrop, soy was reframed as a modern solution. International agencies and postcolonial governments promoted soy and soy-based products, including milk substitutes, weaning foods, and fortified blends. This developmentalist regime broadly overlaps with the continent's long decolonisation moment, during which most nations gained independence and began building new agricultural and state institutions. While many policies aimed at self-reliance, they often depended on external aid. Soy thus re-emerged as both a crop and a symbol, expected to alleviate hunger, overcome perceived agricultural backwardness, and absorb U.S. surpluses.

Experimentation, breeding, and production

Agronomic interest in soy that had already emerged during the first regime did not disappear. Trials continued across the continent with new introductions and breeding lines, yet observers repeatedly concluded that cultivation had not moved beyond the experimental stage.[92] USDA soybean specialist William Morse wrote in 1950 that although experiments had been conducted in nearly all regions of Africa, the crop remained unfamiliar to most farmers despite successful plots in Natal, the Gambia, Nigeria, Egypt, the Gold Coast, Angola, and the Belgian Congo.[93]

Agricultural officers frequently acknowledged this gap. In 1959, a Rhodesian agronomist noted that although soybeans had been grown successfully on research stations for two decades and had proved well suited to local conditions, with an average yield of approximately 1,500 kilograms per hectare at the Salisbury station, they were still planted on few farms. The explanations offered were consistent: the absence of stable markets, unreliable inoculants, limited processing capacity, and varieties prone to shattering when mechanical harvesting required non-shattering types with uniform maturity. Seed improvement typically lacked capacity for hybridisation, which kept the genetic base narrow and slowed gains.[94]

Faith in the soybean persisted, however: In the *Soybean Digest*, A. R. Saunders from the Potchefstroom College of Agriculture reported that while soy had not yet attained economic importance, progress was being made through cooperative breeding at both Potchefstroom and the Natal Agricultural Research Institute on non-shattering types suitable for mechanised harvest by combining U.S. early maturity strains with seed-retaining local strains. He

92 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 278–298.

93 FAO, Plant Production: Tabulated Information on Tropical and Subtropical Grain Legumes, Rome 1959, xvi–367; William Joseph Morse, History of Soybean Production: World Distribution, in: K. S. Markley (ed.), Soybeans and Soybean Products, vol. I, New York 1950, 11–14, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 287–288.

94 H. C. Thorpe, Annual Report for the Year 1951, vol. 2: Record of Investigations, Nairobi 1951, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 299.

anticipated that adoption would still take more time despite growing interest among farmers and manufacturers, however.[95]

These hopes aligned with postwar confidence in accelerated plant improvement.[96] Controlled hybridisation and other experimental techniques were expected to close yield gaps and expand agro-ecological frontiers. Marcel Blanchard of the *Service de l'Expérimentation Agricole* in Algeria advocated a U.S.-style breeding trajectory, envisioning soy as a commercial crop and potential export commodity.[97] Alongside new technologies, faith in 'education' was high. Farmer adoption was promoted through extension and vernacular materials. One example was an Ethiopian growers' manual in Amharic, which introduced the "foreign pea" to local agronomy and cooking.[98] Education was often expected to remedy nonadoption even when the constraints were structural (credit, input delivery, storage, and assured markets) rather than informational.

FAO yearbooks recorded modest production outside stations in the late 1940s in places such as Nyasaland, Ruanda-Urundi, Southern Rhodesia, Uganda, Ethiopia, and the Union of South Africa, yet production remained marginal and localised.[99] According to FAOSTAT data, total African soybean output stood at roughly 70,000 tonnes by 1961, with Nigeria accounting for around 80 per cent.[100] By contrast, the United States had already been producing more than 1 million tonnes, and 'China Proper' more than 6 million tonnes, by 1947.[101] By 1961, global production had risen to around 27 million tonnes, with Africa contributing roughly 0.27 per cent.[102]

Across the continent, low seed viability, disease and insect pressure, and lodging and shattering made soy unpopular with many farmers.[103] Smallholders faced recurrent constraints: limited access to credit, fertiliser, inoculants, and reliable buyers, as well as to the labour and knowledge required for an unfamiliar crop. Plantings fluctuated with prices, inputs, and seasonal labour demands.[104] From the mid-1960s onward, soy received increased attention as many African states adopted development strategies oriented towards agricultural modernisation and import substitution through state farms, crop diversification, irrigation schemes, and parastatal marketing boards.[105] These efforts illustrate how newly independent

95 A. R. Saunders, Soybeans in South Africa, in: Soybean Digest 13/1 (November 1952), 15–16.

96 Jennifer Clapp, Titans of Industrial Agriculture: How a Few Giant Corporations Came to Dominate the Farm Sector and Why It Matters, Cambridge/London 2025.

97 Marcel Blanchard, Recherches sur la biologie et la culture du soja en Algérie, in: Annales de l'École Nationale d'Agriculture d'Alger (1956), 1–118.

98 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 311.

99 FAO, Yearbook of Food and Agricultural Statistics: Production. Soybeans. Area, Yield, and Production, Geneva 1948.

100 FAOSTAT, Crops and Livestock Products, Production Quantity (Soya beans), Africa (Total) and World (Total), 1961, Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/QCL (10 January 2026).

101 FAO, Yearbook.

102 FAOSTAT, Statistical Database, https://www.fao.org/faostat/ (15 January 2026).

103 T. P. Singh, Soybean Improvement Work at IITA, in: R. A. Luse/K. O. Rachie (eds.), Proceedings of IITA Collaborators' Meeting on Grain Legume Improvement, Ibadan 1975, 19–20.

104 E. M. Shumba, Do Soyabeans Have a Place in Communal Areas? A Review of Production Problems and How the Crop Can Feature in These Areas, in: Zimbabwe Agricultural Journal 80/5 (1983), 189–191; Smartt, A Guide to Soya Bean Cultivation.

105 R. H. Bates, Markets and States in Tropical Africa, Berkeley/Los Angeles 1981.

states attempted to repurpose inherited colonial research infrastructures in line with developmentalist ambitions.

Where research and markets aligned, production rose; where they did not, soy remained confined to stations, projects, and a few commercial farms. From a low base in 1961 (71,813 tonnes), African soybean production rose to 97,545 tonnes in 1971 and around 370,000 tonnes by the mid-1980s.[106] Progress was real but uneven, and country trajectories diverged markedly. Nigeria led throughout the period, with extension services distributing seed widely; a significant share of Nigerian production was exported, with protein and oil contents sometimes reported as higher than in U.S. beans.[107] Uganda grew steadily from a low base.[108] Egypt, South Africa, Zambia, and Zimbabwe saw rapid growth spurts in the 1970s–1980s as state farms, irrigation schemes, and feed markets expanded.[109] Yet they also faced constraints relating to credit, fertiliser, inoculation, and marketing.[110] In Ethiopia and Tanzania, acreage declined despite renewed trials.[111] A 1988 scientific article attributes Tanzania's decline in soy growing partly to a "change in organisation" in 1963, though production later resumed on a parastatal and a prison farm, with plans for large-scale mechanised expansion and an oil mill for soybeans, sesame, and groundnuts.[112] These hopes did not materialise at the time, however.

Across different contexts, lodging, shattering, unreliable seed, and the absence of processing infrastructure still limited uptake. Production remained modest relative to global expansion and played only a minor role in agrarian transformation. Still, African soy performed better than several other development-targeted crops, even as per-capita food production declined in many African countries during the 1970s and 1980s.

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106 FAOSTAT, Crops and Livestock Products, Production Quantity (Soya beans), Africa (Total) and World (Total), 1971; 1985, Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/QCL (10 January 2026).

107 By 1961, Nigeria accounted for the vast majority of recorded African output with 57,000 tonnes, which grew steadily to 78,000 two decades later. FAOSTAT, Crops and Livestock Product: Soya Bean, https://www.fao.org/faostat/en/#data/QCL (10 February 2026); J. A. Yuwa, Introduction of Soyabeans into Abuja, in: Samaru Agricultural Newsletter 5 (1963–1964), 100–101, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 370.

108 Uganda produced around 1,000 tonnes in 1961, rising to 5,000 in 1981. FAOSTAT, Crops and Livestock Product: Soya Beans.

109 Egypt had no commercial production as late as 1971 but rose rapidly to 130,360 tonnes by 1981. Zambia had no commercial production either in the 1960s or early 1970s but produced 3,673 tonnes in 1981. South Africa had a rapid spurt, going from less than 2,631 tonnes in 1961 to 27,600 tonnes by 1981. Zimbabwe (earlier: Rhodesia) followed a similar path of rapid growth, reaching about 90,000 tonnes a year in the 1980s. FAOSTAT, Crops and Livestock Product: Soya Beans; Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 306, 334.

110 Smartt, A Guide to Soya Bean Cultivation; Agricultural Marketing Authority, The 1984–85 Oilseeds Situation and Outlook Report, Harare 1984; William Shurtleff/Akiko Aoyagi, History of Food for Peace (Public Law 480) and Soybeans (1954–2021): Extensively Annotated Bibliography and Sourcebook, Lafayette 2021, 172.

111 Between 1948 and 1966, Ethiopian state farms harvested approx. 10,000–13,000 hectares of soy annually, but by the mid-1970s, only around 6,000 hectares were under soybean cultivation. Food and Agricultural Organization of the United Nations, FAO Production Yearbook: Soybeans. Area Harvested, Yield, and Production, Rome 1980, 14–16; FAOSTAT, Crops and Livestock Products, Area Harvested (Soya beans), Ethiopia and Tanzania, 1961–1989, Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/QCL (10 January 2026).

112 F. Brockman, Tanzania National Grain Legume Research Program, in: Tropical Grain Legume Bulletin 8 (1977), 67–76, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 530.

New institutions, development assistance, and market formation

New institutions coalesced into a postcolonial soy network as research institutes, agricultural colleges, nutrition laboratories, state farms, and development agencies expanded roles previously played by colonial gardens and stations.[113] A central node was the International Institute of Tropical Agriculture (IITA) in Nigeria, established in 1967 by the Ford and Rockefeller Foundations and incorporated into CGIAR in 1971. IITA targeted problems commonly encountered in colonial trials, including seed viability, pests, day length mismatch, storage, and the absence of appropriate Rhizobium/Bradyrhizobium strains.[114] A hallmark was the institute's soybean breeding programme launched in 1970, which combined regional uniform trials with selection of off-types in older cultivars and introduced segregating material; under tropical conditions, breeders reported advancing materials at a rate of three generations per year under offseason nurseries.[115]

Improved varieties with shorter vegetative cycles and better suitability for humid tropics were released by the mid-1970s and trialled in Nigeria's Middle Belt and elsewhere.[116] Average yields across the continent rose from roughly 350–400 kg/ha in the 1960s to about 600–800 kg/ha in the 1970s – a significant increase, though still below other regions – while station trials sometimes reported much higher yields (up to c. 3,600 kg/ha).[117] IITA collaborated with other centres, notably with the International Soybean Program (INTSOY) at the University of Illinois and with USAID. The latter trained African plant breeders, nutritionists, and extension workers, ran variety trials across multiple agro-ecologies, provided advice on processing equipment, organised conferences, and promoted methods for integrating soy into human foods and livestock feed.[118] INTSOY's International Soybean Variety Experiment (ISVEX) distributed more than 2,000 trials to 132 countries between 1973 and 1985.[119] In Egypt, INTSOY's trials during the early 1970s, combined with subsidised fertilisers and pest control, supported rapid expansion: Within a decade, commercial production reached around 175,000 tonnes, yields reportedly rose to c. 2,296 kg/ha, and Egypt surpassed Nigeria as Africa's leading producer.[120] In general, research centres such as IITA argued that soybean production

113 Björn Beckman, Whose State? State and Capitalist Development in Nigeria, in: Review of African Political Economy (1988), 37–51.

114 S. E. Ibrahim, Agronomic Studies on Irrigated Soybeans in Central Sudan: I. Effect of Plant Spacing on Grain Yield and Yield Components, in: International Journal of Agricultural Sciences 2/8 (2012), 733–739; Jacques Larcher/S. Volper/J.-P. Aubin, Le soja en régions tropicales: Une synthèse des recherches de l'IRAT, in: Mémoires & Travaux de l'IRAT 15 (1988), 1–185.

115 IITA, Soybean Breeding, Grain Legume Improvement Program. Report, Ibadan 1973.

116 K. E. Dashiell/L. L. Bello/W. R. Root, Breeding Soybeans for the Tropics, IITA, Ibadan 1987; Zimbabwe and Zambia Move Ahead on Expanded Use of Soybeans, in: INTSOY Newsletter 37 (October 1987), 2–3.

117 FAOSTAT, Crops and Livestock Products, Yield (Soya beans), Africa (Total), 1961–1980, Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/QCL (10 February 2026); Singh, Soybean Improvement Work.

118 INTSOY, Cooperative Efforts in Nigeria Aim to Increase Soybean Use across Africa, in: INTSOY Newsletter 37 (October 1987), 3–4; INTSOY, Outreach – Zaire and Ghana, in: INTSOY Newsletter 10 (February 1977), 2; D. K. Whigham (ed.), Soybean Production, Protection, and Utilization: Proceedings of a Conference for Scientists of Africa, the Middle East, and South Asia, Urbana-Champaign 1976, 196–197.

119 Khojely, History, 227–231.

120 INTSOY, INTSOY Research Highlights. Soybean Genetic Improvement Program, in: INTSOY Newsletter 20 (February 1980), 1–2.

would soon take off given its protein and oil profile and its potential role in addressing hunger and malnutrition.[121] Within this architecture of international cooperation and state planning, extension services, free distribution of inoculants and seed, and state farms were deployed to help soybean make a larger leap. Research networks raised potential yields, but macro-policy and input bottlenecks often stalled diffusion. Moreover, industrialisation strategies (including import substitution and overvalued exchange rates) sometimes disadvantaged agriculture, constraining wider uptake.[122]

Beyond the promotion of soy production, a strong institutional landscape pushed the legume as a 'starvation food.' In this context, Public Law 480 (later known as Food for Peace, 1954) stands out as the principal channel for routing grains and oils into African food systems.[123] Designed to dispose of U.S. surpluses, develop foreign markets, and advance geopolitical aims, PL 480 exported wheat, rice, soybean oil, soy flour, and soy-fortified blends.[124] Title I concessional sales built markets and often converted local currency proceeds into technical assistance, infrastructure, or administrative budgets;[125] Title II humanitarian aid distributed corn-soy and wheat-soy blends to schools, clinics, and emergency rations via voluntary and multilateral partners; Title III later supported non-emergency programmes.[126] Soybean oil, soy flour, and soy-fortified blends (corn-soy milk, corn-soy blend, wheat-soy blend, later also soy-fortified sorghum grits) were programmed across the law's titles.[127] Industry leaders credited PL 480 with absorbing a large share of soybean oil exports, stabilising the U.S. domestic crushing complex.[128] By the late 1960s and early 1970s, Africa received tens of thousands of tonnes of cereal-soy blends annually.[129] Whole beans remained peripheral; processed soy integrated into cereal matrices became routine in aid infrastructures.[130] These channels simultaneously served two purposes: They relieved U.S. commodity pressure at home while feeding the hungry abroad, as President Kennedy said at the 42nd annual convention of the ASA in 1962.[131] In addition, as stated by Fred Marshall in a letter to the U.S. Congress, food

121 Singh, Soybean Improvement Work.

122 Ana P. F. Mendes/Mario Bertella/Rudolph Teixeira, Industrialization in Sub-Saharan Africa and Import Substitution Policy, in: Brazilian Journal of Political Economy 34/1 (2014), 120–138.

123 Nelson J. Post, Food for Peace: Plans and Objectives, in: USDA Northern Regional Research Laboratory (ed.), Proceedings of Conference on Soybean Products for Protein in Human Foods, Peoria 1962, 19–25.

124 Shurtleff/Aoyagi, Food for Peace, 20–47.

125 PL 480 offered long-term, low-interest credit (Title I) for recipient countries to pay in local currency. This enabled poor nations to import U.S. commodities without exhausting scarce foreign exchange. See: Meals for Millions, U.S. Distribution of Relief Shipments, September 1946–May 15, 1963: Friendship Food for a Hungry World, Washington, D.C. 1963.

126 Shurtleff/Aoyagi, Food for Peace, 21–26.

127 Fred Marshall, Congress Letter, in: St. Cloud Times, 21 June 1954, 10.

128 Earl L. Butz, Growth Without Ceiling! Prosperity in the Industry Depends on Producing for a Growing Market and Not for the Government, in: Soybean Digest (October 1957), 12–13.

129 U.S. Department of Agriculture, Food for Peace: 1970 Annual Report on Public Law 480, Washington, D.C. 1971, 113–120, in: Shurtleff/Aoyagi, Food for Peace, 129.

130 U.S. Department of Agriculture, Annual Reports on Activities Under Public Law 480, Washington, D.C. 1975–1979, in: Shurtleff/Aoyagi, Food for Peace, 141–142, 150, 156, 161, 173–174, 183.

131 "[T]his Administration ministration has encouraged expansion of U.S. soybean production, both to bring about a better balance in American agricultural production and to better meet world protein requirements in our Food for Peace program throughout the world. […] We welcome and appreciate your continuing interest in government farm and food programs at home and abroad." John F. Kennedy, Greetings from the President of the United States, in: Soybean Digest 22 (October 1962), 54–57.

could do "more permanent damage to world communism than our armies."[132] It also worked in the longer term by standardising new food technologies abroad and normalising soy's presence in institutional diets and public nutrition.

Beyond aid, the Soybean Council of America, created in 1956 by ASA and NSPA, promoted soy through concessional trade arrangements.[133] A 1960 agreement with USDA's Foreign Agricultural Service gave the Council access to foreign currencies from surplus commodity sales for work in more than forty countries, enabling studies of export barriers, buyer assistance, consumer-level promotion, and technical exchange.[134] Education and training were central, with home economists and nutrition workers acting as cultural intermediaries through workshops, demonstrations, and fairs.[135] Even advocates acknowledged that "consumers are not interested in soybeans" – but they could be interested in what soy became through processing.[136] Promotional materials, culinary demonstrations, and technical assistance linked U.S. commodity interests to postcolonial food systems, leaning on oil, flour, blends, and concentrates.[137] These institutional architectures shaped how soy circulated in processed foods – and, increasingly, in feed.

Uses: Uneven uptake, processed channels, and the rise of feed

Notwithstanding efforts to establish production, soy's most prominent role during this time often came as an ingredient in 'starvation food.' In scientific journals from the period, nutritionists and agronomists remarked that about 40 per cent of the total dry matter content of whole soybeans is protein, that they are high in caloric value (containing about 20 per cent fat), and that they could therefore help reduce the present widespread calorie and protein shortage in both human diets and livestock feed. Dietary acceptance was limited, however, which sometimes caused paternalistic frustration that attributed non-adoption to "conservatism in food habits," as illustrated in this report from a soy seminar in Zaire:

> "People have always agreed, at least in principle, that soybeans are a good solution to the problem of protein malnutrition in disadvantaged regions. Many attempts prior to 1960 in Zaire and other African countries concluded that the failures were exclusively due to the fact that Africans do not like eating soybeans."[138]

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132 Marshall, Congress Letter.

133 Glenn H. Pogeler, Aims, Objectives and Experiences of the Soybean Council of America, Inc., Paper to United Grain Growers, Royal Alexandra Hotel, Winnipeg, 14 March 1967, 13.

134 The major emphasis of the Soybean Council was to explore market potential and conduct promotional and servicing activities that would help to expand markets for the U.S. soybean industry throughout the world.

135 Shurtleff/Aoyagi, Food for Peace, 51–97.

136 Howard L. Roach, Soybean Council of America – Promotional Progress, in: Soybean Digest 20 (September 1961), 1–64; Soybean Council of America Inc., Council–FAS in First Global Contract, in: Soybean Digest 18 (January 1960), 24–25.

137 Roach, Soybean Council, 24.

138 G. Vanneste, De la campagne de soya à la campagne d'éducation sanitaire intégrale, in: Comité de Coordination pour le Développement en République du Zaïre (CODEZA), Séminaire national sur le soja, Kananga 1986, 47–58.

While nutritionists struggled to promote direct consumption, commercial agents achieved better success with soy flour (praised for its shelf life, transportability, and versatility), though palatability and culinary fit remained challenges.[139] In South Africa, an early soy-based baby food marketed under the Zulu name *Incumbe* (meaning gruel prepared by mothers to feed their babies) had been successfully commercialised since the late 1930s, but it began to lose ground in the 1950s. The reason, according to a later scientific article, was that

> "the African was becoming more sophisticated and thus suspicious of a food, or for that matter any other commodity, made specially for him. Quite understandably he believed that such articles must be inferior and that the white man was trying to profiteer at his expense."[140]

This illustrates that paternalistic marketing was starting to provoke negative reactions. The company subsequently rebranded to *Pro Nutro* and altered the product's formulation. Sales revived, and the company offered incentive prices to farmers to encourage both volume and protein quality.[141]

Aid also served to introduce soy diets, familiarising institutions and households with soy products. Before PL 480 fully ramped up, the *Meals for Millions Foundation* founded in 1946 distributed a soy-based supplement in more than twenty African countries.[142] Reports of *kwashiorkor* in the 1950s intensified work and encouraged the use of soy in schools and hospitals.[143] Both domestic governments and international organisations also sought to 'educate' consumers. For example, Iowa State University organised workshops for women on soy-based soups, breads, and porridges; 'food fairs' staged by USDA, ASA, UNICEF, and their partners invited officials to consume soy as an emblem of scientific progress.[144] In Ethiopia, the imperial government saw soy as a tool to address starvation, reduce dependence on imports, and support rural development. State farms and integrated projects trialled hundreds of varieties. The Ethiopian Nutrition Institute (ENI) experimented with soy flour in traditional foods such as *injera, wot, dabbo*, and *kitta*.[145] This approach sought to embed soy within established food cultures rather than replace them. ENI also launched additional products such as soy-wheat

139 Smartt, A Guide to Soya Bean Cultivation.

140 W. A. Odendaal, Experience in Development of Pro-Nutro in South Africa, in: Pre-School Child Malnutrition: Primary Deterrent to Human Progress, Washington, D.C. 1966, 224–232.

141 Ibid., 224.

142 Some of the receiving countries were Angola, Belgian Congo, Cameroon, Egypt, Eritrea, French Equatorial Africa, Ghana, Kenya, Liberia, Libya, Mauritius Is., Morocco, Mozambique, Nigeria, Republique du Congo, Rhodesia, Sierra Leone, South Africa, Tanganyika, Tunisia, Uganda. See Meals for Millions Foundation, Friendship Food for a Hungry World, Los Angeles 1960, 29.

143 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 285–340; Madison Survey (Madison, Tennessee), Madison Health Foods, 27/16 (29 August 1945), 63.

144 ASA To Hold Soy Protein Conference, in: Soybean Digest (November 1964), 28, in: Shurtleff/Aoyagi, Food for Peace, 99.

145 B. G. Hiwot, Home Preparation of Soybeans in Ethiopia, in: Whigham (ed.), Soybean Production, Urbana 1975,198–199.

Figure 4: Children eating *faffa* at Aware C.D. Centre, 1967

Source: Ethiopian Public Health Institute.

non-fat milk and *faffa*, a fortified porridge intended to relieve malnutrition.[146] With support from international aid, the latter became a major commercial success.[147]

By the mid-1970s, *faffa* production reached several thousand tonnes per year, with more than half purchased by UNICEF for famine relief and the rest sold locally as baby food.[148] The ambition was to achieve nutritional sovereignty via domestically grown beans on state farms, but domestic supply remained fragile. Despite sustained efforts, local beans covered only a fraction of *faffa* requirements by the early 1980s.[149]

Across contexts, food scientists explored how soy could be blended into traditional foods such as *ogi* (a fermented maize porridge popular among the Yoruba people), *akara* (Nigerian and West African bean fritters made natively from brown beans, cowpeas, or black-

146 *Faffa* is an Amharic word meaning 'Grow strong and healthy'. See Erwin Kopp, A Production Unit for Low Cost Weaning Food in Ethiopia, in: Proceedings of a Conference for Asia and Oceania, University of Illinois, Urbana 1976, 147; Yngve Hofvander, 50 Years of Ethio-Swedish Collaboration in Child Health and Nutrition: A Chronicle with Recollections and Personal Experiences, 2010, https://cdn.sida.se/publications/files/sida6135-0en-50-years-of-ethio-swedish-collaboration-in-child-health-and-nutrition.pdf (5 December 2025).

147 Gunnar Agren et al., FAFFA: A Supplementary Cereal-Based Weaning Food in Ethiopia, in: M. Milner (ed.), Protein-Enriched Cereal Foods for World Needs, St. Paul 1969, 278–287; Elizabeth Orr, The Use of Protein-Rich Foods for the Relief of Malnutrition in Developing Countries: An Analysis of Experience, Tropical Products Institute Report G73, London 1972, 8, 21.

148 Kopp, A Production Unit.

149 Soybean production declined during the 1970s, and the bulk of soy continued to be imported. Food and Agricultural Organization of the United Nations, FAO Production Yearbook, 14, 116; Orr, The Use of Protein-Rich Foods, 71.

eyed peas), breads and other foods in Nigeria, Kenya, and Ghana.[150] Particularly notable was *Soyogi,* produced by the Federal Industrial Research at Oshodi and widely distributed during the Biafran War (1967–1970).[151] Other examples include *Super Maeu* in Mozambique, *Kupangi Biscuits* in South Africa, *Soya Porridge* in Uganda, and a range of soy-cereal blends produced in Zambia.[152] In parallel, pilot projects explored soymilk for infant feeding and national nutrition programmes, sometimes framed as addressing milk shortages due to tsetse and lactose intolerance.[153] Egypt began producing soymilk for infant feeding in conjunction with France in 1984, using a portion of the national soybean crop.[154] These efforts were shaped by hopes that soy could be "domesticated" within local food cultures. The initiatives paralleled earlier colonial attempts to introduce soy into local diets, but they were now framed in the context of nutritional science, child health, and development planning. In Uganda, *Africa Basic Foods* (est. 1965) contracted small farmers, built a factory near Kampala for low-cost soy foods, and marketed to hospitals, schools, and public institutions.[155]

Soy also entered African food systems through feed. Globally, feed had become the main market driver for soy, and developing regions were targeted for poultry and livestock expansion.[156] The Soybean Council opened an office in Cairo in 1960, and another in Morocco somewhat later, to support the development of a protein feed complex.[157] Africa's soybean oil imports expanded steadily from the early 1960s, rising from around 39,000 tonnes in 1961 to fluctuating levels between 30,000 and 90,000 tonnes during the 1960s. Imports accelerated markedly from the mid-1970s, moving into the 200,000-tonne range and peaking at approximately 366,000 tonnes in 1980, while exports remained negligible (16 tonnes in 1980).[158] Egypt, Morocco and Libya accounted for a substantial share of these flows, often in tandem with state-backed investments in poultry and dairy production.[159] Egypt developed notable crushing capacity and promoted both domestic production (through irrigation, state planning, and protection) and imports of whole beans (60,000 tonnes in 1982/83) to keep crushers supplied.[160] Similar, though smaller, flows reached Tunisia, Algeria, Jordan,

150 O. L. Oke, Chemical Studies on the Nigerian Foodstuff "Ogi", in: Food Technology 21/2 (1967), 98–100; I. A. Akinrele/Charity C. A. Edwards, An Assessment of the Nutritive Value of a Maize-Soya Mixture 'Soy-Ogi,' as a Weaning Food in Nigeria, in: British Journal of Nutrition 26/2 (1971), 177–185, DOI: 10.1079/BJN19710024.

151 E. U. Edem, Soybean in Nigeria, Nigeria Department of Agricultural Research, Memorandum 116, Ibadan 1975.

152 Orr, The Use of Protein-Rich Foods, 59.

153 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 251–297.

154 Soya Foods (ASA, Europe), Egypt. Soymilk, November 1984, 3, in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 648.

155 D. W. Harrison, Analysis of the Uganda Experience Based on Africa Basic Foods Inc., paper at UNIDO Expert Group Meeting on Soya Bean Processing and Use, Peoria 1969, 43.

156 John Haymaker, The World Market Potential for Soybeans, in: Soybean Digest (May 1966), 27–30.

157 Open New Office in Cairo, Egypt, in: Soybean Digest (November 1960), 23.

158 FAOSTAT, Crops and Livestock Products, Import/Export Quantities for Soybean Oil, Africa (Total), 1961–1989, Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/TC (6 February 2026).

159 Javier de Salas, Potential for Soybean Oil in Mediterranean Africa, in: Soybean Digest (May 1964), 60; André Tawa, Egypt: Soy Products for the UAR, in: Soybean Digest (May 1965), 72–73.

160 Mahmoud Naser et al., Soybean in Egypt: Current Situation, Challenges, and Future Perspectives, in: Discov Sustain 5/425 (2024), DOI: 10.1007/s43621-024-00656-x.

and Sudan.[161] Commercial imports supplied feed industries connected to aspirations for protein-rich diets and agricultural modernisation.[162] Where industrial offtake was strong and coordinated, as in feed complexes, production could expand; where offtake was weak, domestic supply rarely kept pace. This development coincided temporally with the erosion of many developmentalist efforts amid the global economic crises of the 1970s and mounting debt burdens, which marked the decline of the Cold War Developmentalist Regime.

Analytical reflection: Soy and the second food regime

In the postwar era, amid Cold War geopolitics and developmentalist planning, soy re-emerged as a nutritional technology and aid commodity. This reflects the dynamics of the second food regime defined by U.S. agricultural hegemony, aid architectures, and the political use of surplus commodities. While newly independent states arrived as central actors with their own developmental ambitions, aspects like programme design, technology choice, and commodity flows were often determined by donors, firms, and international agencies. This helped consolidate soy's role as a processed ingredient and feed input rather than as a widely grown crop. Production expanded most where feed markets, crushing capacity, and coordinated prices were present. Where promotion centred on direct human foods, the most durable gains occurred through processed products such as *faffa* or *Pro Nutro* rather than widespread farmer adoption. Industrial and humanitarian channels moved more quickly than agronomy and extension. In both domains, planners, governments and corporate intermediaries often addressed local populations in paternalist terms, attributing non-adoption to cultural conservatism while paying less attention to price, labour, taste, and the fact that many products were formulated and branded elsewhere. Training and food fairs sought to 'teach' soy as scientific progress. In practice, circulation outpaced cultivation.

The period therefore reproduced earlier ambivalences. Soy was invoked as a solution to malnutrition and livestock shortages and justified institutional expansion, yet its integration into agrarian practice remained partial. The presence of newly independent states changed the political field, but not always the hierarchy of decision-making over supply chains, processing technologies, and standard foods. African producers and consumers were incorporated into global soy circuits largely as buyers of meal, recipients of blends, and occasional growers for commercial farms rather than as the primary site of varietal development, crushing, and cuisine-led demand formation. While Food for Peace continued, classic soy-fortified PL-480 shipments diminished by the 1980s as programme structures changed. As the developmentalist model frayed, many African states faced balance-of-payments crises, commodity price volatility, and mounting debt service. Some developmentalist ambitions survived structural contradictions, however, and the neoliberal era would inherit both the promise of soy and the unresolved institutional frictions that limited uptake.

161 Frank J. Piason, Three Nations Lead Mideast/North African Buying of Soy Products, in: Foreign Agriculture, 10 April 1978, 6–7, 10–11.

162 Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 547–585.

Corporate-Neoliberal Regime (1990s–present): Soy as a flexible frontier commodity

The trade liberalisation impetus associated with the Washington Consensus and the WTO Agreement on Agriculture (established 1995) reconfigured how crops were grown, processed, and traded globally. Liberalisation, population growth, and the westernisation of diets with higher meat consumption combined with the so-called gene revolution and the spread of no-tillage farming from the mid-1990s. Together, these trends helped to push soy into new frontiers.[163] World output rose from about 64 million tonnes in 1975 to approximately 375 million tonnes in 2024.[164]

Within this context, soybeans in Africa were repositioned. Once a colonial experiment and later a developmental nutritional technology, soy now appeared as a flexible frontier commodity. It served as a feed input for expanding poultry sectors, a source of edible oil for urban markets, and a candidate for integration into new investment corridors.[165] As postcolonial agricultural architectures came under strain from mounting debt and deteriorating terms of trade, the familiar promise of soy resurfaced in new forms. Advocates again presented it as a crop capable of repairing soils, supplying protein, reducing oil import bills, and generating rural incomes.[166] Its nitrogen-fixing capacity aligned with soil health agendas, its protein density supported nutrition and feed narratives, and its scientific pedigree suggested rapid adaptability.

A new frontier discourse also emerged. From the early 2000s, concerns over food security, biofuels, and capital returns animated fresh cycles of land seeking and investment speculation. Development reports and academic papers reiterated long-standing claims about soy's high protein and oil content, agronomic versatility, and potential role in climate adaptation and South–South cooperation.[167] The rhetorical pattern was familiar: soy as a 'miracle crop,' Africa as a 'potential giant,' and Western experience as the model to emulate.[168]

Liberalisation and the reconfiguration of agrarian institutions

Although the pace varied across countries, the overall result was a thinning of public capacity in extension, credit provision, seed systems, marketing boards, parastatals, fertiliser subsidies,

163 Baraibar Norberg/Deutsch, Soybean, 167–171.

164 FAOSTAT Crops and Livestock Products, Production Quantity (Soya beans), World (Total), 1975 and 2024, Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/QCL (16 February 2026).

165 Jan Douwe van der Ploeg, The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization, London/New York 2008.

166 Daniel Sisay, Soybean Production and Marketing in Ethiopia: Challenges and Opportunities, EIAR, Addis Ababa 2018.

167 Ninkuu/Han/Dakora, Development of the Soybean Industry; Siamabele, The Significance; Ali Zafar, The Growing Relationship Between China and Sub-Saharan Africa: Macroeconomic, Trade, Investment, and Aid Links, in: World Bank Research Observer 22 (2007), 103–130.

168 Capmad, Africa's Soybean Sector.

state farms, and price stabilisation.[169] As debt service absorbed a growing share of export revenues, these systems became fiscally difficult to sustain. Structural adjustment programmes introduced by the World Bank and IMF dismantled many of the existing institutions: Marketing boards were dissolved, input supply chains were privatised, currencies were devalued, and agricultural trade was liberalised.[170] The developmentalist state did not vanish, but it was disassembled unevenly as the political economy of African agriculture came to be shaped by debt-crisis management and global trade liberalisation.

For a crop such as soy, historically reliant on coordinated extension and public processing, yet marginal within the developmentalist era, this new environment was ambivalent. Smallholder adoption often stalled. At the same time, global demand continued to rise, and liberalisation encouraged agribusiness investment and the entry of multinational grain and oilseed traders.[171] As markets opened, value chain governance shifted toward private actors.[172] Commodity traders, processors, and feed companies increasingly organised soy markets. Quality and safety standards – particularly moisture levels and aflatoxin thresholds – governed access to higher-value segments. In some corridors, sustainability or deforestation risk standards appeared, reflecting pressure from international finance and buyers. Warehouse receipt systems, input credit tied to offtake, and forms of contract farming expanded in certain places as well, with uneven outcomes for smallholders.

The 2007–2008 food price crisis intensified these dynamics. Discourses of scarcity and global opportunity revived frontier narratives. Africa was once again cast as the world's last agricultural frontier, and large-scale land acquisitions were justified as necessary to close yield gaps through technology-driven intensification.[173] Simultaneously, the pendulum once more shifted away from pure faith in the markets: Post-Washington Consensus thinking encouraged a partial return of the state, now oriented toward public-private partnerships, value chain integration, and investor-friendly reforms rather than state-led production. Nigeria, Ghana, Zambia, Mozambique, and Ethiopia became focal points for initiatives seeking to integrate smallholders into procurement networks, strengthen seed systems, and unlock underutilised land.[174]

169 Ibid.

170 Carlos Oya, Agricultural Maladjustment in Africa: What Have We Learned after Two Decades of Liberalisation, in: Journal of Contemporary African Studies 25/2 (2007), 275–297, 278–279.

171 Khojely, History, 229.

172 McMichael, Food Regimes and Agrarian Questions, 122.

173 Rickard A. Sikora et al., Introduction, in: Rikard A. Sikora et al. (eds.), Transforming Agriculture in Southern Africa, London/New York 2020, 3–6.

174 New Master of Science Programme Educates African Students in Africa, in: Soybean Innovation Lab Weekly Digest 1/4 (4 December 2016), https://us10.campaign-archive.com/?u=94232d99724faa322d3fa5543&id=82ffe62db0 (16 February 2026); Tesfaye M. Abush et al., Genetic Variability in Soybean (Glycine max L.) for Low Soil Phosphorus Tolerance, in: Ethiopian Journal of Agricultural Science 27/2 (2017), 1–15; Daniel Muleta/M. H. Ryder/M. D. Denton, The Potential for Rhizobial Inoculation to Increase Soybean Grain Yields on Acid Soils in Ethiopia, in: Soil Science and Plant Nutrition 63/5 (2017), 441–451.

Research architectures and new development actors

IITA remained central to soybean research at the Pan-African level, although the focus had shifted towards shortened project cycles, market integration, and private sector partnerships. Breeding continued. In the 1990s, IITA developed promiscuous TGx soybean lines capable of nodulating with a wider range of native rhizobia, reducing the need for inoculants and making the crop more suitable for resource-constrained farmers.[175] These varieties were incorporated into intercropping systems in Nigeria and tested across Zambia, Malawi, and Ghana. Yet even where high-potential varieties were released, weak seed multiplication, inconsistent inoculation, limited fertiliser use, and fragmented markets kept national yields far below trial potential.[176] Along with the 'gene revolution,' however, IITA started with genome editing, using tools like CRISPR/Cas, which has enabled early-maturing and drought-resistant cultivars that have been performing well under dry agroclimatic conditions; Nigeria, South Africa, and Ghana have approved the cultivation of genetically modified soy.[177]

New actors also emerged. The Soybean Innovation Lab (SIL), established at the University of Illinois in 2013 with USAID funding, sought to build a technical foundation for soybean development across sub-Saharan Africa through a research-for-development (R4D) approach.[178] Working with national research systems, universities, development agencies, and private firms rather than directly with farmers, SIL has helped building up capacity across breeding, agronomy, mechanisation, processing, and training. Central to this effort was a networked model that combined certification-based training, peer-to-peer learning, and regional trial infrastructures aimed at reducing professional isolation and linking producers, seed companies, and processors to markets.[179] Together with IITA, the Syngenta Foundation for Sustainable Agriculture, and the African Agricultural Technology Foundation, SIL launched the Pan-African Soybean Variety Trials (PAT) in 2016. Starting in Malawi, the trials expanded to more than seventy locations across thirteen countries and evaluated soybean lines from Africa as well as from the United States, Brazil, Colombia, and Australia. By generating comparable, multi-location data to accelerate varietal release and commercialisation, SIL contributed to a renewed—if uneven—neo-developmentalist narrative in the 2010s. Ethiopia emerged as a prominent site within this framework, with the Jimma Agricultural Research Center developing into a continental reference point for soybean improvement.[180]

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175 Hailu Tefera, Breeding for Promiscuous Soybeans at IITA, in: Aleksandra Sudaric (ed.), Soybean – Molecular Aspects of Breeding, Rijeka 2011, 147–162; Khojely, History.

176 Siamabele, The Significance, 3–5.

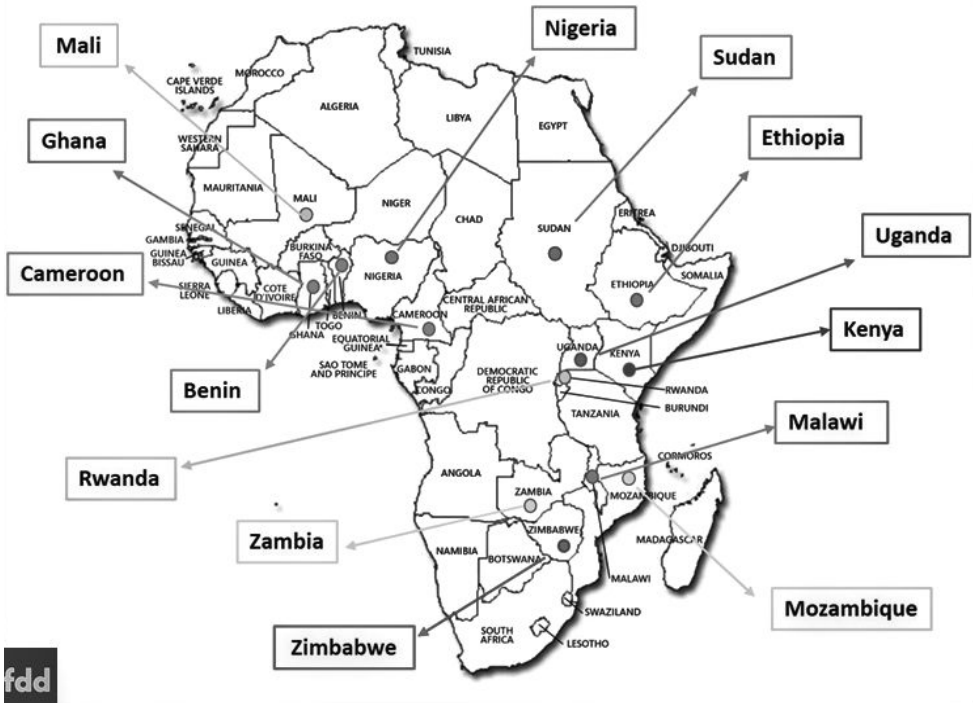
177 IITA, Soybean Crop Improvement, https://www.iita.org/research/our-research-themes/improving-crops/soybean-crop-improvement/ (10 February 2026); ISAAA, GM Approval Database, https://www.isaaa.org/gmapprovaldatabase/default.asp (10 February 2026).

178 Soybean Innovation Lab, https://www.soybeaninnovationlab.illinois.edu/ (13 January 2026).

179 SIL, Soybean Disease Watch for West Africa Weekly Newsletter, 1 October 2024, https://preview.mailerlite.io/preview/470190/emails/133537714752455932 (13 May 2026); SIL, Webinar on Early Detection and Effective Management of Soybean Rust: The Role of Sentinel Plots, Weekly Newsletter, 1 November 2024, https://preview.mailerlite.io/emails/webview/470190/136800189573760818 (13 May 2026).

180 Soybean Innovation Lab, Activities and Impact Report 2020, 1–40, https://soybeaninnovationlab.illinois.edu/2020report (14 May 2026).

Figure 5: African countries in which Pan-African Soybean Variety Trials were implemented



Source: Michelle Santos, The State of Soybean in Africa: Soybean Varieties in Sub-Saharan Africa, in: farmdoc daily 9, 21 August 2019, 155.

Figure 6: Soybean Innovation Lab closing

Source: WAND Digital Team, Closure of Illinois-led Soybean Lab due to USAID Funding Cut, in: 25News Now (10 February 2025), https://www.25newsnow.com/2025/02/10/closure-illinois-led-soybean-lab-due-usaid-funding-cut/ (14 May 2026).

Numerous advances notwithstanding, most countries still had very small teams dedicated to soy.[181] Moreover, progress depended heavily on external funding and coordination. This donor dependence translated into institutional fragility. On 27 February 2025, SIL received a termination notice from USAID as part of a broader contraction of U.S. foreign aid spending.

Following the withdrawal of USAID funding, SIL initially announced its closure and subsequently reduced its operations from thirty-one countries to four. Residual activities, including work in Malawi, continued through limited private funding but could not offset the loss of federal support. The episode underscored the vulnerability of Africa's soybean research ecosystem to geopolitical shifts and the structural limits of donor-dependent development models.[182]

Production, trade, and uses: Feed-driven demand and uneven outcomes

Africa's soybean production grew from roughly 600,000 tonnes in the early 1990s to nearly 7.5 million tonnes in 2023, before dropping back to ca. 5.76 million tonnes in 2024 due to drought.[183] As Figure 7 shows, the most significant acceleration occurred after 2010, when production outpaced area expansion.

This pattern reflects a combination of scale effects (more area) and rising average yields – from below 0.4 t/ha in the 1960s to over 1 t/ha in the 2000s.[184] Yields vary distinctly by country and production system, however: Egypt regularly achieves 2.9–3.2 t/ha, while Uganda and Togo remain below 1 t/ha. South African commercial farms frequently exceed 2.3 t/ha, reflecting higher levels of mechanisation, GM adoption, and stronger feed markets.[185]

Despite the significant growth in the region's soy production, the increase remains modest from a global perspective. South America's production rose from about 0.3 million tonnes in 1961 to more than 192 million tonnes in 2023, surpassing North America. Global output expanded from approximately 26.9 million to more than 371 million tonnes over the same period.[186] Africa's share nevertheless increased from 0.27 per cent in 1961 to about 2 per cent in 2023. This is a meaningful rise in regional terms, but still proportionally quite small in relation to the continent's demographic and land endowments: Africa accounts for roughly

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181 Wodimu Bekele/K. Belete/T. Tana, Effect of Soybean Varieties and Nitrogen Fertilizer Rates on Yield, Yield Components and Productivity of Associated Crops under Maize/Soybean Intercropping at Mechara, Eastern Ethiopia, in: Agriculture, Forestry and Fisheries 5/1 (2016), 1–7.

182 Miles MacClure, University of Illinois Soybean Lab Took a Big Hit from Trump Cuts: Here's What's at Stake, in: Chicago SunTimes (19 June 2025), https://chicago.suntimes.com/politics/2025/06/19/trump-cuts-soybean-innovation-lab-university-illinois-urbana-champaign-malawi-africa-agriculture-peter-goldsmith-usaid (10 January 2026); Soybean Innovation Lab Project to Expand Soybean Markets in Africa with New Grant, in: EurekAlert! (1 December 2025), https://www.eurekalert.org/news-releases/1108001 (14 May 2026).

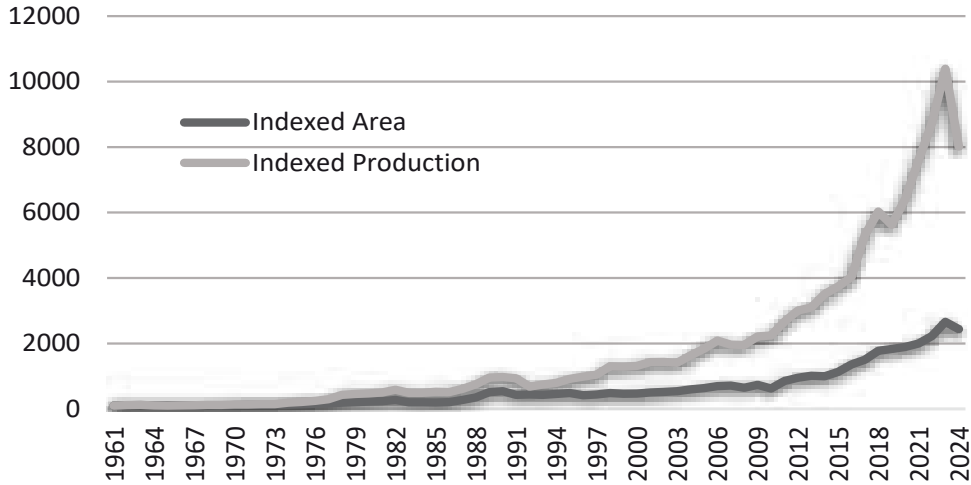
183 FAOSTAT, Crops and Livestock Products (Africa), https://www.fao.org/faostat/en/#data/QCL (10 January 2026).

184 FAOSTAT Crops and Livestock Products, https://www.fao.org/faostat/en/#data/QCL (16 February 2026).

185 FAOSTAT Crops and Livestock Products: Area Africa, Soya Beans, yields in kg/ha, hhttps://www.fao.org/faostat/en/#data/QCL (16 February 2026).

186 FAOSTAT, Soya Bean (UN Data), https://data.un.org/Data.aspx?d=FAO&f=itemCode%3A236 (14 January 2026).

Figure 7: Relative growth of soybean production and area in Africa (1961 = 100)



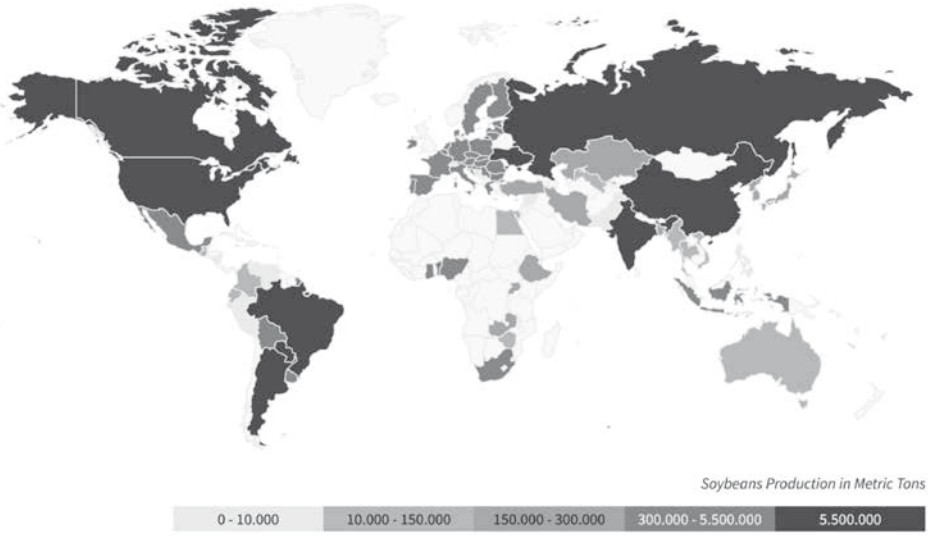
Source: Author's calculations based on data from FAOSTAT (Food and Agriculture Organization of the United Nations, Crops and livestock products), regional aggregate for Africa (10 January 2026).

Figure 8a: Top soybean producing countries by production volume and share of world production, 2025/2026 (1,000 metric tonnes)

Country	Value	% of World
Brazil	186,000 (1000 MT)	42.14 %
United States	120,701 (1000 MT)	27.35 %
Argentina	50,000 (1000 MT)	11.33 %
China	21,000 (1000 MT)	4.76 %
India	11,500 (1000 MT)	2.61 %
Paraguay	11,100 (1000 MT)	2.52 %
Russia	8,800 (1000 MT)	1.99 %
Canada	7,300 (1000 MT)	1.65 %
Ukraine	5,600 (1000 MT)	1.27 %
Bolivia	4,000 (1000 MT)	0.91 %
Uruguay	3,100 (1000 MT)	0.7 %
European Union	3,000 (1000 MT)	0.68 %
South Africa	2,800 (1000 MT)	0.63 %
Nigeria	1,500 (1000 MT)	0.34 %
Benin	700 (1000 MT)	0.16 %

Source: U.S. Department of Agriculture, Foreign Agricultural Service (USDA FAS), Production, Supply and Distribution (PSD) Online, Oilseed/Soybean, Production, 2026/2027 (public domain), https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery (30 June 2026).

Figure 8b: Map of World Soybean Production 2025/2026



Source: U.S. Department of Agriculture, Foreign Agricultural Service (FAS), Production Data for Soybeans (public domain). Available at: https://www.fas.usda.gov/data/production/commodity/2222000 (15 January 2026).

20.3 per cent of the world's land area and about 18–19 per cent of the global population.[187] From the vantage point of the historical trajectory of Africa itself, however, it is clear that soy under the third regime constitutes a clear break with the previous two, with the crop well and truly taking off.

Country paths diverged markedly. South Africa has become Africa's largest soybean producer: Its output rose from approximately 84,000 tonnes in 1987 to around 1.32 million tonnes in 2016, reaching a record of almost 2.8 million tonnes in 2025/26 and accounting for more than one-third of the continent's production that year.[188] However, annual production fluctuates considerably, ranging from 1.9 million tonnes in 2021 to 2.3 million in 2022, 2.8 million in 2023 and 1.8 million in 2024. Over the past decade, the planted area has more than doubled. The vast majority of the crop is crushed for oil and meal and absorbed by a vertically integrating poultry industry, with only a small share – around 2 per cent – destined for direct human consumption. This feed–soy nexus was further reinforced by anti-dumping measures on imported poultry, which strengthened incentives for domestic feed availability.[189]

187 Africa (Encyclopaedia Britannica).

188 FAOSTAT, Crops and Livestock Products, https://www.fao.org/faostat/en/#data/QCL (16 February 2026). U.S. Department of Agriculture, Foreign Agricultural Service (USDA FAS), Production, Supply and Distribution (PSD) Online, Oilseed/Soybean, Production, 2026/2027 (public domain), https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery (30 June 2026).

189 Ibid.; Makoma Makgopa/Amy Caldwell, Poultry and Products Annual, Report Number SF2023-0028, FAS/USDA, 12 September 2023, https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?file

Figure 9: Major African soybean producing countries, 1981–2024 (thousand tonnes)

	1981	1991	2001	2011	2021	2024
South Africa	27.6	126.0	226.2	710.0	1,897.0	1,848.0
Nigeria	78.0	145.0	436.0	492.9	1,166.1	1,150.0
Benin	-	0.4	3.5	67.2	291.3	652.5
Malawi	-	-	-	75.7	264.5	305.0
Togo	-	-	-	4.4	207.6	284.3
Ghana	-	-	-	164.5	218.0	260.0
Ethiopia	-	-	4.4	49.6	271.1	240.0
Zambia	3.7	27.7	2.4	116.5	411.1	169.7
Uganda	5.0	59.0	144.0	31.8	138.0	155.0
Burkina Faso	-	0.5	3.8	23.1	106.7	138.1
Egypt	130.4	120.0	14.9	29.8	62.6	75.0
Tanzania	1.1	2.1	0.9	2.5	75.0	42.7

Source: FAOSTAT, Crops and livestock products, selected countries, Production quantity, soya bean, selected years (10 January 2026).

Nigeria, a leading producer during the developmentalist period, has maintained a steady trajectory. Uganda has also expanded production but from a low base. In both cases, policies favouring domestic food processing, improved varietal adaptation across agroclimatic zones, culinary incorporation into selected foods, and the willingness of manufacturers to use soy in baby foods, oils and feeds supported growth and continued smallholder participation.[190] Development projects have repeatedly promoted soy as both a cash crop and an affordable source of protein.[191] Yet yield constraints persist: Average on-farm yields in Nigeria often hover around 1.0–1.2 t/ha, and in Uganda around 0.6–0.9 t/ha.[192] Access to high-yielding seed with robust disease packages remains a common bottleneck, as do inoculation practices and reliable input delivery.[193]

Egypt showed an early peak in the 1980s (130,360 tonnes in 1981), but lower levels thereafter despite consistently high yields, reflecting a strategy centred on imports for crushing. By contrast, Benin forms part of a post-2010 "new growth belt" alongside Ghana, Togo, Malawi, Burkina Faso, Zambia, and Ethiopia. Benin's expansion is one of the fastest in recent years: Negligible before the 1990s, production rose sharply to over 650,000 tonnes in 2024, much of it exported to Nigeria as farmers diversified away from weakening cotton prices.[194] This growth was achieved largely through smallholder area increases rather than estate produc-

Name=Poultry%20and%20Products%20Annual_Pretoria_South%20Africa%20-%20Republic%20of_SF2023-0028.pdf (16 February 2026).

190 Mary Agada, Constraints to Increasing Soybean Production and Productivity in Benue State, Nigeria, in: Asian Journal of Agricultural Extension, Economics & Sociology 4/4 (2014), 277–284; Shurtleff/Aoyagi, History of Soy in Africa, 1120–1131.

191 Soybean Innovation Lab Newsletter (2018), in: Shurtleff/Aoyagi, Soybeans and Soyfoods in Africa, 1127.

192 FAOSTAT, Crops and Livestock Products, Soya Beans, Yields in kg/ha, Nigeria and Uganda, Specific Years, https://www.fao.org/faostat/en/#data/QCL (16 February 2026).

193 D. S. Ugwu/H. C. Ugwu, Soybean Production, Processing and Marketing in Nigeria, in: Journal of Applied Sciences and Development 1/1 (2010), 45–61.

194 FAOSTAT, Crops and Livestock Products, Soya Beans, https://www.fao.org/faostat/en/#data/QCL (16 February 2026).

tion, thereby embedding soy in existing agrarian structures and limiting political backlash. In several of these 'new growth' countries, soy has been integrated into broader agricultural development strategies aimed at smallholder commercialisation within diversified crop systems, with processors and feed manufacturers providing a rising market pull.[195]

Across the region, feed demand has been a principal driver. Urbanisation and rising incomes have expanded the poultry and dairy sectors in countries such as Nigeria, South Africa, Zambia, Benin, and Egypt. Soybean meal became central to poultry rations, and crushing grew where scale and infrastructure permitted. At the same time, agronomists and extension agents increasingly emphasised the soil benefits of soy, particularly biological nitrogen fixation that can improve subsequent cereal yields. Soy has therefore been promoted as a cash crop for feed markets, as a food ingredient, and as a contributor to soil fertility.[196] Yet the predominance of very small plots for many farmers limits economies of scale, constrains the use of yield-enhancing inputs, and weakens incentives for investment in processing.

Climatic shocks continue to expose vulnerabilities as well. Climate change is already affecting harvests through prolonged droughts and heat stress.[197] In 2024, an El Niño-linked drought dramatically reduced maize and oilseed yields across Southern Africa, with soybean output falling in several countries. With most production rainfed, rainfall variability translated into yield risk, higher food prices, and pressure on foreign exchange. Zambia, Zimbabwe, and South Africa experienced significant reductions (on average, around a quarter lower than prior seasons). In most countries of the sub-region, production is concentrated among communal smallholders, who are more exposed to weather and market shocks. In this setting, emergency imports of maize and soybeans have periodically been required to stabilise food and feed supplies. USDA facilitated import of 300,000 tonnes of corn and 165,000 tonnes of soybeans from the U.S. between May 2024 and April 2025, for a total value of USD 140 million, the highest value in the past 30 years.[198]

As in previous regimes, there are many optimistic projections about future export surpluses waiting just around the corner. The business press periodically announces a looming transformation: "Soybeans are becoming a flagship product of African exports".[199] Despite production gains, demand has outpaced supply, and trade deficits have persisted. Africa has

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195 Z. Kahenge/K. Muendo/N. Nhamo, Factors Influencing Crop Commercialization among Soybeans Smallholder Farmers in Chipata District, Eastern Zambia, in: Journal of Agriculture, Science and Technology 19/1 (2019), 3–31; Sisay, Soybean Production.

196 Francis Akabo Asodina et al., Are Non-Market Benefits of Soybean Production Significant? An Extended Economic Analysis of Smallholder Soybean Farming in Upper West Region of Northern Ghana, in: Agriculture & Food Security 9/1 (2020), 1–13, 13.

197 Confidence Duku et al., Soybean Uganda: Climate Change Risks and Opportunities, Wageningen 2019.

198 FAS/USDA, Southern Africa Shortages Boost United States Corn and Soybean Exports Benefiting American Farmers, Report Number SF2025-0019, 27 June 2025, https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Southern%20Africa%20Shortages%20Boost%20United%20States%20Corn%20and%20Soybean%20Exports%20Benefiting%20American%20Farmers_Pretoria_South%20Africa%20-%20Republic%20of_SF2025-0019.pdf (13 January 2026); Dave Nyongesa et al., The Economics and Gender Factor in Soya Bean Production and Profitability in Kenya: A Case of Smallholder Farms in Western Kenya, in: International Journal of Agricultural Resources, Governance and Ecology 13/3 (2017), 211–240.

199 Capmad, Africa's Soybean Sector.

consistently imported more soybeans and soy products than it exported.[200] In 1998, the continent imported about 786,000 tonnes of soy oil and exported roughly 3,000 tonnes; by 2023, imports had grown to around 1.86 million tonnes and exports to about 221,000 tonnes. For whole beans, imports rose from roughly 427,000 tonnes in 1998 to about 5.94 million tonnes in 2023, while exports rose to approximately 767,000 tonnes.[201]

In 2022, Africa's total soy trade was valued at roughly 5.9 billion U.S. dollars, with African exports accounting for about one-fifth of the total.[202] Egypt stands out for the growth of domestic crushing alongside continued bean imports, functioning as a regional processing hub.[203] Elsewhere, processors frequently operate with overcapacity relative to local bean supply and import substantial volumes of soybeans to keep plants running. Using a soybean-equivalent measure (oil, meal, and beans), the continent imported the equivalent of roughly 21 million tonnes a year between 2010 and 2022 – comparable to around six million hectares of soybean production. If palm oil is included, the broader edible oil deficit more than doubles.[204]

In short, if there is a soybean 'revolution' in Africa, it lies more in demand (especially for soy meal in feed) than in the continent becoming a net supplier to world markets, as imagined in earlier regimes. This demand did not appear spontaneously: The promotion of soy for feed and fortified foods goes back to the developmentalist era and was later recast through new institutional vehicles. In the 2000s, for example, the ASA established the World Initiative for Soy in Human Health (WISHH) to promote growth across the "protein market space" in Africa through programmes ranging from bakery applications to school feeding and poultry development projects, typically in concert with public agencies and private partners.[205] At the same time, U.S. food aid architectures such as the Food for Peace programme have continued to send hundreds of thousands of tonnes of soybean meal and other soy products to African countries every year, often in cooperation with the World Food Programme.[206] The FAS of USDA is also involved in numerous activities and programmes across the continent to showcase the versatility and high quality of agricultural products from the United States.[207]

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200 Africa's Agri-Trade Deficit Persists as Only Five Countries Export More Than They Import, in: Ecofin Agency, https://www.ecofinagency.com/news-agriculture/2401-52237-africa-s-agri-trade-deficit-persists-as-only-five-countries-export-more-than-they-import (13 January 2026).

201 FAOSTAT, https://www.fao.org/faostat/en/#data/QC (16 February 2026).

202 Tralac, Soya Bean Value Chain Factsheet (2023), https://www.tralac.org/documents/resources/infographics/4780-soya-bean-value-chain-factsheet-2023/file.html (1 December 2025).

203 FAS/USDA, FAIRS Country Report Annual, Egypt, Report Number EG2025-0025 (19 December 2025), https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=FAIRS%20Country%20Report%20Annual_Cairo_Egypt_EG2025-0025.pdf (24 February 2026); FAS/USDA, U.S. Trade with Egypt in 2025, https://www.fas.usda.gov/regions/egypt (24 February 2026); FAS/USDA, Exporter Guide – Cameroon, Report Number NI2025-0001 (27 January 2025), https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Exporter%20Guide%20-%20Cameroon_Lagos_Cameroon_NI2025-0001.pdf (24 February 2026).

204 FAOSTAT, https://www.fao.org/faostat/en/#data/QC (24 February 2026).

205 Why WISHH, https://www.wishh.org/why-wishh (24 February 2026).

206 USDA, Food for Progress Report, Fiscal Year 2024, https://www.fas.usda.gov/sites/default/files/2025-12/FY24%20FFPr%20Report.pdf (20 February 2026).

207 FAS/USDA, Ghana – "Chicken Me Out" (USAPEEC Training/Competition), GH2025-0030 (31 July 2025), https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=GHANA+-+Chicken+Me+Out+-+USA+Poultry+and+Egg+Export+Council+-USAPEEC-+Stellar+Training+Progra

Soy is accordingly most widely consumed indirectly: as oil in urban markets and as meal used for poultry and livestock products. Over time, processors expanded their capacity, and by 2002, the industry had transitioned from an under-capacity position to overcapacity, with processing capacity exceeding available local soybean supplies. This resulted in significant acceleration in the imports of soybean grain. Recently, processors have been operating at 40–60 per cent overcapacity relative to domestic supply, importing around 5.4 million tonnes of soybeans annually to keep their factories operating.[208] Human food uses have developed more selectively. Textured vegetable protein and fortified cereal blends entered school feeding and low-cost retail channels, often under private ownership and donor procurement rather than via state-led distribution.

Analytical reflection: Soy and the third food regime

In the neoliberal era of liberalised trade and consolidated global value chains, soy has been reframed as a flexible frontier commodity. It is deployed not only as a crop but as an instrument for development and diplomacy – covering edible oil deficits, feeding expanding poultry and dairy sectors, and entering processed foods. Where soy has embedded materially, it has done so most consistently through feed complexes and crushing networks, notwithstanding the relatively widespread adoption of soy as a smallholder food crop. Soy's presence in African food systems has thus expanded more in the shape of oil, meal, and processed ingredients than as a farmer staple.

Continuities with earlier periods are clear. The gap between station and farm persists; breeding advances often outpace seed multiplication and extension; and scaling is most visible where processor demand is assured. What has changed is the architecture: from state-led development to contract- and finance-mediated value chains in which private standards, trader finance, and donor projects set the terms of participation. United States influence has continued through food aid shipments, commercial promotion, and technical training, although the development landscape has shifted. The termination of SIL in 2025 highlighted the fragility of donor-dependent research systems. Moreover, while the U.S. has shown a clear interest in creating markets for its soy since the beginning of the second regime, the Trump administration has made it even more explicit that U.S. food aid must deliver in line with "America First International Food Assistance"; this includes the stipulation that food aid should "benefit American farmers and producers and help people in need around the world in a way that respects hardworking American taxpayers."[209]

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m+and+Cooking+Competition_Accra_Ghana_GH2025-0030.pdf&utm_source=chatgpt.com (23 February 2026).

208 Should U.S. Growers Look to Africa as the Next Big Market? Understanding Africa's Soy Import Demand, in: Succesful Farming (20 November 2025), https://www.agriculture.com/partners-should-u-s-growers-look-to-africa-as-the-next-big-market-understanding-africa-s-soy-import-demand-11853436 (23 February 2026).

209 USDA to Purchase 211,000 Metric Tons of American Commodities, Administer Food for Peace Program as America First International Food Assistance, in: FAS/USDA (3 February 2026), https://www.fas.usda.gov/newsroom/usda-purchase-211000-metric-tons-american-commodities-administer-food-peace-program# (9 February 2026).

At the same time, China's role has expanded by way of the Forum on China-Africa Cooperation and bilateral science partnerships, positioning soy as a strategic crop in diversified sourcing strategies and joint research agendas. Motivated by food security concerns and trade frictions, China has explored diversified soybean sourcing and technical collaboration, including germplasm exchange and joint research – once again reviving the narrative of Africa as underutilised potential and soy as the unlocking mechanism.[210] Several African governments have expressed hopes that new agreements could transform export prospects to China, although such aspirations remain contingent on infrastructure, quality standards, and reliable volumes.[211]

Overall, the regime's outcomes align with the article's central claim. Circulation has tended to outpace cultivation, and the projection–production gap remains visible. The corporate era has deepened soy's presence in African food systems primarily as oil, meal, and processed ingredients, while persistent structural constraints continue to limit broad-based on-farm transformation.

Concluding remarks

Across 150 years of interventions, soybeans have featured not simply as a crop but as a recurring site of projection. From the late nineteenth century to the present, officials, scientists, development planners and corporate actors have projected a wide range of hopes onto soy: hopes for soil improvement, nutritional uplift, industrial development, foreign exchange savings – and recently, climate-smart intensification. These visions have been remarkably persistent even as the institutional settings in which they are articulated (imperial science, Cold War developmentalism, and neoliberal value chain integration) have shifted profoundly.

A central finding of this study is that Africa's marginal position within global soybean production cannot be understood solely through agronomic constraints or market failures. Rather, its history reflects a recurring pattern in which future-oriented imaginaries outpace material outcomes. Each regime mobilised soy in ways that mirrored its governing logics: colonial administrations cast the crop as a symbol of scientific modernity and imperial improvement; postwar states and international agencies framed it as a nutritional and geopolitical instrument within architectures of aid; and neoliberal actors have treated it as a flexible frontier commodity suited to liberalised markets and expanding feed complexes. Yet across all periods, the gap between projection and production has proved resilient.

This persistence is not accidental. The soybean has repeatedly functioned as a conceptual technology of development: a crop through which broader aspirations for agricultural modernisation, dietary reform, and economic transformation are articulated. Its appeal lay in its versatility and the ease with which it could be folded into prevailing models of improvement (whether scientific agronomy, Green Revolution planning, or contemporary narratives of

210 China Implements Historic Zero Tariffs for All African Nations with Diplomatic Ties, in: gov.cn (1 May 2026), https://english.www.gov.cn/policies/policywatch/202605/01/content_WS69f45e35c6d00ca5f9a0ac01.html (14 May 2026).

211 Joseph Rajabu Kangile et al., Soybeans Imports Replacement Policies in Tanzania. Feasibility and the Anticipated Effects on People and Nature, UKRI GCRF Trade, Development and the Environment Hub, 2021.

climate resilience and protein demand). In this sense, the soybean's African history illuminates how agrarian imaginaries operate across regimes: not simply as rhetorical flourishes but as tools that legitimise interventions, organise research priorities, and sustain visions of incorporation even when results remain modest.

At the same time, the comparison across regimes reveals important differences. Colonial experimentation relied on trial plots and imperial networks; the developmentalist regime assembled research, extension, and food aid infrastructures that scaled the circulation of processed soy more than its cultivation; the corporate regime embedded soy most firmly in feed and crushing complexes for poultry and dairy. These shifts underline how material uptake has been most pronounced where institutional coordination, market pull, and processing capacity have aligned. Where they were absent – especially among smallholder farmers with limited access to seed, credit, inoculants, and assured buyers – soy remained peripheral.

The article also highlights how Africa's role within the global soy complex has been shaped by geopolitical interests and external agendas: from the use of soy in colonial nutrition schemes through its centrality in U.S. food aid programming to the emergence of new Chinese partnerships. These dynamics have sustained Africa's symbolic importance as a 'latent frontier' even as large-scale production has lagged behind projections.

In the present corporate food regime, soy continues to attract new waves of expectation. Its association with climate-smart agriculture, its role in feed markets, and its relevance for edible oil deficits all ensure that it remains at the centre of policy and investment debates. Yet the historical record suggests caution: The structural conditions that limited adoption in earlier periods (fragmented seed systems, labour constraints, climatic risk, uneven processing infrastructure, and the persistence of very small farm sizes) remain largely intact. Without changes in these underlying conditions, new projections risk reproducing familiar cycles in which soy functions more as a screen for developmental ambition than as a transformative crop.

By placing Africa's soybean history within a broader global and regime-based perspective, this article contributes to a more nuanced understanding of how agricultural futures are imagined and pursued. It suggests that regimes are sustained not only through realised commodity flows but also through anticipatory narratives that stabilise expectations and guide intervention even when outcomes disappoint. Soybeans have been unusually potent in this regard. They offer a lens through which to examine the entanglement of science, development, and geopolitics as well as to understand how agricultural imaginaries travel, sediment, and recur across time.

Ultimately, the history of soy in Africa underscores the need to interrogate not only what crops do, but what they are *imagined* to do. It is in the tension between these registers (projection and agrarian reality) that the longue durée patterns of intervention, aspiration and constraint become most visible. Whether emerging regional markets, continental trade initiatives or climate pressures will finally shift soy's position remains uncertain. What is clear is that the narratives surrounding soy have endured far more robustly than its material footprint, reminding us that the histories of crops are also histories of the worlds they are called upon to transform.

Ernst Langthaler/Natalia Ryzhova

Modernist Dreams and Agrarian Realities

Soy Expansions in the USA and USSR during the Global Agro-Food Regime Transition, 1920s–1950s

Abstract: This article compares the "soybean revolutions" envisioned in the USA and the USSR from the 1920s to the 1950s. Using an adaptation of the multi-level perspective to historical inquiry, the paper traces niche formation, crisis management, and regime building across both cases. In the United States, a state-coordinated yet decentralized knowledge network (US Department of Agriculture, experiment stations, and the American Soybean Association), synergies with hybrid corn, New Deal price and conservation policies, wartime substitution of tropical oils, and postwar trade frameworks upscaled soy from experimental niches to a pillar of the US-centred agro-food regime. In the Soviet Union, early imperial and Far Eastern niches, centralized institutionalization under the All-Union Academy of Agricultural Sciences, and ambitious five-year plans encountered ecological mismatches, weak knowledge transfer to collective farms, coercive collectivization, and repression of scientific expertise. Despite propaganda, selective incentives, and episodic industrial uses, soy remained regionally confined and socially devalued, its expansion repeatedly stalling. The paper argues that these divergent modernization pathways – low modernist, participatory, and socioecologically embedded in the USA versus high modernist, directive, and disembedded in the USSR – better explain the complex outcomes of the "soybean revolutions" than the simple systemic opposition of 'market' versus 'plan.'

Zusammenfassung: Dieser Artikel vergleicht die zwischen den 1920er und 1950er Jahren in den USA und der UdSSR angestrebten ‚Sojarevolutionen'. Mithilfe einer für die Geschichtswissenschaft adaptierten Multi-Level-Perspektive werden in beiden Fällen Nischenbildung, Krisenmanagement und Regimeaufbau nachgezeichnet. In den Vereinigten Staaten ermöglichten ein staatlich koordiniertes, aber dezentralisiertes Wissensnetzwerk (Landwirtschaftsministerium, Versuchsstationen und die American Soybean Association), Synergien mit dem Hybridmais, die Preis- und Naturschutzpolitik des New Deal, die kriegsbedingte Substitution tropischer Öle sowie die Handelsabkommen der Nachkriegszeit die Aufwertung von Soja von einem experimentellen Nischenproblem zu einem Grundpfeiler des US-zentrierten Agrar- und Ernährungsregimes. In der Sowjetunion stießen frühe imperiale und fernöstliche Nischen, die zentralisierte Institutionalisierung unter der Allunionsakademie der Agrar-

DOI: 10.25365/rhy-2025-7

Accepted for publication after external peer review (double-blind).

Ernst Langthaler, Department of Economic, Social and Environmental History, Johannes Kepler University Linz, Altenbergerstraße 69, 4040 Linz, Austria, and Institute of Rural History, Kulturbezirk 4, 3109 St. Pölten, Austria, ernst.langthaler@jku.at; Natalia Ryzhova, Department of Asian Studies, Palacký University Olomouc, Czech Republic, and Faculty of History, Ruhr University Bochum, Universitätsstraße 150, 44801 Bochum, Germany, natalia.ryzhova@upol.cz

Acknowledgments: The authors would like to thank the participants of the international workshop *Agro-Food Change Through the Lens of Soy* from 14 to 15 October 2024 at Johannes Kepler University Linz, as well as two anonymous reviewers for their comments on an earlier version of this article.

wissenschaften und ambitionierte Fünfjahrespläne auf ökologische Fehlanpassungen, schwachen Wissenstransfer in die Kollektivwirtschaften, gewaltsame Kollektivierung sowie die Unterdrückung wissenschaftlicher Expertise. Trotz Propaganda, selektiver Anreize und gelegentlicher industrieller Verwendung blieb Soja regional begrenzt und gesellschaftlich geringgeschätzt und seine Ausbreitung kam wiederholt zum Erliegen. Der Artikel argumentiert, dass die komplexen Ergebnisse der ‚Sojarevolutionen' weniger aus dem Gegensatz von ‚Markt' und ‚Plan', sondern aus den unterschiedlichen Modernisierungspfaden erklärbar sind: in den USA niedrig-modernistisch, partizipativ und sozioökologisch eingebettet, in der UdSSR hoch-modernistisch, autoritär und von Sozial- und Naturbeziehungen entkoppelt.

Keywords: soybean, United States, Soviet Union, New Deal, collectivization, agro-food regime

Introduction

Although neither William J. Morse nor Nikolai I. Vavilov were what might be called dreamy men, they shared a dream. The former was an agronomist at the Bureau of Plant Industry of the US Department of Agriculture (USDA) (Figure 1), while the latter served as president of the Lenin All-Union Academy of Agricultural Sciences (VASKhNIL) (Figure 2). In 1930, Morse issued a USDA report praising the virtues of a recent crop innovation: "The widespread interest in the soybean, created by the phenomenal increase in acreage and production, indicates that the crop is destined to become one of considerable economic value in the United States."[1] In the same year, Vavilov answered the question why his academy had founded research institutes for soybeans and corn in the newspaper *Pravda*: "Because these two crops are destined to revolutionize the fields of the USSR in the southern agricultural belt, and in the very near future."[2] It was their shared enthusiasm for the 'miracle bean' that made the two men's paths cross: Morse, accompanied by his elder colleague Palemon H. Dorsett, visited Vavilov in Leningrad that year.[3] It was not their first encounter, however. The two restless USDA officials had already met the world-famous geneticist a year before in Seoul when they were studying soybean cultivation and collecting seeds during a two-year expedition across East Asia. They had also known each other from an earlier meeting in Washington, D.C.[4] In short, the US and Soviet soy enthusiasts crossed the oceans in both directions. Despite the different politico-economic environments, such international contacts were the rule rather than the exception during the interwar period. Agricultural engineers, plant breeders, and other agrarian experts were fascinated by steps towards the modernization of farming on the other side of the ocean: "The Russians tended to be envious of the level of capitalization,

1 William J. Morse, Soybean Utilization, Farmers' Bulletin 1617, Washington, D.C., 1932, 1. The report was issued in 1930.

2 Nikolai Vavilov, Pochemu Sel'skokhoziaistvennaia akademiia otkryla vne ocheredi instituty soi i kukuruzy [Why the Agricultural Academy Has Urgently Opened the Institutes of Soy and Maize], in: Pravda, 15 April 1930, 3.

3 Igor G. Loskutov, Vavilov Institute (VIR): Historical Aspects of International Cooperation for Plant Genetic Resources, in: Genetic Resources and Crop Evolution 67 (2020), 2237–2253, 2240.

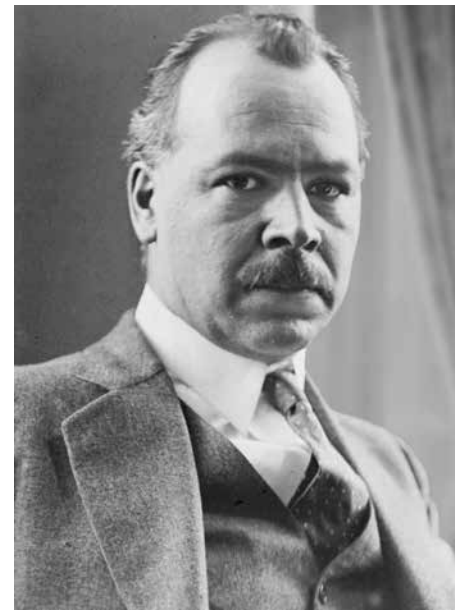
4 Theodore Hymowitz, Dorsett-Morse Soybean Collection Trip to East Asia: 50 Year Retrospective, in: Economic Botany 38/4 (1984), 378–388, 381.

particularly in mechanization, of American farms, while the Americans were envious of the political scope of Soviet planning."[5] These mutual interests between US and Soviet agrarian experts motivated the emergence of transnational networks of knowledge and technology transfer.

Figure 1: William J. Morse, 1929

Source: Shurtleff/Aoyagi, Morse, 310.

Figure 2: Nikolai I. Vavilov, 1933



Source: Library of Congress Prints and Photographs Division, World Telegram & Sun, photo, LC-USZ62-118109. Public domain.

When Morse and Vavilov anticipated the American and Soviet "soybean revolutions" as part of agricultural modernization, the 'miracle bean' had already attracted attention in the transnationally connected field of science and beyond. "There are few plants whose cultivation has aroused as much interest and, let us put it this way, as much hope, as soy," the General Secretary of the International Institute of Agriculture in Rome stated in 1936.[6] Originating from East Asia, the soybean plant had taken root in the Americas and Eurasia by the 1930s. In the USA, soybeans already covered 1.2 million hectares in 1930, compared to 0.6 million hectares in 1924. But this was only the beginning of an ongoing soy expansion that would skyrocket to 4.2 million hectares in 1940 and 6.1 million hectares in 1950.[7] Meanwhile, in the USSR, soybean acreage had grown from 26,200 hectares in 1927 to 467,800 hectares in 1931.[8]

5 James C. Scott, Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed, New Haven 1998, 197.

6 Institut International d'Agriculture, Le soja dans le monde, Rome 1936, V.

7 USDA, Agricultural Statistics 1951, Washington, D.C., 1951, 136. Calculations by the authors.

8 Posevnyye ploshchadi SSSR [Sown Areas in the USSR], vol. 1, Moscow 1957, 20–23.

Despite the expanding areas planted with the new crop, however, production was limited due to harvest failures. While US soybeans gained global importance in the postwar era, transforming agro-food relations from production to consumption around the world, their Soviet counterparts remained a regional crop grown in the Russian Far East, close to its centre of origin, and perceived as a low-quality food substitute. Obviously, Morse's dream had come true, but Vavilov's had burst. And it was not just their dreams that ended up differently, but also their lives: While Morse retired from the USDA in 1949 after having been honoured for his scientific and organizational achievements, Vavilov was arrested in the course of Stalinist political cleansing, sentenced to twenty years imprisonment and held captive in a camp, where he died in 1943.[9]

In this article we describe, explain, and compare the envisioned "soybean revolutions" in the USA and the USSR from the 1920s to the 1950s. We argue that Morse's and Vavilov's ambitions reflect modernist projects, which met more or less favourable conditions, including ecological dynamics, political orders, economic modes, social relations, and cultural orientations. Despite the shared vision of industrialized (meaning mechanized, specialized, large-scale, etc.) farming,[10] the outcomes of these projects were quite different. To interpret the gathered empirical evidence, we apply the multi-level perspective (MLP) as a theoretical framework and adapt it for historical inquiry. Accordingly, a transition of an agro-food regime or system results from its interplay with endogenous (niche) and exogenous (landscape) levels. By agro-food regime, we mean a hegemonic arrangement of agricultural production, agro-industrial processing and distribution, and food consumption that is coordinated by regulatory institutions (state policies, business models, popular lifestyles, etc.) at diverse levels from global to (sub-)national. At the global level, the "soybean revolutions" were inserted in the transition from the pre-1914 unipolar regime centred around the British Empire to the post-1945 bipolar regimes centred around the USA and the USSR.[11] In the protected spaces of niches at the regime's margins (scientific laboratories, innovative firms, grassroots movements, etc.), alter- or counter-hegemonic activities emerge. Struggles between regime and niche actors are influenced by the surrounding landscape through secular trends (e.g., economic booms) and sudden shocks (e.g., military conflicts).[12]

According to our adaptation of this approach, a regime transition unfolds over time in three phases: First, both human and non-human niche actors build stable but small-scale networks (*niche formation*); second, exogenous pressures from the landscape and endogenous pressures from the niche destabilize the regime, thereby opening windows of opportunity for alternative or radical practices to be upscaled (*crisis management*); third, upscaled niche practices reconfigure the regime, become settled in lock-in mechanisms, and establish a new hegemony (*regime building*). However, this ideal-typical trajectory contrasts in reality with

9 William Shurtleff/Akiko Aoyagi, William Joseph Morse – History of his Work with Soybeans and Soyfoods, Lafayette 2017, 7, 701.

10 Scott, Seeing Like a State, 196–201.

11 Philip McMichael, Food Regimes and Agrarian Questions, Halifax/Winnipeg 2013. On the contested periodization of agro-food regimes, see also the contribution by Mark Tilzey in this issue.

12 Frank W. Geels, Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-level Perspective and a Case-study, in: Research Policy 31/8–9 (2002), 1257–1274; Frank W. Geels/Bruno Turnheim, The Great Reconfiguration: A Socio-Technical Analysis of Low-Carbon Transitions in UK Electricity, Heat, and Mobility Systems, Cambridge 2022, 8–12.

a multitude of transition pathways. These pathways may be successful, but they may also fail if the previous regime succeeds in restabilizing.[13] According to the MLP framework, the US and Soviet cases represent two contrasting pathways in the transition (sometimes referred to as the "great transformation") of the global agro-food regime from the mid-1920s to the mid-1940s. However, they also deliver empirical evidence for adapting this theoretical approach.[14]

Soy expansion in the USA

Niche formation

Soy emerged in the USA as a crisis winner during the economic and military turmoil between the 1920s and the 1940s. The dynamics of the First World War, the Great Depression, and the Second World War opened up a window of opportunity for the 'miracle bean' from the Far East to take root in North American soils. As early as 1916, William Morse, together with his boss Charles V. Piper, predicted that the soybean's properties "give this crop a high potential importance and assure its greater agricultural development in America."[15] This vision materialized over the following decades. Between 1924 and 1945, the area under soybean cultivation in the USA increased almost eightfold from 0.7 to 5.6 million hectares (Figure 3). Soybean growing changed not only in quantity but also in quality, however – from a farm input in the form of seed and animal feed to a farm output in the form of soy oil and soy cake as cash crops for domestic and world markets. In this way, soy emerged as a key commodity of agro-industrial capitalism.[16]

The Corn Belt in the US Midwest became the centre of gravity of the American soy expansion, despite Morse's initial expectation that the crop would flourish in the south of the country.[17] This regional development reflected global dynamics. During the British-centred agro-food regime from the 1870s onwards, the US Midwest served as a settlement space for European farming families and an agricultural production area for grain and meat shipped to the urban and industrial centres on the East Coast and in Europe. The closing of the "American Frontier" after its expansion from east to west not only displaced indigenous human, animal, and plant communities but also changed the direction of agricultural development

13 Ernst Langthaler/Maximilian Martsch/Gabriel Tober, Conceptualizing Historical Commodity Studies: The Case of Soy, in: Juan Carmona-Zabala (ed.), Commodities in History. Theoretical Reflections and Empirical Case Studies, Rethymno 2023, 25–60.

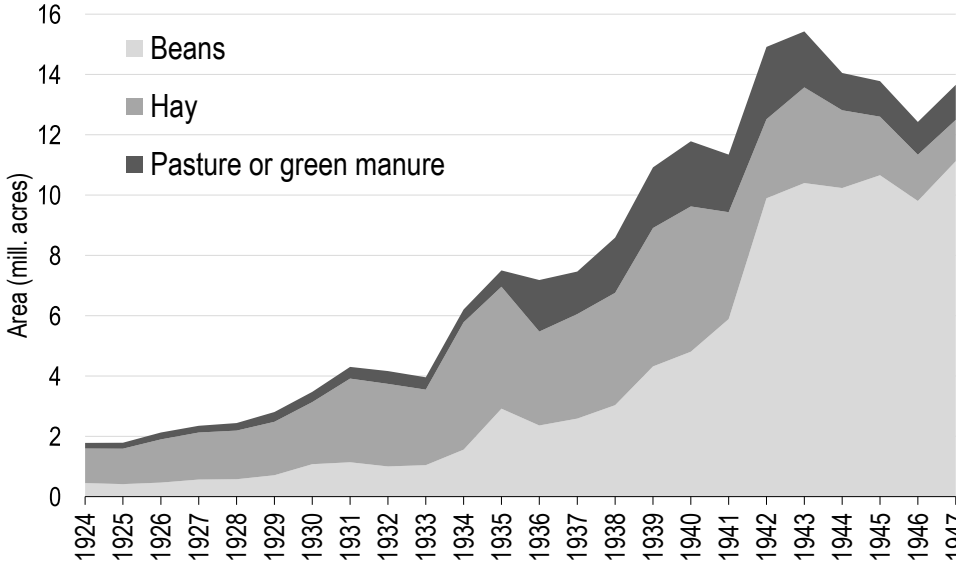
14 On the period from the mid-1920s to the mid-1940s as an agro-food transition from a comparative perspective on the USA, the USSR, and Germany, see Ernst Langthaler, The Great Depression as Great Transformation? Global Food Regime Crisis and (Inter)National Transition Pathways, 1925–39, in: Gérard Beaur/Francesco Chiapparino (eds.), Agriculture and the Great Depression: The Rural Crisis of the 1930s in Europe and the Americas, London/New York 2023, 21–38; Ernst Langthaler, Soy, in: Jeannie Whayne (ed.), The Oxford Handbook of Agricultural History, Oxford 2024, 304–324.

15 Charles V. Piper/William J. Morse, The Soy Bean, with Special Reference to Its Utilization for Oil, Cake, and Other Products, USDA Bulletin 439, Washington, D.C., 1916, 7.

16 Ernst Langthaler, Die wundersame Krisengewinnerin: Sojaexpansion im US-amerikanischen Maisgürtel in der ersten Hälfte des 20. Jahrhunderts, in: Wolfgang Meixner/Gerhard Siegl (eds.), Regionale Wirtschafts- und Sozialgeschichte im Zeitalter globaler Krisen, Vienna 2023, 141–164.

17 Piper/Morse, Soy Bean, 8.

Figure 3: Acreage of soybeans in the USA, 1924–1947



Source: Strand, Soybeans, 55. Calculations by the authors.

under the auspices of the USDA: from extensive European-style mixed farming to more (land- and labour-)intensive agriculture. During the urbanization and industrialization of American society, family farms in the temperate Corn Belt specialized in the commercial production of corn and pigs. However, from the turn of the nineteenth to the twentieth century, overexploitation and overproduction caused soil fertility and product prices to stagnate. Moreover, family farms dependent on investment loans faced mounting debt. Many farming families responded to these adversities with self-exploitation, that is, by decreasing consumption standards and increasing production efforts, thereby exacerbating the agricultural crisis. The regional shift towards monoculture corn cultivation for pig fattening, which had fuelled prosperity until the turn of the century, gradually led to a dead end.[18]

The key to solving the structural crisis of Corn Belt agriculture emerged from a powerful biotechnological package: hybrid corn and soybeans. Corn is a cross-pollinating plant, which facilitated hybrid breeding techniques pioneered from the 1920s onwards by crossing different inbred lines. Hybrid corn achieved maximum yields in the first generation in combination with nitrogen fertilizers (heterosis effect). Due to the steep decline in yield in subsequent generations, farmers had to purchase new hybrid seeds every year, thereby opening up a lucrative business area for seed and fertilizer traders. In other words, the adoption of hybrid corn transformed formerly self-reproduced seeds into a marketable commodity.

18 John C. Hudson, Making the Corn Belt: A Geographical History of Middle-Western Agriculture, Bloomington 1994, 151–172; Ines Prodöhl, Globalizing the Soybean: Fat, Feed, and Sometimes Food, c. 1900–1950, London/New York 2023, 138–150; Matilda Baraibar Norberg/Lisa Deutsch, The Soybean through World History: Lessons for Sustainable Agrofood Systems, London/New York 2023, 138–146.

The advertising messages of agribusiness promised that the additional yield generated by the technological package of hybrid seeds and nitrogen fertilizers would exceed the additional costs, thereby increasing the profitability of the farm business.[19]

Hybrid corn and soybeans established a multi-functional symbiosis in the Corn Belt. Until the turn of the century, soybeans only existed in the USA in the niches of agricultural research, religious minorities, and Asian immigrant communities. In the early twentieth century, they emerged as a key crop for the Corn Belt farming system due to multiple functions: as a legume, the soybean improved the cereal-heavy cultivation ratio; as a nitrogen-fixing plant, it improved nutrient management of the soils; and as a protein-rich crop, it provided cheap feed for pigs and cattle. Since the self-pollinating soybean is not suitable for hybridization and associated commercialization, seed breeding was promoted by the state-led knowledge network under the auspices of the USDA rather than by private companies. Soy's connection to non-commercial breeding efforts gave agrarian experts in public service, such as Morse, a powerful role in the diffusion of this innovation. The USDA organized collections of soy seeds in East Asia (like the Dorsett-Morse expedition from 1929 to 1931), selected site-adapted varieties in trial fields, and provided high-yielding seeds to innovative farmers.[20] At the Arlington Experimental Farm in Virginia, close to the USDA's headquarters in Washington, D.C., Morse was in charge of testing soybean plants introduced mainly from East Asia before distributing them to experimental stations in different US states. Within the agrarian knowledge network, he and his colleagues in the USDA's Bureau of Plant Industry were the nationwide brokers of soybean seeds.

In close connection to hybrid corn, a more-than-human network emerged around soy from the 1920s onwards, which opened up a sustainable niche for this crop innovation. Various groups of actors worked together: the public research, education, and extension system, which generated, applied, and disseminated specialist knowledge; the American Soybean Association (ASA), which promoted internal communication between soy farmers and represented their interests externally; and the regional oil-crushing industry, which stimulated private and public willingness to invest through marketing incentives. The central human in this more-than-human network was perhaps Morse, who combined his professional affiliation with the USDA with leading positions in the ASA, including three terms as its president. Soy's commodity web encompassing beans, oil, and cake spread out from Illinois and proved its viability across the Corn Belt.[21]

Crisis management

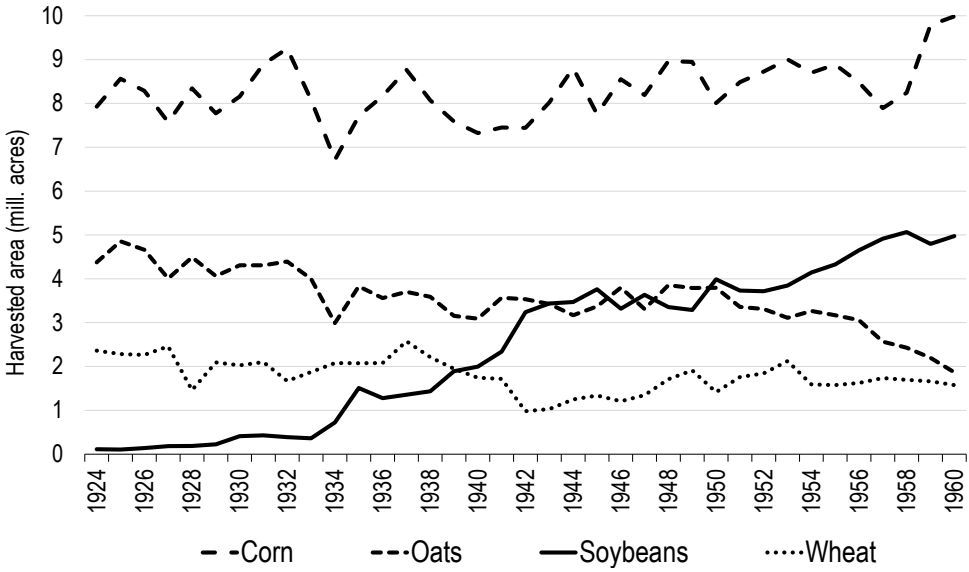
Attempts to address the multiple agricultural crises in the Corn Belt opened a window of opportunity for soybean expansion in the 1930s. From 1929 onwards, the Great Depression pushed the price of corn, which had already come under pressure during the world agricultural crisis since 1925, to a level that threatened the livelihoods of farming fami-

19 Jack R. Kloppenburg, First the Seed: The Political Economy of Plant Biotechnology, 1492–2000, Madison 2004, 91–129.

20 Christine M. Du Bois, The Story of Soy, London 2018, 53–70.

21 Matthew Roth, Magic Bean: The Rise of Soy in America, Lawrence 2018, 62–85; Shurtleff/Aoyagi, Morse, 560.

Figure 4: Harvested area of the main arable crops in Illinois, 1924–1960



Source: USDA, Quick Stats, https://quickstats.nass.usda.gov. Calculations by the authors.

lies. The vulnerability of family farms was exacerbated by the catastrophic wind erosion in the so-called Dust Bowl, caused by the large-scale conversion of grassland to fields since the mid-nineteenth century and triggered by an exceptional drought in the mid-1930s.[22] The crisis management by the ruling Democratic Party under Roosevelt was based on state intervention: Production controls and price supports for agricultural products produced in excess under the Agricultural Adjustment Act (AAA) were intended to raise farm incomes. Moreover, the government promoted the replacement of nutrient- and water-consuming grains with soil-conserving crops. These interventions institutionalized price stabilization through supply management, which served the interests of the cotton–wheat–corn coalition of farmer lobbies for decades to come.[23]

State-led agricultural regulation in the 1930s did not limit itself to short-term crisis management, but also pursued a long-term modernization project: the generalization of agrarian industrialization across the country, including the medium-sized farms of the Corn Belt, that had been pioneered in specific regions as early as the 1920s, notably by large wheat farms on the Great Plains. Accordingly, agricultural politicians, economists, and engineers – and increasingly also educated and affluent farm owners – conceived the farm as a factory run by the farmer as a businessman. The USDA, with Morse as its soybean expert, stood at the forefront of this 'factorization' of the farm. It supported the adoption of productive technology such as fuel- and electrically powered machinery. However, the Soviet lesson with

22 Donald Worster, Dust Bowl: The Southern Plains in the 1930s, Oxford 2004.

23 Bill Winders, The Politics of Food Supply: U.S. Agricultural Policy in the World Economy, New Haven 2009, 51–74.

forced industrialization of state and collective farms taught that this transition should be implemented smoothly rather than too harshly.[24]

Although the agricultural policy of the New Deal did not directly promote soybeans, the new crop benefited indirectly from the expanded room for manoeuvre (Figure 4). First, soy spread as a product not covered by the AAA on the set-aside areas formerly planted with corn. Second, soybean cultivation for hay production or green manure was promoted as a soil conservation measure. Third, the accelerated mechanization through the adoption of motorized machinery opened up areas formerly used to grow forage for draught animals for alternative uses such as soybeans. Fourth, the combine harvesters purchased for corn cropping were also suitable for soy plants. Fifth, soybeans were not only the most lucrative alternative in absolute terms but also an increasingly profitable alternative relative to corn itself. Sixth, the growing supply of soybeans fuelled demand from the processing industry and the Chicago Board of Trade.[25] At the ASA's annual meeting in 1936, Morse praised soy's rise in the USA as "one of the most remarkable agricultural developments of recent times." On the eve of the country's entry into the war, soy in the USA was already on its way from a niche to a key commodity.[26]

Regime building

The state regulation of strategically important commodity chains during the Second World War finally established soy as a key commodity in the Corn Belt. The Pacific War interrupted imports of tropical oils and fats from Southeast Asia, which were essential for the armaments industry. As a result, the US government launched a production offensive for protein and oil crops, including soybeans, by sending material and non-material signals to farmers. The government's 'soybean battle' expanded the commodity frontier, as indicated by expanding acreages and crop yields. The supply-driven expansion was also closely linked to a demand-driven expansion: Soy oil, as the main product, flowed into the food and other industries; soy cake, as a by-product, went to the growing cattle fattening complex (Figure 5). The rapidly expanding oil-crushing industry fuelled the upsurge of soy production and consumption in the Corn Belt.[27] This glorious soy boom taking off during the war also cast its light on Morse, who was honoured as the "father of the soybean" upon his retirement from the USDA in 1949. However, the marketization of soy oil and cake by agribusiness was quite different from Morse's enthusiasm for home-grown green beans, called *edamame*.[28]

Soy established itself as a key commodity of the emerging US-centred agro-food regime in the postwar period. The agro-industrial technology package of high-yielding seeds, motorized combines, and efficient herbicides promised to simplify and cheapen soybean cultivation in the core area now known as the Corn-Soy Belt. The stabilization of producer prices at a high level generated surplus supply, for which new channels of demand were opened up in the

24 Deborah Fitzgerald, Every Farm a Factory: The Industrial Ideal in American Agriculture, New Haven/London 2003, 184–190.

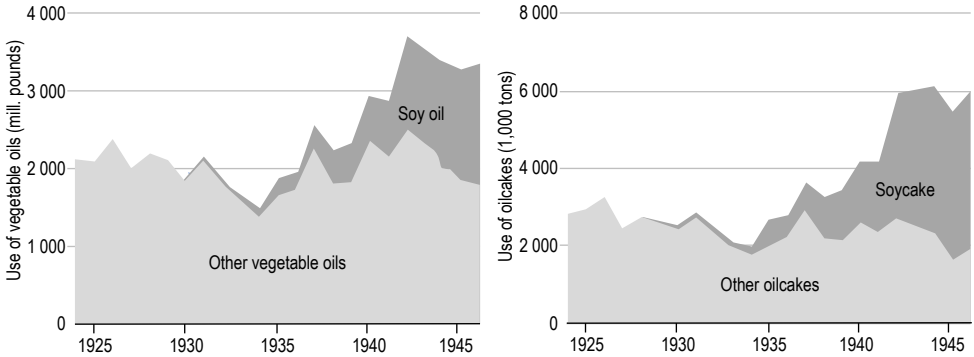
25 Edwin G. Strand, Soybeans in American Farming, Technical Bulletin 996, Washington, D.C., 1948.

26 Shurtleff/Aoyagi, Morse, 469.

27 Roth, Bean, 118–134; Prodöhl, Globalizing, 155–165.

28 The Washington Post, 30 November 1949, 10.

Figure 5: Use of vegetable oil and oil cake in the USA, 1924–1946



Source: Strand, Soybeans, 1948, 45.

interests of soy farmers and agribusiness: Soy oil as a raw material for margarine, vegetable oil, and other high-fat foods; soy cake as protein-rich animal feed. As a versatile, though hidden, ingredient of prestigious oil- and meat-rich diets, soy thus nurtured middle-class lifestyles.

During the Cold War, cheap soy from North America also served as a geopolitical weapon to contain both world hunger and world communism through US-style economic development. Under the General Agreement on Tariffs and Trade (GATT) of 1947 and the European Recovery Program (ERP) of 1948, the USA exported surplus soy cake at preferential tariffs or subsidized prices. It was used as animal feed by the growing livestock complex in Western Europe and Japan, where middle-class families adopted meat-heavy diets as part of the 'American way of life.' Surpluses of soy oil flowed to food-deficient countries in the 'Third World' on a price-supported basis as part of the Food for Peace Program of 1954. These trade policies served the interests of the soy–corn coalition that organized farming and corporate interests in the US parliamentary and governmental domains. The postwar agro-food regime integrated soy into a mode of production and consumption based on unequal political and economic relations. However, soy played a paradoxical dual role in this framework as both a protagonist and an antagonist: On the one hand, cake as an animal feed and oil as an industrial raw material were inserted into the agro-industrial mainstream; on the other hand, whole beans served as a nutritional symbol of social movements in counter-cultural niches.[29]

29 Bill Winders, The Global Ascension of Corn and Soybeans: From Managing Supply to Expanding Production in the United States and the World, in: Agricultural History 98/3 (2024), 470–480; Winders, Politics, 129–159; McMichael, Regimes, 32–39; Ernst Langthaler, The Soy Paradox: The Western Nutrition Transition Revisited, 1950–2010, in: Global Environment 11 (2018), 79–104.

Soy expansion in the USSR

Niche formation

Soybeans were known in the Russian Empire since the 1860s due to the Tsarist government's attempts to colonize the northeastern provinces of China ("Manchuria"), where the crop was native and expanded tremendously. Moreover, the Russo-Japanese War from 1904 to 1905 contributed to the imperial interest in soy. The Russian defeat was attributed to the worse provisioning of the Russian army, including its food rations as compared to the Japanese ones based on soy foods.[30] Furthermore, Russia benefited from transporting soybeans along the Chinese Eastern Railway (CER) as global trade began taking off before the First World War. Finally, the Russian colonists in the Amur region in the Far East learned how to grow and use soybeans from Korean immigrants and Chinese living on both sides of the border river.[31]

In the late nineteenth and early twentieth centuries, imperial agents in Manchuria established a diverse knowledge network around soy. The Imperial Russian Academy of Sciences, the Bureau of Applied Botany under the Ministry of Agriculture and State Property, and the largest Russian landowners sent their representatives to Manchuria or acquired networks of agents who supplied agro-botanical knowledge about soy. Representatives of diplomatic authorities and trading companies were also involved in knowledge accumulation, since the soybean was seen as a driver of economic growth. The CER established three departments for plant trials. Initially, their purpose was to provide "peaceful colonization" of Manchuria – that is, to disseminate Russian seeds and agro-technical knowledge to local people and facilitate the relocation of Russian peasants. But it soon became clear that the effectiveness of plant departments would increase if they accumulated knowledge about soybeans. At the experimental stations and laboratories, Russian specialists studied the botanical, chemical, and climatic features of soybeans.[32] The CER collection of soybean seeds was later transferred to the genetic bank established by Nikolai Vavilov as President of the VASKhNIL and became the base for Soviet experiments.[33]

The Manchuria-based knowledge network fostered experiments with soybeans by large landholdings, public agronomists, and peasants in other parts of the Russian Empire. Agronomists at landholdings in Kherson, Podolia, Grodno, Volyn, Chernigov, Voronezh, and other

30 On the role of soybeans in the Russo-Japanese War, see Du Bois, Story, 7–10.

31 On knowledge exchange between Russian colonists and Korean and Chinese inhabitants in the Amur River basin, see Natalia Ryzhova, The Failure of the 'Soybean Revolution' in the USSR, in: Ab Imperio 22/1 (2022), 191–222.

32 An overview of the work carried out by CER staff is presented in the paper: Petr F. Konstantinov, Raboty Sel'sko-Khozyaystvennoy Laboratorii Zemel'nogo Otdela KVZHD v Oblasti Issledovaniya Soyevykh Bobov [Work of the Agricultural Laboratory of the Land Department of the Chinese Eastern Railway on the Study of Soybeans], in: Vestnik Man'chzhurii 5 (1926), 40–55.

33 Information on the CER's contribution was obtained thanks to analysis of the collection of the Vavilov Institute and is described in the paper: Irina V. Seferova/Margarita A. Vishnyakova, Vklad sel'skokhozyaystvennykh opytnykh uchrezhdeniy Kitaysko-Vostochnoy zheleznoy dorogi v formirovaniye kollektsii soi VIR i v razvitiye yeye selektsii v SSSR [The Contribution of the Agricultural Experimental Institutions of the Chinese Eastern Railway to the Formation of the VIR Soybean Collection and to the Development of Its Breeding in the USSR], in: Vavilovskiy zhurnal genetiki i selektsii 18/3 (2014), 572–577.

agrarian provinces were among the most grateful recipients of soy knowledge.[34] At the turn of the century, these landholdings were already beginning to shift to capitalist production, therefore acquiring high-quality land and animal feed. Knowledge about the properties of soy often came from researchers in Central European countries (like Austria), but for seeds, educated agronomists went to Manchuria, including the CER's trial stations.[35]

Public and private attempts to transfer knowledge about soybeans into practice yielded considerable success in the Russian Far East. Large landowners and even ordinary peasants in these regions, who had witnessed the incredibly rapid economic development of Manchuria, were already well aware of the commercial potential of soy in the 1910s. Experiments conducted near the Amur and in the province of Primorye aimed to obtain varieties and technologies that would reduce the required amount of manual labour, the scarcest resource in recently colonized regions.[36] Russians needed to either create a predominantly mechanized technology, along with appropriate varieties, or exploit the manual technique of the Chinese or Koreans as wage labourers or leaseholders. State agronomists struggled to follow the first option, but the second one was spreading, as illustrated by rising exports of soybeans and oilcake from Primorye to Manchuria.[37] However, the informal leasing of land by the Chinese and Koreans ran counter to the Russian Empire's plans for the colonization of the region.

The combined efforts of scientific, state, and commercial actors in late-imperial Russia established a polycentric and multifaceted network that provided soy with a promising niche. Many imperial agents visiting Manchuria siphoned knowledge and collected seeds; large commercial farms in the black earth regions used soybeans to improve the land; and Far Eastern farms, including peasant holdings, tried to develop the commercial potential of soybeans.

Crisis management

In the 1920s, the Bolshevik government faced two acute shortages: oil-bearing raw materials for various industries and protein sources for human and animal nutrition. The shortage of vegetable oils emerged during the First World War, but it was only overcome on the eve of the Second World War. A wide range of crops were considered as potential sources of vegetable oils – both those traditional for Russia, such as flax and sunflower, and new ones such as soybeans. In 1919, the acreage of oil crops amounted to only 54 percent of the level in 1917. Although it eventually exceeded the prewar benchmark by 70 percent by 1925, supplies of

34 Anastasiya K. Leshchenko, Kul'tura Soi [The Cultivation of Soy], Kyiv 1978.

35 The life and work of Ivan Ovsinski, a Ukrainian agronomist of Polish origin, serves as a good illustration of this point: Dmytro Korzun, The Repressive Policy of the Russian Empire Authorities towards the Agronomist-Innovator, I. Ye. Ovsinsky (1856–1910), in: Evropský Filozofický a Historický Diskurz 6/4 (2020), 31–37.

36 One of the most significant mass experiments with soy was the one commissioned by steamship owners and conducted under the direction of agronomist Rubinsky near Blagoveshchensk: Vladimir I. Rubinskiy, Otchet o proizvedennykh v 1915 g Amurskoy agronomicheskoy organizatsiyey opytakh po kul'ture maslinichnoy soi v usloviyakh Amurskoy oblasti [Report on the 1915 Experiments on Cultivating Oil Soybeans under the Conditions of the Amur Province by the Amur Agronomic Organization], Blagoveshchensk 1916.

37 For more details, see Ryzhova, Failure, 206–207. Statistics on export volumes from the Ussuri region in 1911: Vladimir D. Pesotskiy, Khun'-Chun'skaya dolina [Khun-Chun Valley], in: Vestnik Azii. Zhurnal obshchestva russkikh oriyentalistov 1 (1913), 9–27.

vegetable oils were still insufficient for both food and industrial purposes.[38] This was due to shifts in the structure and scale of demand for vegetable fats: On the one hand, consumption of animal fats was declining; for instance, butter was in short supply and prohibitively expensive. On the other hand, new industries such as soapmaking, paint and varnish production, and food processing were demanding ever greater volumes of oils.

The shortage of proteins in particular, and of foodstuffs in general, developed later than the oil deficit, but it proved no less acute.[39] Soviet citizens lived in conditions of chronic undernourishment, and food technologists began inventing various alternative products including soy milk, soy sausages, and soy-based meat substitutes. Soy appeared to be an ideal solution. A newspaper article citing research by botanists and nutritionists claimed that "one kilogram of soybeans can yield twelve glasses of sour milk."[40] The use of soy-based products for mass consumption had first been discussed during the Russo-Japanese War, but soy was still regarded as the "meat of the poor" at the time.[41] The wave of innovations that emerged in the 1920s, drawing on experiences from Austria, Hungary, Manchuria, and the United States, was relatively effective. Although the new foods tasted bland and it was difficult to eliminate the soybean odour, there was at least something to eat.

In the face of the oil and protein crises, the Bolshevik government sought not only to mitigate shortages but also to reconfigure the political and economic order by restructuring knowledge infrastructures. Soviet administrative bodies made use of imperial-era networks and expertise: The Oil and Fat Syndicate dispatched representatives to Japan and Manchuria to study soybean cultivation and processing,[42] while simultaneously organizing geographical experiments that enlisted peasants for soybean production.[43] Agronomist Vsevolod Zolotnitsky was assigned to the Amur experimental station, a site of extensive pre-revolutionary trials, to initiate breeding trials with soybeans. Later on, this station was visited by Vavilov.[44] These initiatives illustrate the broader transformation of knowledge networks around soy, and cash crops in general, as Soviet institutions sought to integrate international expertise with domestic imperatives.

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38 Viktorin A. Popov, Soyevyye boby i syr'yevaya problema zhirovoy promyshlennosti [Soybeans and the Raw Material Problem of the Fat Industry], Moscow/Leningrad 1927, 54–59.

39 Nataliya Lebina, Sovetskaya povsednevnost': normy i anomalii. Ot voyennogo kommunizma k bol'shomu stilyu [Soviet Everyday Life: Norms and Anomalies. From War Communism to the Grand Style], Moscow 2015, 45–48.

40 Dorogu zamechatel'noy kitaianke [Give Way to the Remarkable "Chinese Lady" (Soybean)], in: Povolzhskaya pravda, 27 April 1930.

41 Yaponskaya soya (ili „myaso bednyakov"), samyy pitatel'nyy produkt rastitel'nogo tsarstva i pitatel'nyy kofe iz soi, prigotovlennyy v m. Kvirily [Japanese Soybean (or "Meat of the Poor"), the Most Nutritious Product of the Plant Kingdom, and Soy Coffee Prepared in Kvirila], Tiflis 1910, 27; Anatoliy Y. Vuchino, Soya kak odin iz luchshikh pishchevykh i kormovykh produktov rastitel'nogo tsarstva [Soy as One of the Best Food and Fodder Products of the Plant Kingdom], in: Dokl. S'yezdu deyateley po sadovym kul'turam, Tiflis 1901, n.pag.

42 Popov, Soyevyye boby, 3.

43 Vladimir D. Blagorazumov, K voprosu o raionakh vozmozhnogo vozdelyvaniia soevykh bobov na Amure i v smezhnykh oblastyakh DVK [On the Regions Suitable for the Cultivation of Soybeans on the Amur and in Adjacent Areas of the Far Eastern Krai], in: Soya na Amure, Blagoveshchensk 1930, 47–55.

44 Ol'ga O. Kletkina, K 125-letiyu so dnya rozhdeniya Vsevoloda A. Zolotnitskogo – vydayushchegosya dal'nevostochnogo uchenogo-selektsionera [On the 125th Anniversary of the Birth of Vsevolod A. Zolotnitsky – an Outstanding Far Eastern Breeder], in: Vestnik DVO RAN 2/186 (2016), 20–23.

The Soviet networks of plant knowledge production were to be further extended as well as becoming more centralized. Regional branches and small experimental stations were instructed to carry out all work exactly according to the authorities' assignments, sending collected knowledge to the centre as well as facilitating the local implementation of decisions taken by the planning bodies.[45] This system was in place by the 1930s and existed – with cosmetic changes – for the next seven decades. The All-Russian Institute of Plant Protection, directed by Vavilov, maintained central control together with two specialized institutes, the Institute of Soy and Special Crops and the Institute of Oilseeds.

The Soviet model of large-scale production and centralized knowledge acquisition promoted techno-scientific exchange with the USA, which was a forerunner of industrialized and state-supported agriculture. Despite the fundamental differences between socialist and capitalist modes of production, Soviet scholars and technocrats were convinced that the US model required only minor adaptation to work in the USSR. The main feature that the Bolsheviks sought to copy was the replacement of a great diversity of plants with few industrialized specimens.[46] Soybeans, as a source of industrial oils, animal feed, and edible proteins and fats, had an important role to play in this regard. Despite the modest volumes of soybean production in the USSR, scientists from both countries – through personal correspondence as well as via the Bureau of Applied Botany opened by Vavilov in New York in 1921 – exchanged seeds, scientific literature, and personal observations. By the mid-1930s, however, free academic exchange, and therefore effective scientific enquiry, had become more difficult under Stalinist rule.[47]

Regime building

The "soybean revolution" was implemented in the late 1920s and early 1930s in the framework of state-enforced collectivization, which replaced peasant family farms and villages with centrally planned collective and state farms to boost grain output for domestic consumption in industrial districts and export to technology-supplying countries. The means to this end included suppression, expropriation, displacement, starvation, and even execution of large numbers of rural dwellers suspected to be hostile *kulaks*.[48] The political, economic, and social turmoil induced by the forced collectivization both enabled and limited the expansion of the soybean as a crop innovation on Russian soils.

In the late 1920s, the Bolshevik government announced a "soybean revolution" to overcome the twofold shortage of oils for the emerging industry and of protein and fats for human and animal nutrition. The idea of introducing soybeans was actively discussed in

45 On the changes in selection management, which were not only about soybeans, see Ol'ga Y. Yelina, Ot tsarskikh sadov do sovetskikh poley: Istoriya sel'skokhozyaystvennykh opytnykh uchrezhdeniy [From Tsarist Gardens to Soviet Fields: The History of Agricultural Experimental Institutions], Moscow 2008.

46 It is no coincidence that many similarities can be found between the selection systems in the USSR and the USA: Courtney Fullilove, The Profit of the Earth: The Global Seeds of American Agriculture, Chicago 2017, 14.

47 Peter Pringle, The Murder of Nikolai Vavilov: The Story of Stalin's Persecution of One of the Great Scientists of the Twentieth Century, New York 2008, 150–157.

48 Scott, Seeing Like a State, 201–218.

the press, at government meetings, at scientific events, and at assemblies of collective farm members. Soybeans even made their way into children's literature: Lev Kassil wrote a short propaganda piece entitled *Fried Eggs without Eggs*,[49] and Soviet satirical writers Il'ia Ilf and Evgenii Petrov mocked the craze surrounding the crop.[50] Propaganda materials continued to report on the success of soybean introduction, even when it became clear that the "revolution" was stalling: "The best collective farms of the region, which this year achieved soybean yields of 30 centners per hectare, show that the Far East can and will become a land of high Stalinist harvests."[51] Brochures on soybean production, published in the United States and imported into the USSR, were fully translated from English into Russian and apparently used in preparing printed materials for propaganda and training.[52]

Despite the propaganda for voluntary adoption of soy, this crop innovation was also imposed via directives from the central planning bodies. A striking example of such a directive, with demotivated peasants and intellectuals, is the sowing of soybeans in the Caucasus and Ukraine from 1928 to 1932. In 1930, Leonid Bordakov, professor at the All-Union Institute of Plant Industry, had to inspect disastrous soybean and cotton sowings in the northern Caucasus and eastern Ukraine. He reported on countless mistakes, negligence, and disregard for local labour and climatic conditions. Despite his detailed analysis, his recommendations were neither published nor acted upon, and mass sowings in the Caucasus and Ukraine continued for two more years. Bordakov himself was executed in 1938 as a suspect person.[53] According to the five-year plan, soy was to be introduced in all territories suitable in terms of the number of sunny days. In some cases (like Semirechye in Kazakhstan), the Soviet authorities undertook scientific experiments, testing agro-techniques, analysing water and climatic conditions, and, most importantly, selecting regionally suitable seeds. In other areas like the Azov-Black Sea region, however, they simply sowed mixed varieties of unadjusted seeds across huge territories, causing crop failures and contributing to repeated famines.[54]

Besides disregard for social and natural conditions in the rural areas, the soy experts themselves came under scrutiny by the authoritarian state. The repression machine worked to equalize all specialists, ensure their obedience, and preclude potential criticism of irrational decisions. The agrobotanist Irina Savich,[55] who bred the Primorskaya 529 cultivar used as the main seed in the Primorsky region until the end of the 1970s, was executed in 1938. Her encounter with the repressive apparatus began earlier, however, with her husband already having been arrested in 1933. Despite disagreeing with this repressive treatment, Savich had

49 Lev A. Kassil, Yaichnitsa bez yaits [Fried Eggs without Eggs], Moscow 1931.

50 Il'ia A. Ilf/Evgenii P. Petrov, Kak sozdavalsya Robinzon [How Robinson Was Created], Moscow 1933.

51 Chrezvychainyi VIII S'ezd Sovetov. Stenograficheskii otchet: 25 noiabria – 5 dekabria 1936 [Extraordinary VIII Congress of Soviets. Verbatim Report: 25 November – 5 December], Moscow 1936, n.pag.

52 Vladimir I. Geymer, Sortirovka i poluchenie uluchshennogo semennogo materiala [Sorting and Obtaining Improved Seed Material], Moscow 1932; Soya (soevye boby): Kak vozdelyvat' soiu v Armavirskom okruge Sev.-Kav. kraia [Soy (Soybeans): How to Cultivate Soy in the Armavir District of the North Caucasus Region], Armavir 1930.

53 https://istmat.org/node/36515 (10 October 2025).

54 Ryzhova, Failure, 216–217.

55 Irina N. Savich, K voprosu o klassifikatsii soyevykh bobov [On the Classification of Soybeans], in: Vestnik Man'chzhurii 11 (1929), 20–35.

to continue breeding – but her effective work did not prevent her later arrest.[56] Similarly, Ivan Zolotnitsky, later awarded the Stalin Prize for his soybean breeding, was arrested in 1937 and remained imprisoned for two years. He lived under pressure for the rest of his life.[57] Even Vavilov, one of the most enthusiastic promoters of the "soybean revolution" and founder of the Soybean Institute, was gradually dismissed from the mid-1930s onwards and finally died of starvation in a camp in 1943.[58]

Despite all hopes, soy failed to become a significant source of industrial oils, foodstuffs, and animal feed, and thus a key resource in the Soviet planned economy.[59] During the first five-year plan from 1928 to 1932, the planners initially envisioned a sevenfold increase of arable land under soybean cultivation to 358,000 hectares, with these figures eventually even being doubled to 720,000 hectares.[60] The actual cultivated acreage amounted to 50,000 ha in 1928, 140,000 ha in 1930, 468,000 ha in 1931, 300,000 ha in 1932, 170,000 ha in 1937, and 290,000 ha in 1940. Soviet statistics must be treated with caution, of course; the final figure in particular seems unreliable, since another source reported 25,100 hectares for 1938.[61] The broader pattern is clear, however: At first the planned targets consistently exceeded reality; then, after a short-lived boom in the early 1930s, soybean cultivation contracted rapidly. The targets first articulated in 1928 eventually appear to have been met as late as 1962, when the acreage expanded to 825,000 hectares.[62] In other words, the announced "soybean revolution" – a significant and lasting increase in soy production and use – did not happen in the USSR. Its champions – above all, Vavilov and his associates – failed to achieve the goals they had set. The Soviet state did eventually manage to achieve the proposed goals, but only much later and with serious losses in efficiency. Thus, the Soviet "soybean revolution" remained a floundering attempt that can be classified neither as a total success nor as a complete failure. In any case, the Soviet Union clearly failed to replicate the US soy expansion it had tried to emulate.

The outcome of the Soviet "soybean revolution" was man-made. The planning authorities preferred large-scale, mechanized monoculture production – an approach that required appropriate technology, such as machinery, along with crop varieties suitable for industrial production and processing. Criticism by agricultural experts was disregarded and even prosecuted by the authorities. The Soybean Institute was closed, some experimental stations shifted to other crops, and mass soybean experiments were curtailed. The Oil and Fat Syndicate, a centralized body acting on behalf of the state, terminated the financing of the "soybean revolution" in favour of sunflower, flax, and other oilseeds. Obstacles emerged not only on the production side but also on the consumption side of the fragile commodity chain: Consumers regarded soy foods as inferior substitutes and therefore replaced them with more prestigious dishes after the era of crisis and war. Moreover, demand for soy as

56 Elena V. Vasil'eva, Stanovlenie sovetskoi nauchnoi intelligentsii na Dal'nem Vostoke Rossii [Formation of the Soviet Scientific Intelligentsia in the Russian Far East], in: Revue des études slaves 71/1 (1999), 35–57.
57 Kletkina, 125-letiyu so dnya, 121.
58 Shurtleff/Aoyagi, Morse, 701.
59 Ryzhova, Failure.
60 Sel'skoye khozyaystvo SSSR: K pyatiletke 1927/28–1932/33 [Agriculture of the USSR: For the Five-Year Plan 1927/28–1932/33], Moscow 1927, 23.
61 Posevnyye ploshchadi, 20–23.
62 https://www.fao.org/faostat (1 October 2025).

animal feed and as an industrial raw material was limited. Soviet soy may thus be seen as a symbol of the gap between plans and reality: On the one hand was the modernist vision of industrialized agriculture; on the other, the dire reality in which its implementation failed to work.[63] Due to the floundering of the envisioned "revolution", the soybean only occupied a small niche in the Soviet agro-food system – whereas in the US, it became a pillar of a new global agro-food regime.[64]

Soy expansions in comparison

The United States and the Soviet Union offer sharply contrasting cases among the world's soybean producers. Between the late 1930s and the early 1950s, soybean acreage in the USA expanded nearly fivefold (+ 385 per cent), while in the USSR it increased by only about one-third (+ 34 per cent), well below the global average (+ 65 per cent). If USDA statistics can be considered reliable, the evidence is clear: The true "soybean revolution" as part of the state-regulated industrialization of privately-owned family farms unfolded in the United States, whereas in the Soviet Union, it was a faltering attempt within the dynamics of state-imposed land collectivization and agrarian industrialization (Table 1). To frame these development pathways in MLP terms: In the USA, soy was scaled up from a niche to the regime and became a pillar of the transformed agro-food system. In the USSR, despite attempts to incorporate soy into the regime, it only occupied a niche within the transformed agro-food system.

Table 1: Soybean acreage by countries, 1935/39–1950/54

Country	Average 1935/39 (1,000 hectares)	Average 1950/54 (1,000 hectares)	Change (per cent)
China (incl. Manchuria)	8,661	11,420	+ 32
USA	1,231	5,968	+ 385
Korea/South Korea	777	253	– 67
Dutch Indies/Indonesia	360	431	+ 20
Japan	329	421	+ 28
USSR	246	329	+ 34
European countries	36	36	– 1
Other countries	136	518	+ 281
World	11,776	19,376	+ 65

Source: USDA, Agricultural Statistics 1948, Washington, D.C. 1949, 152; USDA, Agricultural Statistics 1960, Washington, D.C. 1961, 138. Calculations by the authors.

63 For a similar gap using different empirical material (with soybeans also mentioned only in passing), see Jenny L. Smith, Works in Progress: Plans and Realities on Soviet Farms, 1930–1963, New Haven 2014.

64 For further information on the marginal role of soybeans in Soviet industry and the reasons behind it, see Thomas W. Bickerton, USSR Oilseed Production, Processing, and Trade, Washington, D.C. 1987.

The US and Soviet soy expansions involved factors that determined their outcomes, including ecological conditions, knowledge and technology, farmers' attitudes and networks, market dynamics, and regulatory institutions. Although these factors were intertwined in various ways, they can be assessed separately for comparative purposes. First, *ecological conditions* mattered because the soybean plant originating from East Asia had to be adapted through breeding efforts to the respective regional soils, climates, and day lengths. In the USA, the state-coordinated knowledge network of agricultural colleges and experimental stations under the auspices of the USDA organized seed collection, testing, selection, crossbreeding, and distribution in a concerted effort over several decades. Though centrally coordinated by the USDA, the agrarian knowledge network, with its decentred nodes in diverse states, was flexible enough to respond to regional obstacles and opportunities. While the first initiatives were centred in the Cotton Belt in the subtropical US South, the soybean finally experienced its breakthrough in the Corn Belt in the climatically moderate Midwest.[65] It also did not expand in the Corn Belt on its own, but rather in close connection with hybrid corn. The synergies mobilized by this inter-crop relation were crucial for the US soy expansion from the 1930s onwards. The annual corn–soy rotation became the dominant mode of using the region's previously depleted agricultural soils. It helped to restabilize the nutrient cycle in a plant-based fashion through the interplay of nitrogen deposition by soybeans and nitrogen extraction by hybrid corn. The dominance of this biotechnological package is reflected in the region's labelling as the Corn-Soy Belt by the 1950s.[66]

In the USSR, soybean selection was organized in a highly centralized and standardized manner that rarely reflected the ecological conditions of the respective regions. Curiously, Soviet planning authorities initially believed that soybeans were suitable for arid climates and designated regions for cultivation based on this assumption. Due to a lack of understanding of agroecological conditions, centralized seed selection and the prescribed agricultural requirements were often far from the necessary conditions. All activities necessary for selection – seed collection, testing, and breeding – were coordinated from above, leaving little room for local initiatives. The rejection of scientific pluralism was a key factor in Soviet innovation failures,[67] and the case of soy illustrates this argument vividly. Dozens of trial stations in the peripheries were instructed to plant a limited set of centrally-selected varieties while also searching for potential local ones.[68] Yet, local varieties were often disregarded as unsuitable and could even vanish entirely, as happened with the Dungan soybean discovered by the Almaty station in 1931: Though described in a scholarly article, it soon disappeared without a trace.[69] Soybean plants were not integrated into an agroecologically sound crop rotation, and hybrid corn, as a potential partner, expanded in the USSR only after the Second World War.

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65 Roth, Bean, 62–85.

66 Robert S. Loomis/David J. Connor/Kenneth G. Cassman, Crop Ecology: Productivity and Management in Agricultural Systems, Cambridge 2011, 459–467.

67 Loren R. Graham, What Have We Learned About Science and Technology from the Russian Experience? Stanford 1998.

68 Ryzhova, Failure; Tsentral'nyi gosudarstvennyi arkhiv nauchno-tekhnicheskoi dokumentatsii Sankt-Peterburga [Central State Archive of Scientific and Technical Documentation of Saint Petersburg], fond R-318, opis' 11, delo 558, 11.

69 Vladimir Yu. Lobanov, Dunganska Soya [Dungan Soybean], in: Prikladnaya botanika, genetika i selektsiya 9 (1934), 85–86.

Second, although the necessary *knowledge and technology* were available in both countries, US and Soviet farms' access to it differed. In the USA, the state-coordinated research, education, and extension network was well-connected to the ASA, which organized the soy farmers. While the former generated, applied, and disseminated specialist knowledge, the latter distributed practical knowledge among soy farmers, either directly through personal communication (for example, annual field days) or indirectly through mass media like the monthly *Soybean Digest*. Once this techno-scientific network had created a stable niche for soybeans in the 1920s, the diffusion of innovations in farm technology driven by the government-led industrialization of agriculture paved the way for further expansion from the 1930s onwards. Most importantly, machinery for corn cropping, such as combines, was also applicable to soybeans.[70] While the techno-scientific network around soy was state-coordinated, its complementation with hybrid corn was organized by capitalist enterprises that exploited the associated profit opportunities. Whereas farmers could reproduce soybean seeds year by year, they had to purchase hybrid corn annually as a market product due to its biotechnological fixation on one-year yields.[71]

By contrast, in the USSR, the transfer of knowledge from academic elites and trained agronomists to collective farmers was weak, while at the same time planning authorities, often poorly educated, set unrealistic targets. In this context, neither breeders nor agricultural producers had much interest in maintaining close contact. When crops failed, responsibility was placed on agronomists or farmers rather than on the planners themselves, leaving farmers with little incentive to try new crops and breeders with little motivation to innovate. The political 'socialization' of scientists and breeders also contributed to the lower efficiency of the innovation process.[72] Marginalization and repression of those trained in imperial Russia undermined professional standards and weakened resistance to ill-founded directives. As the cases of Bordakov, Savich, and Zolotnitsky show, soy experts were also prosecuted, imprisoned, and even killed in the turmoil of Stalinist political cleansing. Thus, the Soviet repressive apparatus was an obstacle to the emergence of an effective knowledge network around soy.

Third, *farmers' attitudes and networks* played a decisive role in the US and Soviet "soybean revolutions". Both countries developed networks of interested agents who pursued personal benefits by participating in a shared undertaking. However, the guiding logics of these networks, oscillating between self-organization and subordination, differed. In the USA, the ASA interlinked soy farmers and tried to convince them both directly (via personal interaction) and indirectly (via print and audiovisual media) of the great benefits and low costs of the "miracle bean". Support from the state-coordinated knowledge network and the oil-crushing industry strengthened these efforts as early as the 1920s. Legal and financial incentives from the 1930s onwards further improved soy's reputation and profitability. Most importantly, soy cultivation became a target of federal policies in the New Deal era and the Second World War. Farmers were not only urged by agricultural extension and the mass media to grow soybeans for patriotic and agronomic reasons, but also incentivized to do so by attractive prices and bonuses. Moreover, the regionally concentrated but growing farmers' network organized by

70 Roth, Bean, 62–85; Strand, Soybeans; Fitzgerald, Farm, 184–190.

71 Kloppenburg, Seed, 91–129.

72 This phenomenon, as it concerns technical intelligentsia, was studied in Kendall E. Bailes, Technology and Society under Lenin and Stalin: Origins of the Soviet Technical Intelligentsia, 1917–1941, Princeton 2015.

the ASA created its own contagious dynamics for the diffusion of soy, especially in conjunction with hybrid corn: Early adopters among the farming community motivated their relatives and neighbours to adopt this promising crop innovation.[73]

In the USSR, members of agrarian knowledge networks – including workers from academic institutions, the Oil and Fat Syndicate, and occasionally agrarian volunteers – were required to prioritize the interests of the socialist state. This pressure did not always negatively impact outcomes; for instance, collective farmers initially participated actively in academic geographical experiments, including those focused on soybeans. However, the general chaos of the early Soviet period, frequent shifts in goals and objectives, and most notably the economic demotivation typical of collective farms rendered these networks ineffective. This reservation was particularly strong in regions such as the Ukraine and Caucasus, where soy was introduced to replace familiar and income-generating crops. Since the plant innovation was conceived as a cash crop rather than a food crop, it was not suited as a source of self-provision during the widespread famines of the 1930s induced by the Soviet government's struggle with resistant peasant communities (*kulaks*).[74]

In addition, the chronic gap between the ambitious plans according to the centre's political expectations and the actual infrastructural, ecological, and personnel capacities on the ground contributed to soy's floundering in the USSR.[75] A particularly telling example of the gap between plans and realities was the Soviet Korean case. The only region of the USSR where soybeans were produced on an industrial scale was Primorsky Krai, and the only ethnic group that had begun to cultivate the crop for Soviet industry in response to state incentives (fixed purchase prices and tax relief) was the Koreans. Yet, Soviet functionaries frequently claimed that the Korean method of manual soil cultivation did not conform to Soviet modernism and therefore had to be abandoned. In practice, Koreans combined their traditional knowledge (including soybean cultivation on raised beds) with the use of agricultural machinery whenever possible.[76] Almost every collective farm operated by Koreans, before their forced deportation to Central Asia in 1938, owned at least one tractor (some even had several), and the majority cultivated soybeans.[77] Although the available varieties could not be harvested mechanically, this did not prevent Koreans from steadily increasing production each year. Nonetheless, 'non-modern' techniques constantly irritated Soviet functionaries. As a result of the deportations, soybean production in the Primorsky Krai region collapsed almost entirely in the 1940s.

Finally, peasants' everyday resistance to innovations contributed to the faltering of the soybean expansion. Although the official reports must be read critically, they complain about widespread drunkenness in the villages, peasants' unwillingness to cultivate the crop, and the refusal of unfamiliar industrial techniques. One report even mentions popular songs about soybeans killing everyone around them, forcing people to flee the region, and causing them to refuse to work altogether, even though the Soviet government provided them with everything

73 Roth, Bean, 62–145; Strand, Soybeans.

74 Ryzhova, Failure, 216.

75 Smith, Works.

76 Boris L. Bruk, Birsko-Bidzhanskii raion Dal'nevostochnogo kraia: Trudy ekspeditsii 1927 Birsko-Bidzhan [District of the Far Eastern Krai: Proceedings of the 1927 Expedition], ed. Vasilyi R. Vil'yams, Moscow 1928.

77 Natalia Ryzhova, Koryo Saram in Agriculture: 100 Years of Everyday Resistance, in: Ojkumena Regional Researches 4 (2023), 67–77, 71.

they needed for free.[78] Peasant resistance was a widespread phenomenon, of course – but in the early Soviet years, it acquired particularly distinctive forms.[79]

Fourth, *market dynamics* – primarily shifts in demand from industry and consumers – also affected the soy supply. In the USA, the oil-crushing industry in the Corn Belt offered attractive market opportunities to soy farmers as early as the late 1920s. Increasing demand from the 1930s onwards, especially during the Second World War, channelled soy to the food and manufacturing industries. However, soy foods did not manage to break out of their small niche. For instance, full-fat soymeal produced for domestic consumers ended up as food aid for allied and neutral countries during the war. Rather than whole beans, their separated components – oil and cake – were increasingly marketed during and after the war. They were used as raw materials for the emerging food industry and thereby incorporated into agro-industrial commodity chains. Throughout the Corn Belt, the state-subsidized oilseed crushing industry expanded its locations and capacity. For consumers in postwar America and beyond, soy became a nearly omnipresent, though hidden, ingredient of emerging middle-class lifestyles.[80]

In the USSR, the market situation was quite different. Despite the shortage of proteins and oils for nutrition and industrial use – especially in the prewar, wartime, and postwar years – soy-based products did not find their way to mass consumption.[81] Contrary to the planners' hopes during the 1930s of introducing soybeans in most Soviet peripheral regions to generate a significant supply of this oil and protein product, they were actually produced in considerable amounts only in the Russian Far East. Even the tax reliefs and other incentives offered to soybean producers by the state from 1928 until the end of mass collectivization in 1935 were of particular interest only to Soviet Koreans. But besides supply, domestic demand was also limited. Despite enthusiastic newspaper reports about soy-based protein and fat substitutes,[82] propaganda campaigns, and even the opening of several soy food factories, people were reluctant to consume the strange-tasting commodity. Only after the 1950s was soy lecithin more commonly incorporated into the formulation of Soviet sausages, candies, or chocolates. In this way, soy eventually became a hidden and permanent ingredient in the diet of Soviet citizens as well – with this 'hiddenness' in certain products being quite literal. Consumers were not always informed of, but often suspected, the presence of cheap and low-quality substitutes. Unlike domestic demand, international demand did not play a major role for the Soviet Union in the postwar era. While the USA became the world's leading producer and exporter, with Western Europe and Japan becoming major importers of soy, the USSR did not play a prominent role in world trade.[83] After 1950, with the development of the Council for Mutual Economic Assistance, the USSR attempted to take control of soybean variety

78 On the failure of mass soy experiments in Ukraine and the Caucasus, see Ryzhova, Failure, 216–217.

79 Sheila Fitzpatrick, Stalin's Peasants: Resistance and Survival in the Russian Village after Collectivization, New York 1994.

80 Langthaler, Krisengewinnerin.

81 Lebina writes about the communist fascination with soy foods in her book about Soviet everyday life: Lebina, Sovetskaya povsednevnost', 45–48.

82 Kul'tura soi [The Cultivation of Soy], in: Nauka i tekhnika 15 (1928), n.pag.; Interventsiia v polevodcheskii uklad nashei strany [Intervention in Our Country's Field-Crop System], in: Sel'skokhoziaistvennaia gazeta, 28 March 1930, 3.

83 Ernst Langthaler, Great Accelerations: Soy and Its Global Trade Network, 1950–2020, in: Claiton Marcio da Silva/Claudio de Majo (eds.), The Age of the Soybean. An Environmental History of Soy During the Great Acceleration, Winwick 2022, 65–90.

selection and promote greater cooperation in soy utilization in food and other industries. Despite some progress in the expansion of cultivated area in several other socialist countries (Hungary, Yugoslavia, and Romania),[84] it was hardly noticeable against the background of the global leadership position of US soy.

Fifth, all the factors discussed above were, in one way or another, related to the *state-led regulatory framework* of the agro-food system – first and foremost, to government policies. In the USA, the crisis management efforts of the New Deal administration with production control, price support, and soil conservation in the 1930s opened up windows of opportunity for soy to scale up from a niche product to a mainstream commodity. In the 1940s, soy became a pillar of the US-centred global agro-food regime. The initial impulse in this direction was the wartime policy to replace scarce foreign oilseeds with domestic ones. The upscaling of soy was further amplified by the GATT and ERP frameworks during the post-war era. In this way, the US administration extended the market for soy products beyond its national borders and across the Atlantic and Pacific Oceans to include Western Europe and Japan. GATT negotiations to relieve tariffs provided the US soy business with free market access. By the 1950s, the USA had gained undisputed dominance in the world market for soy.[85] Despite the glorification of market forces vis-à-vis central planning in the Cold War discourse, the rise of soy as a key commodity of the US agribusiness was only secondarily driven by supply and demand factors. Its prime driving force was the interventionist federal government, which had to manage major economic, ecological, and military crises while also respecting the interests of farmers and agribusiness. In short, the state created the market conditions for soy to flourish.

In the USSR, the state-led "soybean revolution" aimed to replicate the US soy expansion already underway in the 1920s. This drive for soy production, initially dictated by the acute shortage of oils and fats, also involved an ideological impulse. Every five-year plan, all-Soviet meeting, or ministerial document – whether in 1930, 1950, or 1970 – contained the same statement: The USA is the world leader in soy production, but the Soviet Union has the potential to achieve no less, and perhaps more, successful utilization of this crop. However, all attempts to introduce soy in the USSR fell through due to technical and institutional problems resulting from the modernist project of large-scale, mechanized, and monocultural – and therefore putatively "efficient" – production. The various efforts largely disregarded or contradicted both human and non-human dynamics: In the 1930s, there was insufficient access to acclimatized soy varieties and suitable technologies; in the 1940s, there were no trained people who could master the new technologies; in the 1950s, there were no consumers demanding soy foods; and during the entire period, there were no enthusiastic collective and state farm chairmen willing to risk the prescribed plans for unfamiliar crops. The fact that Soviet soy experiments continued even in regions that were considered unsuitable (like Kazakhstan or Kyrgyzstan) was also due to state policy: Central planners always returned to soy when another crisis arose. The Academy of Sciences was ready to serve this transitory

84 Zoya F. Slavova et al., Proizvodstvo, pererabotka i ispol'zovanie soi [Production, Processing and Utilization of Soybeans], Kyiv 1977.

85 Langthaler, Krisengewinnerin.

interest by providing the results of sluggish and therefore ineffective experiments.[86] While agricultural planning was also part of US policies starting in the 1930s, Soviet planning differed in one major respect: It was planning conducted by a central elite of experts, backed – but sometimes also prosecuted – by the Stalinist dictatorship, which largely disregarded social and ecological dynamics in peripheral places. In contrast to its US counterpart, the Soviet soybean expansion was rather disembedded from rural communities and agro-ecosystems.

Conclusion

Our comparison of the soy expansions in the USA and USSR from the 1920s to the 1950s highlights how and why transitions of the agro-food regime may unfold or not. The US case represents a fully-fledged agro-food transition spanning several decades. It began with niche formation until the 1920s, when a state-led knowledge network organized by soybean enthusiasts such as William Morse, market opportunities provided by the oilseed industry, and the ASA, as a dedicated farmers' organization, established a soy commodity network. It continued with crisis management in the 1930s, when the New Deal administration, by managing the economic and ecological crisis, opened up windows of opportunity for soy – in alliance with hybrid corn – to enter the farming systems in the Corn Belt. It was completed with regime building in the 1940s, when the wartime government ramped up soy production, processing, retail, and consumption before institutionalized commodity chains under the postwar US-centred agro-food regime channelled American soybeans to domestic and overseas markets.

The Soviet case also represents a fully-fledged transition, at least with respect to the state-enforced transfer of peasant property rights to centrally controlled collective and state farms. However, the agro-food transition floundered concerning the proclaimed "soybean revolution." This faltering transition began with niche formation until the 1910s, when a multi-local knowledge network around soy emerged, with an emphasis on the Far East. It continued with crisis management in the 1920s, when the Bolshevik government centralized the agricultural knowledge network and identified soy as a key resource for food, feed, and industrial processing. It was dynamized in the 1930s and 1940s, when agricultural collectivization transformed not only the distribution of landed property rights according to the model of industrialized agriculture but also destroyed the material, social, and symbolic foundations of peasant families and communities. However, the announced "soybean revolution" as a crucial part of the envisioned agro-food transition did not materialize. Despite the efforts of dedicated scientists such as Nikolai Vavilov, this goal was not achieved – mainly due to the contradictions between the general approach of ideologically and technocratically driven state planning and the particular logics of rural communities and agro-ecosystems. Unlike wheat, which could easily be produced in a standardized fashion with large-scale machinery, soybeans required more careful treatment by skilled workers – a commodity widely lacking on Soviet collective and state farms. Unlike its US counterpart, soy in the USSR was not

86 Curiously, the soy-related knowledge published in the 1970s under the heading "New in Engineering and Technology" repeats almost verbatim the contents of the brochures issued in the 1930s: Compare Slavova et al., Proizvodstvo; and Semen B. Vul'fson, Kul'tura soi [The Cultivation of Soy], in: Sel'skoe khoziaistvo SSSR: Ezhegodnik 1935, Moscow 1936.

upscaled to the Soviet-centred agro-food system, and instead was pushed back to its niches at least until the mid-twentieth century.

The different outcomes of these two soy expansions were not primarily caused by (dis-) functional markets, (un-)favourable ecosystems, or (in-)appropriate technologies; rather, the disparity was first and foremost determined by the state regulation of agriculture and food – not only in the USSR, but also in the USA. It seems reasonable, at least from the perspective of Cold War rhetoric, to assume that the systemic opposition between market capitalism and state socialism determined the different approaches to agro-food regulation in the USA and USSR. However, our comparative analysis suggests an alternative explanation: Since both governments shared the vision of agricultural modernization according to the model of the industrialized farm, it was their different forms of state intervention to realize this ideal that determined the outcomes of their soy expansions. The theoretical debate and empirical research on 'modernization' call for a pluralist notion of this singular, expressed as "multiple modernities" or "varieties of modernity."[87] A crucial distinction can be made between societally and ecologically embedded or disembedded modernities:[88] On the one hand, 'high modernism' refers to the planned upheaval – implemented even in the face of resistance – of social relations by the power of a centralized state, driven by the utopia of techno-scientific progress.[89] On the other hand, 'low modernism' characterizes the restructuring of society by a coordinating centre not *against*, but rather *with* decentral actors and their socioecological relations, socioeconomic networks, and sociocultural traditions.[90] While high modernisms are primarily associated with (though not exclusively confined to) dictatorships, low modernisms also emerge beyond democratic orders.

The US and Soviet soy expansions occupy different positions in the spectrum between high modernist and low modernist approaches to industrialized agriculture, despite mutual exchanges of knowledge and technology between both countries. The US case shares many features of a low modernist transition, including democratic participation, evolutionary change, and socioecological integration. The New Deal's approach to managing the agro-food crisis is a low modernist case in point: Farming families and rural communities received state support, market incentives, and opportunities for participation as potential allies of US-style modernization. Farmers who had regained trust in the state-managed agro-food system had enough reasons to adopt the new crop.[91] The Soviet case reveals the imperatives of high modernism characterized by authoritarian decision-making, revolutionary change, and suppression of societal and ecological counterforces. The Stalinist collectivization of agriculture represents an extreme case of high modernism: Peasant families and villages were suppressed, expropriated, displaced, starved, and even executed in large numbers by state authorities as potential enemies of Soviet-style modernization. Distrustful peasants and

87 Volker H. Schmidt, Multiple Modernities or Varieties of Modernity?, in: Current Sociology 54/1 (2006), 77–97.

88 Mark Granovetter, Economic Action and Social Structure: The Problem of Embeddedness, in: American Journal of Sociology 91/3 (1985), 481–510.

89 Scott, Seeing Like a State.

90 Jess Gilbert, Planning Democracy: Agrarian Intellectuals and the Intended New Deal, New Haven/London 2015.

91 Gilbert, Planning, 80–112.

inexperienced managers of collective and state farms therefore had little interest in adopting a state-promoted and unfamiliar crop.[92]

Our basic argument to explain the outcomes of the US and Soviet soy expansions prioritizes specific modernization pathways over general systemic properties. Rather than the politico-economic system per se, be it market capitalism or state socialism, it was the pathways taken by state-affiliated political, economic, and scientific elites towards agricultural modernization, along with the degree of societal and ecological embeddedness of these planned interventions, that largely determined the outcomes of the envisioned "soybean evolutions" – and of Morse's and Vavilov's shared dream.

92 Scott, Seeing, 193–222.

Leo Chu

Multiple Soy

The Transformation of Soybean Science in Taiwan since 1945

Abstract: This paper studies soy science in postwar Taiwan, where the Republic of China (ROC) government incorporated the crop into its development strategy. Using the infrastructure created in the Japanese colonial era (1895–1945), the ROC promoted rice–soy multiple cropping to increase the production of food, feed, and fat. By 1970, however, the liberalization of grain import from the United States led to the collapse of Taiwan's soy sector. Soybean scientists in Taiwan then turned their attention to collaboration with Southeast Asian nations via the Asian Vegetable Research and Development Center (AVRDC), an international centre created in Taiwan in 1971 to extend the Green Revolution in cereal grains to vegetables. By analysing materials from Taiwan's agricultural agencies and the Rockefeller Archival Center, I intend to bring the history of a minor soy-consuming country into the wider studies of soybean trade between China, Japan, and the Americas. I also scrutinize how a non-monoculture, yet no less chemically intensive soy research program emerged in Cold War Southeast Asia. Through an approach employing history of science and food regime theory, this paper contextualizes soy agro-food systems in less explored regions and scrutinizes the politics of soy from a new angle.

Zusammenfassung: Der Beitrag untersucht die Sojaforschung in der Republik China (Taiwan) in der Nachkriegszeit, in der die Pflanze für die Entwicklungsstrategie der Regierung einen wichtigen Stellenwert bekam. Aufbauend auf der in der japanischen Kolonialzeit (1895–1945) entstandenen Infrastruktur förderte Taiwan den Mehrfachanbau von Reis und Soja, um die Produktion von Nahrungsmitteln, Futtermitteln und Fetten zu steigern. Ab 1970 führte jedoch die Liberalisierung der Getreideimporte aus den Vereinigten Staaten zum Zusammenbruch des taiwanesischen Sojasektors. Sojaexperten in Taiwan lenkten daraufhin ihre Aufmerksamkeit auf südostasiatische Länder und kooperierten mit ihnen im Rahmen des Asian Vegetable Research and Development Center (AVRDC). Das 1971 in Taiwan gegründete internationale Zentrum hatte das Ziel, die Grüne Revolution der Getreideproduktion auf Gemüse auszuweiten. Basierend auf der Analyse von Materialien taiwanesischer Landwirtschaftsbehörden und des Rockefeller Archival Center verfolgt der Beitrag das Ziel, die Geschichte dieses Landes mit geringem Sojakonsum in die breitere Forschung zum Sojahandel zwischen China, Japan und Amerika zu inkludieren. Zudem wird untersucht, wie während des Kalten Krieges in Südostasien ein Forschungsprogramm entstand, das zwar auf eine Ausrichtung auf Soja als Monokultur verzichtete, aber dennoch einen intensiven Einsatz von Chemikalien befürwortete. Mit einem Ansatz, der Wissenschaftsgeschichte und die Theorie verbindet, kontextualisiert dieser Beitrag sojabezogene Agrar- und Ernährungssysteme der Nahrungsregime in weniger erforschten Regionen und beleuchtet die Soja-Politik aus einer neuen Perspektive.

Keywords: Taiwan, Southeast Asia, multiple cropping, Cold War

DOI: 10.25365/rhy-2025-8

Accepted for publication after external peer review (double-blind).

Leo Chu, Laureate Centre for History and Population, University of New South Wales, 353 Morven Brown Building, School of Humanities & Languages, UNSW, Kensington 2052, Australia, leo.chu@unsw.edu.au

Introduction

In 1960, Zheng Yuwei (Y. W. Cheng), a Taiwanese agronomist, visited the United States Regional Soybean Laboratory in Urbana and returned the next year with nearly three thousand accessions gifted by the institution.[1] He then planted these seeds to record their characteristics. Intriguingly, the resulting report published in 1965 stressed the crop's Chinese origin, emphasizing that Europe and America were latecomers in soy cultivation and that part of Zheng's collection was from China. "While China [*shenzhou*] had fallen," the report remarked, "the recovery of the materials from overseas is surely a precious opportunity."[2]

This paper analyses how state efforts to promote soy cultivation and research in Taiwan are entangled with the island's colonial history and Cold War geopolitics. Under the government of the Republic of China (ROC), an exiled regime after China's communist revolution, Taiwan became an ally of the United States. Ruling by way of an authoritarian one-party system grounded in martial law (1949–1987), the ROC sought to bolster its legitimacy among the local population by engineering economic growth. As a former Japanese colony (1895–1945), Taiwan possessed an extensive agricultural extension and administration system. Building on this established system, ROC officials strove to further improve crop productivity, supply cheap food for urban workers, and use foreign exchange from agricultural exports to fuel industrialization.[3]

The incorporation of soy into this state-led development strategy was far from self-evident, however. In the colonial era, beancake was imported for fertilizer from Korea and Manchuria – likewise under Japanese occupation at the time – but little attention was paid to soy in the ROC compared to rice and sugar, the two main export items, or other cash crops like pineapple, banana, and tea.[4] Cold War geopolitics intensified Taiwan's dependence on foreign soy. Under the ROC policies, sugar and rice continued to dominate the rural economy in the 1950s while American wheat, soy, and maize were imported as human food and animal feed.[5] For a small island with less than 900,000 hectares of arable land, most of which was already planted with rice, the ROC's decision to engage in research on soy appeared puzzling.

Against this background, this paper analyses how the ROC government initially envisioned making Taiwan more self-sufficient in soy through the technique of multiple cropping – the cultivation of more than one crop in the same field in a single year, either simultaneously (i.e. intercropping) or sequentially (i.e. crop rotation). Acknowledging that Taiwan's environment was most suitable for rice, officials believed productivity could still be increased through multiple cropping of rice and legumes. Besides, when the government launched a

1 Pinyin is used throughout the article for romanization. Alternative spellings used by authors publishing in English are shown in parentheses.

2 Y. W. Cheng/K. L. Chan, A Monograph of Introduced Soybean Varieties in Taiwan, Taipei 1965, preface.

3 Tai-Chun Kuo/Ramon H. Myers, Taiwan's Economic Transformation: Leadership, Property Rights and Institutional Change 1949–1965, London/New York 2012.

4 Wei Yi Leow, Horai Rice in the Making of Japanese Colonial Taiwan, in: History and Technology 36/3–4 (2020), 360–381; Chih-Ming Ka, Japanese Colonialism in Taiwan: Land Tenure, Development, and Dependency, 1895–1945, London/New York 1995; Manhong Lin, Taiwan Yu Dongbei Jian de Maoyi, 1932–1941, in: Jindaishi Yanjiusuo Jikan 24/2 (1995), 655–696.

5 Chi-wei Liu, Guoji Nongliang Tizhi Yu Guomin Yinshi: Zhanhou Taiwan Mianshi de Zhengzhi Jingjixue, in: Journal of Chinese Dietary Culture 7/1 (2011), 1–60.

land reform in 1949–1953 that turned tenants into landowners, farmers were expected to intensify their land use by adopting new seed types and applying more fertilizer. This labour-intensive, non-mechanized, small-scale but agrochemical-dependent soy production thus offers a less-explored case study compared to the established literature on large-scale soy monoculture in places such as Latin America.[6]

Moreover, this contribution expands current discussions of food regimes to include Taiwan's unique position in the conflux of Japanese, American, and Chinese influences. Food regime scholarship commonly divides the entanglement between global food systems and political hegemony into the British-dominated imperial-colonial first food regime (1880–1930), the American-dominated second food regime during the Cold War (1950–1980), and the neoliberal, corporate-environmental third food regime (1990–). Recent research has extended the perspective to East and Southeast Asia, where Japan held a prominent role especially during the first food regime.[7] As I will show in the following, the laborious farming practice in Cold War Taiwan originated in the rural mobilization techniques developed by the Japanese in the first food regime.[8] In addition, while Taiwan's postwar agricultural intensification could be read as part of the Green Revolution policy engineered by the United States, the legacy of colonial rural mobilization and the new regime's lack of legitimacy made the protection of smallholder agriculture a priority. This protectionism was finally undone in the third food regime, making the island entirely dependent on American grain imports.

By adopting a thematic focus on multiple cropping, a geographic scope covering East and Southeast Asia, and a wider time frame extending from the end of the first food regime to the dawn of the third, the case of Taiwanese soybean science promises to challenge the overemphasis on the American hegemony by scholars of the Green Revolution and food regime theory. Echoing the recent "global turn" in the history of science, scholars have enriched narratives of the Green Revolution with actors from the Global South who contested, expanded, and repurposed the technological and political interventions of the Global North for their own domestic and international agendas.[9] In the same vein, this article examines how postwar officials and scientists in Taiwan retooled colonial research and extension infrastructures for Cold War geopolitics and created a regional soybean research network linking Taiwan and Southeast Asia, thereby charting a path that both intersected with and moved beyond the American-dominated narrative.

The following three sections trace the evolution of this research network. I begin with the arrival of American soy feed and chemical fertilizer in the 1950s amid the ROC's plan

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6 Kregg Hetherington, The Government of Beans: Regulating Life in the Age of Monocrops, Durham 2020; Ryan Nehring, The Brazilian Green Revolution, in: Political Geography 95 (2022), DOI: 10.1016/j.polgeo.2021.102574.

7 Kuan-chi Wang, East Asian Food Regimes: Agrarian Warriors, Edamame Beans and Spatial Topologies of Food Regimes in East Asia, in: The Journal of Peasant Studies 45/4 (2018), 739–756.

8 For a study of mobilization in Europe during the Great Depression, see Ernst Langthaler, The Great Depression as Great Transformation? Global Food Regime Crisis and (Inter-)National Transition Pathways, 1925–39, in: Francesco Chiapparino/Gérard Béaur (eds.), Agriculture and the Great Depression: The Rural Crisis of the 1930s in Europe and Americas, Abingdon/New York 2023. Fascism can be seen as an extreme type of rural mobilization in response to the crisis of the first food regime. See Tiago Saraiva, Fascist Pigs: Technoscientific Organisms and the History of Fascism, Cambridge 2016.

9 Prakash Kumar et al., Roundtable: New Narratives of the Green Revolution, in: Agricultural History 91/3 (2017), 397–422.

to promote domestic soy production as a food crop. The next section scrutinizes efforts to reduce soy imports through breeding and multiple cropping research in the 1960s. Finally, I illustrate how Taiwan became a centre for soybean research in tropical Asia in the 1970s and 1980s despite the decline of domestic production. I conclude with the afterlife of the Taiwanese soy programmes by focusing on the rise of edamame (vegetable soybean) as a new export-oriented product and summarizing the significance of the paper's findings in relation to existing scholarship on the Green Revolution.

From fertilizer to feed

Soy had traditionally been grown by the indigenous Austronesian-speaking peoples in Taiwan, and its cultivation expanded since the seventeenth century with the arrival of Chinese settlers, who grew the crop in winter as green manure or for backyard production of tofu and soy sauce.[10] The onset of Japanese colonialism in 1895 introduced modern soy product factories and large-scale import of soy as a fertilizer. When Northeast China was a Japanese puppet state in the 1930s, Taiwan was the second largest importer of Manchurian soybeans for fertilizer, animal feed, and human consumption.[11] Although the regime's desire to boost rice and sugar production made chemical fertilizers increasingly common in the 1920s, beancake remained widely used due to its lower price. The imported quantity of beancake was exceeded by that of chemical fertilizers only in the late 1930s, when the Second Sino-Japanese War (1937–1945) restricted trade with Manchuria.[12]

Postwar geopolitical events changed the role of soy. Following the ROC's retreat to Taiwan in 1949 and the outbreak of the Korean War (1950–1953), the United States intensified its aid to Taiwan. An intergovernmental agency, the Sino-American Joint Commission on Rural Reconstruction (JCRR), became a key actor in rural policy and research. Created through the 1948 China Aid Act, the JCRR had a budget supervised by the American government and was composed of divisions based on an evolving range of development issues: agronomy, livestock, forestry, fisheries, public health, economics, and so forth.[13] It worked closely with the Council for United States Aid (CUSA) that handled general aid resources, the Taiwan Provincial Food Bureau (PFB) controlling production input and the marketing of staple grains, and the Taiwan Provincial Department of Agriculture and Forestry (PDAF) in charge of research and extension.

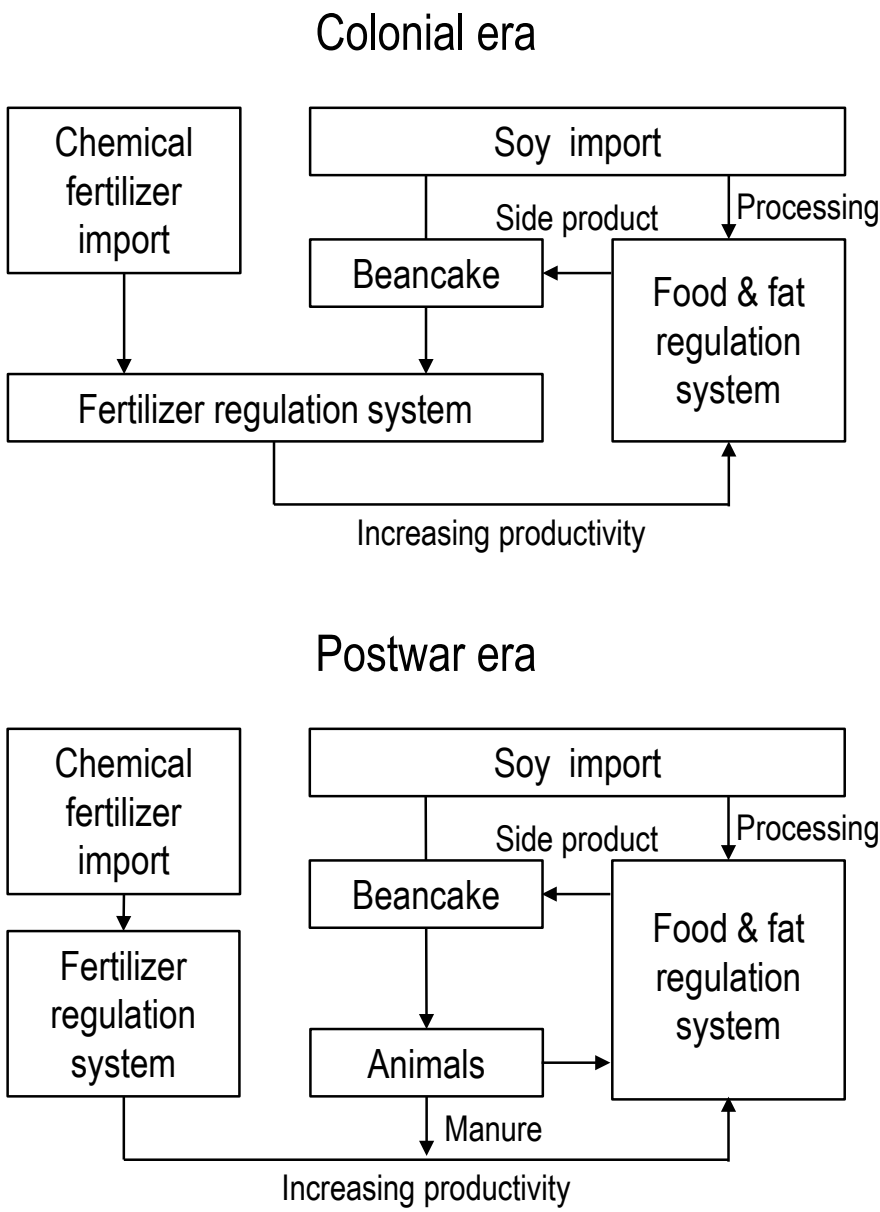
10 Christian Leipe et al., Archaeobotanical Evidence of Plant Cultivation from the Sanbaopi Site in South-Western Taiwan during the Late Neolithic and Metal Age, in: The Holocene 33/2 (2023), 131–146. On the colonization of Taiwan in the 17th and 18th centuries, see John Robert Shepherd, Statecraft and Political Economy on the Taiwan Frontier, 1600–1800, Stanford 1993. On the traditional industry of soy products, see Jianhui Zhang, Meiyuan Huangdou Yu Taiwan Shiyongyou Zhi Gongye Fazhan Zhi Yanjiu, master thesis, National Central University, Taoyuan 2013.

11 Lin, Taiwan Yu Dongbei, 672–674.

12 Renzi Huang, Erzhan Shiqi Liangshi Zengchan Zhengce Xia de Feiliao Tongzhi: Taiwan, Riben Yu Chaxian, Tokyo 2018.

13 The top decision-makers were three ROC and two American (later two ROC and one American) commissioners. Most staff were hired locally and embedded in the agricultural extension system.

Figure 1: The changing role of beancake from a fertilizer (top) to a feed (bottom) in the colonial and postwar periods



Source: Author. Note that hog manure served as fertilizer as well.

As the ROC considered itself in a civil war with the PRC, the state continued selective wartime policies imposed on Taiwan by Japan, allowing the government to centralize agricultural

and food planning.[14] The main impact of American aid on Taiwan's soy was the repurposing of beancake from fertilizer to feed. Although soybean and beancake were under the colonial government's regulation as sources of food and fertilizer, feed was not regulated. Unlike Japan's other colonies like Manchuria and Korea, Taiwan's livestock sector had been confined to backyard chicken and hog production. Most pigs, for instance, fed on domestic waste and sweet potatoes, with the latter also serving as a major staple in the nutrition of farmers who could not afford rice.[15]

By contrast, beancake was imported chiefly as feed by the postwar administration. This policy was prompted both by the US government's desire to dispose of surplus products and the JCRR's belief in the economic and nutritional benefits of increasing hog production.[16] Under this policy, the soybean and fertilizer subcommittees of CUSA coordinated imports with the US Economic Cooperation Administration and its successors, the PFB supervised the transfer of inputs to and procurement of food from farmers, and the JCRR studied the logistics and demand for feed and fertilizers and advised on relevant policies. Figure 1 captures this change, with the top graph depicting how beancake entered the fertilizer system directly during the colonial era while the bottom graph highlights its new role as animal feed in the 1950s.

Notably, with beancake replaced by chemical fertilizers, the demand for soy in the 1950s – around 120,000 tonnes per year – was lower than during the colonial period, when annual imports had peaked at 226,800 tonnes in 1934.[17] However, the JCRR was concerned about the reliance on imported soy as well as wheat and maize, and believed Taiwan had ample potential to increase domestic production. Due to the previous regime's focus on making Taiwan a supplier of tropical products, it had paid less attention to soybeans, considering them a staple that thrived in more temperate climates like Korea and Manchuria. Categorized as a "miscellaneous grain" (*zaliang*) or "dryland crop" (*hanzuo*), soy was cultivated less intensively and had lower cultural prestige than paddy rice.[18] Ironically, many ROC scientists from the mainland were trained in the breeding of crops such as wheat, maize, barley, and soy that were crucial in Northern China but less suitable for the subtropical island.[19]

Seen in this light, the interest of the ROC officials in soy research may have been not only a quest for food self-sufficiency, but also in part a desire to make their knowledge relevant. At any rate, the soybean programme was launched under the broader plan to boost miscel-

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14 Pin-Tsang Tseng, The Wartime Regime and the Development of Public Diet in Taiwan (1947–1950s), in: Journal of Current Chinese Affairs 47/2 (2019), 113–136.

15 Liu, Guoji Nongliang Tizhi, 122–123.

16 Ibid., 125–127. On the politics of food aid, especially under Public Law 480 (1954), also known as the "Food for Peace" programme, which allowed aid recipients to import American surplus products using local currencies, see Nick Cullather, The Foreign Policy of the Calorie, in: The American Historical Review 112/2 (2007), 337–364.

17 Liu, Guoji Nongliang Tizhi, 127; Wenqing Liu/Mindui Li, Ganshu Dadou Jianzuo Fangfa Zhi Yanjiu, Pingtung 1958, 1.

18 Among the non-rice staples, the colonial government did launch extensive studies on sweet potatoes, which were more suitable for the climate of Taiwan and widely cultivated since the seventeenth century. H. Wang, Ganshu Xin Yinjin Pinzhong Texing Guancha, in: Nongye Yanjiu 2/3 (1951), 91–116.

19 Most commissioners and division directors of the JCRR were trained this way and had received advanced degrees at American land-grant universities. See Harry H. Love/John H. Reisner, The Cornell-Nanking Story: The First International Technical Cooperation Program in Agriculture, Ithaca 1964.

laneous grain production. The JCRR began supporting wheat seed multiplication in 1949/50, followed by the introduction and testing of American maize, sorghum, barley, soybean, and peanut varieties in 1952/53.[20] A major goal of these early studies was to demonstrate to farmers the yield potential of new varieties under high-fertilizer conditions. In June 1953, the Plant Industry Division of the JCRR approved a grant application from the Kaohsiung District Agricultural Improvement Station (DAIS), one of the extension stations under the PDAF that served Southern Taiwan. Described as "the first project dealing with a crop in which the Division is very much interested," the experiment focused on yield trials of 29 soybean varieties from the United States, the Philippines, and Japan and their comparison with local varieties.[21] In collaboration with the Provincial College of Agriculture, the project was expanded in 1955 to include 67 varieties and involve four other DAIS across the island.[22] By 1957, several varieties like Shishi and Palmetto were selected for promotion via free seed distribution, and scientists from the Provincial College began crossing high-yielding introduced varieties with their local counterparts.[23]

American aid also funded the research of soybean scientists and facilitated seed exchange. For example, Zheng Yuwei, the agronomist mentioned in the introduction, received a grant to study wild relatives of soy at the United States Regional Soybean Laboratory while securing the introduction of three thousand accessions.[24] Together with another soybean expert, Zhan Guolian (K. L. Chan), Zheng launched a breeding programme targeting bean rust, a common disease in the humid tropics that posed a severe threat to crop productivity. By the end of the 1960s, Zheng and Zhan successfully developed the rust-resistant variety Tainung 3 by crossing two of the American accessions and began promoting its adoption through the Kaohsiung DAIS.[25]

As a result of these efforts, the acreage used for growing soybeans increased by 50 per cent from 28,225 hectares in 1953 to 43,629 hectares in 1958; production more than doubled, reaching 37,043 tonnes in 1958, with soy imports amounting to 87,683 tonnes in the same year. Domestic beans still predominantly served as material for tofu, soy sauce, and soy milk, while imported beans were mostly for oil production. Seeking to bridge the supply gap, the Plant Industry Division set an ambitious goal of increasing soybean acreage to 84,000 hectares and production to 105,000 tonnes by 1963, meaning another twofold increase in acreage and 50 per cent increase in per-area yield.[26] Acknowledging Taiwan's limited amount of arable land, the JCRR eagerly sought productivity-enhancing techniques for local conditions in addition to funding plant breeding. The approach it decided to pursue was multiple cropping.

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20 Joint Commission on Rural Reconstruction, General Report III, Taipei 1953, 5; Joint Commission on Rural Reconstruction, General Report IV, Taipei 1954, 42.

21 Academia Historica, Council of Agriculture Records (CA), folder 7218A, "Yield Trial, Plant Selection and Investigation of the Soybean Crop," 1, 11 June 1953.

22 Academia Historica, CA, folder 7406A, "Soybean Improvement Program in 1955," 11 August 1955.

23 Yingquan Lu, Dadou Zai Taiwan Yuzhongxue Zhi Yanjiu, in: Nonglin Xuebao 8 (1959), 1–21.

24 Y. W. Cheng, Studies on the Characteristics and Chromosome Numbers of Some Glycine Spp., in: Journal of Taiwan Agricultural Research 12/3 (1963), 1–9.

25 Y. W. Cheng/K. L. Chan, The Breeding of Rust Resistant Soybean 'Tainung 3', in: Journal of Taiwan Agricultural Research 17/2 (1968), 30–34.

26 Academia Historica, CA, folder 0162A, "Duiyu taiwan sheng jinchukou shangye tongye gonghui lianhehui jianyi kaifang doulei ji haichanlei shenqing jinkou yian zhi yijian," 1–3, 26 February 1959.

Laborious beans

Multiple cropping is certainly not a new idea for either farmers or agronomists. Before mechanized monoculture dominated food production in North America and Europe in the early twentieth century, multiple cropping and intercropping had been practiced by smaller farmers for economic security and researched by agricultural scientists, and such systems were studied by European officials in the tropical colonies well into the 1950s.[27] In colonial Taiwan, double cropping of rice with a winter crop of green manure began to spread in the southern half of the island in the 1920s. The JCRR's objective was therefore to further intensify such systems with high-yielding seeds, chemical fertilizers, and expanded irrigation infrastructure.[28]

Alongside technological extension, Taiwan inherited a far-reaching rural administration network from the Japanese. Starting with colonial police and neighbourhood surveillance, the system had evolved by the late 1930s into a mechanism not just for suppressing political resistance but for mobilizing rural youth for civilian and military services.[29] The network was also interwoven with the state monopoly on the collection of grains and distribution of fertilizers, and it aided in absorbing local innovations such as small motor and wind pumps into the public irrigation systems.[30] A countryside deeply penetrated by state power while familiar with both commercial production and planned economy became the foundation for the JCRR's postwar agricultural extension efforts.

Building on the mobilization techniques of its colonial predecessor, the postwar state used two institutional interventions in the 1950s to foster the further expansion of multiple cropping practices. First, the JCRR initiated a land reform that began with a rent ceiling in 1949 and culminated in the transfer of lands exceeding 3 *jia* (1 *jia* = 0.9 hectare) from landlords to tenants in 1953. Next, to ensure the co-option of smallholders into the development policy, the Joint Commission restructured farmers' and irrigation associations created in the colonial era to replace landlords with owner-cultivators in the management of their operations.[31] In this concept, the Taiwanese countryside was organized into a tightly connected web of co-ops from the provincial to the municipal and village levels in which family farms – generally around one *jia* in size – were the basic units that could be mobilized for policy goals. At the centre of this vision was the figure of diligent farmers who, incentivized by their land ownership and new technology, increased their labour input through intercropping and reduced the amount of time the lands lay fallow. The image was imbued with a Cold War rhetoric, as the

27 Jonathan Harwood, Coming to Terms with Tropical Ecology: Technology Transfer during the Early Green Revolution, in: International Journal of Agricultural Sustainability 19/3–4 (2021), 305–318.

28 T. H. Lee, Agricultural Diversification and Development, New York 1971, 12–16.

29 The neighbourhood system organized ten households into a *jia* and ten *jia* into a *bao*, all under the obligation of carrying out government orders. Shiyung Liu, Building a Strong and Healthy Empire: The Critical Period of Building Colonial Medicine in Taiwan, in: Japanese Studies 24/3 (2004), 301–314; Sayaka Chatani, Nation-Empire: Ideology and Rural Youth Mobilization in Japan and Its Colonies, Ithaca 2018.

30 Shuntaro Tsuru, Irrigation Pumps in Late Colonial Taiwan: Farmers' Utilization of Technology and the Transition to Rice Cultivation, in: Modern Asian Studies 57/6 (2023), 1866–1902.

31 S. C. Hsieh/V. W. Ruttan, Environmental, Technological, and Institutional Factors in the Growth of Rice Production: Philippines, Thailand, and Taiwan, in: Food Research Institute Studies 7/3 (1967), 307–341.

JCRR officials often contrasted Taiwan's land reform with that on the mainland, presenting the latter as a bloody class struggle that ended in disastrous famine.[32]

The local reality proved to be more complex than the JCRR had envisioned, however. As social surveys in the 1960s pointed out, the livelihoods of the tenants-turned-owners had not necessarily improved in the decade after the reform. The income generated by increasing productivity was largely used to pay off production costs for seed, tools, agrochemical manufactured goods, and children's education.[33] Seasonal migration to cities also gradually drained the countryside of available labour, and farmers' associations frequently reported the younger generation's distaste for agriculture due to its perceived drudgery.[34] In a sense, the laborious work of multiple cropping was adopted by smallholders not so much for the technocratic efficiency depicted by the JCRR than because of a notion of temporary sacrifice: Farmers worked harder so that their children would not have to. In the meantime, the apparent hegemony acquired by the party-state in the countryside was complicated by the emergence of local factions intertwined with the interests of former landed elites, who retained influence over the rural economy by serving in municipal governments, investing in food processing and logistics businesses, and running for local elections.[35]

Despite these diverse local responses, claims about Taiwan's agricultural intensification possessed a grain of truth from a statistical perspective: Labour input per hectare had grown from 220 person-days in 1931–35 to 305 person-days in 1956–60, and the averaged input for a farm of 1.45 hectares reached 577 days in the north and 658 days in the south.[36] When the American officials, recognizing Taiwan's shift to an export-oriented economy, phased down economic aid in 1961 and terminated it in 1965, the JCRR tried to support domestic soy production and save foreign exchange. The prospect of intercropping soy with other staples gained the most traction in the plains of Southern Taiwan, where the crop had three growth seasons: In spring and summer, soy was typically grown as a substitute for the first rice crop in dryland farms or partly irrigated paddies, while in winter it was planted concurrently with the harvest of the second rice crop. In this scenario, a technique called *huzi zaipei* was used by intercropping soy with near-mature rice, which slightly decreased the yield of soybeans but significantly reduced their growing time. In 1967, when soy production reached its record high of 52,300 hectares and 75,200 tonnes, 73 per cent of the acreage and 78 per cent of the harvest was winter crop, and average productivity measured 1.4 tonnes per hectare –, more than double the best results during the colonial period.[37]

The government's protectionist import control nevertheless ended abruptly in a scandal: In 1964, several oil factories were found to be bribing the railway administration and stealing

32 Leo Chu, "A Bloodless Social Revolution:" Land Reform and Multiple Cropping in Cold War Taiwan, 1950–1979, in: Plants, People, Planet 6/5 (2024), 1104–1110.

33 Martin M. C. Yang, Socio-Economic Results of Land Reform in Taiwan, Honolulu 1970. The problem of labour migration became serious by 1970. See Qinlang Zhang, Ruhe Wanliu Nongcun Qingnian, in: Fengnian 23/13 (1973), 41.

34 T. S. Wu/H. C. Tsai, Patterns of Agricultural Emigration and Multiple-Crop Farming in Taiwan, in: Journal of Population Studies 1 (1977), 1–29.

35 Kevin Wei Luo, Redistributing Power: Land Reform, Rural Cooptation, and Grassroots Regime Institutions in Authoritarian Taiwan, in: Comparative Political Studies 58/2 (2025), 227–260.

36 Lee, Agricultural Diversification, 9–13.

37 Academia Historica, CA, folder 0162A, "Jinhou shengchan dadou fazhan quxiang ji dui weichi zhongzhi lizuo dadou nongmin liyi ji xingqu zhi jianyi," 1–2, 13 January 1969.

thousands of tonnes of beans from government storage.[38] The resulting public outcry attacked the import regulation as corrupted and insensitive to market demand, and trade officials seized the chance to promote the benefits of liberalization.[39] Combined with pressure from the USA to curb domestic protection, the government eventually removed the import regulation for soy in 1966. Fortunately, the impact of liberalization seemed not to be immediate: According to the JCRR's evaluation in 1969, the cultivation of soybeans remained profitable since they were one of the few crops that could be directly planted on paddies without land preparation.[40]

The JCRR's cautious optimism for soy in Taiwan was strengthened by the growing outreach of the island's agricultural achievements. Anxious to retain its international presence, and especially its seat in the United Nations, the ROC – with covert American aid – sent out more than a dozen technical missions to its allies during the 1960s.[41] Complementing this official bilateral diplomacy was the JCRR's attempt to engage in multilateral collaboration by creating international agricultural research centres. One such centre was the International Rice Research Institute (IRRI) established by the Ford and Rockefeller Foundations in the Philippines in 1960. Considered pivotal for the Green Revolution in 1968 thanks to its breeding of high-yielding varieties, the IRRI encapsulated the vision of agricultural development the JCRR had been promoting since the 1950s. When the US government proposed the establishment of a similar institution in 1963 that would focus on vegetables in Southeast Asia, the JCRR promptly voiced support. After years of negotiations to secure donations, the Asian Vegetable Research and Development Center (AVRDC) was established in 1971 in Tainan, Southern Taiwan, with soybean serving as one of its mandate crops.

Making soy for tropical Asia

A series of changes in domestic economic structure and international politics during the 1970s cast shadows on the JCRR's confidence. After the end of American aid, the Joint Commission experienced a period of financial instability until it was able to secure new funding from the ROC as the executive agency of the Accelerated Rural Development Program (ARDP) in 1973. The ARDP was the government's attempt to remedy the discrepancy between urban and rural development with a mix of welfare policies and production incentives. On the one hand, the PFB abolished its fertilizer-rice barter programme, which had been used to artificially devalue rice by setting the exchange rate below the market price, and instead established a guaranteed rice purchase price.[42] On the other hand, aware of the declining

38 Zhang, Meiyuan Huangdou, 105–106.

39 Ibid., 113–116.

40 Academia Historica, CA, folder 0162A, "Jinhou shengchan dadou fazhan quxiang ji dui weichi zhongzhi lizuo dadou nongmin liyi ji xingqu zhi jianyi," 2, 13 January 1969.

41 James Lin, Martyrs of Development: Taiwanese Agrarian Development and the Republic of Vietnam, 1959–1975, in: Cross-Currents: East Asian History and Culture Review 9/1 (2020), 67–106.

42 On the function of fertilizer–grain barter for keeping food prices down, see Takeharu Sasamoto, A Salient Feature of Capital Accumulation in Taiwan, in: The Developing Economies 6/1 (1968), 27–36. The price guarantee was a response to a global food shortage in 1973–74 caused by the oil crisis and unusual climate conditions. See Fred H. Sanderson, The Great Food Fumble, in: Science 188/4188 (1975), 503–509.

workforce due to outmigration and aging, the JCRR aimed to turn "the traditional labour-intensive farming methods" into "capital-intensive ones, with more emphasis on mechanized and commercialized operation," declaring this transformation "necessary and inevitable as part of the process of modernization."[43]

The results were ambivalent. Utilizing farmers' associations as a voluntary labour force, the ARDP successfully fostered infrastructural improvement through self-financed local projects, extending sewer and drinking water access, paved roads, and power supply to rural areas.[44] Meanwhile, the government faced considerable difficulties in promoting labour-saving technology due to the prevalence of small family farms it had created two decades earlier with the land reform. Most farms were simply too small to make mechanization feasible, farmers were unwilling to sell or rent out their land, and initiatives for machinery sharing on a co-op base usually failed due to lack of coordination.[45] Thus the land reform that had cemented the smallholder system ended up preventing farm expansion and mechanization. Instead of following the continual push to produce more food, farmers transitioned to high unit cost commodities like fresh fruits, vegetables, and flowers; as a result, the production of grains other than rice – particularly wheat, maize, and soy, which faced import pressure – quickly plummeted. By 1979, soy production was only around 30,000 tonnes, the level of the late 1950s.

As soybean production in Taiwan began to decline, the AVRDC, originally envisioned as a venue for promoting the island's agricultural achievements including soybean breeding, also ran into troubles. Following the replacement of the ROC by the People's Republic of China (PRC) at the United Nations in 1971, the future of the newly established centre was called into question. Over the following decades, most of its member states cut diplomatic ties with Taiwan, and foreign donations dwindled. Under the directorship of Rober Chandler, who had formerly served as the funding director of the International Rice Research Institute (IRRI), the AVRDC tried to navigate this delicate situation by maintaining a subtle distance from the ROC government, which was by far its largest donor, while aligning its agenda with other organizations like IRRI so as to secure its international presence.[46] For example, building on Taiwan's success with multiple cropping, the AVRDC joined the Asian Cropping Systems Network launched by IRRI in 1974 as a key provider of improved vegetable varieties.[47]

Both the soybean and mung bean were AVRDC mandate crops due to their nutritional and economic significance. While the centre's mung bean programme focused on increasing the plant's resistance to diseases and environmental stresses in poorly irrigated marginal lands, the soybean programme was more aligned with the Green Revolution push for high productivity under agrochemical-intensive conditions. The latter also drew the attention of the Indonesian government: Following the archipelago's pursuit of improvements in rice growing during the 1960s, Indonesian officials tried to extend their intensification efforts to

43 Joint Commission on Rural Reconstruction, General Report XXIX, Taipei 1974, 2.

44 Kristen E. Looney, Mobilizing for Development: The Modernization of Rural East Asia, Ithaca 2020.

45 Chongyi Wen et al., Nongmin Chuantong Xingwei Dui Nongye Gongtong Jingying Zhi Yingxiang, in: Zhongyang Yanjiuyuan Minzuxue Yanjiusuo Jikan 49 (1980), 1–114.

46 Leo Chu, With and Against the Grain: The Asian Vegetable Research and Development Center (AVRDC) and Modest Narratives of Green Revolution in Taiwan, 1963–2002, in: Agricultural History 97/3 (2023), 448–477.

47 R. Villareal/S. H. Lai, Developing Vegetable Crop Varieties for Intensive Cropping Systems, in: International Rice Research Institute (ed.), Symposium on Cropping Systems Research and Development for the Asian Rice Farmer, Los Baños 1977.

coarse grains, pulses, roots, and tubers, broadly labelled as secondary food crops (*palawija*).[48] Similar to the situation in Taiwan, the government was eager to reduce soy imports for the fat and feed industry.

Notably, food legumes came under the spotlight of aid agencies in the 1970s, especially within the growing number of research centres associated with the Consultative Group on International Agricultural Research (CGIAR) founded by the World Bank in 1971 to streamline funding and amplify the impacts of the Green Revolution.[49] Tapping into these networks, Indonesian researchers launched a soy programme with a wide range of breeding targets – from general attributes like high yield, early maturity, and pest and disease resistance to those tailored to local environments, like tolerance to drought and waterlogging, seed viability under humid weather, and adaptation to acidic soil and shade for intercropping. The resulting variety, Wilis – developed by crossing a rust-resistant Indonesian variety with a high-yielding AVRDC accession – achieved popularity in the 1980s and made up nearly 30 per cent of the Indonesian soy acreage, or 350,000 hectares.[50] The AVRDC's research capability became widely recognized as a result: A 1985 review commissioned by the CGIAR on the contribution of CG centres in Indonesia reported that many interviewees believed the institution was either a CG centre "or that it should be one."[51] Taiwanese soybean experts also used the AVRDC to boost their international outreach. For instance, Zhan Guolian, developer of the rust-resistant Tainung 3 variety, shared his experience in bean rust research at a 1977 workshop in Manila co-sponsored by the AVRDC and the University of Illinois. Despite the obstacles soy growers in Taiwan faced, the island's scientists were able to stay in the international arena and sustain their research on soy through regional collaboration.

Conclusion

By the 1980s, the Taiwanese government had to admit that the island's agriculture could no longer rely on state-led production policies and protectionism. As the United States kept up its pressure on Taiwan, which by now was an industrial powerhouse, to further liberalize its food market, the administration lifted import regulations and deepened the island's reliance on cheap American products.[52] With dietary changes – chiefly including the increasing consumption of meat, fat, and wheat products along with declining demand for rice – food self-sufficiency simply became impractical considering the unequal production conditions and trade relationships.

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48 Ibrahim Manwan et al., Agricultural Diversification in Indonesia: The Potential Roles of Research, Extension, and Irrigation, in: Shawki M. Barghouti et al. (eds.), Trends in Agricultural Diversification: Regional Perspectives, New York 1992, 151–165.

49 On the history of the CGIAR, see Derek Byerlee/John K. Lynam, The Development of the International Center Model for Agricultural Research: A Prehistory of the CGIAR, in: World Development 135 (2020), 1–19.

50 K. Sebayang/D. A. Sihombing, The Technology Impact on Soybean Yield in Indonesia, in: J. W. T. Bottema et al. (eds.), Soybean Research and Development in Indonesia, Bogor 1988.

51 Barry Nestel, Indonesia and the CGIAR Centers: A Study of Their Collaboration in Agricultural Research, New York 1985, 50.

52 Chien-Pin Li, Trade Negotiation between the United States and Taiwan: Interest Structures in Two-Level Games, in: Asian Survey 34/8 (1994), 692–705.

Under the market-driven policy, soy production in Taiwan nevertheless continued to survive and evolve. Since the 1990s, entrepreneurial farmers have upscaled the production of edamame, or vegetable soybean, for the Japanese market. Despite facing competition from cheaper products from China and Thailand, broader adoption of mechanization and seeds developed by the AVRDC – renamed the World Vegetable Center in 2008 – and Kaohsiung DAIS helped Taiwanese edamame maintain its edge.[53] In 2019, edamame acreage was roughly 9,500 hectares, with production reaching 76,000 tonnes; exports to Japan measured 38,915 tonnes, constituting 41 per cent of its market.[54] This large-scale, mechanized, agrochemical-intensive edamame farming demonstrates the continued dominance of the ideals of the Green Revolution. Yet a parallel industry focused on traditional varieties and organic production has also emerged, crafting high-end soy sauce and soybean milk for consumers valuing environmental protection and smallholders' livelihoods.

In conclusion, the various roles soy has played in Taiwan's agriculture over the years reflect an intriguing genealogy of the East Asian food regime. Starting with the Japanese colonial regime that used cheap rice and sugar from the island to fuel its industrialization, agriculture in Taiwan was subjected to a dense policing, research, and extension system to boost crop productivity and later mobilize the colony for Japan's autarky and aggressive wars. Due to its lack of legitimacy, the postwar ROC sought to balance the extractive policies with a land reform to facilitate the industrialization of the island by way of surplus labour and food from the countryside. A labour- and agrochemical-intensive agriculture was thus consolidated as the JCRR's plan to adapt to and benefit from the American-led second food regime. Through widespread multiple cropping practices, soy was remade from a fertilizer to a crucial source of nutrition self-sufficiency despite Taiwan's limited amount of arable land. However, this successful export-oriented industrialization ended up impeding labour-intensive farming, while the land reform prevented land consolidation for mechanization. By the dawn of the third food regime, the government had abandoned the self-sufficiency policy, even though soybean research continued on the island for international collaboration as well as for new commodities like edamame and organic produce. In short, the multiple 'lives' of soy kept evolving along with the ever-changing political economy of the island and the region.

Appendix: List of Organizations

National Institutions

CUSA (Council for United States Aid): The ROC central government agency supervising the use of US financial aid, including the budget of the JCRR.

JCRR (Joint Commission on Rural Reconstruction): The ROC agency funded with US aid that was in charge of Taiwan's rural development by collaborating with the PDAF and PFB.

53 Kuan-Chi Wang, The Art of Rent: The Making of Edamame Monopoly Rents in East Asia, in: Environment and Planning E. Nature and Space 3/3 (2020), 624–641.

54 Guolong Zhou, Taiwan Lujin Maodou: Zouguo Waixiao 50 Nian, Taipei 2019.

PDAF (Provincial Department of Agriculture and Forestry): The provincial government agency in charge of research and extension services via the District Agricultural Improvement Stations (DAIS).

PFB (Provincial Food Bureau): The provincial government agency in charge of the distribution of fertilizers and food procurement.

International Institutions

AVRDC (Asian Vegetable Research and Development Center): An international organization established in Taiwan 1971 and modelled on the IRRI.

CGIAR (Consultative Group on International Agricultural Research): A platform launched in 1971 to streamline funding for international agricultural research institutions like the IRRI.

IRRI (International Rice Research Institute): An international organization established in the Philippines in 1960 by the Ford and Rockefeller Foundations and credited with decisive contributions to the Green Revolution in rice.

Claiton Marcio da Silva

The Great Pig Massacre

A Multispecies History of Agricultural Modernization in Brazil's Southern Frontier Region during the Great Acceleration

Abstract: The historiography of the Anthropocene suggests, at least in a generic way, the dramatic contribution of humans to the transformations of the planet, especially in recent centuries. One of the contemporary criticisms of the Anthropocene concept and its approach within the humanities is its failure to incorporate certain epistemological advances developed by areas such as post-humanism or the study of relations between humans and non-humans. Based on this perspective, this study analyses agricultural modernization in the Southern Frontier (*Fronteira Sul*) region of Brazil during the Great Acceleration, arguing that conflicting episodes involving human and non-human elements exemplify disputes in the scientific, technological, and industrial fields like that between the dominant but 'decadent' animal fat (lard) and the more versatile vegetable oil made from soy. This battle between oils and fats also gave rise to social struggles and new hierarchies – not just regionally, but on multiple scales. Methodologically, this study intersperses the analysis of regional events with national and global changes linked to economic, political, and scientific debates and the associated intentions regarding the management of pigs, soybeans, and viruses. In addition to the bibliography on the subject, I use articles from contemporary newspapers and scientific journals as well as technical articles and an interview.

Zusammenfassung: Die Geschichtsschreibung des Anthropozäns weist, zumindest in allgemeiner Form, auf den dramatischen Beitrag des Menschen zur Transformation des Planeten hin. Einer der zeitgenössischen Kritikpunkte am Anthropozän-Konzept und seiner Rezeption in den Geisteswissenschaften betrifft die mangelnde Berücksichtigung von erkenntnistheoretischen Entwicklungen aus dem Posthumanismus beziehungsweise der Erforschung von Beziehungen zwischen menschlichen und nichtmenschlichen Elementen. Ausgehend von dieser Perspektive analysiert der Beitrag die landwirtschaftliche Modernisierung in der südbrasilianischen Grenzregion (*Fronteira Sul*) während der *Great Acceleration*. Er argumentiert, dass Episoden von Konflikten zwischen menschlichen und nichtmenschlichen Elementen Auseinandersetzungen in wissenschaftlichen, technologischen und industriellen Feldern exemplarisch veranschaulichen können, wie etwa jene zwischen dem dominanten, aber ‚dekadenten', Tierfett (Schmalz) und dem vielseitigeren Pflanzenöl aus Soja. Diese Auseinandersetzung zwischen Ölen und Fetten brachte nicht nur auf regionaler, sondern auf mehreren Ebenen soziale Kämpfe und neue Machtverhältnisse hervor.

DOI: 10.25365/rhy-2025-9

Accepted for publication after external peer review (double-blind).

Claiton Marcio da Silva, Department of History, Universidade Federal da Fronteira Sul, Rodovia SC 484, Km 02, Bairro Fronteira Sul, Chapecó, Santa Catarina, Brazil, CEP 89815-899, claiton@uffs.edu.br

A first version of this article was published in Portuguese at Topoi Journal 24/54 (2023), 795–815.
The author would like to thank the Foundation for Research Support of Santa Catarina (FAPESC) for its financial support (call 21/2024).

Methodisch verschränkt die Studie die Analyse regionaler Ereignisse mit nationalen und globalen Entwicklungen, geprägt durch wirtschaftliche, politische und wissenschaftliche Auseinandersetzungen und den damit verbundenen Vorstellungen wie mit Schweinen, Sojabohnen und Viren umzugehen ist. Neben Forschungsliteratur stützt sich die Untersuchung auf zeitgenössische Zeitungsartikel, wissenschaftliche Fachzeitschriften, technische Berichte sowie ein Interview.

Keywords: Anthropocene, Great Acceleration, multispecies approach, agricultural modernization, African swine fever

On 27 August 1978, around 200 settlers gathered to prepare a traditional Sunday barbecue in the small community of São João belonging to the municipality of Xanxerê in the interior of the Brazilian state of Santa Catarina. Their menu, however, was modified: Instead of the usual beef barbecue, several Large White pigs from the local herd were slaughtered and roasted, possibly over an open fire (*fogo de chão*), and around noon the meat was served to the pig owners themselves, their neighbours in the community, and progressive members of the Catholic Church. This change to the traditional fare had a political motivation – namely, to draw societal attention to the controversy regarding an outbreak of African swine fever (ASF) affecting Brazilian herds. The pigsties in the community of São João had been declared infected by the health authorities 86 days earlier, even though no new potential cases had been registered. For the group of rural producers, eating pork from their herds thus symbolized a challenge to the authorities declaring the existence of an outbreak of swine fever at their location. A few days later, on 1 September, a platoon of the Santa Catarina military police invaded the property in question and shot the entire herd; the pigs were thrown into a mass grave to be burned along with the entire pigsty they had occupied.[1]

The case reported above is a microcosm of what had been happening in Brazil since 10 May 1978, when pathologists from the Brazilian Animal Institute (*Instituto Brasileiro Animal* – IBA) were asked to investigate the death of 150 pigs from a herd of 1,000 animals in Paracambi in the state of Rio de Janeiro. The Rio de Janeiro outbreak triggered a major health alarm throughout the country, and during the four subsequent years until the last case of ASF was officially reported, similar brutal culling occurred at numerous rural properties in Brazil. Between June and October 1978, within just a few months after the identification of the infections in Paracambi, further occurrences of ASF were diagnosed in the states of Pará, Piauí, Pernambuco, Espírito Santo, Rio de Janeiro, São Paulo, Minas Gerais, and Goiás in addition to the mentioned case in Santa Catarina. Between March and July of 1979, new cases of the disease appeared in Santa Catarina, São Paulo, Rio de Janeiro, Bahia, and Minas Gerais; in 1981, outbreaks occurred in Santa Catarina, Espírito Santo, and Pernambuco. Officially, health authorities reported that around 70 per cent of all outbreaks occurred in the southern and southeastern regions, and the most immediate result was that the Brazilian government mandated the slaughter of a total of 66,000 pigs across the country during the four years of the epidemic.[2] In many of the affected communities, a collective trauma was

1 Interview with Wilmar D'Angelis and Juracilda Veiga, 13 December 2022.

2 Carlos Tokarnia et al., O surto de peste suína africana ocorrido em 1978 no município de Paracambi, Rio de Janeiro, in: Pesquisa Veterinária Brasileira 24/4 (2004), 223–238.

evident in their memory, exemplifying the brutality of the civil-military dictatorship in relation to small independent rural producers as reported by D'Angelis.[3]

It was precisely this aspect – the fact that the pig producers affected by the slaughter of their herds were not associated with the growing agro-industries or food cooperatives in the Southern Frontier region of Brazil[4] – that influenced the first generation of academic work on the subject. In the eyes of historians, social scientists, and memorialists linked to progressive social and political movements, the mass killing of animals was driven by the interests of the agro-industry system in introducing exotic breeds and controlling the entire production chain of meat and derivatives.[5] In a dictatorial context, the military adopted a model of agricultural modernization that aimed to create a small elite of rural producers with access to abundant credit and machinery while most of the peasantry would be expelled from the countryside to serve as unskilled labourers in nascent urban centres. Over the subsequent decades and the accompanying changes in the political-institutional system, however, a different subset of explanations on the subject developed. These interpretations consider aspects of scientific and technological changes which – according to their advocates – may likewise have influenced the repeated events of pig culling by the government.[6] It is important to note that these two approaches do not conflict in their fundamental aspects: Both agree that the mechanization and intensification of pig production reinvented the entire production chain. For followers of the former, however, African swine fever in Brazil was – in most cases – a hoax invented by political authorities and business groups to disrupt the structure of pig producers who resisted integration into the agro-industrial system, the adherents of the latter approach argue that, despite the arbitrariness of the sanitary and governmental authoritarianism focused on the diagnosis and subsequent killing of pigs, there actually were outbreaks of swine fever.

For the purposes of this contribution, I will disregard neither approach; my aim is to consider the events during the mentioned period as representative for the analysis of human and non-human relations controlling (or not controlling) the flow of materials at the local, national, and global scale, and to observe how the growing agro-industry, food cooperatives, and national governments faced changes in dietary regimes during this period. Therefore, rather than taking a stand on whether the ASF epidemic was a hoax or not, my argument is that this episode involving human and non-human elements exemplifies disputes within the scientific, technological, and industrial fields between antagonists such as the dominant, but 'decadent' lard and the more versatile vegetable oil derived from soybeans. Following this line of thinking, the late 1970s constitute a crucial moment of transition away from the trading and use of lard at the national and global scale for several reasons; these include the

3 Interview with Wilmar D'Angelis and Juracilda Veiga, 13 December 2022.

4 This region covers the north of Rio Grande do Sul, the west of Santa Catarina, and the southwest of Paraná in an area bordering Argentina; it comprises 381 municipalities with a total area of 139,000 km² and an estimated population of 3.7 million inhabitants in 2010. See Paulo Zarth, Fronteira Sul: História e historiografia, in: Paulo Zarth/José Carlos Radin/Delmir Valentini (eds.), História da Fronteira Sul, Porto Alegre/Chapecó 2015, 9–24, 10.

5 As summarized by André Luís Zanotto, Senhores e criadores: Uma história do combate à Peste Suína Africana em Santa Catarina (1978), Florianópolis 2013; and Odilon Poli, Leituras em movimentos sociais, Chapecó 2008.

6 See Tokarnia et al., O surto de peste suína africana. See also Francisco Cecílio Viana, História e Memória da Peste Suína Africana no Brasil: Passos e descompassos, Belo Horizonte 2008.

Brazilian national policy of discontinuing the production of animal fat due to successive epidemics, the production of pigs with lower fat content at an industrial level, the adoption of refrigerators to replace animal fat as a food preservative, and finally the rise of the vegetable oil industry – and here especially soy. Thus, if specific geopolitical factors – the Cold War, the Brazilian civil-military dictatorship, and the advance of capitalism – placed certain 'Brazilian' pigs, exotic pig breeds, a specific virus, and oil made from plants in the same conflict arena, the results are unique and indicative of a multi-species resource historiography including its political aspects.

Therefore, whether it actually happened or not, the outbreak of African swine fever that supposedly began in 1978 stimulated, on the one hand, the intensification over the following decades of an industrial elite dominating part of the world's animal protein market. On the other hand, it promoted the emergence of social struggle movements that would be foundational for social, political, and environmental resistance at the national as well as the global scale. A prime example of the latter is the emergence of the Movement of Landless Rural Workers (*Movimento dos Trabalhadores Rurais Sem Terra*). In this sense, my methodological concern is to make it clear that the slaughter of pigs is not the *sensu stricto* key event for the formation of both interest groups. Rather, I suggest that the battle between the vegetable oil and animal fat industries intensified the conditions of existence of both sides, as will be discussed throughout the text. But any historiography of the Anthropocene – contrary to what this human-managed geological era might suggest in its name – must also address aspects of a growing post-humanist concern in historical analysis. More specifically, environmental history as a field responds to successive theoretical and methodological calls to acknowledge the role of non-humans in historical agency.[7] Therefore, this work is an exercise in dialogue between the fields of history and the environmental humanities; it defines humans as diverse beings who are co-constituted and act together with the social, material, and ecological environments they are located in.[8]

This contribution seeks not only to broaden the range of questions about what this entanglement implies for the analysis of human beings, their agency, and power imbalances in the Anthropocene, but also to understand what constitutes the mentioned material and ecological environments that involve them. The environment is not a stage, a static space in which humans have acted throughout history. In contrast to the singularized environment analysed by the natural sciences studying the Anthropocene, this text addresses the multiple and possibly unfair worlds arising together with the imagination and practices of the humans living within them. Critically, by understanding human beings and their environments as co-constituents, we can observe the (post)colonial power relations and inequalities in the formation of a human and environmental world on multiple scales.[9] Furthermore, how do these relationships converge or conflict with aspects of science and technology, which in turn connect diverse postcolonial trajectories? In order to complement this methodological

7 Bruno Latour, Reagregando o social: Uma introdução à teoria Ator-Rede, Salvador/Bauru 2012; Donna Haraway, Quando as espécies se encontram, São Paulo 2022; Anna Tsing, O cogumelo no fim do mundo: Sobre a possibilidade de vida nas ruínas do capitalismo, São Paulo 2022.

8 Evelien de Hoop/Aarthi Sridhar/Claiton Marcio da Silva/Erik van der Vleuten, Introduction. Historicising Entanglements: Science, Technology and Socio-Ecological Change in the Postcolonial Anthropocene, in: Global Environment 15/2 (2022), 194–208, 200.

9 De Hoop/Sridhar/da Silva/van der Vleuten, Introduction, 202.

concern, I view the episode of the slaughter of pigs in São João in 1978 as an event indicative of technical transformations promoted by authoritarian governments (especially in Brazil), which in turn stimulate new technological developments leading to the abandonment of humans, animals, and materials, among other historical consequences – sometimes characterized as 'conservative modernization'.[10] In this sense, the Green Revolution[11] itself is an opportunity to consider how technological changes have enabled the advancement of capitalism without altering agrarian structures – a historical agenda for Brazilian social movements, which were in turmoil in the years leading up to the 1964 military coup. In summary, within an authoritarian historical context, modernization programmes such as the Green Revolution overshadowed agrarian reformism; complementarily, inspired by Tiago Saraiva's work on non-humans and fascism, I engage in a multi-scale discussion about how non-humans are integrated and possess (albeit limited) agency in the making of historical processes.[12]

In a brief genealogy, soybeans and the oil derived from them, as well as the production of lard and ASF, came to exist in the same territory based on commercial and industrial relationships built in imperial and neocolonial contexts. Originally, soy was a plant domesticated in northeastern China which already served as a staple food for families in the region between 5,000 and 6,000 years ago before initially expanding to the current territories of Japan and the Korean peninsula.[13] European scientific expeditions introduced soy into botanical gardens and experimental institutions within the imperial context of modernity. In the eighteenth century, it arrived in the United States, where it was used in industry and saw new varieties being discovered whose seeds began to compete with China in international trade. Finally, in order to exploit vast tracts of land for the intensification of profits, the colonialism and neocolonialism of the nineteenth and twentieth centuries introduced or expanded soy monocultures in Latin America and Africa, in addition to countries in Asia that had previously

10 In summary, the term 'conservative modernization' addresses how some countries modernized their socio-economic structures, with a hallmark of transformations from above lacking effective popular participation and under the command of landlords. (See Juliana Lemos Faleiros/Sílvio Luís de Almeida, O coronelismo de Victor Nunes Leal e a modernização conservadora: Colocações iniciais, in: Revista de Direito 12 (2020), 1–26, 3.) In the Brazilian case, there is a kind of consensus to approach historical events such as the agro-industrial expansion through the lens of Barrington Moore, Jr.'s concept of conservative modernization. Although authors such as Carlos Fico have critiqued the decontextualized uses of this concept in the Brazilian case, the genealogy used by these authors obliterates or undermines how transformations in the Brazilian countryside through intensification of technology could coherently redefine Moore's concept in dialogue with authors overlooked by Fico in his prolix text, such as Alberto Passos Guimarães and Graziano Neto, among others. For authors both affiliated with and critical of the concept of conservative modernization – Ridenti and Sá Motta, according to Fico – the conservative transformations in rural Brazil are ignored, which suggests a focus on analyses of the national state, the dictatorship, and political repression, notably in urban centres, rather than on an approach incorporating other elements. See Carlos Fico, Ditadura militar brasileira: Aproximações teóricas e historiográficas, in: Revista Tempo e Argumento 9/20 (2017), 5–74.

11 For a more comprehensive understanding of the Green Revolution, see Wilson Picado-Umaña, Breve historia semántica de la Revolución Verde, in: Agriculturas e innovación tecnológica em la Península Ibérica (1946–1975), Madrid 2011, 25–50.

12 Tiago Saraiva, Fascist Pigs: Technoscientific Organisms and the History of Fascism, Cambridge 2016.

13 Brian Lander/Thomas David Dubois, A History of Soy in China: From Weedy Bean to Global Commodity, in: Claiton Marcio da Silva/Claudio De Majo (eds.), The Age of the Soybean: An Environmental History of Soy During the Great Acceleration, Winwick 2022, 29–47.

not produced the grain on a large commercial scale.[14] The growing contexts of commercial exchange in turn stimulated the spreading of ASF to new territories. Named after a colonialist conception – the name of the family *Asfarviridae* and genus *Asfivirus* are derived from the English acronym for African Swine Fever (and Related Viruses) – this type of swine fever is endemic to regions in the east and south of the African continent. The virus spreads by way of a sylvatic cycle involving transmission between wild *suidae* (*Phacochoerus africanus* and *Potamochoerus larvatus*) and a tick species (*Ornithodoros spp*). With the introduction of domestic pigs in Kenya during the 1920s, it infected new herds throughout sub-Saharan Africa, eventually reaching Portugal (1957) and Spain (1960s), where it has likewise become endemic. In 1971, an outbreak in Cuba wiped out nearly half of the country's livestock, and in addition to the aforementioned Brazilian case, the disease was officially identified in the Dominican Republic and Haiti until 1980. Highly contagious and haemorrhagic, ASF differs from classical swine fever (CSF), which is caused by a virus of the genus *Pestivirus* in the *Flaviviridae* family, in the severity of its symptoms and its lethality. In general, the disease attacks *suidae*, the family of artiodactyl mammals ranging from domestic pigs (*Sus scrofa domesticus*) to those considered feral (wild boars, or *Sus scrofa scrofa*). In the Brazilian case, as we will see below, CSF was already known to health authorities and pig farmers and affecting the lard production chain since the mid-twentieth century.[15]

As an indication of a broader history of the flow of materials being transformed into economic resources, however, it is necessary to analyse the social, environmental, and cultural importance of different types of fat in the regional society of the area under scrutiny. This will serve as a foundation for understanding the economic integration of the Southern Frontier region of Brazil in the national and global economy.

Global insertions and singularities: Pigs and lard in the Southern Frontier region of Brazil

The Brazilian civil-military dictatorship (1964–1985) invested heavily in expanding the agricultural frontier, focusing on the production of commodities of interest to the foreign market such as soy, wheat, corn, and rice in addition to the traditional coffee and rubber. Given the governmental desire for industrialization based on urbanization, construction of industrial centres, and intensifying the exploitation of natural materials after the end of the Second World War, intense mechanization and introduction of technology guided the connection between the urban and rural worlds.[16] In this conjuncture, Brazil – with the majority of its population living in rural areas during the first years after the end of the Second World War – was radically modified over the following decades, albeit with some fundamental differences:

14 Claiton Marcio da Silva/Claudio de Majo, Towards the Soyacene: Narratives for an Environmental History of Soy in Latin America's Southern Cone, in: Historia Ambiental Latinoamericana y Caribeña 11/1 (2021), 329–356.

15 Josélio de Andrade Moura, A Peste Suína Africana no Brasil: A epidemiologia, os registros históricos, a erradicação da doença e o desenvolvimento da suinocultura pós-ocorrência, Brasília 2009.

16 Claiton Marcio da Silva, The Making of Modern Agriculture: Nelson Rockefeller's American International Association (AIA) in Latin America (1946–1968), Winwick 2023, 34.

In subtropical Brazil, or more specifically in the interior of the three southern states of Paraná, Santa Catarina, and Rio Grande do Sul, the state governments had begun a process of occupying the regions bordering on Argentina during the first decades of the twentieth century. The descendants of Italians, Germans, and Poles who had originally settled closer to the Atlantic regions were encouraged to migrate inland and replace – through the use of violence – the peasant and indigenous populations and ultimately occupy the newly conquered lands in dispute with Argentina. This form of state enclosure appropriated the lands of squatters who, due to the state's own lack of action, had no titles to the lands they occupied. The affected *caboclos* or simply *brasileiros* were descendants of indigenous peoples, of formerly enslaved individuals, and of Portuguese who had settled in small rural communities; they were relegated to the margins of society as the government's objective of civilizing the *sertões* (backlands) pursued a model of agriculture based on family work and subsistence polyculture.[17]

This difference between the two farming models – small rural properties worked by neo-European migrants versus larger properties with salaried work – is one of the specificities in our analysis. In the sixty years preceding the African swine fever episode, the different government spheres stimulated the creation of a society dominated by white farmers and their alleged agricultural-technical superiority in relation to the poor peasants historically living in the region.[18] In the decades following the borderland occupations, only a relatively small and sparse *caboclo* population subsisted in the region, growing mainly wheat, corn, and beans on a family scale, complemented by citrus fruits, indigenous-influenced foods like pumpkins, native corn, and cassava seeds, and animals including cattle, mules, goats, chickens, and 'Brazilian' pig breeds such as *Piau*, *Canastra*, *Caruncho*, and *Pirapitinga* – breeds that had been 'Brazilianized' over several centuries. Three characteristics of this historical process are fundamental to the central argument of this text: the slow but continuous growth of urban centres in the Southern Frontier region, formed around a commercial elite relatively skilled in the disposal of surplus production; the decline of the figure of the family settler previously viewed by governments as the ideal model of civilization, which was equated with the "backward" *caboclo* in many aspects after the Second World War; and finally, the fact that both neo-European and *caboclo* settlers managed non-humans and the materials produced from them in a way that created surpluses connecting these farmers – albeit in a subaltern relationship – to regional urban centres and national markets.[19] Pork lard is a prime example.

In Brazil, swine herds were historically domesticated to adapt to new ecologies; in addition to meat consumption and the use of leather, states such as São Paulo and Rio Grande do Sul developed industries focused on jerky – meat that is dried and salted to increase its storage life. Since the middle of the nineteenth century, the US pork slaughter and commercialization industry had also exerted a considerable technological and financial influence on Latin American countries, notably through the invention and dissemination of the concept of efficient industrial slaughterhouses and cold storage for meat conservation by Armour & Company in the 1870s. In this context, the oligopoly of industries in the United States began

17 Zarth, Fronteira Sul.

18 José Carlos Radin, Companhias colonizadoras em Cruzeiro: Representações sobre a civilização do sertão, Florianópolis 2006.

19 Elisandra Forneck/Aline Lubenow, De fábricas de banha a agroindústrias internacionais: A construção da cultura agroindustrial de Chapecó, Chapecó 2021.

a process of acquiring slaughterhouses in the Plata region in the late nineteenth century, taking advantage of the growth of pig herds in the region even though Brazilian lard was considered to be of poor quality at the turn of the twentieth century and faced problems in foreign trade, with exports declining from 8 tonnes in 1896 to just 1.2 tonnes in 1899.[20] The lard used in Brazil had previously been imported in wooden barrels from the United States. During the last decades of the nineteenth century, however, the development of a national Brazilian industry was facilitated when Italian businessman Francesco Antônio Matarazzo began using metal packaging, which increased the product's storage life and allowed consumers to buy smaller quantities.[21]

In the southern states of Brazil, pig breeds suited for lard production – that is, with a more harmonious morphological distribution between their front and rear parts, depending on nutritional management, selection of animals, and age at slaughter – became widespread. In this region, until the 1970s, a live pig considered ready for sale was expected to provide an average of 50 per cent lard.[22] This was because pork lard served as an additional source of energy for local families and as a way of preserving their own meat. In the absence of electricity (and therefore refrigerators), small non-commercial producers would usually butcher one or more pigs and, in the style of the *caboclos*, distribute the meat among their neighbours, who returned the kindness when they slaughtered their own animals.[23] To preserve the meat intended for family consumption, the settlers would fry medium-sized pieces in large pans capable of holding up to 100 kg; after cooling, they kept the pieces in lard-filled cans of the type created by Matarazzo, which were readily available around the time of the Second World War. For consumption, the pieces of meat were removed from the can and usually fried again, then kept in dishes covered with towels and taken to the fields to be served at lunchtime. In cooking, the preference for pork lard shared by country people from the interior of the state of São Paulo and *caboclos* as well as settlers from the south of Brazil was based on it being better "for providing slow digestion and, therefore, a feeling of prolonged satiety, whereas vegetable oil was considered thin and poor".[24] Lard was also appreciated for its flavour, since cottonseed and vegetable oils did not possess a pleasant palatability according to the cultural standards of these social groups.

Pork lard was thus a non-human matter transformed into a resource that furthered the economic integration of regions in southern Brazil – and the entire La Plata Basin – along with salami, unprocessed meat, and an incipient agricultural production. The establishment of this market was based on the creation of free-ranging herds by settlers and poor *caboclos*. As a result of their small production surpluses, capitalized traders of Italian origin became interested in acquiring animals, founding small butcher's shops and agro-industries that slaughtered pigs and cattle – and to a lesser extent, sheep, and goats – with the aim of producing meat, salami, sausage, and cheese, including adaptations of Polish and Ukrainian recipes such as the Kraków special salami made with pork shoulder and pork shank. Therefore, between the 1930s and 1960s, the number of small butcheries that became slaughter-

20 P. F. Teixeira, A banha de porco, in: Revista Chácaras e Quintaes (December 1915), 427.

21 Forneck/Lubenow, De fábricas de banha.

22 Ibid., 10.

23 Arlene Renk, A luta da erva: Um ofício étnico no oeste catarinense, Chapecó 1997.

24 Nichole Ramos da Silva/Fabiana Bom Kraemer, Alimentação na obra "Os parceiros do Rio Bonito": Mudanças nas práticas alimentares dos caipiras frente à urbanização, in: Revista IDeAS 13 (2019), 1–15.

houses or agro-industries grew dramatically, with the capital generated by a few companies bringing together smaller establishments, initiating an era of conglomerates with their own headquarters and plants for production and slaughter in multiple cities in the region. Within this dynamic, lard consolidated its position as the only by-product with commercial value.[25]

With some butcher shops and agro-industries reaching a certain degree of capitalization between the 1950s and 1970s, they played a role in mediating the construction of infrastructure by the state and national governments – building roads, expanding the electricity network, managing water, and in a secondary sense, stimulating the establishment of schools and hospitals. Small agricultural cooperatives created by descendants of European immigrants also embarked on similar trajectories of expansion. Importantly, while they initially only traded the surpluses of local production, these agro-industries and cooperatives eventually began to control which types of animals were raised, how they were reared, what they were fed, and to whom the producers allocated their products. This radical change will be the subject of the next section.

Agricultural industrialization

The turning point in this assemblage interrelating humans and non-humans for at least six decades in a specific territorial region came by way of the expansion and modernization of the agro-industrial complex and the way in which it was articulated with the financial and political support of the civil-military dictatorship.[26] With the suppression of the popular vote, Attílio Fontana, founder of food producer Grupo Sadia, was indirectly elected Deputy Governor of Santa Catarina for the 1971–1975 fiscal period. In the city of Concórdia, where the Sadia headquarters were located, his nephew Victor Fontana mediated the installation of one of 42 centres of the Brazilian Agricultural Research Corporation (*Empresa Brasileira de Pesquisa Agropecuária* – Embrapa) – in this case, specializing in research on poultry and swine – by the Ministry of Agriculture of the civil-military dictatorship in 1975. In this tangle of relationships increasingly based on intensive capitalization of agro-industrial production, the device used by Sadia – and later by other cooperatives and agricultural companies as well – was the so-called "integration model": Pork production slowly began to become homogenized by adopting exotic breeds and confining animals previously raised in free-ranging herds in individualized or semi-individualized pigsties.[27] Little by little, producers introduced controlled grain-based feeding and, eventually, special feed for pigs; in addition, a series of inputs such as vaccines, medicines, drinkers, feeders, curtains, and the like were incorporated[28] with the intent to produce an animal model distinct from the 'lard pig' in terms of weight and height. With the creation of the Brazilian Association of Pig Breeders (*Associação Brasileira de Criadores de Suínos* – ABCS) in 1958, a period of genealogical control of pigs began, with non-endemic breeds being imported to increase the proportion of meat in slaughtered animals. Some breeds such as the American Duroc Jersey and, already in the

25 Forneck/Lubenow, De fábricas de banha, 6.
26 Carlos José Espíndola, As agroindústrias no Brasil: O caso Sadia, Chapecó 1999.
27 Maria Ignez Silveira Paulilo, Terra à vista … e ao longe, Florianópolis 1996, 27.
28 Dinarte Belato, Os camponeses integrados, Campinas 1986.

early 1960s, 'white' breeds like the British Landrace or Large White were spread across the country to differentiate the prices paid for animals by slaughterhouses. In this scenario of the introduction of new breeds, pigs in Brazil began to be classified into 'meat type', 'mixed type', and 'lard type': 'meat' pigs were white animals – Landrace and Large White; the 'mixed' type included pigs of various red hues like Duroc, as well as animals with some white stripes like Wessex and Hampshire; finally, the 'lard' classification covered the rest of all pigs – usually black, with characteristics typical of the so-called national breeds.[29]

Hence, as pork production was industrialized, incorporating changes in production methods and technologies as well as in the amount of space used – and by extension, transforming the producers themselves from being considered isolated and backward to becoming the equivalent of rural entrepreneurs – the intensified production system pushed the traditional model of pig farming to the margins.[30] For marginalized or independent farmers, raising pigs continued to serve as an income supplement, with a small number of animals forming part of a polyculture. But there was no longer any room for them to compete in the increasingly restricted market, not least due to sanitary requirements favouring producers integrated into the agro-industry. It is important to clarify in this context that with the capitalization, industrialization, and standardization of agricultural production, even commercial producers who raised pigs independently of the Incentives and Integration (*Fomento e de Integração*) model began to adopt confined husbandry due to the reduction in required property size and the scarcity of food available in the forests. By the end of the 1970s, indoor rearing had therefore become the standard for virtually all subclasses of pig producers in southern Brazil[31] – which incidentally also constituted a facilitating factor in the transmission of diseases such as African swine fever.

If the relatively rapid expansion and mechanization of the agro-industry had a dramatic impact on pig production schemes, a fundamental element of the functioning of the new model provoked a further shock in the system: the likewise dizzying growth in the production and uses of soy, one of the items in a balanced diet for swine – particularly for confined animals. Soybean production in the Southern Frontier region of Brazil, as well as throughout the country, was relatively marginal until the end of the Second World War, although the experiences gained in the municipality of Santa Rosa in the state of Rio Grande do Sul are considered a turning point in soy cultivation at the commercial scale.[32] In the 1940s, farmers in the state introduced soybean cultivation during the interval between cycles of wheat – the main crop at the time – in plantations that took advantage of the entire industrial structure of the cereal, managing to export a few tons to Europe at the beginning of the Second World War. By planting soybeans in succession with wheat, it was possible to employ the same land, machinery, equipment, warehouses, and labour.[33] At the same time, an outbreak of classical swine fever in 1946 affected lard production, particularly in the states of Minas Gerais, São Paulo, and Rio Grande do Sul. To compensate for the shortfall, Brazil had to import lard

29 Jerônimo Antônio Fávero, Evolução da Genética: Do "Porco Tipo Banha" ao Suíno Light, in: Jean Carlos Porto Villas Boas Souza et al (eds.), Sonho, Desafio e Tecnologia – 35 Anos de Contribuições da EMBRAPA Suínos e Aves, Concórdia 2011, 98–110, 106.

30 Zanotto, Senhores e criadores.

31 Espíndola, As agroindústrias.

32 Da Silva/de Majo, Towards the Soyacene.

33 EMBRAPA, Soja: História e Estatísticas, Brasília 1987.

from the United States again. In Rio Grande do Sul, although the outbreak of swine fever did not destroy the lard production chain, it brought about an intensification of public health campaigns and, most importantly for our topic, triggered a timid policy of discontinuing the production of lard.[34] As a result, the area used for lard production slowly began to diminish, though it has not completely disappeared from the market even today. Shortly after the end of the Second World War, the increasing production of soybeans was thus able to provide oil as a substitute for lard – though not without debates and conflicts, as we will see in the next section.

The battle of the fats: From swine fever to human heart disease

In the second half of the 1970s, pig breeds considered exotic were on the rise, as was soy production. This development was fuelled by the organization of breeders' associations, agricultural research companies (the civil-military dictatorship created a specialized soy research unit in Londrina, Paraná, in 1975), technical assistance service, agricultural credit, and instruments promoting subordination of producers to the agro-industry, such as the Incentives and Integration programme.

In addition, the intensification of capital in agriculture and livestock drove a considerable number of families away from rural areas for reasons such as accumulation of bank debt due to property management problems, but also due to droughts or intense rains or frosts, generating a dramatic continuum of rural exodus.[35] The share of producers who at least partly adopted commercial pork production by introducing technical modifications such as confinement as well as breeds such as Large White or Landrace while not participating in the Incentives systems would have been most strongly affected by the African swine fever epidemic. The example cited in the introduction refers to Large White pig producers not integrated into any of the agro-industries. This case, in turn, is similar to the first ASF outbreak registered in Paracambi, from where the disease spread and caused approximately 5,000 animals to be culled throughout the state of Rio de Janeiro. The origin of the plague was reported at a small farm site named Floresta, where animals were fed a mixture of uncooked restaurant food waste collected by their owner from the warehouses of airlines maintaining flights to Portugal and Spain. The suspicion of ASF was raised by South African veterinarian Wilhelm O. Neitz, author of a study on the subject. In the case at hand, pigs vaccinated against classical swine fever developed symptoms, indicating that they had no immunity to the new disease; within the following three days, after involving several researchers in the debate, a sample was sent to the Plum Island Laboratory, which confirmed the diagnosis.[36] According to the researchers, the clinical signs caused by the *Asfivirus* pathogen were "haemorrhages of various forms, in various organs, lymph nodes, and serosa, which were impressive in their extent, severity, and frequency, in addition to marked pulmonary lesions".[37] Shortly after the

34 Ramos da Silva/Bom Kraemer, Alimentação, 14.
35 Poli, Leituras.
36 Tokarnia et al., O surto de peste suína africana.
37 Ibid., 232.

start of the outbreak, the military police quarantined the affected farm and began to burn the animals and pigsties.

In the months following the health alarm triggered by the Paracambi outbreak, defenders of independent producers – including politicians, the Church, and unions – attributed the issues to factors such as the introduction of even more new swine breeds by the hybrid corn company Agroceres, a Brazilian enterprise created with capital from the International Basic Economy Co. (IBEC) founded by Nelson Rockefeller in 1947.[38] At least in part, the remembrance of the epidemic in the press and social memory related the outbreak to the expansionist dynamics of soybean cultivation. At the time, there were many interpretations: Some said that African swine fever had been deliberately introduced; in a conjectural exercise, the literature on the subject demonstrates that the reduction in international soybean stocks began as early as 1971 with the growth of cattle herds in Western Europe and the United States, stimulating the bran market. The entrance of the Soviet Union into the worldwide grain market between 1972 and 1973 also stimulated an increase in international prices. Finally, the 1972/73 harvest in the United States faced unfavourable weather conditions, threatening domestic supply; the government reacted by imposing restrictions on exports of soy and its derivatives.[39]

The recovery of grain production in the United States in 1977, so the spin, was accompanied by a biological warfare offensive of sorts in Brazil, with the introduction of swine fever representing a strategy to stop exports of Brazilian soy for the international market. According to another interpretation, the disease outbreak interrupted pork exports, thereby also affecting the export of grains produced in southern Brazil, a region with a large number of records of outbreaks. As an example, at the end of the 1970s, ten ships loaded with 20,000 tons of pellet feed and Brazilian soy bran had to wait for sanitary release in the port of Hamburg, Germany. In similar fashion, Poland, Romania, and Bulgaria began to demand certificates from the Brazilian authorities that the respective soy-producing region had not been exposed to the African swine fever virus[40] during the last six months. When both of these interpretations are taken together, the outbreak of swine fever not only interrupted the commercialization of pork meat for international trade but also impacted the export of grains – especially soybeans – due to the industrial proximity between the cultivation of plants and the breeding of animals.[41] Therefore, the increase in soy production was interpreted as a triggering factor for the epidemic outbreak – and as a reason for 'biological warfare' supporting the dominance of the United States on the soy market by hampering competition from Brazil. Finally, in another line of argumentation, the independent producers – affected by authoritarian truculence and forced to sacrifice their animals – identified grain production as one of the destabilizing factors for pork production: In their view, the federal government was encouraging the planting of hybrid corn and soybeans to the detriment of combating swine fever.[42]

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38 Da Silva, The Making of Modern Agriculture; Jaine Menoncin, De milho (Zea Mays L.) à Agrocel: O papel do milho híbrido Agroceres na modernização da agricultura no Brasil (1945–1960), Guarapuava 2017.

39 Marília Terezinha Domingos Leão Silva, Comportamento do preço da soja no Brasil, MA thesis, University of Lavras 1988, 8.

40 Edivane de Jesus, O sistema de integração na produção de aves no Oeste Catarinense: Análise sobre o processo de trabalho e a relação contratual entre a empresa Sadia e avicultores, Florianópolis 2010.

41 Ibid., 27.

42 Ibid., 177.

A series of events on the national and international markets corroborate or question these interpretations: Firstly, the end of the 1970s marked the peak of the expansion of commercial soybean production in Brazil that had begun in the 1940s, increasing the production area continuously until the 1979/1980 harvest. In the period between 1979/1980 and 1982/1983, soy acreage decreased by 636,911 hectares, returning to growth only with the following harvest. Secondly, the southern region of Brazil registered a more significant loss of soy-growing area – the total reduction in the states of São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul reached 1,225,180 hectares, while the area under cultivation in central Brazil grew by 588,269 hectares. This decline in the south was primarily caused by an increase in soybean production costs by around 20.7 per cent together with a decapitalization of producers, who received up to 24.6 per cent less for their grain. Given these factors, producers began to invest more intensively in corn production during this period.[43] As a result, the Brazilian dictatorship briefly prohibited exports of soybeans and their derivatives between the end of 1979 and the beginning of 1980 due to the lack of supply in the domestic market compared to growing demand.[44] Also, despite a brief decline during the swine fever episode, Brazil occupied second position in the worldwide ranking of soybean producers since 1976, guaranteeing a viable market for exports of derivatives such as oil.[45] Therefore, soybeans found favourable market conditions until the 1970s, especially abroad. A further factor was the aforementioned policy of discontinuing animal fat production following the outbreak of CSF during the 1940s. In this context, the national market found itself between a decline in the production of animal fats – replacing 'lard type' with 'meat type' pigs – and a concurrent shortage of edible vegetable oils to replace them.[46]

The relatively fast growth of the soy processing industry guaranteed total absorption of the raw material; it also caused an increase in the participation of cooperatives in production and commercialization, as well as of companies specialized in the processing of oil. As a direct or indirect result of the swine fever outbreak, however, the supply and domestic consumption of soybean oil did not increase from 1980/81 onwards. By contrast, before these events, supply had increased by 162.28 per cent compared to the average of the 1970s since 1974, with domestic consumption growing by 123.04 per cent in the same period. Statistically, another indication of the change between the 1960s and the 1970s is that all soybean oil production was absorbed by the domestic market until 1969; in the following decade, when exports intensified, the domestic market consumed only 67.68 per cent of the annual supply. Fundamental to understanding how soy oil came to occupy an essentially unrivalled place in the market, however, is that between the onset of the ASF epidemic and 1987, it accounted for 87.02 to 92.67 per cent of the total production of vegetable oils, reaching a share in consumption of around 93.81 per cent.[47] In other words, from being practically unknown in the 1940s, soybean oil had developed into a ubiquitous product on the shelves of both large supermarket chains and small businesses by the 1980s.

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43 EMBRAPA, Soja, 10.

44 Ibid.

45 Maria Arruda et al., Processamento, estocagem e exportação de soja em grão e derivados e sua relação com a alternância das safras estadunidense e brasileira, São Paulo 1985, 10.

46 EMBRAPA, Soja, 10.

47 Ibid., 33.

In summary, at the time of the slaughter of pigs in Brazil due to a possible epidemic of African swine fever, the breeding of animals for human consumption began a long process of increasing its dependence on soy bran for animal feed on the one hand and of competition between animal fat and vegetable oil on the other. In territorial terms, the area used for soybean plantations grew while productivity simultaneously increased, thus quickly positioning soy as an alternative to pig farming for non-integrated farmers. This factor alone does not suffice to explain the preference for soy oil over lard, however: Firstly, industry and scientific production followed a trend originating in the United States, valuing this vegetable oil with its high protein content that needed only improvement of its methionine levels to become suitable for commercial and industrial purposes.[48] In addition, the Brazilian industrialization process induced a nutritional transition in the domestic market, facilitating the supply and consumption of processed and ultra-processed products rather than in natura products. These transformations in the food production chain included different types of lipids and, consequently, different types of fatty acids. Between the end of the 1970s and the beginning of the 1980s, government statistics indicate a decrease in non-communicable chronic illnesses such as cardiovascular diseases.[49] The reason for this was the publication of studies such as those by North American cardiologist Lester J. Morrison. Based on the initial research by Russian scientist Nikolay Nikolayevich Anichkov on the relationship between cholesterol and arteriosclerosis, Morrison concluded from an experiment with animals in 1946 that lower cholesterol levels in the blood could be therapeutic; he subsequently began what was probably the first study testing the possible benefits of reducing cholesterol.[50] By the end of the 1960s, Morrison's thesis was circulating in agricultural magazines such as *Chácaras e Quintais*, arguing in favour of soy oil which, according to the cardiologist, "is protective against the pernicious effects of pork fat, butter, milk, eggs, and meat". The same publication claimed that "soy attacks and prevents rheumatic fever, liver diseases, ulcers, and cancers" and "protects the heart, brain, and kidneys, and lowers cholesterol", among other benefits.[51] Another study after Morrison's, carried out by the Multiple Risk Factor Intervention Trial group and published in 1962, indicated that animal sources of fat such as pork lard should be avoided due to the saturated fat and cholesterol in their composition. It related "high intakes of saturated fat and dietary cholesterol to increased plasma cholesterol concentrations, as well as increased risk of chronic non-communicable diseases".[52] In Brazil, the differentiation between saturated and unsaturated fats dominated the debate and gave a certain gain to soy

48 Regina Lago et al., Composição de óleos de soja brasileiros: 1. Variedades precedentes de Goiás, in: Revista Pesquisa Agropecuária Brasileira 13/2 (1978), 1–5.

49 Sociedade Brasileira de Cardiologia, I Diretriz Sobre o Consumo de Gorduras e Saúde Cardiovascular, in: Arquivos Brasileiros de Cardiologia 100/1, supl. 3 (2013), 1–48.

50 Daniel Steinberg, An Interpretive History of the Cholesterol Controversy. Part II: The Early Evidence Linking Hypercholesterolemia to Coronary Disease in Humans, in: Journal of Lipid Research 46/2 (2005), 179–190, 187; Lester M. Morrison, Reduction of Mortality Rate in Coronary Atherosclerosis by a Low Cholesterol–Low Fat Diet, in: American Heart Journal 42/64 (1951), 538–545; and Lester M. Morrison, A Nutritional Program for Prolongation of Life in Coronary Atherosclerosis, in: Journal of the American Medical Association 159 (1955), 1425–1428.

51 A soja na alimentação, in: Chácaras e quintais 703 (July 1968), 44.

52 Thaliane Tereza Araújo Dias Mack/Rodrigo Gomes de Souza, Controvérsias acerca do consumo e produção de Banha Suína: Anais Jornadas Interdisciplinarias de Estudos Agrários y Agroindustriales argentinos y latinoamericanos, Buenos Aires 2019.

oil – or rather, to all vegetable oils, but the domestic market practically only offered soy oil after it had been hyper-popularized in the scenario of the late 1970s. According to national health associations, which in a sense replicated international medical indications, saturated fats elevate the risk of cardiovascular diseases by increasing the levels of LDL in the body. Among the corresponding products, lard, bacon, whole milk, and red meat in general stand out. By contrast, the intake of unsaturated fats is considered essential for maintaining health – with an emphasis on soy oil, a polyunsaturated fat.[53]

Based on factors such as the increase in soy production, changes in the pig production chain and the breeds employed in it, the predilection for processed foods to support the industrialization process, and finally the medical discourse condemning pork lard, soy oil gained its place as a sovereign product in the Brazilian national market. At the same time, lard as well as fresh meat became objects of questioning based on the new sanitary standards.

Final considerations: Materials, non-humans, and social struggles

The process of replacing lard with soy oil as the dominant product in the Brazilian market was relatively quick – although in the mid-1970s, some scattered newspaper articles indicated that the development was merely the result of a "sophisticated advertising technique."[54] The outbreak of African swine fever in Brazil mobilized government and health authorities to intensify measures to eradicate the disease – and from there, resume the country's role as a rising exporter of soy products and pork. In the Southern Frontier region of Brazil, two other historical processes were likewise influenced by the ASF outbreak and the subsequent killing of animals. On the one hand, the organization of breeders' associations as well as agro-industries, cooperatives, and national as well as international input companies began to lobby directly with local and national governments for homogenization of the production chain. This factor contributed to an agro-industrial elite consolidating itself in the region and dominating a large share of the national and international market over the following decades by creating the largest Brazilian swine herd.[55] The former small lard factories and slaughter-houses entered the era of globalization at the end of the 1980s, receiving decisive assistance from government bodies to open up markets such as Russia, the Middle East, and Southeast Asia. Faced with increased agro-industrial demand, companies such as *EMBRAPA – Suínos e Aves* (swine and birds) developed "light pork" in the 1990s, a pork variety with a minimum of fat.[56] At the same time, cooperatives began to pay better prices for animals with lower levels of fat through the "carcass typification" policy. This scheme gradually decreased the average slaughter time alongside other changes, demonstrating the sophistication of the economically hegemonic productive chain.

53 Sociedade Brasileira de Cardiologia, I Diretriz Sobre o Consumo de Gorduras.
54 Correio Brasiliense, 1 March 1975, 2.
55 Espíndola, As agroindústrias.
56 Fávero, Evolução da Genética.

On the other hand, the African swine fever episode brought together independent producers around a very concrete agenda of demands. Previously relatively dispersed and without mobilization power in the face of the capitalization of the rural environment and the proletarianization of the peasantry, the Pastoral Land Commission and other progressive civil society groups gathered 20,000 rural producers in Chapecó in 1979 to denounce the "farce of African swine fever"[57]. Even in this context where breeders were fighting for their rights, however, with the closing of the agricultural border in the 1970s, the Southern Frontier region of Brazil – more specifically, the west of Santa Catarina – saw 664,375 people in a situation of extreme poverty. The share of impoverished people eventually reached around 15 per cent of the total population and about 24 per cent of the rural population around 1990.[58] If structural conditions such as the mechanization of agriculture and integration into the agro-industry initiated a rural exodus of dramatic proportions, events such as the ASF outbreak contributed decisively to the expulsion of independent farmers – as well as to their struggle for their rights. Small farmers who invaded indigenous lands in the north of Rio Grande do Sul and were expelled from them by the resistance in the late 1970s later occupied Fazenda Sarandi in 1978. Some of the families that were unable to settle there subsequently created the Encruzilhada Natalino camp on 8 December 1980 – the same year in which the Burro Branco farm in Campo Erê, Santa Catarina was occupied. Finally, in this scenario of opportunity for social mobilization, the Movement of Landless Rural Workers and the Movement of People Affected by Dams (*Movimento dos Atingidos por Barragens* – MAB) were founded, enabling the creation of a new environment of social struggles.[59]

Therefore, the analysis of social struggles or the creation of agro-industrial elites must, in a relevant historiographical proposal for a better understanding of the Anthropocene, observe the ecological-cultural mediations that involve humans, non-humans, and resources/materials. The analytical resource in this article consisted of turning viruses, pigs, lard, and oils into historical agents; therefore, modifying the composition of these agents or the relationships between them opens up new perspectives on historical processes. Finally, this small microcosm of the Anthropocene can insert bio-ecological singularities, as it exercises analysis on multiple scales of space and time, positioning itself as a frontal criticism of diffusionism. In this critique, instead of perceiving border regions only as recipients and at most as regions for the re-elaboration of Westernization, this article has organized its narrative as a place of 'passage' in which technique and science are transitory: Although they do influence the formation of local society, the results produced in these contexts – based on a multispecies history – extend through other trajectories of space and time and produce new socio-ecological changes. A broader study, therefore, could invert the diffusionist question that sometimes guides Anthropocene historiography: To what extent do animals, plants, bacteria, viruses, waters, soils, or – no less important – subaltern populations promote significant changes in the governance of bio-geochemical cycles on multiple scales of space and time?

57 Poli, Leituras, 72.

58 Silveira Paulilo, Terra à vista..., 128.

59 João Carlos Tedesco/Jonas José Seminotti/Humberto José da Rocha, Apresentação: A mobilização social rural no Sul do Brasil. Perspectiva de análise, in: João Carlos Tedesco/Jonas José Seminotti/Humberto José da Rocha (eds.), Movimentos e lutas sociais pela terra no Sul do Brasil: Questões contemporâneas, Chapecó 2018, 7–27.

Matilda Baraibar Norberg/Cecilia Gelabert/Enrique Antonio Mejía

Analysing Socio-Technical Regimes

The Case of Herbicide-Tolerant Soybeans in Argentina and Uruguay

Abstract: This study investigates the dynamics of homogenization and heterogenization in soybean production in Argentina and Uruguay, focusing on the widespread adoption of herbicide-tolerant (HT) soybeans. Using an integrated theoretical framework combining systems thinking and socio-technical transitions, it examines how the dominant socio-technical regime of HT soybeans has emerged and evolved. Cross-scale analysis reveals that the current regime developed from a long-term trend of agricultural homogenization and a specific configuration of technologies, policies, and markets that preceded the spread of HT soy in the region. Various aligned stressors and feedback mechanisms, driven by agribusiness strategies and economies of scale, have stabilized the regime and reinforced homogenization over the past three decades. However, the study also uncovers countervailing forces – dynamic social and ecological feedback loops – that challenge the system's foundations. These forces may signal the onset of a new shift in the socio-technical regime.

Zusammenfassung: Diese Studie untersucht die Dynamiken von Homogenisierung und Heterogenisierung in der Sojaproduktion in Argentinien und Uruguay, mit besonderem Fokus auf die weitverbreitete Einführung herbizidtoleranter (HT) Sojabohnen. Anhand eines integrierten theoretischen Rahmens, der Systemdenken und soziotechnische Transitionen miteinander verbindet, wird untersucht, wie das vorherrschende soziotechnische Regime der HT-Sojabohnen entstanden ist und sich weiterentwickelt hat. Eine skalenübergreifende Analyse zeigt, dass sich das derzeitige Regime aus einem langfristigen Trend zur landwirtschaftlichen Homogenisierung und einer spezifischen Konfiguration von Technologien, Politik und Märkten entwickelt hat, die der Verbreitung von HT-Soja in der Region vorausgingen. Verschiedene aufeinander abgestimmte Faktoren und Rückkopplungsmechanismen, angetrieben durch Strategien der Agrarindustrie und Skaleneffekte, haben das Regime in den letzten drei Jahrzehnten stabilisiert und die Homogenisierung verstärkt. Die Studie deckt jedoch auch gegenläufige Kräfte auf – dynamische soziale und ökologische Rückkopplungsschleifen –, die die Grundlagen des Systems in Frage stellen. Diese Kräfte könnten den Beginn einer neuen Verschiebung im soziotechnischen Regime signalisieren.

DOI: 10.25365/rhy-2025-10

Accepted for publication after external peer review (double-blind).

Matilda Baraibar Norberg, Department of Natural Sciences, Technology and Environmental Studies, Södertörn University, 141 89 Huddinge, Sweden, matilda.baraibar@sh.se; Cecilia Corina Gelabert, CONICET-Facultad de Ciencias Forestales, Universidad Nacional de Misiones, Bertoni 124, Eldorado, Misiones, Argentina, and Cátedra de Sistemas Agroalimentarios, Departamento de Economía, Desarrollo y Planeamiento Agrícola, Universidad de Buenos Aires, Av. San Martín 4453, CABA, Argentina, gelabert@agro.uba.ar; Enrique Antonio Mejía, Department of Economic History and International Relations / Stockholm Resilience Centre, Stockholm University, 106 91 Stockholm, Sweden, enriquethinks@gmail.com

Keywords: herbicide-tolerant soy, socio-technical regime, homogenization, heterogenization, Argentina, Uruguay, glyphosate, resistance

Introduction

In 2024, the global area used for genetically modified (GM) crops was approximately 190 million hectares (Mha), of which half (105 Mha) was dedicated to GM soybeans,[1] most of which are designed to be herbicide-tolerant (HT). The majority of this soy production is concentrated in a few countries including the United States, Brazil, Canada, Argentina, Paraguay, Bolivia, India, and Uruguay.[2] The first commercialized HT soy was Monsanto's (now Bayer) Roundup Ready (RR) soybean (GTS-40-3-2), which arrived on the market in 1996, first in the US and almost immediately thereafter in Argentina. RR soy was engineered to tolerate the herbicide glyphosate, which Monsanto sold under the brand name Roundup. This facilitated much cheaper, simpler and more effective weed control than required for conventional soybeans. Farmers could apply glyphosate directly to their fields without damaging the soy plants, making large-scale monoculture much easier and more profitable. Moreover, HT crops are highly compatible with no-tillage (zero-tillage, no-till) practices, which help to preserve topsoil and allow soybeans to be planted on land with less suitable soils.[3]

Modernization and standardization of agriculture are nothing new. The adoption of GM crops can be seen as merely the most recent step in a long history of homogenization of agriculture. However, the rapid pace and extensive scope of the current technological shift are unprecedented. In South America, soy employing the abovementioned technological package offered better economic margins than any other agricultural activity. Accordingly, it became the principal crop in many existing farming areas and expanded into new regions at a pioneering pace in South America, a process referred to as *sojización*. In just a few decades, the area used for soy expanded to almost 30 Mha, and at present the crop is cultivated on approximately 59.7 Mha across Argentina, Brazil, Paraguay, and Uruguay, accounting for significant portions of those countries' export revenues.[4]

The soy expansion has transformed forests, savannahs, grasslands, and diverse farming systems into simplified, often continuously cropped landscapes dominated by soy. This transformation has raised concerns about biodiversity loss and the displacement of family farms.[5]

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1 AgbioInvestor 2025, Global GM Crop Area Review: AgbioInvestor GM Monitor, https://gm.agbioinvestor.com (20 May 2025).

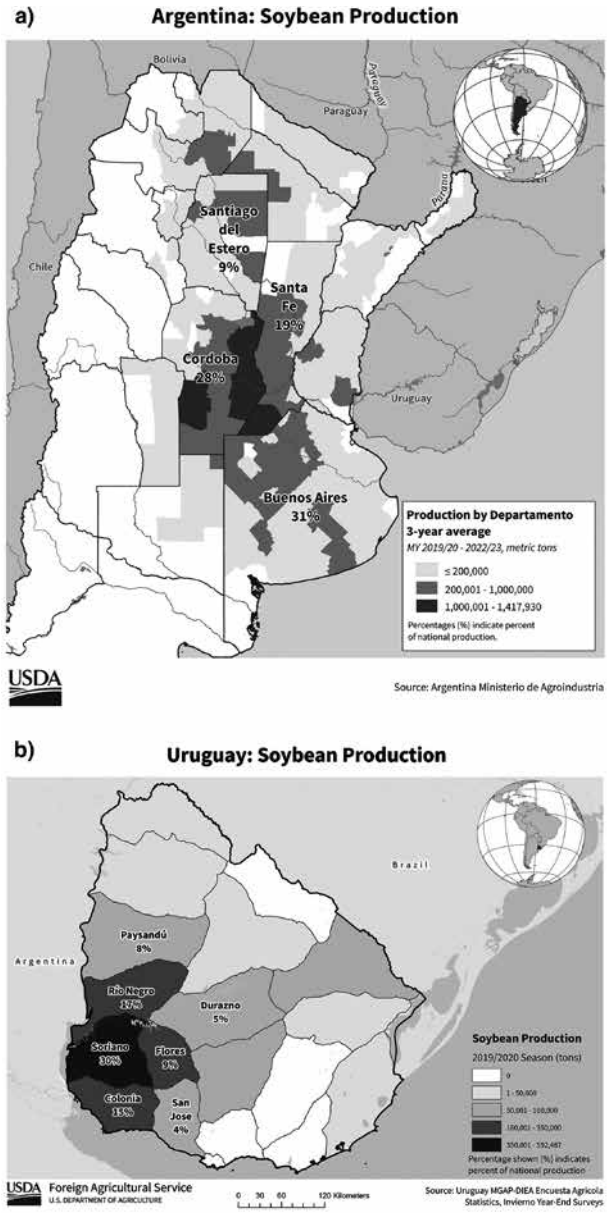
2 FAOSTAT, Crops and Livestock Products, Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/ (25 June 2025); ISAAA, GM Approval Database, https://www.isaaa.org/gmapprovaldatabase/ (28 June 2025).

3 Matilda Baraibar Norberg, The Political Economy of Agrarian Change in Latin America: Argentina, Paraguay, and Uruguay, Cham 2020.

4 FAOSTAT, Crops.

5 Yamila Leguizamón et al., Environmental Potential for Crop Production and Tenure Regime Influence Fertilizer Application and Soil Nutrient Mining in Soybean and Maize Crops, in: Agricultural Systems 210/103690 (2023), 1–11; Sebastián Gómez Lende, El Modelo Sojero en la Argentina (1996–2014), un Caso de Acumulación por Desposesión, in: Mercator (Fortaleza) 14/3 (2015), 7–25, DOI: 10.4215/RM2015.1403.0001; Bert Vander Vennet et al., Different Farming Styles Behind the Homogeneous Soy Production in Southern Brazil, in: Gustavo de T. Olivera/Susanna Hecht (eds.), Globalization, and Environmental Politics in South America,

Figure 1: Soybean production by department, a) Argentina (3-year average for 2019/20–2022/23); b) Uruguay (2019/2020 season)



Source: a) United States Department of Agriculture (USDA) – Foreign Agricultural Service (FAS), Argentina: Crop Summary – Soybean, https://ipad.fas.usda.gov/countrysummary/default.aspx?id=AR&crop=Soybean (3 July 2025); b) USDA-FAS, Uruguay: Crop Summary – Soybean, https://ipad.fas.usda.gov/countrysummary/default.aspx?id=UY&crop=Soybean (3 July 2025).
Note: percentage indicates proportion of national production.

Thus, *sojización* represents not only a change in technological application but a much wider socio-technical transition involving new production logic, social organization, and market practices.

This transition was driven and later stabilized by a combination of stressors, including a long history of agricultural homogenization, the advancement of global agribusiness, supportive policies at various scales, and the role of social organizations and networks. However, it is not an immutable process. While HT soy is the dominant socio-technical regime, there are also stressors pushing towards heterogenization. Moreover, there seems to be emerging ecosystem feedback pushing back against homogenization. This study aims to explore the dynamics of homogenization and heterogenization in soybean production with a focus on Argentina and Uruguay, where soy is the most important agricultural commodity.

Currently, the area under HT soybean cultivation in Argentina is around 17.46 Mha, which accounts for approximately 47 per cent of total crop area (38 Mha) and about 12 per cent of the total arable land (140 Mha).[6] As shown in Figure 1a, production remains concentrated in the traditional breadbasket region of the Pampa (e.g., Córdoba, Buenos Aires, Santa Fe, Entre Ríos), although cultivation has increasingly expanded northward in recent years (e.g., Chaco, Santiago del Estero). In Uruguay, the harvested area of HT soy has fluctuated between 0.9 and 1.4 Mha in recent years, reaching approximately 1.38 Mha in the 2024–25 season. This represents about 60–80 per cent of Uruguay's total crop area (2.5–3 Mha) and roughly 7–8 per cent of its total arable land (16 Mha).[7] As shown in Figure 1b, the primary production zone is located in the western littoral region (e.g., Soriano, Río Negro, Colonia), although soybean cultivation has increasingly expanded beyond traditional crop areas (e.g., Cerro Largo, Durazno, Rocha).

Drawing on the literature on systems thinking and socio-technical transitions, we explore the emergence and maintenance of the dominant socio-technical regime in Argentina from 1996 and in Uruguay from 2003 until today. We examine how soybean farming, along with the broader systems in which it is embedded, responds to stressors that either reinforce ever more uniformity or challenge and counteract homogenization. In this way, we seek to provide a more nuanced understanding of the social-ecological dynamics of soy cultivation, challenging simplistic conclusions and offering a holistic perspective on the complex relationship between agriculture and place.

New York 2017, 146–168; Facundo Zorzoli, De la Fiebre de la Soja a la Degradación de los Suelos: Economía, Ecología y Política en la Agricultura del Centro-Oeste del Chaco Seco, Argentina (1960–1990), in: Quinto Sol 25 (2021), 111–132, DOI: 10.19137/qs.v25i1.4355.

6 Eugenia Chialvo et al., Productividad y Calidad de la Soja en la Zona Núcleo Sojera: Campaña 2024/25, Laboratorio de Calidad Industrial y Valor Agregado de Cereales y Oleaginosas. EEA – INTA Marcos Juárez, Ministerio de Economía 2025; Guido Di Mauro et al., Transformations in Argentinean Soybean Systems: Recent Changes, Challenges, and Opportunities, in: Crop and Environment 4/2 (2025), 130–141; USDA-FAS, Argentina.

7 USDA-FAS, Uruguay; URUPOV, Teledetección y Caracterización del Cultivo de Soja en Uruguay 2025, https://www.urupov.org.uy/wp-content/uploads/2025/06/URUPOV-Informe-teledeteccion-_-SOJA-2025.pdf (22 October 2025).

Previous studies and gaps

Previous studies have analysed the process of *sojización* in Argentina and Uruguay in various social, economic, and ecological dimensions as well as across different spatial scales. Traditionally, agrarian social studies have employed a structuralist approach, describing agrarian subjects based on their access to production factors such as land, capital, and labour. This research has typically focused on increasing economies of scale and the substitution of labour for capital, along with their effects including land concentration, rural displacement, and rising rural conflicts.[8] The displacement of family farmers and indigenous communities as well as the expansion of agribusiness are well-documented phenomena.[9]

From an economic perspective, numerous studies have examined the benefits of HT soy such as lower costs for weed management and increased export revenues, mainly through dependence on China as a critical market.[10] However, other research within the political economy highlights how rising land and leasing prices have increased pressure towards land-use intensification, ousting smaller farmers and fuelling competition.[11] Several studies have also addressed how these changes intersect with national governance structures, international regulations, and markets.[12]

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8 Irma Acosta Reveles, El Enfoque de la Nueva Ruralidad como Eje de las Políticas Públicas: ¿Qué Podemos Esperar?, in: Revista Electrónica Zacatecana sobre Población y Sociedad 8/32 (2008), 1–20; Susana Aparicio/Carla Gras, Las Tipologías Como Construcciones Metodológicas, in: Norma Giarraca (ed.), Estudios Rurales: Teorías, Problemas y Estrategias Metodológicas, Buenos Aires 1999, 151–172; Javier Balsa, La Conceptualización de los Productores Rurales y su Transformación a lo Largo del Siglo XX: Reflexiones a Partir de la Confrontación con los Estudios sobre el Agro Norteamericano, in: Fernando Jumar (ed.), Empresas y Empresarios Rurales en la Argentina del Siglo XVIII al XX, Buenos Aires 2002, 29–58, 51–55; Pablo Lapegna, Soybeans and Power: Genetically Modified Crops, Environmental Politics, and Social Movements in Argentina, Oxford 2016; Matilda Baraibar Norberg, Sojización as a New First Movement. A Polanyian Analysis of the South American Soybean "Boom," in: Claiton Da Silva/Claudio De Majo (eds.), The Age of the Soybean: An Environmental History of Soy During the Great Acceleration, Winwick 2022, 91–114.

9 Diego Domínguez/Pablo Sabatino, La Conflictividad en los Espacios Rurales de Argentina, in: Lavboratorio: Revista de Estudios Sobre Cambio Estructural y Desigualdad Social 22 (2008), 38–44, 39; Gustavo García-López/Nancy Arizpe, Participatory Processes in the Soy Conflicts in Paraguay and Argentina, in: Ecological Economics 70/2 (2010), 196–206; Leguizamón et al., Environmental Potential; Gabriel Oyhantçabal Benelli et al., Who Rents Out the Land? Agrarian Capital Accumulation and Lessor Landowners in South America. The Case of Uruguay, in: Journal of Agrarian Change (2024), 1–20, DOI: 10.1111/joac.12603.

10 Roberto Bisang et al., Una Revolución (No Tan) Silenciosa: Claves para Repensar el Agro en Argentina, in: Desarrollo Económico (2008), 165–207; Eduardo Trigo/Eugenio Cap, The Impact of the Introduction of Transgenic Crops in Argentinean Agriculture, in: AgBioForum 6/3 (2003), 87–94; Rebecca Ray, The Panda's Pawprint: The Environmental Impact of the China-Led Re-Primarization in Latin America and the Caribbean, in: Ecological Economics 134 (2017), 150–159.

11 Gastón Caligaris, Los Países Productores de Materias Primas en la Unidad Mundial de la Acumulación de Capital: Un Enfoque Alternativo, in: Cuadernos de Economía Crítica 3/6 (2017), 15–43; Clara Craviotti, Which Territorial Embeddedness? Territorial Relationships of Recently Internationalized Firms of the Soybean Chain, in: The Journal of Peasant Studies 43/2 (2016), 331–347; José Muzlera/Rocío Pérez-Gañán, The Legacy of Megapools and Chacareras in the Pampa Húmeda of Argentina (2010–2015), in: Perfiles Latinoamericanos 30/60 (2022), 1–26; Leguizamón et al., Environmental Potential.

12 Baraibar Norberg, Political Economy; Matilda Baraibar Norberg/Lisa Deutsch, The Soybean through World History: Lessons for Sustainable Agrofood Systems, New York 2023, DOI: 10.4324/9780367822866; Mariano Turzi, The Political Economy of Agricultural Booms: Managing Soybean Production in Argentina, Brazil, and Paraguay, Cham 2017.

Ecological and agronomic research has extensively analysed the impacts of agricultural intensification on ecosystems in Argentina and Uruguay. Studies have examined how the shift from mixed farming systems for continuous cropping (primarily soybeans) has led to increased agrochemical use, soil degradation, and biodiversity loss.[13] In Uruguay, soil erosion and declining productivity have emerged as prominent concerns.[14] The simplification of crop rotations has also reduced resilience against environmental and economic variability.[15] In Argentina, the expansion of soy production beyond the Pampas has driven deforestation and carbon emissions, with far-reaching impacts on regional ecosystems.[16]

Technological adoption studies, particularly in Argentina, have analyzed levels of mechanization, input use, and process technologies across production regions.[17] In Uruguay, research has often assumed uniform input use, though recent studies have begun to differentiate practices by soil type and crop rotation.[18] Some new modeling approaches integrate multiple decision-making variables such as farmer preferences, technology levels, yields, and natural resources, aiming to optimize both economic and environmental outcomes.[19]

Despite the breadth of research on *sojización*, significant gaps remain. The different strands of literature – whether social, economic, or ecological – are largely disconnected and lack a cohesive framework that examines the systemic dynamics at play. Most studies focus on individual components without exploring the interdependencies between technological transformations, social structures, and ecological impacts.

This research seeks to bridge these gaps by adopting a holistic, interdisciplinary approach based on an integrated theoretical framework to examine how the dominant socio-technical

13 Fernando Andrade et al., Los Desafíos de la Agricultura Argentina: Satisfacer las Futuras Demandas y Reducir el Impacto Ambiental, Buenos Aires 2017, 25; Alfredo Bruno, Plaguicidas Usados en el Cultivo de Soja: Evolución de su Uso y Estimación de su Impacto Ambiental, Río Negro 2007; Enrique Antonio Mejía, Five Decades of Soybean Agriculture: Soil Nitrogen Exports and Social Costs in the Argentine Pampas, 1970–2021, in: Da Silva/De Majo (eds.), The Age of the Soybean, 185–203; Pablo M. Demetrio et al., Effects of Pesticide Formulations and Active Ingredients on the Coelenterate Hydra Attenuata (Pallas, 1766), in: Bulletin of Environmental Contamination and Toxicology 88 (2012), 15–19.

14 Oswaldo Ernst et al., Depressed Attainable Wheat Yields Under Continuous Annual No-Till Agriculture Suggest Declining Soil Productivity, in: Field Crops Research 186 (2016), 107–116; Mario Pérez Bidegain et al., La Erosión de Suelos en Sistemas Agrícolas, in: Fernando García Préchac et al. (eds.), Intensificación Agrícola: Oportunidades y Amenazas para un País Productivo y Natural, Montevideo 2010, 67–89.

15 García Préchac et al., Intensificación.

16 Mitchell Aide et al., Deforestation and Reforestation of Latin America and the Caribbean (2001–2010), in: Biotropica 45/2 (2013), 262–271; Matthias Baumann et al., Land-Use Competition in the South American Chaco, in: Jörg Niewöhner et al. (eds.), Land Use Competition: Ecological, Economic, and Social Perspectives, Cham 2016, 215–229; Esteban Jobbágy et al., Impronta Ambiental de la Agricultura de Granos en Argentina: Revisando Desafíos Propios y Ajenos, in: Ciencia Hoy 29/173 (2021), 35–44.

17 Eugenio Cap/Paz González, La Adopción de Tecnología y la Optimización de su Gestión como Fuente de Crecimiento de la Economía Argentina, Buenos Aires 2004; Eugenio Cap et al., Perfil Tecnológico de la Producción Agropecuaria Argentina: Análisis Descriptivos y Prospectivos, Buenos Aires 1993.

18 Gonzalo de Rizzo/Oswaldo Ernst, Mapeando la Brecha de Rendimiento en Soja para Diferentes Zonas Climáticas y Grupos de Suelos, in: Cangué 41 (2018), 10–14.

19 Diego Ferraro/Rodrigo de Paula, A Fuzzy Knowledge-Based Model for Assessing Risk of Pesticides into the Air in Cropping Systems, in: Science of the Total Environment 820 (2022), 153–158; Felipe Ghersa et al., AgrOptim: A Novel Multi-Objective Simulation Optimization Framework for Extensive Cropping Systems, in: Computers and Electronics in Agriculture 224 (2024), 109–119; Sebastián Pessah et al., An Integrated Ecological-Social Simulation Model of Farmer Decisions and Cropping System Performance in the Rolling Pampa, in: Journal of Artificial Societies and Social Simulation 25/1 (2022), 1–34.

regime of HT soybeans has emerged and evolved in Argentina and Uruguay using a cross-cutting (global to local) analysis. By combining insights from the natural and social sciences, we explore the dual forces of homogenization and heterogenization in these agricultural systems in detail.

Research design, theoretical frameworks and methods

This study examines soybean farming in Argentina and Uruguay through the lens of processes of homogenization/heterogenization. It investigates whether the widespread adoption of HT soy (since 1996 in Argentina and 2003 in Uruguay) has merely reinforced uniformity or whether countervailing forces have also emerged over time.

Drawing on systems thinking and socio-technical transitions theory, the study conceptualizes HT soy not as a discrete technological breakthrough but instead as being embedded within a broader socio-technical regime. This regime is shaped and stabilized through the alignment of multiple factors including global market demand, institutional and technological infrastructures, actor coalitions, and historical legacies.

Systems thinking offers a conceptual approach for analysing agriculture as a dynamic, non-linear, and interconnected system. Central concepts in this tradition such as feedback loops, system boundaries, and leverage points guide the study's analysis of how interventions and pressures reverberate across coupled social and ecological structures.[20] Systems thinking also draws attention to emergent properties, thresholds, and delayed effects, which are critical for assessing the resilience and potential fragility of agro-industrial regimes.

In this study, feedback loops refer to the recurring interactions among social, ecological, and technological components that either reinforce or counteract the dominant HT soy regime. Some feedbacks are stabilizing (e.g., the co-evolution of glyphosate-tolerant varieties and mechanized equipment), while others introduce friction or resistance (e.g., herbicide resistance, soil degradation or sociopolitical contestation). Although we do not model these loops visually, the terminology of reinforcing and balancing dynamics is used descriptively to trace how system behaviour evolves over time. Particular attention is paid to ecological thresholds and feedbacks that may signal or precipitate systemic shifts, especially when accumulated pressures challenge the regime's internal coherence and external legitimacy.[21]

This study also builds on socio-technical transitions theory, with particular focus on the multi-level perspective developed by Frank Geels.[22] This framework conceptualizes systemic change as emerging from interactions across three analytical levels:

- Landscape (macro-level): Broad, external forces and long-term trends such as climate change, global trade dynamics, or geopolitical realignments;
- Regime (meso-level): Stabilized configurations of technology, practice, institutions, and actor networks that reproduce dominant systems;

20 Diana Wright/Donella H. Meadows, Thinking in Systems: A Primer, London 2012.

21 Carl Folke et al., Building Resilience and Adaptive Capacity in Social-Ecological Systems, in: Fikret Berkes et al. (eds.), Navigating Social-Ecological Systems, Cambridge 2003, 352–387.

22 Frank W. Geels, Technological Transitions as Evolutionary Reconfiguration Processes. A Multi-Level Perspective and a Case Study, in: Research Policy 31/9 (2002), 1257–1274.

- Niches (micro-level): Spaces in which alternative practices and innovations can be tested, nurtured, and potentially upscaled.

This provides a structured lens through which to examine both the emergence, rise, and consolidation of HT soy as a dominant regime and its subsequent contestation. In the context of Argentina and Uruguay, the study maps landscape-level pressures (e.g., international regulations, market shifts, and climate variability), regime-level dynamics (e.g., technological lock-ins, agronomic limits, and institutional support), and emerging niches (e.g., agroecological or low-input farming initiatives). These are interpreted not as isolated developments but as interacting processes across scales that jointly shape the trajectory of soybean agriculture.[23]

By combining systems thinking with socio-technical transitions theory, this research enables an integrated, cross-scalar analysis of how homogenizing forces such as monoculture expansion, input standardization, and market integration can become challenged by heterogenizing dynamics including ecological feedbacks that demand innovation and differentiation. This dual perspective also highlights that transitions in agricultural systems are often non-linear, contested, and reversible, shaped by both material and discursive power.

Methods and empirical material

This study is based on a multi-method qualitative research design combining two complementary sets of interviews with secondary sources, thus enabling a cross-scale, multi-actor analysis of soybean production systems in Argentina and Uruguay.

The core empirical material consists of 15 semi-structured expert interviews conducted between January and October 2024, complemented by a second set of 33 face-to-face interviews carried out between 2008 and 2020, which provide historical and contextual depth. The interviews targeted a broad range of stakeholders involved in monitoring, managing, and researching soybean systems. Many respondents held multiple roles related to soybean production in Argentina and Uruguay, but they were selected to represent three broad domains of expertise:

1. Academic researchers: This group includes scholars in agrarian ecology, soil science, crop physiology, and environmental governance, affiliated with leading research institutions such as the Faculty of Agronomy at the University of Buenos Aires (FAUBA), the Institute for Physiological and Ecological Research Related to Agriculture (IFEVA), the National Scientific and Technical Research Council (CONICET), the National Institute of Agricultural Technology (INTA), the Faculty of Agronomy of the University of the Republic (FAGRO-UDELAR), and the National Institute of Agricultural Research (INIA). In addition to their research on agronomic processes, ecological dynamics, and sustainability challenges in soybean systems, several have also served as consultants or advisors to producers, bridging academic and practical domains.
2. Technical field experts and agribusiness practitioners: This category comprises private consultants, extensionists, production managers, and technical directors working in commercial agriculture across Argentina and Uruguay. Their expertise lies in the daily manage-

23 Geels, Technological Transitions.

ment of soybean cultivation, pest control, and soil conservation, as well as in implementing precision and input-intensive technologies. Through their practical engagement with producers and firms, they provide grounded perspectives on technological adoption and production strategies.
3. Public sector and policy specialists: This group includes officials and advisors from key governmental institutions such as Uruguay's Ministry of Livestock, Agriculture and Fisheries (MGAP), the Ministry of Housing, Territorial Planning and Environment (MVOTMA), and Argentina's Secretariat of Agriculture, Livestock, Fisheries and Food (SAGPyA), as well as international organizations such as the Inter-American Institute for Cooperation on Agriculture (IICA) and the Food and Agriculture Organization of the United Nations (FAO). These experts design, implement and monitor policies related to land use, soil and water conservation, and territorial planning.

The interviews focused on recent transitions in HT soy systems, emerging challenges (e.g., resistance, soil degradation), and potential pathways for transformation. Interviewees were contacted through professional networks, provided with detailed information about the study, and gave informed consent. All interviews were recorded, transcribed, and thematically coded, focusing on actors' perspectives on technological change, ecological pressures, institutional dynamics, and governance. Together, these materials provide a rich understanding of the emergence and stabilization of the HT soy regime, as well as its tensions and challenges. Full details on the interviewees and dates are provided in the appendix.

The interview data are complemented by a diverse set of written materials, including official agricultural and environmental statistics, policy and regulatory documents, agricultural press and corporate communications, and reports from multilateral and national institutions, as well as international market studies on soy and agrochemical inputs. The triangulation of interview data with documentary and statistical sources enables a multilayered and cross-scalar analysis of soybean production dynamics. It allows for the integration of both structural and institutional trends with grounded, actor-specific experiences and interpretations. This approach supports the study's overarching aim of understanding how agro-industrial systems are stabilized, challenged, and potentially transformed over time through the interaction of ecological, technological, and political-economic forces.

Forging *sojización*: Historical precedents, emergence and stabilization

The rise of HT soy has played a pivotal role in transforming agricultural landscapes across South America. Its rapid adoption brought about a profound simplification of farming systems, standardizing and homogenizing agriculture. This section examines the broader sociotechnical regime of HT soy within a longer historical trend of technology-driven agricultural homogenization. It also explores the global-to-national policy and market changes that facilitated *sojización*, as well as how these shifts in production practices and social relations further accelerated the uniformity of agriculture. By linking historical trajectories, policy

environments, and the reconfiguration of social relations, we will trace how HT soy emerged and became stabilized as a dominant regime.

HT soy situated in the long historical trend of technology-driven homogenization

Agriculture inherently involves a degree of ecological simplification, and the expansion of farming significantly affects biodiversity as well as carbon, nitrogen, and hydrological cycles.[24] However, considerable variation exists between small-scale, diverse farming systems and large-scale, uniform ones.[25] In South America, colonialism marked a major shift from the diverse agricultural practices of indigenous communities to more standardized systems. This transition reduced agricultural biodiversity and made the region's economy heavily dependent on a narrow range of commodities.[26]

Agricultural homogenization accelerated during the first wave of globalization (1860–1914), as technological innovations and infrastructure investments lowered transportation costs and facilitated the specialization and globalization of agricultural production and trade.[27] South America became a key agro-food supplier to industrial centres, particularly Great Britain.[28] The construction of railways and ports enabled the export of cash crops and deepened the region's integration into global markets, reinforcing uniformity. Argentina and Uruguay exported vast quantities of meat and wool, while Argentina also shipped wheat, corn, and other grains from its breadbasket region, La Pampa Húmeda.[29]

Technological innovations including chemical fertilizers, pesticides, and mechanization spread gradually – albeit unevenly – across the region, enabling large-scale, standardized farming. The Green Revolution of the mid-twentieth century intensified these trends by promoting high-yield crop varieties tailored for industrial agriculture, further reducing crop diversity. Monoculture, the large-scale cultivation of a single crop over consecutive seasons, became more widespread, maximizing machinery efficiency and economies of scale while reducing biodiversity and local crop varieties. Though Argentina and Uruguay adopted Green

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24 Morufu Olalekan Raimi et al., Exploring How Human Activities Disturb the Balance of Biogeochemical Cycles: Evidence from the Carbon, Nitrogen and Hydrologic Cycles (30 July 2021), available at SSRN, DOI: 10.2139/ssrn.3896054.

25 Natalia Estrada-Carmona et al., Complex Agricultural Landscapes Host More Biodiversity than Simple Ones: A Global Meta-Analysis, in: Proceedings of the National Academy of Sciences 119/38 (2022), e2203385119, https://pubmed.ncbi.nlm.nih.gov/36095174/ (31 July 2025).

26 Carlos Assadourian et al., Agriculture and Land Tenure, in: Victor Bulmer-Thomas et al. (eds.), The Cambridge Economic History of Latin America, Cambridge 2005, 75–314; Victor Bulmer-Thomas, The Economic History of Latin America Since Independence, New York 2014, 87–125.

27 Federico Givoanni, Feeding the World: An Economic History of Agriculture, 1800–2000, Princeton 2010, 85.

28 Luis Bértola/José Antonio Ocampo, The Economic Development of Latin America since Independence, Oxford 2012; Luis Bértola/José Antonio Ocampo, Latin American Economic History in the Light of the Recent Economic Cycles, in: Felipe Valencia Caicedo (ed.), Roots of Underdevelopment: A New Economic and Political History of Latin America and the Caribbean, Cham 2023, 33–67.

29 Vicente Pinilla/Agustina Rayes, How Argentina Became a Super-Exporter of Agricultural and Food Products During the First Globalisation (1880–1929), in: Cliometrica 13/3 (2019), 443–469; Bulmer-Thomas, Economic History, 87–125. La Pampa Húmeda is a vast, fertile plain covering central-eastern Argentina, including parts of Buenos Aires, Santa Fe, Córdoba, and Entre Ríos provinces.

Revolution technologies more slowly than some other regions, in part due to capital constraints and conservative producer attitudes, those who invested in these inputs transitioned toward more uniform, large-scale farming.[30] This transformation concentrated land ownership, marginalized small-scale farmers, and eroded traditional practices and crop diversity.

During the Green Revolution era, soybeans began to gain ground in Argentina, initially being used in mixed systems as a rotational crop to improve soil fertility and diversify production. Soy cultivation was modest in 1970 at only 25,000 hectares (ha) but grew rapidly to over 2 Mha in 1980. This expansion was driven by local seed adaptation efforts alongside rising global demand for vegetable oils and animal feed. Yet the dominance of soy was still limited by high input costs and scarce herbicide options, which made weed control labour-intensive and expensive.

Uruguay likewise saw growth in soybean cultivation after the 1970s, peaking in 1987–89 due to a bilateral trade agreement with Taiwan. However, low yields meant soy was mainly used as a rotational crop to enhance pastures within mixed farming systems.[31] By the 1990s, soybean growing had nearly vanished in Uruguay, and the leading public research organization dedicated to innovation and development in agriculture, INIA, discontinued its soybean research program due to minimal national production.[32]

While soybean cultivation in Argentina was already expanding, the major transformation known as *sojización* did not occur until the 'gene revolution', when Argentina became one of the first countries to approve Monsanto's RR soybeans. Within a few years, this HT variety almost completely replaced conventional soybeans, and Argentina emerged as a global leader in no-till farming, with these technologies adopted in 95 per cent of its grain and oilseed production.[33]

As this section has shown, the homogenization of agriculture in Latin America is a long-term process that began with colonialism. Yet the technological package of HT soy, glyphosate, and no-tillage farming represented a significant acceleration of this trend. New technologies do not emerge in a vacuum, however, nor do they arrive in isolation. Historical legacies such as highly concentrated land ownership, powerful domestic agricultural lobbies, and export-oriented infrastructure aligned seamlessly with large-scale HT soy production.[34] In addition, the neoliberal reforms of the late twentieth century, both globally and nationally, created favourable conditions for the expansion of *sojización*, as we will now explore.

Changes in markets and policies paving the way for sojización

The policy and market shifts that enabled the expansion of soy farming in Argentina and Uruguay from the 1970s to the late 1990s were rooted in broader global transformations. After

30 Baraibar Norberg, Political Economy.

31 Matilda Baraibar, Green Deserts or New Opportunities? Competing and Complementary Views on the Soybean Expansion in Uruguay, 2002–2013, doctoral thesis, Stockholm University 2014.

32 Interview no. 6 (Research Director; specialist in crop ecophysiology, soil management, and simulation models, INIA, Uruguay; adjunct professor, FAGRO-UDELAR), 12 August 2024.

33 Baraibar Norberg, Political Economy; OECD, Agricultural Policies in Argentina, in: OECD Food and Agricultural Reviews, Paris 2019, DOI: 10.1787/9789264311695-en.

34 Baraibar Norberg, Political Economy.

the collapse of the Bretton Woods system in 1973, the global governance of food production began moving away from the nationally oriented, state-led developmentalist model that had defined the post-war era of embedded liberalism. In its place emerged a more corporate-driven, globally integrated market system. During this period, South America underwent a profound transformation. Import substitution industrialization strategies were increasingly seen as unsuccessful, and the debt crisis of the 1980s prompted international financial institutions to demand austerity, liberalization, privatization, and deregulation as conditions for debt relief. In response to these pressures and their own economic crises, Argentina and Uruguay adopted neoliberal reforms, promoting export-oriented agriculture in line with the logic of comparative advantage.[35]

Under President Carlos Menem (1989–1999), Argentina fully embraced Washington Consensus reforms including the liberalization and privatization of state-owned enterprises, the Convertibility Plan that pegged the peso to the US dollar, and measures to attract foreign investment. Key agricultural reforms included dismantling the Junta Nacional de Granos, which had controlled grain and oilseed exports, and eliminating export taxes on most grains – though a reduced rate of 3.5 per cent was retained for soybeans and sunflowers. Uruguay likewise adopted neoliberal reforms, though more cautiously, with popular referendums blocking several privatization efforts. Both countries reduced tariffs on imported agricultural machinery and inputs, cut back on farmer support programs, and liberalized land markets, indirectly promoting the growth of large-scale, industrialized farming.[36]

At the same time, multinational agribusiness corporations (including Cargill, Archer Daniels Midland [ADM], Bunge, and Louis Dreyfus Commodities [LDC]) became increasingly vertically integrated through mergers and acquisitions, consolidating control over global commodity supply chains.[37] These firms invested heavily in infrastructure such as grain storage and port facilities, reinforcing South America's role as a key supplier in the global grain trade. International markets favour consistency and high volumes, incentivizing farmers and agribusinesses to produce standardized crops tailored to buyers' specifications. Moreover, the high cost of idle shipping time in ports pushes traders to cooperate by sourcing and blending grain from multiple suppliers to load ships quickly.[38] This highly efficient system leads to the grain losing traceability to its place of origin, eliminating any reward for superior quality and further reducing varietal and geographical differentiation.

Another key development was the rise of agrochemical giants like Monsanto, BASF, Bayer and DuPont, which moved into biotechnology during the 1980s and 1990s. These firms acquired or partnered with seed companies to develop proprietary technologies bundled into complete input packages (standardized seeds, fertilizers, and pesticides) that facilitated homogenization. This expansion was supported by the growing strength of global intellectual property regimes. Reforms to the International Union for the Protection of New Varieties of Plants (UPOV) in 1991 enhanced breeders' rights and curtailed farmers' ability to save seeds.

35 Interview no. 20 (Director of Social Studies, Institute of Social Studies, INTA; former coordinator, 2013 National Census of Agricultural Producers; former researcher, Ministry of Economy, Argentina), 2 March 2017.

36 Baraibar Norberg, Political Economy, 170–177.

37 Jennifer Clapp, Titans of Industrial Agriculture: How a Few Giant Corporations Came to Dominate the Farm Sector and Why It Matters, Cambridge 2025.

38 Interview no. 30 (Traders; commercial agents from major trading companies involved in soy and grain trade, Port of Nueva Palmira, Uruguay), 11 March 2017.

These changes informed the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organization, which requires signatory countries to protect plant varieties through patents, sui generis systems, or both.[39]

The dominant role of a few giant agribusiness firms in the 'gene revolution' marked a clear departure from the earlier Green Revolution, where the public sector played a central role. It promotes even more large-scale, standardized production systems aimed at maximizing yields and protein content while minimizing labour costs.

The convergence of these technological innovations, corporate strategies, and liberalization policies laid the foundation for the rapid spread of soy cultivation in South America. The result was a highly efficient but increasingly homogenized socio-technical regime centred on HT soy. The dynamics of this model will now be examined in the cases of Argentina and, subsequently, Uruguay.

Effects of sojización *on production practices and social relations*

Argentina experienced one of the fastest and most extensive adoptions of HT soy in the world. Within just a few years of its introduction in 1996, over 90 per cent of soybeans planted in the country were of the glyphosate-tolerant variety known as RR soy. Several factors facilitated this rapid spread. One key driver was the coordinated effort of actors promoting its integration with no-till farming and glyphosate use.[40] This alliance drew strength from Argentina's well-developed network of public and private agricultural institutions as well as influential producer organizations, most notably the Argentine Association of Zero-Tillage Farmers (AAPRESID), the Argentine Association of Regional Agricultural Experimentation Consortia (AACREA), and Argentina's main public agricultural research body INTA.

AAPRESID, founded in 1989 by farmers and agronomists concerned about soil degradation from conventional tillage, became a leading advocate of no-till farming. With the arrival of HT soy and glyphosate in the mid-1990s, the organization embraced the new package as a way to boost productivity while preserving soil health. It facilitated field trials, training, farmer networks, and partnerships with seed companies and agronomists, serving as a key link between research and practice.[41] AACREA, established in the 1960s, supported the model through its regional producer-consultant groups. Known for on-farm experimentation, AACREA tested and refined RR soy varieties across diverse environments, monitored input use and yields, and produced practical, site-specific data to guide adoption. This helped to legitimize and tailor the model to local conditions.[42] INTA further advanced the diffusion of HT soy and no-till systems through applied research and technical support. INTA worked

39 Clapp, Titans, 211–218.

40 Rocío Ceverio et al., Obtentores de Semillas, Agricultores y Estado: El Conflicto por los Derechos de Propiedad Intelectual en Argentina, in: Cadernos de Ciência & Tecnologia 1/3 (2008), 9–35.

41 Interview no. 3 (Researcher; extensionist and consultant; professor of ecology of agrarian systems, IFEVA, FAUBA, CONICET, Argentina; FAGRO-UDELAR, Uruguay), 20 May 2024.

42 Eduardo Trigo et al., The Case of Zero-Tillage Technology in Argentina, IFPRI Discussion Papers 915, International Food Policy Research Institute, 2009, https://cgspace.cgiar.org/server/api/core/bitstreams/ee9f9cc6-11cf-49b3-8ae9-b51074e42f0f/content (31 July 2025); María Soledad Córdoba et al., Agronegocios y Hegemonía: Estrategias para la Producción de Consenso Social Ampliado, in: Población y Sociedad 30/2 (2023), 121–149.

closely with machinery manufacturers to adapt no-till equipment, assessed varietal performance, and framed the technological package as both agronomically sound and environmentally beneficial.[43] Together, these organizations aligned technical, institutional, and discursive support behind the HT soy model.[44] By promoting soil conservation, efficiency, and competitiveness, they helped to normalize a profound transformation of Argentine agriculture, establishing a new socio-technical regime centred on HT soy, glyphosate, and no-till farming.

A further crucial factor was the absence of a valid Monsanto patent on the RR gene in Argentina. This allowed local seed companies licensed by Monsanto to sell RR seeds without enforcing royalty payments. Farmers were able to save and replant seeds, a legally protected practice under Argentina's 1973 seed law. As a result, Argentine producers faced significantly lower seed costs than their counterparts in countries with stricter intellectual property regimes, accelerating adoption. Monsanto initially tolerated this arrangement, pursuing a "seed now, pay later" strategy to encourage diffusion and build future market dominance.[45] However, once adoption was widespread, Monsanto shifted strategy and began seeking royalty payments. These efforts were met with strong resistance from farmers and the Argentine government. Although Argentina was a signatory to UPOV and TRIPS, its national legislation explicitly upheld the farmers' privilege, i.e. the right to save and reuse seed.[46]

Beyond business strategies and institutional arrangements, the core driver of the rapid adoption of HT soy was its practical effectiveness. The combination of RR soy and glyphosate offered farmers a simple, reliable, and inexpensive solution for weed control, eliminating the need for labour-intensive tilling and repeated herbicide applications. A single glyphosate spray could replace complex weed management routines, significantly reducing costs especially in large-scale monoculture systems.[47] Moreover, the effectiveness of glyphosate made tilling unnecessary and spurred the adoption of no-till farming, lowering fuel and machinery expenses while minimizing soil disturbance. This helped prevent erosion, retain soil moisture, and preserve organic matter and microbial life. Together, these factors enabled soybean cultivation to expand into areas previously considered marginal or unsuitable for mechanized farming, including forests and shrublands. In this way, soy farming expanded from central Argentina into natural or semi-natural ecosystems in the north of the country.[48] Between 1990 and 2015, Argentina lost 22 per cent of its forests, largely due to agricultural expansion driven by soy.[49] At the same time, crop production in Argentina's breadbasket region, la

43 Trigo et al., Case.

44 Interview no. 18 (Director of Agricultural Affairs, CARI; advisor to the Director-General of FAO on strategic planning; former Vice Minister of Agricultural Economy; former Director General, IICA; former President of the Board, IFPRI), 1 March 2017; interview no. 20.

45 Trigo et al., Case.

46 Eduardo J. Trigo, Veinte Años de Cultivos Genéticamente Modificados en la Agricultura Argentina, [Buenos Aires] 2016, 1–43, https://www.fiba.org.ar/wp-content/uploads/2016/12/informe20gm.pdf (14 July 2025); interview no. 19 (Former Secretary of Agriculture, Livestock and Fisheries, MAGyP; director, CICPES, INTA; former president, INTeA S.A.), 2 March 2017.

47 Interview no. 1 (Researcher, specialist in agrarian ecology, FAUBA, CONICET, Argentina), 3 May 2024; interview no. 2 (Researcher, specialist in management practices in agro-food systems, FAUBA, Argentina), 21 February 2024.

48 Di Mauro et al., Transformations; Trigo, Veinte, 12.

49 Néstor Gasparri/Yann Le Polain de Waroux, The Coupling of South American Soybean and Cattle Production Frontiers: New Challenges for Conservation Policy and Land Change Science, in: Conservation Letters 8/4

Pampa Húmeda, intensified. Traditional rotation systems that included pastures were displaced by simplified schemes such as double cropping (typically soy and wheat) or even continuous soybean cultivation.[50]

Counterintuitively, Argentina's devastating 2001–2002 crisis ultimately benefited its soybean sector as well. In January 2002, the government converted dollar-denominated debts into pesos at a 1:1 rate. Soon after, the peso sharply depreciated, losing about two-thirds of its value by mid-year and stabilizing around 3 pesos per dollar.[51] Many soy producers held significant debts incurred during the era of peso–dollar parity. Once converted to pesos, these debts were drastically reduced in real terms. At the same time, soybean exports (priced in dollars) generated far greater revenues in local currency. This combination of reduced liabilities and soaring income resulted in a substantial windfall for producers. The peso devaluation also enhanced Argentina's overall export competitiveness, positioning soy as a critical source of foreign exchange in the country's economic recovery. Together, these factors intensified the expansion of the soybean sector during the early 2000s.

Around 2002–2003, HT soy began to expand rapidly in Uruguay as well, largely driven by Argentine producers and firms who brought with them technologies, capital, and production practices.[52] A key push factor was the reintroduction of export taxes (*retenciones*) on agricultural products by the Argentine government to address fiscal deficits following the 2001–2002 crisis. Combined with the pull factor of lower land prices and the absence of export taxes in Uruguay, this encouraged Argentine farmers and agribusinesses to spread both their geographical and political risk by expanding across the border.[53] The previously mentioned deregulation of land markets played a crucial role in enabling these firms to rapidly scale and replicate their model elsewhere. While yields in Uruguay were typically lower due to more erosive soils, the adoption of the new technological package centred on HT soy helped reduce the yield gap.[54]

Following this initial, largely foreign-led and 'spontaneous' phase of expansion, domestic actors also began to play an important role in the rapid growth of soybean cultivation in Uruguay. INIA reactivated its soybean breeding program (which had been suspended between 1999 and 2003 due to limited farmer interest) to adapt herbicide-tolerant varieties

(2015), 290–298; Néstor Gasparri et al., Linkages Between Soybean and Neotropical Deforestation: Coupling and Transient Decoupling Dynamics in a Multi-Decadal Analysis, in: Global Environmental Change 23/6 (2013), 1605–1614; Ricardo Grau et al., Agriculture Expansion and Deforestation in Seasonally Dry Forests of North-West Argentina, in: Environmental Conservation 32/2 (2005), 140–148; OECD, Agricultural Policies, 144.

50 Roberto Álvarez et al., Cambios en los Niveles de Fósforo Extraíble de los Suelos Pampeanos por el Uso, in: Carmen Cholaky/José Cisneros (eds.), Actas XXV Congreso Argentino de la Ciencia del Suelo, Río Cuarto 2016, 175–189.

51 Sumit Agarwal et al., The Impact of the 2001 Financial Crisis and the Economic Policy Responses on the Argentine Mortgage Market, in: Journal of Housing Economics 14/3 (2005), 242–270.

52 Baraibar, Green Deserts; Baraibar Norberg, Political Economy.

53 Interview no. 24 (Chief Executive Officer, El Tejar Uruguay; President, MTO; agronomist and consultant), 23 February 2008; interview no. 25 (Chief of Sales, Agronegocios del Plata, Uruguay), 13 February 2008.

54 Interview no. 41 (Director, OPYPA, MGAP; former tax specialist; agronomist, Uruguay), 8 March 2017; interview no. 31 (President, National Institute of Seeds; agronomist; politician, Socialist Party, Frente Amplio, Uruguay), 6 March 2010.

to local conditions and support technological packages such as no-till and crop rotations.[55] These efforts were complemented by new public–private initiatives, such as the Oilseeds Technological Board (MTO), which strengthened the institutional framework for soybean production. As a result, soybean area expanded from 27,600 ha in 2000/01 to 1.33 Mha in 2014/15. Although average yields (2.1 t/ha in 2001–2016) remained lower than in Argentina or Brazil, total production surged due to the vast increase in cultivated area.[56]

This growth was part of broader land-use changes. Over 3.5 Mha of native grasslands were converted to cropping systems, and Uruguay's annually cultivated area grew from 0.4 to 2 Mha within a decade, with soy and wheat accounting for approximately 50 and 25 per cent respectively.[57] The expansion was accompanied by rapid agricultural intensification: Double cropping became widespread, crop rotations were shortened, and agrochemical use surged. Between 2000 and 2023, Uruguay's total pesticide imports more than quadrupled, rising from 10,540 tons to 46,100 tons. During the same period, pesticide use per hectare of cropland increased from 2.58 kg in 2000 to 7.35 kg in 2023.[58] Herbicides accounted for about 89 per cent of this increase, largely due to rising glyphosate use.[59]

A key organizational innovation on the cultivation side was the emergence of a new type of agricultural firm: the *pools de siembra* (sowing pools). These entities aggregated capital from new financial actors such as pension funds and institutional investors and operated primarily on leased land. Originating in the Argentine Pampas, they soon expanded into frontier areas like the Chaco and across borders into Uruguay, Paraguay, and Bolivia. Geographic diversification became a central strategy for managing climatic, market, and political risks.[60] As a result, HT soy in both Argentina and Uruguay came to be predominantly cultivated by large firms operating on leased land.

This marked a sharp departure from traditional arrangements, where large landowners (often cattle ranchers) leased plots to tenant farmers.[61] As land values rose, many traditional tenants and sharecroppers were priced out, with farmland increasingly leased by corporate operators under short-term contracts requiring upfront payment.[62] Not only land but also core production inputs, i.e. machinery, seeds, and labour, were increasingly leased or out-

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55 Interview no. 35 (Director, Programme for Production and Environmental Sustainability, INIA; researcher and lecturer, FAGRO-UDELAR; board member, ISTRO, Uruguay), 3 March 2017.

56 Bruno Lanfranco et al., En la Búsqueda de los Límites de la Intensificación Sostenible de la Agricultura, in: Revista INIA 77 (2024), 32–36.

57 Ingrid Tejada, Soy in Uruguay from 1961–2016: How the Adoption of Soy Has Influenced Agricultural Production Systems and Land-Use, doctoral dissertation, Flinders University, Adelaide 2019.

58 FAO Annual Analytical Brief: FAO. 2025. Pesticides Use and Trade, 1990–2023. FAOSTAT Analytical Briefs, No. 109. Rome, DOI: 10.4060/cd5968en; FAOSTAT, Pesticides Trade, https://www.fao.org/faostat/en/#data/RT (23 October 2025); FAOSTAT, Pesticides Use, https://www.fao.org/faostat/en/#data/RP (23 October 2025).

59 Cintia Palladino et al., Pesticide Dependence and Associated Risks in Uruguayan Agriculture: Limitations in Its Approach, in: Agrociencia Uruguay 27/1156 (2023), 3–4, DOI: /10.31285/AGRO.27.1156.

60 Interview no. 26 (President, Rural Federation; veterinarian, rancher and landowner; lecturer, FAGRO-UDELAR, Uruguay), 3 March 2009; interview no. 24; interview no. 25.

61 José Barrán/Benjamín Nahum, Uruguayan Rural History, in: Hispanic American Historical Review 64/4 (1984), 655–673; James Scobie, Revolution on the Pampas: A Social History of Argentine Wheat, 1860–1910, Austin 1964.

62 Clara Craviotti/Carla Gras, De Desafiliaciones y Desligamientos: Trayectorias de Productores Familiares Expulsados de la Agricultura Pampeana, in: Desarrollo Económico (2006), 117–134; José Manuel Deninotti, Caracterización de los Cededores de Tierra "Rentistas" en los Partidos de Pergamino y Junín, y sus Relaciones

sourced, giving rise to a model of asset-light farming.[63] In this way, *pools de siembra* and other agribusiness actors operated with minimal in-house labour or fixed capital, outsourcing core tasks like planting, spraying, harvesting, and hauling to *contratistas* (contractors). Many of these contractors were former farmers who had lost access to land due to the rising lease prices.[64] By investing in machinery, they began offering services to larger operators, reinforcing a model of highly mechanized and subcontracted farming.[65] This system shifted decision-making power away from farmers and toward input suppliers, agronomists, technical advisors, contractors, and grain traders. Input providers played a central role by offering integrated service packages that included seeds, agrochemicals, technical advice, and financing.[66] Networks of innovation and information linking producers, input suppliers, research institutes, and firms facilitated knowledge transfer and institutionalized the new regime. These networks, often overlapping across the Argentina–Uruguay border, were consistently cited by interviewed actors as a key driver of homogenization. This shift consolidated a production model in both countries based on economies of scale, standardized inputs, and uniform agronomic practices.[67]

Even as new intermediaries emerged, small and medium-sized farmers continued to disappear. In Uruguay, this was exacerbated by high debt levels among traditional farmers during 2002–2005, followed by a sharp rise in lease prices driven by the influx of Argentine producers (from an average of $28/ha in 2000 to $133/ha between 2011 and 2020).[68] Only soy could justify such high rents, creating a reinforcing feedback loop that further concentrated land and capital.[69] Some of the largest firms came to manage up to 100,000 ha, while many smaller producers either exited farming or leased their land to larger operations.[70]

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con la Agricultura Familiar, diploma thesis, Universidad Nacional del Noroeste de la Provincia de Buenos Aires, Pergamino 2020; Oyhantçabal Benelli et al., Who Rents Out the Land.

63 Christian Berndt et al., Postneoliberalism as Institutional Recalibration: Reading Polanyi Through Argentina's Soy Boom, in: Environment and Planning A: Economy and Space 52/1 (2020), 216–236, DOI: 10.1177/0308518X19825657; Pedro Arbeletche, El Agronegocio en Uruguay: Su Evolución y Estrategias Cambiantes en el Siglo XXI, in: Rivar 7/19 (2020), 109–129, DOI: 10.35588/rivar.v7i19.4355; Martine Guibert et al., De Argentina a Uruguay: Espacios y Actores en una Nueva Lógica de Producción Agrícola, in: Pampa: Revista Interuniversitaria de Estudios Territoriales 7 (2011), 13–38.

64 Baraibar, Green Deserts.

65 Valeria Hernández/José Muzlera, El Contratismo y su Integración al Modelo de Agronegocios: Producción y Servicios en la Región Pampeana, in: Mundo Agrario 17/34 (2016), 1–22; José Muzlera, Análisis de los Vínculos Familia-Empresa en los Contratistas de Maquinaria Agrícola Pampeanos, in: La Rivada 6 (2018), 152–166.

66 CASAFE, Industria de Fitosanitarios en Argentina, https://www.casafe.org/informe-industria-de-fitosanitarios-en-argentina/ (15 September 2024); interview no. 4 (Researcher; assistant professor, IFEVA, FAUBA; CONICET, Argentina), 3 September 2024; interview no. 12 (Production Manager, agribusiness firm, various provinces, Argentina), 2 August 2024.

67 Carla Gras/Valeria Hernández, Agribusiness and Large-Scale Farming: Capitalist Globalisation in Argentine Agriculture, in: Canadian Journal of Development Studies 35/3 (2014), 339–357; Carla Gras/Valeria Hernández, El Agro como Negocio, Buenos Aires 2023; interview no. 14 (Advisor; specialist in agricultural public policy, DINOT, MVOTMA, Uruguay), 17 June 2024.

68 DIEA, Anuario de Estadísticas Agropecuarias (2024), Oficina de Estadísticas Agropecuarias, Ministerio de Ganadería, Agricultura y Pesca, https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/diea/anuario2024 (18 September 2024).

69 Gastón Caligaris, Los Países; Clara Craviotti, Embeddedness; Muzlera/Pérez-Gañán, Legacy; Leguizamón et al., Environmental Potential.

70 Baraibar, Green Deserts.

The decline of traditional sharecroppers and the rise of dense, transnational networks of information and services contributed to a striking convergence in production methods. As one Uruguayan agronomist explained:

> "There really aren't any differences in practices or management among soybean farmers anymore. Everyone is well-informed and uses the same technological package centred around herbicide-tolerant seeds. Margins are tight, and competition is fierce – those who didn't get it right have been outcompeted and are no longer in the game. The farmers still in business are managing rather large extensions; they are highly professional, deeply connected to knowledge networks. The same agronomists work across the country, so the only real differences between places are those tied strictly to agroecological conditions."[71]

The homogenization of agricultural practices was further reinforced by downstream market demands. Soybeans from Argentina and Uruguay were (and still are) primarily exported by multinational grain traders – most notably ADM, Bunge, Cargill, LDC, and, since the 2010s, China's state-owned China National Cereals, Oils and Foodstuffs Corporation (COFCO) – who require standardized products for global feed and processing markets. Unlike food products with geographic branding (e.g., wine or coffee), soy for animal feed lacks place-based differentiation. This absence of consumer-facing quality distinctions favours uniformity, prioritizing consistency, protein content, and bulk efficiency over agroecological or varietal diversity.

China's growing demand played a decisive role in reinforcing these dynamics as well. As China liberalized its agricultural trade regime by lowering import tariffs, phasing out export subsidies, and opening key sectors in the wake of its accession to the World Trade Organization in 2001, it rapidly transitioned from a largely self-sufficient soybean producer into the world's largest importer.[72] By 2022, China imported 97 million metric tons of soybeans (around nine times the volume in 2000) and accounted for approximately 60 per cent of global soybean trade. Around 95 per cent of these imports were crushed into soymeal for animal feed, while domestic production remained focused on soy for direct human consumption (e.g., tofu, soy sauce, sprouts). This bifurcated demand structure reinforced the need for a highly standardized, high-protein feed crop with little market incentive for differentiation in taste, texture, or environmental origin, thus further entrenching homogeneity in the global soy supply chain.[73] Together, the mentioned overlapping market, technical, and institutional pressures drove farmers to reduce variability and adopt standardized production systems geared toward efficiency. Uniform inputs, agronomic practices, and managerial models generated economies of scale, favouring large-scale operations and further accelerating the spread of *sojización*.

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71 Interview no. 15 (Public Official; technician in Soil Management and Conservation, RENARE, MGAP, Uruguay), 14 August 2024.

72 Baraibar Norberg/Deutsch, Soybean, 126–128.

73 Interview no. 3; interview no. 6.

Understanding HT soy as a socio-technical regime

The expansion and consolidation of HT soy in Argentina (from the late 1990s) and Uruguay (from the early 2000s) marked the emergence of a new socio-technical regime; a dominant configuration of technologies, practices, institutions, and actors that became increasingly stabilized and self-reinforcing. As illustrated in Figure 2, this regime came to revolve around three interlocking elements: HT soy, glyphosate use, and no-till farming.

At the *landscape level* (characterized by broad, exogenous trends), global shifts such as trade liberalization, strengthened intellectual property rights, and the rise of China as the world's dominant soybean importer created structural conditions that favoured this transformation. These trends were reinforced by strategies pursued by global agribusiness actors, including mergers and acquisitions, vertical integration, and the growing financialization of agriculture, all of which shaped the opportunity space for HT soy adoption across the Southern Cone.

The regional boom was further facilitated by preceding neoliberal reforms at both the international and national levels. These included the deregulation and flexibilization of land markets, the weakening of state support systems for smallholders, and the consolidation of agribusiness networks. Together, these developments helped create an institutional and political context highly conducive to the rise and stabilization of this new socio-technical system.

At the *regime level,* the HT soy system entrenched itself by offering farmers a simple and highly effective technological package. Glyphosate-based weed control drastically reduced labour and input costs, while the adoption of no-till farming enabled expansion into less fertile or marginal lands. The technical advantages of the system were low complexity, adaptability, and cost-effectiveness, making it particularly attractive for large-scale mechanized farming.

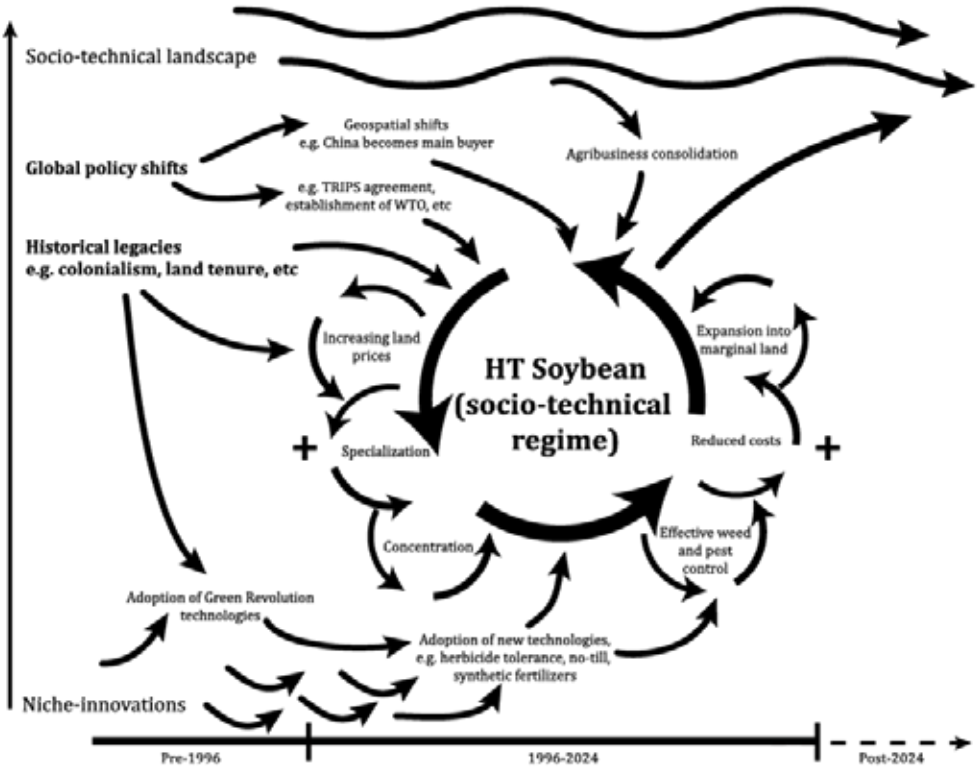
Thanks to strong global demand and high international prices (as shaped by *landscape level* forces), HT soy consistently offered higher profit margins than any alternative land use. These economic incentives contributed to rapidly rising land and lease prices, creating a powerful feedback loop: To remain competitive in an increasingly costly environment, many farmers and firms intensified their reliance on soy. This dynamic further accelerated the expansion of cultivation and promoted the homogenization of agricultural landscapes. Economies of scale favoured large operators, while growing demand for standardized soymeal from multinational grain traders and China's feed industry locked producers into uniform production systems with limited scope for diversification.

Historical legacies also played a significant role. Earlier processes of agricultural homogenization such as colonial frontier expansion, the Green Revolution, and the industrialization of agriculture had already produced highly concentrated land structures and powerful rural lobby groups. HT soy did not break with these trajectories but rather intensified them: Small and medium-sized producers were increasingly displaced, while larger actors cemented their dominance.

The consolidation of the regime was facilitated by multiple self-reinforcing mechanisms: standardized production practices encouraged by downstream actors (e.g., multinational traders and Chinese buyers), rising land prices, dense knowledge networks, and major investments in logistics and infrastructure. As shown in Figure 2, these feedback loops contributed

to stabilizing the dominance of HT soy across diverse agroecological zones in both Argentina and Uruguay.

Figure 2: Representation of the HT soybean socio-technical regime and feedback mechanisms driving homogenization



Source: Authors' illustration, following Geels, Technological Transitions.

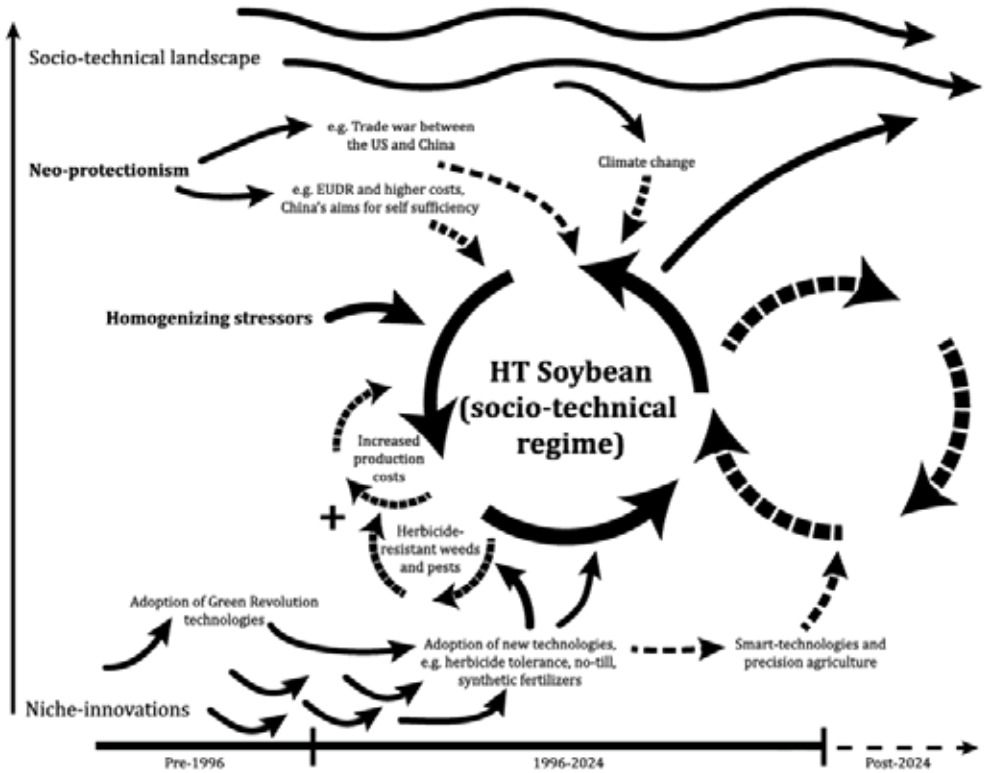
Are social-ecological pressures pushing toward greater complexity?

Socio-technical regimes, however, are not immutable, for social-ecological systems are inherently dynamic. While the HT soy regime in Argentina and Uruguay achieved an extraordinary rate of expansion, transforming diverse agroecosystems into highly specialized monocultures managed through uniform practices, it now faces pressures from both above and below.

This section analyses the dynamic ecological and social feedback mechanisms and other pressures that emerged after *sojización*. By the time these countervailing dynamics became visible, the simplified production systems centred on HT soy seeds, glyphosate, and no-

till practices had already been applied on vast areas for several years. Opposing pressures emerged across multiple scales including national and subnational policies, local ecosystems, international markets, and shifting regulatory frameworks. While some feedback mechanisms continued to align with and reinforce the HT soy regime, others began to contest its dominance and impel the system toward greater heterogeneity and complexity.

Figure 3: Representation of the HT soybean socio-technical regime and feedback mechanisms countervailing it



Source: Authors' illustration, following Geels, Technological Transitions.

Despite the enduring legacy of *sojización,* owed in particular to entrenched infrastructural and logistical systems favouring large-scale operations, countervailing dynamics are gaining ground. As Figure 3 illustrates, environmental degradation, herbicide-resistant weeds, social contestation, and shifting political and trade environments are increasingly challenging the regime's stability. These pressures originating at both the landscape and niche levels remain largely peripheral for now but could eventually become destabilizing forces.

Figure 3 thus complements and contrasts Figure 2. While Figure 2 visualizes the feedback mechanisms reinforcing the homogenization of the HT soy regime, Figure 3 indicates a system at a crossroads. Drawing on developments from the bio-environmental, socio-politi-

cal, and economic domains, the following sections explore potentially destabilizing elements and ask whether the system may be moving away from homogenization.

Socio-political responses to sojización

As noted in the literature review, much of the research on the social effects of soy expansion in Argentina and Uruguay has emphasized the growing power of agribusiness actors, increasing land concentration, and the displacement of family farmers and indigenous communities. These issues were widely debated by the newly elected left-leaning governments across South America (often referred to as the 'pink tide'), including *Kirchnerismo* (2003–2015)[74] in Argentina and Frente Amplio (2005–2020 and again from 2025 onward)[75] in Uruguay. Emerging from the wave of social mobilization against neoliberalism in the early 2000s, both governments embraced state intervention and heterodox economic strategies.[76] While they frequently denounced the socially polarizing and environmentally damaging consequences of the expanding soy sector and emphasized the need for active industrial policies to reduce dependence on natural resource–intensive and low-wage exports, most scholars agree that their policies did little to meaningfully constrain its prevalence.[77] Nonetheless, several policy measures shaped the trajectory of *sojización* in distinct ways.

In Argentina, export taxes became a central pillar of fiscal policy under Kirchnerismo, especially during the commodity boom of the 2000s. By 2008, *retenciones* accounted for nearly 3 per cent of the Gross Domestic Product, with soybeans subject to the highest duties at 35 per cent.[78] These fiscal choices reinforced the HT soy regime by sustaining profitability at scale and by incentivizing asset-light, financialized land control. In addition, these taxes were framed as redistributive tools to capture windfall profits and finance social spending. However, they triggered fierce opposition from farmers' organizations and agribusiness groups. The introduction of a variable export tax tied to global prices in March 2008 provoked the *conflicto del campo*, the largest rural protest in decades. A broad coalition of actors rallied under the banner of *el campo*, portraying the measure as an assault on private property and market freedoms. The resulting political crisis forced the government to retract the reform, revealing the limits of state extractive capacity when confronted with powerful agrarian actors.[79]

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74 *Kirchnerismo* refers to the political project associated with Néstor Kirchner (President of Argentina from 2003 to 2007) and Cristina Fernández de Kirchner (President from 2007 to 2015).

75 The *Frente Amplio* (Broad Front) is a left-wing political coalition that governed Uruguay from 2005 to 2020 under presidents Tabaré Vázquez (2005–2010, 2015–2020) and José Mujica (2010–2015) and returned to power in 2025 under Yamandú Orsi.

76 Berndt et al., Postneoliberalism; Baraibar Norberg, Sojización.

77 Fabio dos Santos/Joana Vasconcelos, The Glyphosate Consensus: Rural Poverty Management and Agribusiness in South America during the Pink Tide (1998–2016), in: Pablo Vommaro/Pablo Baisotti (eds.), Persistence and Emergencies of Inequalities in Latin America: A Multidimensional Approach, Cham 2022, 247–266; Leandro Vergara-Camus/Cristóbal Kay, New Agrarian Democracies: The Pink Tide's Lost Opportunity, in: Socialist Register 54/54 (2017), 211–230.

78 These taxes helped finance federal programs and captured a portion of the global agricultural export boom.

79 Interview no. 22 (Director of Research Promotion; researcher in pedagogy, CLACSO, Argentina), 3 March 2017.

Despite these high duties, soy cultivation continued to expand, driven by strong global demand and lower capital and labour requirements relative to other land uses. Export taxes did, however, influence production and investment patterns. They encouraged the rise of financialized farming models such as the previously mentioned *pools de siembra*, which spread risk and sustained profitability at scale.[80] Meanwhile, differential export tax rates (lower on processed soymeal and oil than on unprocessed beans) supported the development of domestic crushing industries, especially around the Rosario export hub. This strategy reinforced Argentina's position as the world's top soymeal exporter and strengthened vertically integrated agribusiness firms.

Additional fiscal and quasi-fiscal policies also affected soy's trajectory. Currency controls and multiple exchange rates, particularly from 2011 onward, represented a de facto tax on exports. Soy exporters were often required to sell foreign currency earnings at artificially low official rates, reducing their real revenues. To mitigate the resulting export slowdown and boost foreign reserves, the state intermittently introduced preferential exchange rates, for example via the *dólar soja* programs in 2022–2023. While intended to accelerate exports, such interventions added volatility and encouraged strategic stockpiling.[81]

Under the centre-right administration of Mauricio Macri (2015–2019), fiscal policy shifted toward liberalization. Macri reduced export taxes on soybeans from 35 to 30 per cent, eliminated them for most other agricultural goods, and promised a more predictable investment climate.[82] Yet his administration soon faced macroeconomic instability: Amid a currency crisis in 2018, it reintroduced broad-based export taxes via a fixed peso-per-dollar mechanism that effectively raised the burden as the currency depreciated.

Alberto Fernández (2019–2023) restored a more interventionist stance. Soy export duties were raised to 33 per cent by 2021 to address fiscal deficits linked to recession, inflation, and the COVID-19 crisis.[83] The government argued this was essential for macroeconomic stability, but tensions with the agricultural sector resurfaced.

During the 2024 presidential campaign, Javier Milei promised to eliminate export taxes on soy, corn, and wheat.[84] In early 2025, his government temporarily reduced duties on soybeans from 33 to 26 per cent and on soymeal and oil from 31 to 24.5 per cent, citing drought conditions and low prices.[85] However, by July 2025, these rates reverted to their previous values despite protests from rural groups, many of whom had backed Milei politically.[86] The

80 Interview no. 20.

81 Interview no. 3.

82 OECD, Agricultural Policies, 144; OECD, Agricultural Policy Monitoring and Evaluation 2023: Adapting Agriculture to Climate Change, Paris 2023, DOI: 10.1787/b14de474-en.

83 OECD, Agricultural Policy Monitoring.

84 Javier Milei ante Productores Agropecuarios en La Rural: "Vamos a Eliminar el Impuesto PAIS y Después las Retenciones," in: El Economista online (24 May 2024), https://eleconomista.com.ar/politica/javier-milei-productores-agropecuarios-rural-vamos-eliminar-impuesto-pais-despues-retenciones-n73989 (28 June 2025).

85 Argentina Slashes Export Taxes to Rescue Drought-Hit Farmers, in: Buenos Aires Times online (23 January 2025), https://www.batimes.com.ar/news/economy/argentina-slashes-export-taxes-to-rescue-drought-hit-farmers.phtml (16 July 2025). The tax on corn was reduced from 12 per cent to 9.5 per cent. There were also cuts for other major crops including wheat, barley, and sunflowers.

86 El Campo Volvió a Reclamarle a Milei una Baja de Retenciones: "Esperábamos...," in: El Cronista online (6 July 2025), https://www.cronista.com/economia-politica/el-campo-volvio-a-reclamarle-a-milei-una-baja-de-retenciones-esperabamos/ (16 July 2025); Fernando Bertello, A Solas: La Contundente Frase de Nicolás Pino

enduring reliance on *retenciones* reflects Argentina's structural dependence on soy-derived revenue, regardless of political ideology.

More broadly, Argentina's unstable fiscal and exchange rate regimes incentivized spatial and financial diversification among agribusiness actors. Firms increasingly sought to manage risk by expanding into neighbouring countries such as Uruguay, where the tax environment was more predictable. Cross-border leasing, contract farming, and vertical integration enabled companies to operate regionally while hedging against domestic policy shocks. This asset and production flexibility supported continuity of the regime despite domestic policy shocks. Although soybean cultivation continued to expand within Argentina, interviews with producers and company representatives consistently identified tax and currency volatility as key drivers of outward expansion.[87]

By contrast, Uruguay pursued a more stable and transparent fiscal approach. There were no export taxes on agricultural products, and while the 2007 tax reform introduced a progressive personal income tax and a flat 25 per cent corporate tax (IRAE), the system also offered a wide range of favourable tax incentives and exemptions.[88] For instance, the government provided substantial investment incentives through the Investment Promotion Act (Act 16,906) of 1998 and its subsequent decrees (particularly Decree No. 455/07 of 2007), under which agribusiness firms could qualify for corporate tax exemptions of up to 90 per cent on approved investments, lasting between 4 and 25 years, with the highest benefits granted to the largest projects (Art.16).[89] Additional advantages included exemptions from Value Added Tax and import duties on machinery and inputs. Eligible projects covered irrigation systems, soil improvements such as liming, clean technologies, certifications, and agricultural research and development.[90] These incentives effectively reduced the average corporate tax rate for participating firms to around 13.4 per cent, well below the statutory 25 per cent.[91]

Overall, the effective fiscal burden on agriculture in Uruguay remained relatively low. In 2015, however, rural property taxes were slightly increased, placing greater fiscal pressure on large landowners.[92] This was partly framed as a response to public debate on land concentration and the "foreignization" of farmland in the wake of *sojización*.

While progressive income and property taxes have generated some revenue for public spending, including targeted support for family farmers, the investment-promotion regime

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a Javier Milei en un Desayuno donde se Habló Mucho de un Lastre del Campo, in: La Nación online (10 July 2025), https://www.lanacion.com.ar/economia/campo/a-solas-la-contundente-frase-de-nicolas-pino-a-javier-milei-en-un-desayuno-donde-se-hablo-mucho-de-nid10072025/ (16 July 2025).

87 Interview no. 17 (Senior expert; producer and consultant for agribusiness firms and international organisations; former president, INTA, Argentina), 28 February 2017; interview no. 33 (Director, COUSA, soybean oil supplier, Uruguay), 10 March 2010.

88 Interview no. 26; interview no. 41.

89 Act No. 16,906 of 7 January 1998, Ley de Inversiones: Promoción indústrial, in: Diario Oficial online (IMPO), https://www.impo.com.uy/bases/leyes/16906-1998 (28 October 2025); Decree No. 455/07 of 6 December 2007, in: Diario Oficial online (IMPO), www.impo.com.uy/bases/decretos-originales/455-2007 (28 October 2025); and all subsequent decrees and resolutions in: Diario Oficial online (IMPO), https://www.impo.com.uy/bases/leyes/16906-1998?verreferencias=norma (28 October 2025).

90 Fiscal Incentives for Farms in Uruguay, in: Farmland Urugay, https://farmlanduruguay.com/investments/investment-promotion-for-farms-in-uruguay/ (16 July 2025).

91 Comisión de Aplicación de la Ley de Inversiones, Ministerio de Economía y Finanzas, Uruguay, https://www.gub.uy/ministerio-economia-finanzas/Comap (16 July 2025).

92 Interview no. 41.

(together with rising land prices and rents and the economies of scale in agriculture) has allowed high land concentration and *sojización* to persist.

Soil and forest protection responses

Uruguay's primary public policy response to soy expansion has been the Soil Use and Management Plan (PUMS), a system designed to combat erosion and soil degradation. Although not fully implemented until 2013, PUMS built on long-standing legislation, and was later reinforced by decrees that specified responsibilities, acceptable erosion levels, and penalties for non-compliance.[93] Since 2013, the plans have been mandatory for all crop farms over 100 ha, with the threshold lowered to 50 ha in 2018.

PUMS requires farmers to submit soil use and management plans to the state, demonstrating that they adopt practices that sustain long-term soil health and keep erosion within tolerable limits. The tolerated level is estimated through a local adaptation of a widely used universal soil loss equation (USLE/RUSLE).[94] Farmers need to adopt practices such as crop diversification, rotation, and the use of winter cover crop in order to meet the requirements.[95] In this way, continuous soybean cultivation is discouraged and complexity is added to expansion dynamics.[96] By 2018, protective cover crops were already used on 85 per cent of soybean stubble land, and total annual soy acreage had decreased significantly, from 1.33 Mha in 2014 to 0.91 Mha in 2021.[97]

While land use decisions are influenced by multiple factors, this contraction was likely due in part to PUMS restrictions, which made continuous soy planting impossible in many

93 Act No. 15.239 of 23 December 1981, Declaración de Interés Nacional. Uso y Conservación de los Suelos y de las Aguas Superficiales Destinados a fines Agropecuarios, in: Diario Oficial online (IMPO), https://www.impo.com.uy/bases/decretos-ley/15239-1981 (28 October 2025). Two key regulatory decrees were later added: No. 333/04 of 16 September 2004, in: Diario Oficial online (IMPO), https://www.impo.com.uy/bases/decretos/333-2004 (28 October 2025), and No. 405/08 of 21 August 2008, in: IMPO, https://www.impo.com.uy/bases/decretos/405-2008 (28 October 2025). Both decrees are titled Regulación de Usos y Conservación de Suelos y Aguas Superficiales. Sanctions under this system are governed by Act No. 18.564 of 11 September 2009, Regulación de Uso y Manejo de las Aguas y el Suelo, Sanciones por Incumplimiento, in: Diario Oficial online (IMPO), https://www.impo.com.uy/bases/leyes/18564-2009/2 (28 October 2025).

94 Significant local adaptations have been made to the model's parameters, including terrain models, soil mapping, and rainfall erosivity data based on experimental studies. Interview no. 43 (Advisor and Independent Consultant; former researcher, CONEAT and Texas A&M University, Uruguay), 11 March 2017; interview no. 7 (Coordinator; specialist in soil and water systems, DGRN, MGAP, Uruguay), 9 August 2024.

95 Mariana Hill/Juan Andrés Quincke, Erosión Hídrica y Buenas Prácticas: Las Dos Caras que Definen la Realidad de los Suelos Uruguayos, in: INIA Informa 5 (2019), 2–7, https://ainfo.inia.uy/digital/bitstream/item/13875/1/INIA-Informa-Especial-Suelos-Diciembre-2019.pdf; Martín Dell'Acqua/Andrés Beretta, Estimación del Impacto de la Implementación de la Política de Planes de Uso y Manejo Responsable del Suelo, in: Anuario Opypa 2020, https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/comunicacion/publicaciones/anuario-opypa-2020/estudios/estimacion-del-impacto-implementacion (31 July 2025).

96 Cristina Zurbriggen et al., Experimentation in the Design of Public Policies: The Uruguayan Soils Conservation Plans, in: Ibero-Americana: Nordic Journal of Latin American Studies 49/1 (2020), 52–62; interview no. 5 (Researcher; professor of environmental governance, Faculty of Social Sciences, UDELAR; SARAS, Uruguay), 6 June 2024; interview no. 43; interview no. 7.

97 DIEA, Anuario; URUPOV, Teledetección.

areas that would otherwise have remained under soy.[98] At the same time, PUMS encouraged the inclusion of soy within broader crop rotations.[99] As a result, and somewhat counterintuitively, the total cumulative area of land incorporating soy within rotations increased even as the annual harvested area declined. Between 2017 and 2022, the cumulative soybean area in Uruguay reached approximately 2.75 Mha, nearly three times the annual harvested area.[100] In socio-technical terms, PUMS shifts the regime from a single 'HT soy + glyphosate + no-till' operating logic toward locally differentiated management packages.

In Argentina, although its Pampas soils are less prone to erosion, concerns about land degradation (structure, nutrient depletion, water quality) from *sojización* remain significant. However, replicating Uruguay's PUMS model in Argentina is considered infeasible due to political and cultural factors. Many stakeholders perceive such measures as excessive state intervention and a violation of private property rights.[101] Instead, Argentina's flagship environmental response has been the 2007 Forest Protection Act (Act 26,331) aimed at curbing deforestation. The Argentine portion of the Gran Chaco Forest[102] produces less than 10 per cent of the country's soy, but it accounts for 95 per cent of soy-related deforestation. Enforcement of the law has been inconsistent, however, with provinces with the highest deforestation rates often adopting the least rigorous implementation strategies.[103] Between 2015 and 2019, annual deforestation rates in the Gran Chaco rose from 116,000 ha to 211,000 ha, while soy cultivation in the region rose from 2.6 Mha to 2.8 Mha.[104]

Policy responses to pesticides

The dramatic rise in pesticide use associated with the HT soy model has had profound environmental and health implications in both Argentina and Uruguay. Residues have been detected in water, soil, air, and agricultural products, raising concerns over biodiversity loss and human health risks.[105] In many soybean-producing regions, residents have reported a wide range of serious health impacts (e.g., chronic respiratory diseases, diarrhoea, dizziness, cephalalgia, nausea, vision problems, dermal rashes) resulting from aerial and ground spraying of agrochemicals, as well as due to pollution from grain storage and pesticide facilities.[106] Although scientific research and residents have increasingly documented these impacts (see previous research), policy responses have been limited and inconsistent.

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98 Interview no. 14; interview no. 7

99 Interview no. 15.

100 URUPOV, Teledetección; FAOSTAT, https://www.fao.org/faostat/en/#data/QCL (25 October 2025).

101 Interview no. 19; interview no. 3; interview no. 20.

102 The Gran Chaco is the second-largest forest in South America (behind only the Amazon), known for its dry, semi-arid climate and high biodiversity.

103 Gasparri et al., Linkages.

104 Michael Lathuillière, Argentina: The Overlooked Hub of South American Soy, in: Trase online (11 August 2022), DOI: 10.48650/CJZ1-8M45.

105 Palladino et al., Pesticide Dependence.

106 Sebastián Gómez Lende/Guillermo Velázquez, Soybean Agribusiness in Argentina (1990–2015): Socio-Economic, Territorial, Environmental, and Political Implications, in: Gokhan Egilmez (ed.), Agricultural Value Chain, London 2018, 117–136.

Both countries have prohibited some highly toxic pesticides; however, numerous substances banned in the European Union (EU) remain widely used.[107] Buffer zones have been established to restrict pesticide application near water bodies and inhabited areas, yet enforcement remains erratic. In Argentina, the corresponding regulatory framework is decentralized, with each province setting its own standards, resulting in significant variation.

In this context, legal action has emerged as a relevant, albeit limited, avenue for contesting harmful pesticide practices.[108] One of the earliest and most influential rulings occurred in San Jorge, Santa Fe, in 2009, where a court granted an injunction prohibiting land and aerial spraying within 800 and 1,500 meters of a residential area, respectively. This decision invoked the precautionary principle and has since served as a reference point for subsequent cases. Another landmark ruling was issued in Entre Ríos in 2018 following a lawsuit filed by a regional teachers' union and environmental organizations. The court prohibited spraying within 1,000 meters (ground) and 3,000 meters (aerial) of rural schools and mandated the establishment of vegetative barriers and epidemiological monitoring programs. However, in response to agribusiness pressure, the provincial government later reduced these buffer zones to 100 and 500 meters, respectively, provoking widespread protest.[109]

In Uruguay, comparatively stricter regulations have been adopted in ecologically sensitive areas, particularly near water sources. Nevertheless, contamination remains a serious issue. In the Laguna del Cisne watershed (a drinking water source for over 100,000 people), precautionary regulations were introduced in 2016 to promote an agroecological transition. Despite this, a 2019 study found residues from 25 pesticides in both water and fish samples, including glyphosate, chlorantraniliprole, and banned substances such as Dichloro-Diphenyl-Trichloroethane (DDT).[110] These findings illustrate the inadequacy of existing safeguards and the persistent gap between chemical innovation and comprehensive environmental risk assessment.[111]

Mounting concern about pesticide-related effects has also galvanized localized forms of resistance. Civil society organizations, such as RAP-AL and *La Soja Mata* have played a key role in contesting the dominant agrarian model, linking the expansion of HT soy to environmental degradation, rural depopulation, and the displacement of traditional farming systems. These groups often collaborate with local actors such as environmental organizations,

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107 For Uruguay, see DGSA, Dirección General de Servicios Agrícolas, Ministerio de Ganadería, Agricultura y Pesca, https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/dgsa (16 July 2025); for Argentina, see SENASA, Servicio Nacional de Sanidad y Calidad Agroalimentaria, https://www.argentina.gob.ar/senasa (16 July 2025).

108 María Berros, Stop Experimenting on Us! Judicial Stories of Pesticide Resistance in Argentina, in: Global Environment 17/2 (2024), 378–395, DOI: 10.3828/whpge.63837646622495.

109 Ibid.

110 César Rodríguez-Bolaña et al., Multicompartmental Monitoring of Legacy and Currently Used Pesticides in a Subtropical Lake Used as a Drinking Water Source (Laguna del Cisne, Uruguay), in: Science of the Total Environment 874/162310 (2023), DOI: 10.1016/j.scitotenv.2023.162310. Surprisingly, glyphosate and its metabolite AMPA were detected in fish muscle tissue despite their high solubility in water.

111 Rodríguez-Bolaña et al., Multicompartmental Monitoring; Luciana Griffero et al., Basin-Scale Monitoring and Risk Assessment of Emerging Contaminants in South American Atlantic Coastal Lagoons, in: Science of the Total Environment 697/134058 (2019), DOI: 10.1016/j.scitotenv.2019.134058. For instance, researchers found that some newer pesticides marketed as safer alternatives to glyphosate and certain insecticides were even more harmful to pollinators.

teachers, smallholders, and municipal leaders to campaign for tighter regulations. Similar efforts have taken place in other Argentine provinces such as Córdoba, where the *Madres de Barrio Ituzaingó* have denounced pesticide exposure and mobilized public opinion. In Santa Fe, the *Paren de Fumigarnos* (Stop Fumigating Us) campaign has sustained pressure for nearly two decades.

Despite these efforts, the broader influence of objecting endeavours remains limited. Producer organizations in both countries continue to defend HT soy cultivation, emphasizing private property rights and the autonomy of landowners to lease their land under short-term arrangements to maximize returns. As one agronomist affiliated with a crop firm explained, companies coordinate with rural teachers to ensure that schoolchildren are not present during fumigation, but this does not alter the underlying model. In one such instance, a rural teacher – described by the respondent as a vocal critic – was said to stand and watch the spraying while "looking mad," illustrating how the agricultural sector perceives dissenting voices.[112]

In summary, although legal action and civil society mobilizations have challenged certain practices, they have not yet translated into transformative change. National policy frameworks remain permissive, and dominant production practices continue largely unchecked.[113] Still, together with increasing biophysical stresses, which are explored further in the following section, these counteracting pressures may foreshadow deeper tensions within the current agro-industrial regime.

Bio-environmental responses: Weed and pest resistance

The initial success of HT soy in Argentina and Uruguay stemmed largely from its promise of simplified weed management. However, the repeated large-scale use of glyphosate across millions of hectares, combined with simplified agronomic practices and landscape homogenization, has led to significant weed resistance. The absence of winter crops in many areas also left fallow periods rich in resources, further exacerbating the problem. Over time, glyphosate lost its effectiveness; resistant weeds became a major constraint on soybean yields and are now considered the primary biotic limitation to productivity in the region.[114]

In response, farmers and firms began increasing herbicide doses and application frequencies, raising concerns over environmental toxicity, human health, and rising production costs.[115] Biotech companies reacted by releasing new soybean varieties tolerant to other herbicides, such as dicamba and glufosinate. The once-standardized glyphosate regime has thus evolved into a far more complex system requiring diverse herbicide mixtures and locally adapted management strategies. There are also emerging signs of 'stacked resistance', where weed species exhibit resistance to several different herbicide modes of action.

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112 Interview no. 13 (Phytosanitary Specialist, agribusiness firms in Argentina and Uruguay), 28 February 2024.

113 Victoria Evia, Between Denouncing and Enduring: Soybean Expansion, Pesticides, and Environmental Health Participation in Uruguay, in: Saúde em Debate 46 (2022), 62–74.

114 Di Mauro et al., Transformations.

115 Interview no. 11 (Private Consultant and Extensionist; working for private crop firms in Argentina and Uruguay), 31 May 2024.

Farmers and agronomists must now constantly monitor fields, select appropriate chemical combinations, and understand interactions between formulations.[116] Some production managers report attending specialized courses on herbicide mixtures to keep up with the escalating complexity.[117] Several researchers argue that temporary tillage would be the most effective way to reduce weed pressure in soybean fields.[118] This increasing demand for expertise and time-consuming practices undermines one of the foundational promises of HT soy: simplified, low-cost production.

Resistance challenges are not confined to weeds. Since the introduction of Bacillus thuringiensis (Bt) soybeans, which are resistant to certain caterpillar pests, in 2012, pest resistance has also become a growing concern. The widespread use of Bt crops exerts strong selection pressure on insect populations, prompting the development of resistances and complicating pest management. To mitigate this, producers must rotate insecticides with different mechanisms of action and tailor practices to evolving local pest ecologies. As one agronomist noted, "going out to the field, monitoring, and making decisions is now a constant requirement."[119]

Necrotrophic fungi responsible for end-of-cycle diseases, which thrive in monocultural systems, are also becoming more problematic. The lack of crop rotation in the dominant forms of HT soy has thus likely led to increased need for fungicide use, further accelerating the development of chemical resistance. New disease challenges such as root and stem rots are also anticipated to expand. Researchers and firms are now experimenting with alternatives like biostimulants, defence inducers, and bio-fungicides to complement or replace traditional fungicides.[120]

These evolving biophysical constraints form a counteracting feedback loop: The ecological resistance created by prolonged homogenization has begun to erode the functional efficiency of the system. The very features that made HT soy attractive – landscape uniformity, chemical standardization, and low labour intensity – have, over time, fostered biological responses that make the standard practices less efficient, pushing the system toward greater complexity and heterogeneity. Climate change adds yet another layer of complexity: Shifting weather patterns and temperature regimes require adaptation in all types of management practices, and hence further shifts away from standardized solutions.

In this context, non-chemical strategies are gaining traction. Integrated pest management (IPM), which combines chemical, biological, and cultural approaches, is increasingly promoted. However, evidence of overall pesticide reduction remains limited.[121] Agronomic diversification through crop rotation, intercropping, and cover crops is being reintroduced, often under the label of 'service crops' that provide ecological functions rather than direct yields.[122]

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116 Interview no. 13.

117 Interview no. 12.

118 Fernando Oreja et al., Weed Seedbank Changes Associated with Temporary Tillage After Long Periods of No-Till, in: Agronomy 15/6, 1410 (2025), 1–15.

119 Interview no. 10 (Technical Director, agribusiness firm, Province of Buenos Aires, Argentina), 14 April 2024.

120 Interview no. 13; interview no. 2; interview no. 4; interview no. 8 (Senior Data Analyst; leader of data analysis on grain production using business intelligence tools, ReTAA, Buenos Aires Grain Exchange, Argentina), 2 August 2024; interview no. 9 (Researcher; specialist in applied economics for the agricultural sector, INIA, Uruguay), 11 July 2024.

121 Palladino et al., Pesticide Dependence.

122 Marcos Petrasek et al., Are Service Crops an Alternative for Mitigating N_2O Emissions in Soybean Crops in the Argentinian Pampas?, in: Journal of Environmental Quality 52/2 (2023), 258–269; Priscila Pinto et al.,

Crops like vetch and rye, sown in the off-season, help to suppress glyphosate-resistant weeds and improve soil structure. Biological controls are also used to manage pest populations.[123]

Despite these innovations, trends remain ambiguous. Interviews with producers and agronomists suggest both adaptation and entrenchment. While management systems have undeniably grown more complex and knowledge-intensive, imports of herbicides and pesticides continue to rise in both countries (see DGSA for Uruguay and SENASA for Argentina). The use of mixed chemical formulations, commonly referred to as 'cocktails', raises concerns over so-called synergistic toxicity, with ecological impacts poorly understood and rarely evaluated at the community level.[124] This underscores a key spatial mismatch: Despite the broad ecological reach of intensive agrochemical use, risk assessments focus on individual organisms rather than entire ecosystems.

Rather than disrupting the dominant regime, many adaptations seem to reinforce it. Industry groups like CropLife Latin America, active in both countries, promote "Good Agricultural Practices."[125] Meanwhile, firms and farmers rely on increasingly sophisticated technologies such as drones, field sensors, and geo-referenced data systems to fine-tune input application.[126] Producer organizations like CREA and AAPRESID in Argentina, or FUCREA and MTO in Uruguay, serve as key information nodes facilitating knowledge exchange and collective experimentation. Several interviewees described the importance of continuous meetings with other producers to discuss new production strategies and share trial results of new varieties in this rapidly changing context.[127]

These changes reflect a shift from standardized to customized management, but without necessarily challenging the underlying logic of HT soy. Technological tools are streamlining field monitoring and enhancing coordination within large-scale farming operations. For example, some companies use software platforms like SIMA to manage field teams and make real-time decisions. In this sense, the system is becoming more complex and differentiated, but not less dependent on capital-intensive inputs.[128]

Nevertheless, there are signs that the long-standing model is under strain. As mentioned, continuous soy planting has largely displaced the traditional mixed system of crop and livestock rotation in the Pampas and the Uruguayan Littoral, which supported soil health and

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Including Cover Crops During Fallow Periods for Increasing Ecosystem Services. Is It Possible in Croplands of Southern South America?, in: Agriculture, Ecosystems & Environment 248 (2017), 48–57; Priscila Pinto et al., Variable RootShoot Ratios and Plant Nitrogen Concentrations Discourage Using Just Aboveground Biomass to Select Legume Service Crops, in: Plant and Soil 463 (2021), 347–358.

123 Candelario Palma-Bautista et al., Multiple Resistance to Glyphosate and 2,4-D in Carduus acanthoides L. from Argentina and Alternative Control Solutions, in: Agronomy 10/11, 1735 (2020), 1–14, DOI: 10.3390/agronomy10111735.

124 Palladino et al., Pesticide Dependence.

125 Crop Life Latin America, https://croplifela.org/es/nosotros/quienes-somos (26 June 2025).

126 Interview no. 11.

127 Interview no. 12.

128 Ibid.; SIMA monitors fields, geolocates data, analyses information, and generates spray application orders, see SIMA – Integrated Agricultural Monitoring System, https://sima.ag/en (31 July 2025). There are also some public initiatives. For example, INIA Uruguay has developed the CultiDOCTOR app, launched in 2023, which provides free assistance to technicians and farmers for identifying early signs of crop diseases in wheat, barley, soybeans, canola and other crops, see INIA Uruguay, CultiDOCTOR_Uy: Una Nueva Herramienta para Identificación de Enfermedades en Cultivos, https://www.inia.uy/cultidoctoruy-una-nueva-herramienta-para-identificacion-de-enfermedades-en-cultivos (17 July 2025).

long-term productivity. However, some producers are now reintroducing pastures into rotation, especially where grain alternatives are limited.[129] As one researcher noted, these shifts may represent early indicators of a broader systemic transition.[130]

Economic structures are also evolving unevenly. In Uruguay, data from the 2016/17 to 2022/23 seasons show a decline in the number and area of farms larger than 500 ha, alongside growth in mid-sized farms.[131] This contrasts with Argentina, where the 2002 and 2018 agricultural censuses show continued consolidation in provinces like Buenos Aires, Córdoba, and Santa Fe. Here, farms exceeding 1,000 ha have proliferated while smaller units have declined.[132]

These contrasting trajectories suggest that more complex, localized management strategies may be compatible with large-scale operations – but their diffusion is shaped by differing institutional, political, and ecological dynamics. For example, Uruguay's implementation of mandatory soil use and management plans may have reduced profit margins, slowing large-scale expansion. Despite certain variations, however, economies of scale still underpin the extensive agricultural systems in both countries.

Climate change represents another emerging feedback. Nearly all soy production in the region is rainfed, making it highly vulnerable to precipitation variability. The 2022/23 drought in Uruguay led to record losses: 23 per cent of the sown area was abandoned and yields dropped by 73 per cent.[133] The financial losses were exacerbated as input prices rose while output prices fell. In Argentina, a study found that rainfall and temperature explain over 90 per cent of yield variation between 2001 and 2021, with projections indicating a growing frequency of extreme weather events and rising average losses.[134]

Finally, global market shifts – particularly changes in demand from China or regulatory shifts in Europe – may further destabilize the model of *sojización*. These exogenous pressures, together with internal ecological feedback loops, suggest that the future trajectory of HT soy will depend not only on technological innovation but also on the interplay between agrarian social relations, environmental constraints, and international political economy. This dynamic landscape will be further examined in the following section.

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129 Interview no. 12.

130 Interview no. 4.

131 DIEA, Anuario.

132 Carlos Rossi, El Censo Nacional Agropecuario 2018: Resultados Insatisfactorios y Profundización de los Cambios Estructurales en el Agro Bonaerense, in: Susana Soberna (ed.), La Argentina Agropecuaria Vista Desde las Provincias: Un Análisis de los Resultados Preliminares del CNA 2018, Buenos Aires 2021, 239–269; Gustavo Soto et al., Análisis Intercensal 2002–2018 Provincia de Córdoba, in: Soberna (ed.), La Argentina Agropecuaria, 270–278; Roxana Albanesi/Patricia Propersi, Transformaciones Fundiarias y en el Uso del Suelo en la Provincia de Santa Fe entre el CNA 2002 y el CNA 2018, in: ibid., 309–321; see also, Censo Nacional Agropecuario 2002, INDEC, https://sitioanterior.indec.gob.ar/index_agropecuario.asp (18 September 2024); Censo Nacional Agropecuario 2018, INDEC, https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-8-87 (18 September 2024).

133 Catalina Rava et al., El Complejo Oleaginoso en Uruguay en la Zafra 2022/2023 y sus Perspectivas, in: Revista INIA 75 (2023), 45–50.

134 Esteban Otto Thomasz et al., Assessing the Impact of Climate Change on Soybean Production in Argentina, in: Climate Services 34, (2024), 1–20, DOI: 10.1016/j.cliser.2024.100458

The market economy: Key buyers changing the rules?

China's increasing emphasis on soybean self-sufficiency poses a potential challenge for global soy exporters. Historically self-reliant with regard to soy, China's demand for imports surged after the 1990s as it opened up its markets and became a major buyer. Nearly 100 million metric tons of soybeans were imported in 2021, primarily for animal feed and cooking oil.[135] However, concerns over food security, trade tensions, and fluctuating global markets have prompted the Chinese government to push for greater domestic production. In response, China has implemented soybean revitalization plans, offering subsidies and technical support to farmers to boost yields. Additionally, the government is promoting alternative feed crops such as rapeseed, sorghum, and peas to reduce reliance on soy imports. These policies align with China's broader strategy of food sovereignty aimed at reducing vulnerabilities in key agricultural commodities.[136]

While domestic production is still limited by competition with more profitable crops like corn, the government's efforts signal a shift toward less dependence on imported soy.[137] If these initiatives succeed, China's reduced demand for foreign soybeans could significantly impact countries like Uruguay and Argentina (as well as the United States of America and Brazil) which have long been key suppliers.

While China's efforts for self-sufficiency could reshape its role as a major importer, the EU, which is the second most important buyer of Argentine and Uruguayan soy, is also driving market change, but through a different route. The EU is introducing stricter sustainability requirements that could complicate market access for soy from both countries. A central instrument is the EU's new Anti-Deforestation Regulation (EUDR).

Under the EUDR, companies exporting soy to the EU must demonstrate that their products are not linked to deforestation. This requires detailed supply chain documentation, including traceability, geolocation of production plots, and comprehensive due diligence systems. Exporters must also comply with strict standards related to biodiversity, indigenous peoples' rights, and anti-corruption measures. Non-compliance may result in exclusion from the EU market, fines, and confiscation of goods.[138]

As a key supplier of soymeal to the EU, Argentina has raised concerns about these requirements.[139] The main challenge lies in ensuring physical segregation of compliant soy, as most silos, crushing plants and port facilities lack the infrastructure for separate storage and traceability systems. Building such infrastructure would significantly raise operational costs.[140] Originally scheduled to apply for large enterprises from 31 December 2024, the

135 OEC, Soybeans in China, https://oec.world/en/profile/bilateral-product/soybeans/reporter/chn (19 September 2024).

136 USDA, Oilseeds and Products Update – China, Report Number: CH2024-0077, prepared by FAS China Staff, approved by Adam Branson, 2024.

137 GAIN – Global Agricultural Information Network, Oilseeds and Products Annual, Report Number: AR2024-0005, prepared by Chase McGrath, 2024.

138 European Commission, Deforestation Regulation implementation, https://green-forum.ec.europa.eu/nature-and-biodiversity/deforestation-regulation-implementation_en (14 August 2024).

139 Lathuillière, Argentina.

140 Can the EU's Deforestation Law Save Argentina's Gran Chaco from Soy?, in: Mongabay online (6 June 2023), https://news.mongabay.com/2023/06/can-the-eus-deforestation-law-save-argentinas-gran-chaco-from-soy/ (3 September 2024).

EUDR's implementation was postponed following opposition from suppliers and European livestock producers. The regulation now applies from 30 December 2025 for large and medium-sized companies, and from 30 June 2026 for smaller firms.[141] Despite this delay, industry stakeholders continue to call for further postponement, warning that reduced throughput and higher costs could drive up food prices and inflation across the EU.[142]

In parallel, the EU's Carbon Border Adjustment Mechanism (CBAM), which imposes a carbon-based levy on imports, entered into force on 1 January 2026. Initially limited to industrial materials and energy products, it is under discussion for expansion to include agricultural commodities.[143] If adopted, this could impose additional carbon-related costs on South American exporters, further eroding their competitiveness in the European market.

Combined with the EU's efforts to strengthen domestic agricultural production, these regulatory changes pose a long-term challenge to the current articulation of the South American soy industry. In addition, the EU has expressed its intention to include Ukraine as a member state. If accession proceeds, Ukraine would likely become the largest recipient of Common Agricultural Policy (CAP) funding due to its vast agricultural area and production capacity.[144] This could further reduce the competitiveness of overseas soy in the European market. At the same time, the EU's increasing demands for traceability under EUDR may lead to differentiated, location-specific pricing. Soy sourced from regions with robust compliance infrastructure may command a premium, while products from areas with weaker traceability systems could face discounts or be excluded from the market. This could drive more heterogeneous dynamics in soy production, challenging the notion of soy as a uniform commodity.

141 European Commission, On EUDR Regulation on Deforestation-free Products, https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products_en (14 December 2024).

142 COCERAL Urges EU to Postpone EUDR Implementation by One More Year, in: Miller Magazine 191 (November 2025), 61, https://millermagazine.com/magazine/issue-191/; EUDR Concerns Slow EU Soymeal Trade, Raise Alarms in South America, in: S&P Global, Commodity Insights (5 November 2025), https://www.spglobal.com/energy/en/news-research/latest-news/agriculture/110525-eudr-concerns-slow-eu-soymeal-trade-raise-alarms-in-south-america?utm_source (8 November 2025).

143 European Parliament, Opinion of the Committee on Agriculture and Rural Development for the Committee on the Environment, Public Health and Food Safety on the Proposal for a Regulation of the European Parliament and of the Council Establishing a Carbon Border Adjustment Mechanism, COM(2021)0564, C9-0328/2021, 2021/0214 COD, https://www.europarl.europa.eu/doceo/document/AGRI-AD-699239_EN.pdf (8 November 2025).

144 EU-Ukraine Accession Offers Important Opportunity for Common Agricultural Policy Reform, in: EU NEIGHBOURS East online (13 June 2024), https://euneighbourseast.eu/young-european-ambassadors/blog/eu-ukraine-accession-offers-important-opportunity-for-common-agricultural-policy-reform/ (14 December 2024).

Sojización at a crossroads: Destabilization and emerging alternatives

This study has examined the interplay between homogenizing and heterogenizing dynamics within the socio-technical regimes that structure soybean production in Argentina and Uruguay. Drawing on systems thinking and socio-technical transitions theory, we have shown how the HT soy regime emerged as a dominant configuration by aligning technological innovation with broader political, economic, and institutional trends. At the same time, it offered farmers a standardized and profitable package that restructured farm systems, reshaped landscapes, and reinforced global commodity chains.

Yet after decades of expansion, the foundations of this regime (management simplification, chemical dependency, and economies of scale) are showing signs of strain. Ecological consequences such as herbicide and pest resistance coupled with other environmental costs are undermining the agroeconomic efficiencies that once stabilized the system. Climate change further exacerbates these pressures, intensifying soil-borne diseases and the vulnerabilities of monoculture systems.

At the same time, new technologies and shifting market and policy signals are enabling more adaptive, site-specific, and diversified management practices. Tools such as drones, georeferenced monitoring, and precision agriculture offer potential for more nuanced responses, while regenerative techniques like cover cropping, IPM, and biological controls are gaining ground. However, many of these innovations remain embedded in the logic of input-intensive production, limiting their transformative potential.

The adoption and implications of these changes are shaped by divergent socio-economic and institutional contexts. In Argentina, consolidation continues, with digital tools supporting adaptation without disrupting large-scale economies. By contrast, Uruguay shows signs of structural divergence, with mid-sized farms gaining ground under regulatory frameworks such as mandatory environmental management plans. These differences highlight how policy and institutional design mediate both adaptation and the prospects for deeper transformation.

Climate change introduces yet another layer of complexity. As extreme weather events become more frequent, one possible response is the expansion of irrigation infrastructure. However, such investments entail significant costs that could jeopardize Argentina's and Uruguay's role as low-cost soy exporters in the global market.

Global market dynamics also influence the future trajectory of HT soy. China's efforts for agricultural self-sufficiency, although partial, suggest a potential decline in external demand. Meanwhile, Europe's evolving sustainability requirements may impose stricter production standards. For countries whose economies remain closely tied to soy exports, these global developments may both constrain and open new opportunities for transitioning away from monoculture systems.

Thus, while the HT soy regime remains dominant, its internal coherence is weakening. It is no longer sustained by uniformity and simplification alone, but increasingly by adaptive complexity. Whether current adaptations can resolve the deep-seated environmental and socio-economic contradictions of *sojización* or merely defer a more fundamental regime shift remains uncertain.

At any rate, cracks are visible. As the system is faced with growing ecological, technological, and socio-political complexity, a tipping point may be approaching. The future of soybean production in the Southern Cone will not be determined by technological innovation or market signals alone, but by contested decisions over what kind of agriculture is desirable – and for whom. The evolution of the HT soy regime thus offers a revealing window into the broader tensions, limits, and possibilities of agricultural modernization in the twenty-first century.

Appendix

The core empirical material comprises 15 semi-structured interviews conducted between January and October 2024, and a set of 33 longitudinal in-depth interviews conducted between 2008 and 2020. Eight of the 2024 interviews were carried out jointly by *Matilda Baraibar Norberg* and *Cecilia Gelabert* via Zoom, four were conducted in person in Argentina by *Gelabert*, and three were conducted independently by *Baraibar Norberg* via Zoom. The longitudinal interviews were all conducted by *Baraibar Norberg* and provide historical and contextual depth.

Many respondents have held multiple positions relevant to soybean production in Argentina and Uruguay; the most pertinent affiliations are listed below. All names are anonymised in accordance with ethical research guidelines.

Principal interviews (2024)

1. Researcher, specialist in agrarian ecology, Faculty of Agronomy, University of Buenos Aires (FAUBA); National Scientific and Technical Research Council (CONICET), Argentina. Lecturer at FAUBA and researcher at CONICET. Buenos Aires, 3 May 2024.
2. Researcher, specialist in management practices in agro-food systems, FAUBA, Argentina. Zoom, 21 February 2024.
3. Researcher, extensionist and consultant, professor of ecology of agrarian systems, Institute for Physiological and Ecological Research Related to Agriculture (IFEVA), FAUBA; CONICET, Argentina; Faculty of Agronomy (FAGRO) - University of the Republic (UDELAR), Uruguay. Independent consultant for grain producers in Argentina and Uruguay. Zoom, 20 May 2024.
4. Researcher, assistant professor, specialist in pesticide dynamics and sustainability indicators in agroecosystems, IFEVA, FAUBA, Argentina. Buenos Aires, 3 September 2024.
5. Researcher, professor of environmental governance, Faculty of Social Sciences, UDELAR; South American Institute for Resilience and Sustainability Studies (SARAS), Uruguay. Zoom, 6 June 2024.
6. Research Director, specialist in crop ecophysiology, soil management, and simulation models, National Institute of Agricultural Research (INIA); adjunct professor, FAGRO-UDELAR, Uruguay. Zoom, 12 August 2024.
7. Coordinator, specialist in soil and water systems; contributor to national soil conservation models (RUSLE), General Directorate of Natural Resources (DGRN), Ministry of

Livestock, Agriculture and Fisheries (MGAP), Uruguay. Zoom, 10 July and 9 August 2024, additional email correspondence.

8. Senior Data Analyst, leader of data analysis on grain production using business intelligence tools (e.g. Power BI, matplotlib), Survey of Applied Agricultural Technology (ReTAA), Buenos Aires Grain Exchange, Argentina. Zoom, 2 August 2024.
9. Researcher, specialist in applied economics for the agricultural sector, INIA, Uruguay. Zoom, 11 July 2024.
10. Technical Director, agribusiness firm, Province of Buenos Aires, Argentina. Buenos Aires, 14 April 2024.
11. Private consultant and extensionist, working for private crop firms in both Argentina and Uruguay. Buenos Aires, 31 May 2024.
12. Production Manager, agribusiness firm, various provinces, Argentina. Zoom, 2 August 2024.
13. Phytosanitary Specialist, agribusiness firms in Argentina and Uruguay. Zoom, 28 February 2024.
14. Advisor, specialist in agricultural public policy, National Directorate of Territorial Planning (DINOT), Ministry of Housing, Territorial Planning and Environment (MVOTMA), Uruguay. Zoom, 17 June 2024.
15. Public Official, technician in Soil Management and Conservation, National Directorate of Renewable Natural Resources (RENARE), MGAP, Uruguay. Zoom, 5 July and 14 August 2024.

Longitudinal interviews (2008–2020)

Argentina

16. Researcher, associate professor of ecology, FAUBA; CONICET, Argentina. Agricultural extensionist; consultant to grain producers in Argentina and Uruguay. Buenos Aires, 11 February 2017.
17. Senior expert, producer and consultant, agribusiness firms (e.g. El Tejar) and international organisations (World Bank, Inter-American Development Bank [IADB], Inter-American Institute for Cooperation on Agriculture [IICA], Food and Agriculture Organization of the United Nations [FAO]); former President, National Institute of Agricultural Technology (INTA); former national director of agricultural production, Secretariat of Agriculture, Livestock, Fisheries and Food (SAGPyA); author of works on agro-industrial chains and competitiveness. Buenos Aires, 28 February 2017.
18. Director of Agricultural Affairs, Argentine Council for International Relations (CARI); adviser to the FAO Director-General on strategic planning; former vice minister of agricultural economy; former director general, IICA; former president of the board, International Food Policy Research Institute (IFPRI); agricultural producer; author of works on agricultural policy and development. Buenos Aires, 1 March 2017.
19. Former Secretary of Agriculture, Livestock and Fisheries, Ministry of Agriculture, Livestock and Fisheries (MAGyP); director, Centre for Research in Political, Economic and Social Sciences (CICPES), INTA; former national director of agricultural information

and quality systems, INTA; former President, Agricultural Technological Innovations Inc. (INTeA S.A.). Buenos Aires, 2 March 2017.

20. Director of Social Studies, Institute of Social Studies, INTA; former coordinator, 2013 National Census of Agricultural Producers; former researcher, Ministry of Economy (MECON), Argentina. Buenos Aires, 2 March 2017.
21. Rural Development Specialist, specialist in territorial management, agriculture, and rural wellbeing, IICA, Argentina office. Buenos Aires, 3 March 2017.
22. Director of Research Promotion, researcher in pedagogy, Latin American Council of Social Sciences (CLACSO), Argentina. Buenos Aires, 3 March 2017.
23. Researcher and Former Public Official. Department of Rural Development, University of Misiones; Department of Economy and Crop Planning; former advisor, Secretariat of Family Agriculture, Ministry of Agroindustry, Argentina. Stockholm, 10 September 2018.

Uruguay

24. Chief Executive Officer, El Tejar Uruguay; president, Oilseeds Technological Board (MTO); agronomist and consultant. Young, 23 February 2008.
25. Chief of Sales, Agronegocios del Plata (ADP). Dolores, 13 February 2008.
26. President, Rural Federation of Uruguay (FRU); veterinarian, rancher and landowner; lecturer, FAGRO-UDELAR. Montevideo, 3 March 2009.
27. Director, Schandy Shipping and Logistics. Montevideo, 19 February 2009.
28. President, National Commission for Rural Development (CNFR); agricultural producer. Montevideo, 5 March 2009.
29. Agronomist and Family Farmer, grain cooperative of Dolores (CADOL). Dolores, 5 March 2010.
30. Traders, commercial agents from major trading companies involved in buying and selling soy and grains in the Port of Nueva Palmira. Nueva Palmira, 11 March 2017.
31. President, National Institute of Seeds (INASE); agronomist; politician, Socialist Party, Frente Amplio. Montevideo, 6 March 2010.
32. Director, Alcoholes del Uruguay (ALUR). Montevideo, 9 March 2010.
33. Director, Compañía Oleaginosa Uruguay S.A. (COUSA). Montevideo, 10 March 2010.
34. Chief Executive Officer, regional head of Marfrig Beef Southern Cone. Montevideo, 7 March 2010.
35. Director, Programme for production and environmental sustainability, INIA; Researcher and lecturer FAGRO-UDELAR; Board member of the International Soil Tillage Research Organisation (ISTRO). Skype, 3 March 2017.
36. Researcher, professor in Political Science, Faculty of Social Sciences, UDELAR.; Former Director at the Latin American Faculty of Social Sciences (FLACSO), Uruguay office. Montevideo, 6 March 2017.
37. Former Minister, MGAP, Uruguay; member, Movement of Popular Participation (MPP), Frente Amplio; former president, National Institute of Colonisation (INC); lecturer FAGRO-UDELAR. Montevideo, 6 March 2017.
38. Advisory Director, National Office of the Environment (DINAMA), MVOTMA; political advisor, Frente Amplio; author of works on the impacts of soybean expansion. Montevideo, 6 March 2017.

39. Director, National Agency for Research and Innovation (ANII); professor in farming systems and production ecology, Department of Plant Production, FAGRO-UDELAR. Montevideo, 7 March 2017.
40. Senior Researcher, Department of Nutrition in Intensive Dairy and Livestock Systems, INIA La Estanzuela. Skype, 8 March 2017.
41. Director, Office of Planning and Agrarian Policy (OPYPA), MGAP; former tax specialist, OPYPA, MGAP; agronomist. Montevideo, 8 March 2017.
42. Director, SARAS; professor in limnology, Eastern Regional University Centre (CURE), UDELAR; member, Santa Lucía water basin group. Punta del Este, 10 March 2017.
43. Advisor and independent consultant, former researcher, National Commission for Agronomic Land Assessment (CONEAT) and Texas A&M University; former executive director, International Network on Migration and Development; long-standing advisor on soils and land planning for MGAP. Punta del Este, 11 March 2017.
44. Coordinator, Uruguayan Centre for Applied Technologies (CEUTA). Montevideo, 12 March 2017.
45. Dean, Faculty of Social Sciences, UDELAR; professor of sociology; author of works on land concentration, agrarian history, and rural relations. Montevideo, 13 March 2017.
46. Researcher, specialist in erosion, FAGRO-UDELAR; course leader at CEUTA. Stockholm, 23 June 2018.

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