



Epic narratives of the Green Revolution in Brazil, China, and India

Lídia Cabral¹ · Poonam Pandey² · Xiuli Xu³

Accepted: 24 June 2021 / Published online: 3 July 2021
© The Author(s) 2021

Abstract

The Green Revolution is often seen as epitomising the dawn of scientific and technological advancement and modernity in the agricultural sector across developing countries, a process that unfolded from the 1940s through to the 1980s. Despite the time that has elapsed, this episode of the past continues to resonate today, and still shapes the institutions and practices of agricultural science and technology. In Brazil, China, and India, narratives of science-led agricultural transformations portray that period in glorifying terms—entailing pressing national imperatives, unprecedented achievements, and heroic individuals or organizations. These “epic narratives” draw on the past to produce meaning and empower the actors that deploy them. Epic narratives are reproduced over time and perpetuate a conviction about the heroic power of science and technology in agricultural development. By crafting history and cultivating a sense of scientific nationalism, exceptionalism, and heritage, these epic narratives sustain power-knowledge relations in agricultural science and technology, which are underpinned by a hegemonic modernization paradigm. Unravelling the processes of assemblage and reproduction of epic narratives helps us make sense of how science and technology actors draw on their subjective representations of the past to assert their position in the field at present. This includes making claims about their credentials to envision and deliver sustainable solutions for agriculture into the future.

Keywords Green Revolution · Brazil · China · India · Agricultural science and technology · Epic narrative

Introduction

For developing countries’ agricultural systems, the Green Revolution (GR) is often portrayed as the advent of scientific and technological modernity, helping them to avert famines and revert food deficits. Pingali (2012, p. 12302) writes: “The developing world witnessed an extraordinary period of food crop productivity growth over the past 50 y[ears],

despite increasing land scarcity and rising land values. Although populations had more than doubled, the production of cereal crops tripled during this period, with only a 30% increase in land area cultivated. Dire predictions of a Malthusian famine were belied, and much of the developing world was able to overcome its chronic food deficits.”

Unfolding between the late 1940s and 1980s,¹ the GR was a top-down, state-led process that involved the roll-out of high-yielding varieties responsive to high inputs of chemical fertilizers and irrigation. The aim was to intensify production and productivity, and address pressing concerns related to hunger, social stability, and industrial development. Despite the time that has elapsed, the GR remains a powerful “legend” (Stone 2019), which continues to reverberate, inspire, and influence perspectives and practices

✉ Lídia Cabral
l.cabral@ids.ac.uk
Poonam Pandey
p.pandey23@gmail.com
Xiuli Xu
xxl@cau.edu.cn

¹ Institute of Development Studies, University of Sussex, Library Road, Falmer, Brighton BN1 9RE, UK

² Indian Institute of Science, CV Raman Rd, Bengaluru, Karnataka 560012, India

³ Professor at the College of Humanities and Development Studies, China Agricultural University, 17 Qinghua E Rd, Haidian, Beijing, China

¹ Our time horizon for what came to be known as the first Green Revolution starts with the early wheat breeding experiments in Mexico, supported by the United States government and the Rockefeller Foundation (Cotter 2003; Wright 2012), and ends with the first wave of expansion of modern agriculture in the Brazilian Midwest (Pereira et al. 2012). However, the periodisation of the first Green Revolution is contested, as discussed at length by Patel (2013b). The issue raised by Patel as to whether the Green Revolution has even ended yet is indeed a central theme in this paper.

in agricultural science and technology (S&T). Calls for a doubly Green Revolution (Conway 1998), a second Green Revolution (Singh 2006), and an evergreen revolution (Swaminathan 2010) illustrate the GR's enduring influence. The African Green Revolution is the latest expression of GR revivalism (Blaustein 2008; Morris et al. 2009; Toenniesen et al. 2008).

The resurgence of the GR has happened despite it being one of the most contentious experiments in modern agricultural history, questioned since its early days. Research on the impact of GR technology in India, conducted in parallel to the implementation of GR policy and practices in the mid-1970s, exposed misperceptions about high-yielding varieties. For example, studies highlighted how the role played by irrigation was overlooked in success narratives, and the many factors (not just yields) that shape technology adoption by farmers, including labour relations, subsidies, and water access (Bardhan 1970; Farmer 1977; Ladejinsky 1969). Over the years, scholars studied the GR from multiple angles, emphasising (for example): the unaffordability of modern varieties for poor people and their detrimental impact on crop diversification and vulnerability to pests (Lipton and Longhurst 1989); the geopolitical dynamics underpinning technocratic cooperation programmes on agricultural S&T (Cullather 2004; Perkins 1997); the reproduction of class-based and gender-based inequalities by GR technologies (Das 2002; Patel 2013b; Shiva 1992; Sobha 2007); and harmful social, health, and environmental impacts (Shiva 1991, 2016). Others sought revisions that addressed concerns raised by some of the critique (Conway 1998; Swaminathan 2010). The long-running controversy over the GR legacy was reignited with calls for an African GR (Blaustein 2008; Sanchez and Swaminathan 2005; Toenniesen et al. 2008), which have been challenged for serving the interests of large producers, international agribusiness corporations, and aid donors (Moseley et al. 2015), and for failing to benefit Africa's rural masses (Anseeuw 2013). Scholarly positions on whether to extend or reform the GR remain firmly divided (Harwood 2018).

Rather than trying to resolve this enduring controversy, this paper seeks to understand how and why the now distant GR retains its power to inspire and influence. To do so, we focus on three countries—Brazil, China, and India—that have, in recent years, actively exported their agricultural S&T to Africa. They have done so through South–South cooperation comprising material resources (crop varieties and machinery), scientific expertise, as well as narratives about past agricultural successes (Bräutigam 1998; Cheru and Modi 2013; Scoones et al. 2016). This paper focuses on the domestic processes that underpin these international cooperation transactions—specifically, narratives about agricultural S&T history that frame the GR as a moment of great and heroic accomplishments. Although not the focus of this

paper, these success narratives travel beyond borders and feed policy and technology transfer imaginaries, as illustrated by suggestions that Brazil's GR constitutes a reference model for Africa's green savannah belt (The Economist 2010; World Bank 2009).

Within the three countries, institutionalised narratives depict a past moment of science-led agricultural transformation in glorifying terms—a time of pressing national imperatives, unprecedented technological achievements, and heroic individuals and organizations. In China, the advent of “scientific farming” in the 1950s is portrayed as embodying the modernization of peasant agriculture and the deployment of S&T as an instrument of class struggle, nation building, and modernization.² In India, the GR of the 1960s is described as “the beginning of scientific agriculture in India” that saved the country from hunger (Swaminathan 1993). In Brazil, the expansion of modern farming into the Cerrado³ since the mid-1970s is regarded as the country's very own science-driven “tropical revolution”, which eventually turned Brazil into a global agricultural power (Albuquerque and Silva 2008).

These “epic narratives” are storylines about the past that produce meaning and seek to empower those who articulate them—individuals, organizations or governments. They validate a “regime of truth”, in a Foucauldian sense, which defines what is legitimate knowledge and what are valid ways of knowing (Scoones 2016), and they assert authority for imagining the future (Jasanoff and Kim 2009). Epic narratives about the GR centre on record increases in productivity, achieved through genetically superior varieties coupled with other modern inputs, and driven by determined states and dedicated scientists to (as the narrative goes) avoid starvation and feed growing populations. Such narratives are linked to a positivist epistemology celebratory of science and a Malthusian worldview that sees hunger and food insecurity as resulting from lack of food availability, rather than from structural inequalities (Patel 2013a) or failures of entitlements (Sen 1981). The GR epic narrative celebrates a techno-economic paradigm that emphasises the primacy of S&T and increasing productivity and competitiveness, in line with the dominant corporate agri-food regime (Lang 2015; McMichael 2009). From this perspective, the three countries' narratives are analogous to the global GR narrative associated with

² The term “Green Revolution” is not used often in China to account for the country's science-led agricultural transformation. This is unsurprising as the term was conceived in the US as a counterpoint to China's “red revolution” (Schmalzer 2016). Instead, “scientific farming” is used to refer to the advent of agricultural S&T in the 1950s. The role of S&T in farming has been particularly highlighted since China initiated its open door policy at the end of the 1970s.

³ The Cerrado is Brazil's savannah-like biome, which covers an area of about 2 million km² and nearly 24% of the country's territory.

American influence of the (first) Green Revolution, and the “grand missions of agricultural innovation” (Wright 2012) championed by American philanthropy (such as the Rockefeller Foundation), and heroic individuals (such as Norman Borlaug). Borlaug’s work on dwarf, high-yielding, and disease-resistant wheat (first developed in Mexico) dominated the early stages of the GR, and helped, in his words, by “feeding a hungry world” (Borlaug 2007). The recognition of his heroic feats granted him the 1970 Nobel Peace Prize, which made him the global father of the GR and its most recognizable ‘brand hero’ (Sumberg et al. 2012).

Our use of the notion of “epic” aims to capture the subjective process of historical framing—that is, the narration of the GR as a past, finished, and heroic endeavour. We build on Patel’s (2013b) argument that the periodization of the GR is political, and that there is a need to expose the continuities of (as well as adjustments to) its underlying “biopolitical” project.⁴

In pushing for a ‘second Green Revolution’, the first Green Revolution needs to be sold as a success. To do that requires the first Green Revolution be considered completed, and that it be considered unequivocally effective. But if the Green Revolution is still unfolding, as I argue it is, and if its results have been ambiguous, as we shall see they have been, then the foundational knowledge required to refashion the Green Revolution project requires continuous and ongoing work to legitimize the actions carried out in its name (Patel 2013b, p. 4).

The ways in which celebratory narratives about the GR empower individuals, organizations, and corporations have been discussed in the literature. Cotter (2003), for example, offers an exhaustive analysis of how Mexican *agrónomos* asserted their professional authority and ensured their upward mobility by embracing the GR. And the claimed “grand missions of agricultural innovation” championed by the Rockefeller Foundation (Wright 2012) are seen in a different light by analyses that expose the close links between philanthropy, corporations, and states, and how research agendas are entangled with political and economic interests (Holt-Giménez 2008; Patel 2013b; Smith 2009).

In this paper, we explore specifically the processes whereby actors in Southern countries—the hosts of GR experiments—construct their own GR epic narratives.⁵

⁴ Patel (2013b) suggests that the GR is understood as a biopolitical project of states, across the global North and South, attempting to rationalise and control biological phenomena.

⁵ In this paper, we analyse the processes whereby epic narratives are constructed, replicated, and modified. We do not explore whether these narratives are widely endorsed by the general public. We do, however, document attempts made by governments to get widespread endorsement (as in the issuing of celebratory stamps in India), and we

Rather than simply reproducing the global US-centric epic, the three countries’ epic narratives add their own meaning, highlighting their country-specific imperatives, achievements, and national heroes. Southern countries’ domestic narratives about science-led agricultural transformations, we argue, are instrumental to produce a national history and a scientific identity that legitimise and empower these countries and their S&T institutions as twenty-first century leaders of agricultural modernization in the global South. In other words, S&T actors in these Southern countries use their historical narratives about the GR to support policies and arguments for new GRs where they can again play a central role, either domestically or abroad.

Our analysis draws on secondary literature and a selection of interviews conducted in Brazil, China, India, and the United Kingdom (UK) between March 2018 and November 2019. We conducted 32 interviews with key informants knowledgeable about GR history and with actors within the three countries’ S&T systems, including the scientific organizations that were at the forefront of the GR experiment: the Brazilian Agricultural Research Corporation, the Chinese Academy of Agricultural Sciences, the China Agricultural University, the Punjab Agricultural University in Ludhiana, and the Indian Agricultural Research Institute in New Delhi.⁶

We proceed by elaborating our analytical framework in further detail (Sect. “Analytical perspectives for understanding the knowledge politics of the GR”). We then review, for each of the three countries, the historic moment that came to be celebrated by epic narratives (Sect. “The Green Revolutions of China, India, and Brazil”). We also discuss the processes of making and remaking such narratives (Sect. “How epic narratives are assembled and safeguarded”), as well as underlying motivations (Sect. “Why epic narratives are deployed”).

Analytical perspectives for understanding the knowledge politics of the GR

Epic narratives portray the GR as resulting from a strong, state-led sense of urgency and purpose (famines, industrialization, national sovereignty, and social stability), which motivated highly trained scientists and technicians (some of them becoming legendary figures) to work hard to deliver great scientific feats, such as new wheat, rice, and soybean

Footnote 5 (continued)

also note the common characterisation of scientists associated with the GR as heroic figures.

⁶ These comprised 8 interviews in Brazil, 12 in India, 8 in China, and 4 in the UK.

varieties that were high-yielding and pest-resistant.⁷ In India, the GR was about averting a famine and asserting post-colonial national sovereignty, and centred—in the first instance at least—on adapting high-yielding varieties of wheat developed in Mexico to the Indian setting. Brazil’s “tropical revolution” was about making the country food self-sufficient and supporting industrialization by modernising the hinterland and, specifically, taming the “unproductive” Cerrado largely by enabling soybean cultivation at scale in a tropical environment. In China, “scientific farming” entailed the development of high-yielding rice by leading scientists alongside an approximation of science to grassroots knowledge, in a context where state provision was key to ensure social stability of a newly established country.

The epic dimension captures a national heroic past, “a world of ‘beginnings’ and ‘peak times’ in the national history” and “a world of fathers and founders” (Bakhtin 1981, p. 15). But the narration of an epic is not a neutral act of historical assemblage or nostalgic recollection; rather, it is an active exercise of history-making that performs a role, as in legitimising a “biopolitical project” (Patel 2013b). As conceptualised by discourse theory, a narrative, framing or storyline is used by actors to justify, influence, and position themselves in a disputed field (Hajer 1997, 2005; Jørgensen and Phillips 2002). From this perspective, these countries’ epic narratives can be regarded, as discussed in this paper, as “rubber stamps” of authoritativeness for the scientific institutions that enacted the epics.

Whereas the epic narration of the GR centres on the past, its active deployment is underpinned by the politics of the present and negotiations about the future. This brings us to the concept of “sociotechnical imaginary”, defined in Science and Technology Studies (STS) as “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology” (Jasanoff 2015, p. 322). Sociotechnical imaginaries project visions of desirable futures and their proponents argue that they are different from “master narratives”, which are extrapolations of past events used for justificatory purposes (Jasanoff and Kim 2009). In this paper, we build on this conceptualization but add a layer to it by suggesting that the processes of

recollecting past events and imagining the future, from a present-day standpoint, are not separate; instead, the authority of an actor to justify its present stance and project the future is claimed through a representation of the past that amplifies and valorizes it. However, as we will discuss in relation to the “greening” of the GR narrative, in line with the normalization of the sustainability agenda, the GR paradigm is not fixed but is permeable to adjustments that incorporate concerns and values of present-day times. This links back to Patel’s (2013b) point about the continuous refashioning of the GR and the deployment of novel terms.

This process of epic-making and reproduction is political, as it reflects and reinforces a particular configuration of power in S&T, with conventions and rules defined by dominant actors. The “regime of truth”⁸ associated with the GR epic privileges science over experiential knowledge, technological over social innovations, and national goals over local needs (IPES-Food 2015; Leach and Scoones 2007). It defines success in agricultural S&T largely as rising yields and productive intensification, and is firmly tied with Malthusianism (the urge to continue expanding production to feed the world) and a view on agricultural modernization, or industrial agriculture, as the only virtuous pathway forward. Alternative pathways and different ways of knowing and practising agriculture are marginalized (IPES-Food 2016).

This dominant regime is reproduced in cultures of evaluation of technological innovation that claim to be apolitical and guided by objective science and observable metrics, while overlooking variables and complex dynamics that are hard to quantify (Thompson and Scoones 2009). For example, Luna and Dowd-Urbe (2020) illustrate how success narratives about genetically modified (Bt) cotton in Burkina Faso are based on yields alone and ignore effects on cotton quality or distributional impacts. The fact that Bt cotton benefits wealthier farmers disproportionately is irrelevant for narrowly framed agronomic studies that overlook the complex social interactions and the power dynamics that define how farmers relate to technology. The authors’ analysis suggests not only an epistemological bias in these evaluations but also how this bias serves the interests of certain actors—in this case, those of Monsanto (the owner of Bt cotton technology)—as positive evaluations may have contributed to an increase in the Bt seed price and in royalty payments to the

⁷ In his book, *The Doubly Green Revolution: Food for all in the twenty-first century*, (Conway 1998) starts off with a reference to an epic poem, Homer’s *Odyssey*, where dying of hunger is described as the bitterest of all fates. Conway, too, seems to frame his analysis of the GR and his agenda for a doubly (more productive and even more ‘green’) GR around the epic mission of feeding the world. Though claiming not to be a Malthusian, he expresses concern with the challenge of feeding an extra 2.5 billion people in the developing world, and confidence in the power of science and technology to avoid hunger.

⁸ Following Foucault, Scoones (2016, p. 305) suggests that “regimes of truth” are about “who understands what and in which frame” and these “may impose forms of governmentality (...) that define what is regarded as legitimate and justifiable knowledge and practice for sustainability transformations, thus constraining and channelling pathways”. Referring specifically to environmental and climate science, he also notes that “the deployment of such regimes of truth may occur through particular practices and routines, creating calculative devices to generate, for example, environmental change or climate models that provide scientific justification for what needs to be done”.

company. The politics of knowledge in S&T is, therefore, about how particular ways of knowing and framing success are linked to power and material interests.

Such discursive-material dynamics have been highlighted by “cultural political economy” in analyses of the remaking of neoliberal capitalism (Jessop 2010; Sum 2009). Actors, with unequal access to power and resources, interact to construct, contest, and negotiate alternative imaginaries that simplify a complex reality in ways that suit their (material) interests. Hegemonic projects are framed as actors’ “efforts to produce and reproduce political, intellectual, moral, and *self*-leadership within specific populations” (Sum 2009, p. 186). In our analysis, the GR epic narrative of science-led and yields-centric success strengthens the hegemonic project of agricultural modernization that suits dominant S&T institutions. In this paper, we do not discuss the links between state and capital and between scientists and capital in the hegemonic GR project—an aspect that has been discussed in the literature (Cleaver 1972; McMichael 2009; Patel 2013b; Seshia and Scoones 2003) but deserves further attention in the context of the three countries under study.

In the next sections, we outline what form GR epic narratives take across the three countries and discuss through what discursive and symbolic efforts the hegemonic GR project is maintained over time. We argue that, by crafting history through discourse and cultivating a sense of (and identity centred on) scientific nationalism, exceptionalism, and heritage, GR epic narratives perpetuate power-knowledge relations in agricultural S&T that are underpinned by a hegemonic agricultural modernization paradigm. By engaging with the knowledge politics embodied in the epic narratives, and their selectively partial framing of history, we draw attention to the subtle processes of marginalization, deskilling, and devaluation that endanger the diversity of agricultural knowledge systems in the global South. Although this paper does not dwell on the alternatives to the hegemonic paradigm, it is worth noting here the growing strength and credibility of knowledge systems that value more bottom-up, socially embedded, and ecologically sound knowledge production and innovation, emphasized by work on transformative innovations (Smith and Stirling 2018) and the expansive field of political ecology (Forsyth 2003; Goldman et al. 2011; Robbins 2012). Agroecology, specifically, has generated “cognitive, technological, and sociopolitical innovations” (Holt-Giménez and Altieri 2013, p. 93), combining elements of traditional knowledge and modern science, while mindful of power dynamics and the need to resist co-optation by the hegemonic paradigm (Altieri and Toledo 2011; Rosset and Altieri 2017). We will come back briefly to the counterforces to the GR when we consider the reframing and “greening” of the GR narrative. We now proceed by outlining the contours of the three countries’ GRs that came to be framed as epic moments.

The Green Revolutions of China, India, and Brazil

This section outlines the historical moments that epic narratives have come to glorify in each of the three countries. We contextualize decisions to strengthen S&T systems and develop high-yielding varieties, and discuss the impact of these decisions on production and yields. We also consider the establishment of an agricultural science apparatus and the emergence of the identity of the modern farmer in each country. In subsequent sections, we analyse the processes whereby epic narratives are created and protected, as well as the underlying motivations for those who deploy such narratives.

China’s scientific farming

China’s agricultural transformation is linked to the advent of “scientific farming”, which entailed the combination of state-led, cutting-edge research—notably on hybrid rice—with a strong push to connect scientists and modern technology with the grass roots. An alliance between the state, scientists and the peasantry, combining modernization with a state provisioning imperative (that was part of the socialist revolution), constituted the essence of scientific farming, which remained unchallenged over the years, even if adapted to the changing context.

The origins of scientific farming can be traced back to the 1840s, when China was pulled by the West towards a modernization and globalization trajectory (Zhong 1997). However, the exact notion of “scientific farming” (科学种田, *kexue zhongtian*) and its institutional structures were formally established with the foundation of the People’s Republic of China (PRC) in 1949.⁹ Ensuring grain self-sufficiency was central to safeguarding national sovereignty and territorial integrity, and the 1956–1967 Long-term Plan for Scientific and Technological Development established “chemicalization, mechanization and electrification” as priorities to increase grain production and ensure basic provisions of food and clothing to the population. The Plan indicated that: “the principle of ensuring food security via grain self-sufficiency needs to be the top priority of the development strategy, and this principle should never be slackened” (Science Planning Committee 1956, p. 4). With this political orientation, the Chinese Academy of Agricultural Sciences (CAAS) was established in 1957 to train talents in agricultural science, overseeing an extensive network of research institutes and colleges across the country.

⁹ Following the Chinese Civil War and the victory by communist forces, Mao Zedong declared the foundation of the PRC and became the country’s leader.

The Cultural Revolution (1966–1976), however, led to the suspension of research institutes and colleges represented by the CAAS. The government emphasized that science needed to connect to field-level practice, leading to the creation of new units of research below the county level, which aimed to connect scientists with the grass roots. A top-down extension system, which had been set up in the 1920s by US-trained Chinese agronomists and agricultural economists, was replaced with a grass-roots extension system (Swanson and Mao 2019). S&T was to become an instrument of class struggle that released the peasantry from the oppression of the elitist bureaucracy (Schmalzer 2016). While the 1963 National Conference on Agricultural Science and Technology had already established experimental fields where new seeds and methods could be tested and demonstrated to farmers, the Cultural Revolution provided the ground for developing methodologies for technology transfer and interaction between extensionists and farmers that would become known as distinctively Chinese, as seen in contemporary technology transfer initiatives in Africa (Bräutigam 1998; Xu et al. 2016).

Parallel to these changes at the grass-roots level, the central government supported large scientific programmes involving collaborations between Chinese research institutes. The most representative of these was on hybrid rice, which started in 1964 with research on rice male sterility (Chen et al. 2004; Li et al. 2009).¹⁰ A key figure at the time was the late Yuan Longping, who is today acclaimed for pioneering rice breeding work developed between the late 1960s and the early 1970s (Chen 2006). His humble personality and scientific accomplishments made him the ideal “intellectual peasant”, who could connect cutting-edge science with grass-roots practice (Schmalzer 2016). Yuan reported his findings on mutant male sterile rice plants in the *Chinese Science Bulletin* in 1966, which won him the title of “father of hybrid rice”, despite hybrid rice technology being the result of a wider collaborative effort.¹¹

Although the modern S&T system was partly dismantled during the Cultural Revolution, resources to support the continuation of the hybrid rice programme were protected given its perceived strategic importance.¹² Although the Chinese

state’s view on S&T suffered considerable turns during this period, it set the foundations of scientific farming through: the creation of an agricultural S&T system with CAAS at the top; the development of methodologies for technology transfer and demonstration to farmers; and the development of large collaborative research on cutting-edge technologies, with hybrid rice as the most symbolic.

While increases in grain production in this early period resulted largely from the expansion of the agricultural frontier and the spread of modern inputs (such as fertilizer and pesticides), scientific innovations (such as that on hybrid rice) laid the foundations for subsequent gains (Li et al. 2009). The impact of scientific farming, and the role of scientists, became more noticeable after the 1980s when China started its “open doors” policy and market-oriented reforms. Achievements in agricultural development in the previous four decades, expressed in land and labour productivity gains, were officially attributed to the power of S&T. Deng Xiaoping’s famous statement, “science and technology are the primary productive forces”, was first made at a meeting with the Czechoslovak President Gustáv Husák in 1988 (Zhong 1997, pp. 503–505). From then onwards, the development of S&T advanced rapidly and many national programmes were put in place. Praising of science and scientists became widespread. In 2000, the State Council established the highest national S&T award to value science, highlight its contribution to society, and encourage scientists to make unremitting efforts to S&T for national development.

Today, China’s scientific farming continues to highlight the success of food provisioning at a very large scale and through a model of state-sponsored modern technology tailored to the needs of the farmer. Although China’s significant achievements in rice productivity happened in the 1970s and are associated with the work of Yuan Longping, the long history of China’s rice is emphasized in references to the Honghe Hani rice terraces in Yunnan province, dating back 1,300 years (Chen 2006).¹³ Scientific farming encapsulates, therefore, both modern science, and grass-roots knowledge and tradition.

India’s wheat revolution

In India, agricultural experiments that used improved crop varieties and other inputs, such as irrigation and farm machinery, had been going on since the beginning of the twentieth century (Saha and Schmalzer 2016; Swaminathan 1993). These improvements focused on local agro-climatic conditions and were specific to local needs and available

¹⁰ Li et al. (2009) outline the various stages of China’s hybrid rice research, from 1964 to 2009, and describe government support through policies, standards, and investments in human resources and supporting infrastructures.

¹¹ In order to find the “wild abortive” (WA, 野败 yebai)—a key step for developing hybrid rice—a large team of researchers and farmers were mobilized. This was initiated in Hunan province in 1970 but soon spread across the country.

¹² The hybrid rice programme was considered as high a priority as the national security programme *Two Bombs, One Satellite*, a nuclear and space programme.

¹³ The Honghe Hani rice terraces are a complex system of terraces that has developed over 1300 years. It has been designated as a UNESCO heritage site.

inputs. However, within the post-independence strategy of rapid growth through industrialization, the localized and slow developments in agriculture came to be regarded as a roadblock to progress. Committees led by US experts (comprising the United States Agency for International Development (USAID), the Ford Foundation, and the Rockefeller Foundation) identified multiple constraints within Indian agriculture that included subsistence-oriented cultivation practices, and lack of investment and risk-taking by farmers (Perkins 1990; Patel 2013b). Traditional crop varieties and farming techniques were considered inadequate to meet the needs of the industrial sector and a growing population.

New strategies and programmes to modernize agriculture were rolled out immediately after independence from British colonial rule. In a famous 1948 speech, Jawaharlal Nehru, the first Prime Minister of India, said that “everything else can wait but not agriculture” (Swaminathan 1993, p. vii). To bring agriculture up to speed with industrialization, the 1960s witnessed a major restructuring in the organization of agricultural research along the lines of the Council of Scientific and Industrial Research. This included bringing agricultural universities, research institutes, and funding schemes within the purview of the Indian Council of Agricultural Research (ICAR) and initiating All India Coordinated Programmes for different crops that focused on targeted use of S&T in time-bound, goal-oriented programmes (Subramaniam 1979). The Indian government initiated a series of programmes with the support of US research and funding agencies (Saha and Schmalzer 2016). These included development of input-responsive varieties, irrigation, fertilizer production, strengthening of research at selected agricultural universities, and organization of a national extension service (Abrol 1983; Swaminathan 1993).

Amid these programmes, two consecutive droughts in 1965 and 1966 led to a famine-like situation. In response, India imported 10 million tonnes of wheat from the US under the PL480 programme. For a newly independent country with a large agricultural sector, surviving on US aid was a matter of deep political concern (Subramaniam 1979). In addition to internal pressure to deal with droughts, famines and rising population, there was external pressure coming from international academia and media that labelled Indian leadership as incapable of handling the crisis situation, resulting in rising rural unemployment and poverty, distress, and conflict (Ehrlich 1975).

Against this background, C. Subramaniam, then Minister of Agriculture, rolled out a new strategy for agriculture that involved large-scale release of input-responsive hybrid wheat varieties based on Mexican lines for wide adoption (Visvanathan 2003). Along with the restructuring of S&T, a major focus of agricultural modernization was on developing infrastructures that could facilitate production, procurement, and distribution of grains. These initiatives included

strengthening road networks, rural electrification, and storage units. State support also included minimum prices, bulk purchasing, subsidized public distribution systems, and agricultural loans and credit mechanisms. However, for effective implementation on the ground, there were still challenges ahead—not least scientists having to win the trust of farmers, who were largely considered “traditional” in their approach to agriculture, to encourage them to plant these modern varieties and follow the package of practices (Subramaniam 1979). To motivate farmers, the government portrayed them as the “soldiers” defending national (food) security.¹⁴

The impacts of these investments on production and yields were soon felt in input-responsive hybrid dwarf varieties of primarily wheat and rice. The year of 1968 marked the apex of the GR in India with a bumper harvest of 17 million metric tonnes of wheat. This was seen as a very significant accomplishment for a newly independent country struggling to feed its population and amid internal and geopolitical challenges. According to M.S. Swaminathan, who became known as the father of the Indian GR, “the harvest of 1968 changed India’s agricultural destiny with the beginning of a wheat revolution which became an affirming flame in the midst of the sea of despair” (Gopalkrishnan and Swaminathan 2002, p. 46). From a country dependent on US food aid in the 1960s, India became self-sufficient in food production by 1977 (Gopalkrishnan and Swaminathan 2002).

The success of the Indian GR is often attributed to legendary institutions such as the Indian Agricultural Research Institute, Punjab Agricultural University, Tamil Nadu Agricultural University, and founding fathers such as M.S. Swaminathan. While the institutions publicize their role in the GR through their websites,¹⁵ scientists are often celebrated as national heroes.

Brazil’s tropical revolution

In Brazil, the expansion of farming into the Cerrado from the 1970s is seen as marking the advent of agricultural modernization (Albuquerque and da Silva 2008). The incorporation of the Cerrado was integral to the state’s strategy of modernizing the hinterland and connecting it to the coast—a

¹⁴ Lal Bahadur Shastri, the second Prime Minister of India, used the slogan “Jai Jawan Jai Kisan” during the Indo-Pakistani war in 1965 when the United States of America (USA) threatened to stop the consignments of PL480. The slogan translates as “victory to the soldier and victory to the farmer” (Bajpai 2018). Shastri used the slogan to portray farmers and soldiers as national heroes who defended the nation’s sovereignty, and thereby motivate them to actively contribute to food security as a national defence endeavour.

¹⁵ On its webpage, Punjab Agricultural University, Ludhiana, presents itself as the “mother” of the Green Revolution. https://www.pau.edu/index.php?_act=manageLink&DO=firstLink&intSubID=13.

process that had started in the 1930s with the “March to the West” (Schallenger and Schneider 2009). It was also driven by industrialization and the imperative of feeding growing cities at a time when Brazil was dependent on food imports (Alves 2010). S&T is claimed to have played a major part in enabling farming in the Cerrado by developing crop and forage varieties and farming practices that allowed grain and livestock production to develop at scale in nutrient-poor and acidic soils (Pereira et al. 2012). Some of the S&T achievements included: the adaptation of soybean varieties to the conditions of the Cerrado; breeding of varieties of *rhizobium*, a bacterium that helps fixate nitrogen in legumes, reducing the need for fertilizer; and the improvement of grasses such as varieties of *brachiaria* that improved soil structure and enabled livestock farming at scale. The following passage reproduces a discourse that emphasizes the centrality of these achievements in turning Brazil into a world reference on tropical agriculture.

Applied science unravels the mystery of acid and previously useless soils of the Cerrado. The new cultivars turn scientific discoveries into production, at increasing rates. The region’s inefficient and extensive beef cattle breeding gives way to pioneering and efficient tropical agriculture. More than 200 million hectares become available to be incorporated into Brazilian agriculture. Brazil turns into an example to the world of how to transform worthless natural resources into productive resources (Alves et al. 2008, p. 74).

Between 1970 and 2006, grain production in the Cerrado expanded from 8 to 48 million tonnes and by the end of this period, this region alone accounted for 50% of the country’s grain production, including 60% of soybean (Pereira et al. 2012). The technological conversion of the Cerrado is often referred to as the “tropical revolution” (Crestana and de Mori 2015; Nepstad and Stickler 2008). Norman Borlaug described it as “one of the great achievements of agricultural science in the twentieth century” (American Society of Agronomy 2006). Although most of the significant gains in yields happened after 1980, it is argued that the S&T advances of that earlier period created the foundations that allowed Brazil to become an agricultural powerhouse (Pereira et al. 2012; Contini 2014).

The transformation of the Cerrado and the broader modernization of Brazilian agriculture are often attributed to the Brazilian Agricultural Research Corporation, Embrapa, portrayed as the hero of Brazil’s tropical revolution, nationally as well as globally (Albuquerque and Silva 2008; Alves 2010; Hosono and Hongo 2012; The Economist 2010). Embrapa was established in 1973, during the military regime, with the aim of reorganizing agricultural research so that it could directly contribute to the modernization of agriculture, increasing its competitiveness, and strengthening its

links with the industry (Mengel 2015). This reorganization entailed the creation of crop-focused research programmes and unprecedented investments in research capability, mainly through a postgraduate training programme that sent Brazilian researchers abroad, predominantly to the USA.

Besides boosting research capability, the policy package for the transformation of the Cerrado also included subsidized credit for the purchase of modern inputs, extension services, and transport infrastructures to allow produce to reach domestic and international markets. These policies were complemented by aid-funded local development programmes that established technology-intensive farms (Hosono and Hongo 2012), often by attracting farmers from Southern states where farming was more developed but tensions over land access were intensifying (Delgado 2010). These programmes further promoted integration between agriculture and industry, feeding the development of large agro-industrial complexes (Oliveira 2016; Pires 2007).

Modern technology, combined with state subsidies and aid funding, turned the Cerrado into a land of soybeans monocropping and extensive livestock pastures, where farming increasingly became a professionalized business for entrepreneurial farmers, as the following account describes:

With cheap land and high subsidies, we were able to attract experienced farmers from the South and Southeast. A farmer in Mato Grosso harvesting 20 sacks of soybean per hectare would have a return of 20%. (...) By the 1980s and after the end of subsidies, the same return required harvesting 50 sacks per hectare. This was now for professionals only. This was a milestone. At the end of the 1970s, beginning of the 1980s, there was no longer a place for amateur farming. Agriculture had to be professional and substitute guesswork with science. Those who had not prepared for this change failed (Embrapa 2014a).

Green Revolutions compared

The three countries went through somewhat similar processes of agricultural modernization at different points in time and with distinct political contexts: a newly established socialist country (China in the 1950s); a newly independent nation (India in the 1960s); and a country at the height of a military dictatorship (Brazil in the 1970s). And yet, the three countries’ governments shared concerns with national sovereignty and food self-sufficiency, and a strong resolve to modernize the countryside and assist industrialization. Science, led by the state, was instrumental for such pursuits, allowing a break away from traditional practices, often regarded as backward, though in China the Cultural Revolution established a strong link between science and peasant wisdom (Saha and Schmalzer 2016). Modern varieties of

Table 1 Green Revolutions compared

Country	China	India	Brazil
National epic	Scientific farming	Wheat revolution	Tropical revolution
Timeframe	1950s–1980s	1960–1970s	1970–1980s
Political setting	Newly founded PRC	Newly independent country	Military dictatorship
National imperatives	Sovereignty, grain self-sufficiency, modernization and rural stability	Sovereignty, avoiding famines, modernization	Modernization of the hinterland, industrialization, food self-sufficiency
GR symbolic crop	Hybrid rice	Dwarf wheat	Tropical soybean
Leading agricultural S&T organizations	Chinese Academy of Agricultural Sciences and China Agricultural University (after the 1980s particularly)	Indian Council of Agricultural Research	Embrapa
Heroic figures	Yuan Longping, father of hybrid rice	M.S. Swaminathan, father of the Indian wheat revolution	Embrapa as mastermind of the Cerrado miracle

dwarf wheat, hybrid rice, and tropicalized soybean opened the way for new, modern practices to be adopted by technology-savvy, modern, and professionalized farmers.

But the remit of the GR extended beyond agricultural technology. It was about asserting national sovereignty in post-colonial India and the new PRC. It was about legitimizing the state and reaching across the territory, both in the military's support of Embrapa in Brazil or in China's pursuit of self-sufficiency. It was about ensuring social stability, as in the Chinese government's provisioning to the peasantry or in the Brazilian government's effort to ease pressure over land in the Southern regions by encouraging entrepreneurial farmers to venture into the comparatively sparse Cerrado. These broader imperatives granted political muscle to the technocratic effort and ensured unprecedented investment in agricultural S&T. The three countries' own scientists and research organizations were distinguished for their achievements, and the contours of national GR epic narratives—with exceptional feats and heroic figures—started taking shape (Table 1).

So, through what efforts (Sect. “[How epic narratives are assembled and safeguarded](#)”) and why (Sect. “[Why epic narratives are deployed](#)”) did the three country experiences with agricultural modernization come to be framed as epic endeavours?

How epic narratives are assembled and safeguarded

There are two distinct but reinforcing processes at play. One is the making of the epic narrative through symbols, celebration of heroes, and construction of history-rooted identity or heritage, which seal off the epic moment as distant, finished, and hierarchically superior (Bakhtin 1981); the GR epic needs to be seen as finished so that it can be celebrated (Patel 2013b). The other process is the weaving of the epic into the narratives of the present, as well as aspirations for

the future. This second process is noticeable in the incorporation of the sustainability agenda by the agricultural S&T establishment; without refuting the GR epic and its legacy, productive intensification is now to be pursued in a sustainable manner. Calls for “evergreen”, “second” or “doubly” Green Revolutions suggest not only that a new epic is needed but also that the fundamentals of the first one remain valid.

Epic narration through symbols, heroes, and heritage-making

In 1968, the government of India issued a special postage stamp with the title “wheat revolution”. Even before William Gaud had coined the term “Green Revolution”, the “wheat revolution” stamp was released to commemorate the historical moment of “quantum jump” in the production of wheat and to “bring these achievements to public attention” (Swaminathan 2010: p. 456).¹⁶ The stamp depicted three wheat twigs alongside bars of comparative yield difference in wheat between 1951 and 1968, and the Indian Agricultural Research Institute (IARI) library in the background. In the words of M.S. Swaminathan (2013, p. 183), the stamp symbolized the “role of science in transforming the yield potential of wheat”. The Indian GR epic has been communicated to the public through colourful displays of several such stamps over the years, contributing to keeping the memory of the GR alive. These stamps have highlighted different aspects of the GR such as domestic fertilizer production, irrigation through dams, agricultural machinery such as tractors, storage facilities, and India's declaration of self-sufficiency in food grains. Besides stamps, other mediums through which the GR epic is communicated to the wider public include the display of the story of the GR in

¹⁶ After Gaud popularized the term “GR” for the overall transformation of agriculture, the term “wheat revolution” became less prominent in India.

agricultural museums, city circles named after and decorated with models of celebrity scientists and scientific institutions that led the GR, and songs broadcast on national television. In all these diverse modes of communicating the epic to the public, the narrative of yield gain and the victory of S&T in conquering the Malthusian doom remains constant.

In China, throughout the Cultural Revolution, propaganda posters documented—with powerful visual effect—how technology had become an instrument of peasant struggle and modernization in the countryside (Fu and Yan 2017). And during the market-oriented reform period, narratives about the importance of S&T, as well as the prestigious role of scientists in society, were widely disseminated in media channels to shape the mindsets of the bureaucracy and the public (Zhong 1997).

The acclamation of heroes of science-led agricultural transformations is another element in the process of epic making. Alongside Borlaug, the global father of the GR, other “fatherly” figures have emerged across the global South, including M.S. Swaminathan in India and Yuan Longping in China (Rao 2015; Schmalzer 2016). On his 90th birthday, M.S. Swaminathan was praised as a “living legend”:

Many harvests have passed between now and the first two decades of Independence when Swaminathan made the stellar scientific contributions, both on- and off-field, that led to the country’s transformation from a ‘basket case’ to achieving food grain self-sufficiency (Damodaran 2015).

The recent death of Yuan Longping was also met with widespread mourning and pouring of tributes across China, where he has the status of a celebrity scientist, respected by the scientific community and well known to the wider public (Cabral and Xu 2021).

Internationally, the World Food Prize (the Nobel-like award envisioned by Borlaug for achievements in food and agriculture) has been a channel for the acclamation of (typically male) heroes and reproduction of a Malthusian worldview. M.S. Swaminathan was awarded the first World Food Prize in 1987 and was credited as a global GR leader. Embrapa scientists Edson Lobato and Alysson Paolinelli, together with American scientist Colin McClung, received the award in 2006 for their roles in “transforming the Cerrado—a region of vast, once infertile tropical high plains stretching across Brazil—into highly productive cropland”.¹⁷ Yuan Longping was laureated in 2014 and was portrayed as the father of China’s hybrid rice miracle.¹⁸

Malthusianism is firmly embedded in the celebration of the heroic feats of agricultural science. In his acceptance speech for the World Food Prize, M.S. Swaminathan noted:

We have no time to relax on the food production front, as my good friend Dr. Norman Borlaug often reminds us. True, the global reserves of food grains, milk powder, and butter are growing daily. But simultaneously, the number of children, women, and men who go to bed hungry is also increasing. Why have all of our intellectual, technological, financial, and spiritual resources failed to find a solution to this age-old irony. (...) In most developing countries, a vertical growth in productivity and a higher intensity of cropping are the two major pathways through which the additional food needed will have to be produced (Swaminathan 1987, pp. 1–3).

Agricultural science heroes have also been celebrated domestically, as already noted. In China, Yuan Longping and other scientists such as Yan Longan, Zhang Xiancheng and Li Bihu received the First-Class Intervention Award in 1981 for their work on hybrid rice, although news and reports focused mainly on Yuan. He was also awarded the Republican Medal in 2019, which constitutes the highest honour of China, and is widely regarded as one of the most outstanding scientists to have ever served the Chinese state. Besides individual heroes, organizations are also praised. China’s scientific farming epic includes iconic organizations, with the CAAS (established in 1957) as the most prominent.¹⁹ Crucially, for the construction of a scientific identity, CAAS has established the research culture represented by the “Qiyang Station Spirit”²⁰ and “China Cotton Institute Spirit”,²¹ which stress values of diligence and sacrifice for national benefit.

In Brazil, Embrapa is the undisputable hero of the GR, with a central place in the history of Brazil’s modern agriculture (Albuquerque and Silva 2008), and is globally acclaimed for its achievements (Borlaug 2007; The Economist 2010; World Bank 2009). As the organization commemorated its 40th anniversary, in 2013, an initiative designated *Memória Embrapa* paid tribute to its history and the contributions of its distinguished scientists, including the

¹⁷ Cf. The World Food Prize. https://www.worldfoodprize.org/en/laureates/20002009_laureates/2006_lobato_mcclung_paolinelli/.

¹⁸ Cf. The World Food Prize. https://www.worldfoodprize.org/en/laureates/20002009_laureates/2004_jones_and_yuan/.

¹⁹ CAAS has 34 directly affiliated research institutes and more than 10,000 employees.

²⁰ Qiyang Station is the CAAS experimental station that carries out soil and water management and agricultural demonstration in the red soil area of Qiyang, Hunan. The Qiyang Station Spirit represents the hardworking attitude of agricultural technicians.

²¹ The China Cotton Institute is located in Anyang, Henan. The older generation of scientists gave up comfortable living conditions for a harsh environment in the name of scientific research.

consolidation of farming in the Cerrado, the tropicalization of grains, placing Brazil in the frontline of tropical agricultural science, and feeding the world—“what Embrapa sows, the world harvests” (Embrapa 2014b). The scientific heritage celebrated by *Memória Embrapa* is narrowly connected to productive intensification and a view of the farmer as passive taker of technologies developed by experts. This officialized memory simplifies a complex history, purges it of blemishes and contestations, and ignores experimentation with multiple approaches to scientific research and technological innovation that do not fit the accepted scientific cannons, including different modes of interaction with farmers seen in action-research on social innovation and in work with indigenous communities (Bustamante et al. 2017; Eidt and Udry 2019). *Memória Embrapa* can be regarded as a branding exercise that roots the organization in an epic history and thereby creates a sense of a shared scientific heritage to be nurtured and carried forward by younger generations of scientists (Cabral 2020).

Safeguarding the epic narrative

While GR epic narratives are the celebration of the “walled off” past, this does not mean that the regime that uses them has not adapted to changing times—as (Patel 2013b, p. 4) notes, “that the Green Revolution has been long is not to argue that it has remained constant”. The second process of narrative-making that we wish to highlight here is the weaving of the epic into the narratives of the present. This can be seen in claims about: (1) how green the GR was; and (2) how the scientific institutions that enacted the GR can lead the way in the pursuit of greener and more sustainable scientific revolutions.

The effort to “green” the GR to safeguard the epic past is noticeable in the literature. For example, it is claimed that productivity gains delivered by the GR saved millions of hectares of land from deforestation (Stevenson et al. 2013; Swaminathan 2010) and that the possibility to produce more on less land allowed for agricultural diversification and non-agricultural land use (Li et al. 2009). Pingali (2012, p. 12304) notes that “GR driven intensification saved new land from conversion to agriculture, a known source of greenhouse gas emissions and driver of climate change, and allowed for the release of marginal lands out of agricultural production into providing alternative ecosystem services, such as the regeneration of forest cover”. And, despite acknowledging the environmental costs of intensive use of pesticides and irrigation, he goes on to say that the environmental damage was not caused by the GR technology per se but by “the policy environment that promoted injudicious and overuse of inputs and expansion of cultivation into areas that could not sustain high levels of intensification” (ibid.).

Meanwhile, the scientific institutions that enacted the GR epic have embraced the environmental sustainability agenda mainstreamed by the Sustainable Development Goals (SDGs) (United Nations 2015) and are showcasing “green” solutions for agriculture, comprising different types of so-called climate smart agriculture and particular (highly contested) interpretations of “agroecology” (Bergius and Buseth 2019; Giraldo and Rosset 2016; Holt-Giménez and Altieri 2013). But while the GR narrative has become greener, the same ethos centred on the heroic power of science to guide farmers and feed the world has been carried forward. The SDGs are therefore selectively used—the reframing of the narrative is aligned with SDG targets around increased productivity and production to end hunger and food insecurity, but overlooks targets related to agrobiodiversity, recognition, inclusion, and distribution that are relevant from the point of view of “equitable sustainability” (Leach et al. 2018).

Across the three countries, similar processes of greening of the GR epic and engaging with the sustainability agenda are noticeable. In India, since its highest moment in 1968, the epic narrative of “a science-induced revolution” (Rao 2015, p. 26) has been repeatedly rehearsed to legitimize science-led interventions in agriculture (Pandey 2016). The GR epic is framed as a moment in history that continues to deliver its promise by ensuring food self-sufficiency for a growing population (Swaminathan 2013). As a result, recurrent calls for a “second” GR weave the legitimizing power of the GR epic to justify current and future political strategies. For example, in 2006, while addressing the 93rd Indian Science Congress Prime Minister Singh remembered the glory of the past GR and motivated the scientists to work towards a “second” one (Singh 2006). Similarly, despite ideological differences, Prime Minister Modi has repeatedly called for a “second” GR in agriculture for India’s eastern states (Deogharia 2015). The practice of adding prefixes to the GR is again noticeable in the promotion of genetically modified crops—by calling for a “gene” revolution, multinational corporations, politicians, and scientists allude to public trust on the past GR to draw support for this technology (Visvanathan 2003).

Furthermore, the shift to sustainability in India’s agricultural science is well embodied by the M.S. Swaminathan Research Foundation (MSSRF), established in 1988 with World Food Prize funds. It was created to extend the GR mission into an “Evergreen Revolution” (Swaminathan 2006), by putting “science and technology at the service of society” (Rao 2015, p. 36). Through a process as simple as adding a prefix (“ever”), the epic narration has served as a tool for justifying a dominant paradigm of agricultural S&T that endures but adjusts to the preoccupations of our times. The MSSRF advocates a shift of focus from productivity to “productivity in perpetuity” (i.e. without compromising the environment and ensuring productivity into the future),

from food security to nutritional security, and from crop-centred to natural resource-centred farming (Kesavan and Swaminathan 2008). Although this vision of sustainable agricultural development contrasts with the original GR, it carries through the same mission-like belief in science as the driver of a grand societal transformation, and the same focus on productivity as the prime metric of success.

In Brazil, the engagement with sustainability by leading S&T organizations followed an intense critique that emerged in the 1980s and became widespread in the 1990s, emphasizing the environmental destruction as well as inequalities created by the first GR. Such concerns were voiced over the years by alternative agriculture, agrarian, environmentalist, and agroecology movements (Brazilian Federation of Agricultural Engineers Associations (FAEAB) and Agricultural Engineers Association of the State of Rio de Janeiro (AERJ) 1984; Shiva 1991; Wolford 2005). The end of the military dictatorship in 1985 enabled an unprecedented level of social mobilization for land and labour justice, and for broader social and political transformation in agriculture (Grzybowski 1990), which would consolidate over the years and eventually shape public policy (Grisa and Schneider 2015; Schmitt et al. 2016). Embrapa incorporated some of its concerns by gradually widening its target population and, eventually, creating a research programme targeting family farmers. The term “sustainability” was eventually included in its mission statement and vision for the future, *Visão 2030*, which centres on sustainable intensification (Embrapa 2018).

The package of new sustainable intensification technologies includes (for example) integrated crop-livestock-forestry systems (ILPF). Building on earlier technological innovation on forages, biological nitrogen fixation, soil improvement, and zero tillage, ILPF alternates crops, livestock, and trees in the same farming unit (typically soybean or maize, bovine cattle, and eucalyptus). By exploring synergies between individual systems, this technology promises to increase efficiency, profitability, and competitiveness, while reducing risk and contributing to carbon sequestration. ILPF also aims to rescue degraded pasture land, which has become a widespread problem in the Cerrado, where 80% of pasture land displays a degree of degradation (Cordeiro, 2015)—a legacy of the GR. Criticized for maintaining a top-down diffusionist approach to innovation, for its bias to large farms (that can afford the costs of the technology), and for failing to engage with local biodiversity (using eucalyptus rather than native trees), ILPF technology encapsulates the latest ready-made solution for farmers, centred on yields and profitability, but now building in a strong sustainability narrative.

In China, concerns with ecological conservation and sustainability came to the fore from the 1990s, with a focus on the potential contribution of modern varieties. The Ten-Year Plan for Science and Technology (1991–2000) drew

attention to environmental protection and rational natural resource use (National Science and Technology Commission 1991). This was the first time these concerns were connected to agricultural S&T. The Chinese government thereby aligned with global trends—a key step to establish its image as a modern and responsible global power. Since the turn of the century, China’s scientific farming has emphasized biotechnology and information technology to optimize resource allocation and promote industrial development. In the 2000–2010 period, the policy discourse brought together technological innovation and sustainability, while linking industrial development with the revitalization and greening of rural areas. The twelfth five-year plan (2011–2015) incorporates these concerns and presents biological industry as strategic (N. Chen 2015), with private enterprises expected to play a central role in scientific farming. With the latest advances in biotechnology, scientific farming was now seen as truly sustainable and able to deliver “scientific development” (ibid.). In the words of a scientist from China Agricultural University:

As the remote sensing and gene technology are widely used in agriculture, resource recycling and environmental sustainable development will become important directions for future agricultural development, and the GR will become “actually green”.²²

Food quality and safety have been highlighted recently, echoing consumer awareness and widespread concerns with GM rice and contaminated, counterfeit foods voiced by academia, non-governmental organizations (NGOs), and the general public. In response, the government has announced that quality improvement and “green development” are the new main drivers of China’s agriculture (MNW 2018). Scientific farming is no longer just about yields but also about sustainability and safety.

Overall, there are two concurrent processes of epic-making: one glorifies the past through symbols, heroes, and heritage-building; the other recasts the narrative on agricultural modernization by either claiming the first GR to have been environmentally beneficial or by presenting science and technology innovation for agriculture as the source of new, greener epics. The essence that remains unchanged is the firm belief in the heroic power of science to avert a Malthusian catastrophe, and the primacy of yields and profitability as metrics of success. Environmental considerations are built in because they safeguard productivity in the future—and deliver, as M.S. Swaminathan put it, “productivity with perpetuity”.

²² Interview with researcher at China Agricultural University (Beijing, 20 January 2019).

Why epic narratives are deployed

Several factors explain the deployment of epic narratives, with some variation across the three countries. These include: the drive for self-preservation by leading S&T organizations whose history is connected to the GR (particularly in Brazil and India); efforts by states and S&T corporations to harness public trust in technology (India and China); and the construction of a national scientific identity that enables these Southern countries to assert themselves internationally (Brazil and China).

In Brazil and India, the epic narration of the GR is a performance by leading players of the agricultural S&T system, whose history and identity are tightly linked to the GR. It reflects an effort to preserve their credibility and position in the system, in response to the accumulation of evidence, from early on, interrogating the extent of achievements and negative social and environmental impacts (Aggarwal 1973; Bardhan 1970; Byres 1981; Farmer 1977; Harriss-White and Harriss 2007; Lipton and Longhurst 1989; Pimentel and Pimentel 1990; Prahladachar 1983). It is also a reaction to the increasingly articulate and forceful societal critique to productive intensification that unfolded since the mid-1980s and the early 1990s (Petersen et al. 2013; Shiva 1991), including from within the agricultural sciences (FAEAB and AERJ 1984).

In Brazil, confronted with growing awareness about environmental stresses and inequalities in rural areas, Embrapa invested in communication with the general public (not just farmers) to create a broader “mentality favourable to science”.²³ It established direct links with the media, leading to the creation of a television programme (*Globo Rural*) that would become a key channel for showcasing Embrapa’s successes, and which strengthened the organization’s political power and ensured a stable flow of public funding (Mengel 2015). Since the 2000s, Embrapa’s position in S&T became challenged by the advances of multinational agro-chemical and seed corporations. Having been at the forefront of soybean research for decades, Embrapa was eventually displaced by Monsanto, which currently dominates the market for genetically modified (GM) soybeans (Bonacelli et al. 2015; Crestana and de Mori 2015). In this challenging context, the crafting of an epic narrative illustrates the effort to assert and shield the organization’s legacy (Cabral 2020).

This active valorization of Embrapa’s identity, by rooting it in a history of success, ensures the organization’s continuity by inspiring young generations of scientists, “detached from the epic past that established the organisation” (Navarro and Alves 2014, p. 8), who can carry forward the legacy.²⁴ It also builds a “historical heritage as the largest tropical research company in the world”, which helps to project the organization internationally and place it in the frontline of world agricultural science.²⁵ Embrapa’s continuing relevance, domestically and abroad, is therefore secured by asserting its credentials on “sustainable agricultural technology for the tropics”.²⁶ Yet, while envisioning this future, the past Cerrado miracle continues to symbolize the organization’s epic feats that ensure authoritativeness in a competitive environment. Embrapa’s legitimacy to justify its present stance and project the future is therefore claimed through a glorifying representation of the organization’s past.

In India, the variety of ways in which the epic is woven into a narrative demonstrates its capacity to influence the knowledge politics and power relations. As a result, it is deployed by different actors to legitimize their interests and justify their actions. For agricultural scientists, as in Brazil, this too has been part of an effort to maintain an environment favourable to agricultural S&T by creating an alliance with government, funding agencies, and farmers. When asked about the role of agricultural institutions in ensuring national food security, one scientist at Punjab Agricultural University corroborated our analysis by saying that “the institutions produced GR and eventually the GR enabled the institutions”.²⁷ This means that the institutional set-up that made space for the GR in the first place is reinforced by the epic narrative, which situates S&T and scientists at its core. The epic narrative, and its repetitive rehearsal at various sites, works towards sustaining the public’s trust in agricultural institutions and scientists.

In China, the celebration of scientific farming has helped to consolidate a narrative of non-Western exceptionalism in the country’s route to modernization. Scientific farming “with Chinese characteristics” connects scientific advancement (in line with global trends) with the domestic imperative of state provisioning for the collective good. The direct link between scientists and the peasantry, pushed by the state during the Cultural Revolution, defined China’s “radical [Green Revolution] epistemology”, which combined

²³ Interview with former President of Embrapa (Brasília, 6 February 2019).

²⁴ Interview with member of staff in Embrapa’s Communications Directorate (Brasília, 12 September 2019) and Embrapa researcher (Aracaju, 7 November 2019).

²⁵ Memoria Embrapa webpage, <https://www.embrapa.br/memoria-embrapa/inicial> (accessed 4 March 2020, translated by the author).

²⁶ Ibid.

²⁷ Interview with scientist at Punjab Agricultural University (Ludhiana, 11 February 2019).

peasant wisdom, party ideology, and modern technology (Saha and Schmalzer 2016, p. 166).²⁸ With the advent of biotechnology, however, this link has been challenged on two fronts. Because of its complexity, biotechnology has hardened hierarchical relationships between scientists and grass-roots technicians, contributing to the “ascendancy of scientists as custodians of increasingly specialized knowledge” (Chen 2015, p. 226). It has also brought into the system new, private players and concerns over the quality and safety of food in a more market-driven society where counterfeit and contaminated foods have become a widespread problem. In this setting, reinstating the link between the state and collective wellbeing is part of a nation-building process where the state pays attention not only to its rural producers but also harnesses the trust of increasingly enlightened food consumers. State-guided scientific farming with developmental motivations reaffirms this link and the social contract between state and people as modernization deepens and scientific production is increasingly a hybrid of private and public endeavours.

Conclusion

The GR remains a powerful historical reference in agricultural S&T. Accounts about the resolve of states and dedication of scientists leading to unprecedented increases in yields and production that averted starvation continue to inspire, and announcements of new GRs have been recurrent. This paper has analysed historical framings of the GR in Brazil, China, and India, and how states and S&T actors have constructed narratives about science-led agricultural transformations of epic proportions, comprising pressing goals, unparalleled scientific breakthroughs, and heroic individuals and organizations. Narratives about past S&T accomplishments, we argue, have been instrumental to produce a national history and a scientific identity that legitimize and empower these countries and their S&T institutions as twenty-first century leaders of agricultural modernization in the global South. Unravelling the assemblage of epic narratives, and underpinning scientific cultures and identities, helps to make sense of how these countries’ S&T actors draw on their subjective representations of the past to assert their position in the field at present, including making claims about their credentials to envision and deliver sustainable solutions for agriculture into the future.

This paper has focused on processes of narrative-making within the three countries and shed light on how national histories, organizations, individuals, and ideas about modernization and development have been combined to produce meaning and empower actors in domestic S&T systems. Epic narratives—about the establishment of scientific farming in China, a wheat revolution in India, and a tropical revolution in the Cerrado—help to build and consolidate a national scientific identity that preserves the role of leading S&T organizations and the scientific culture they endorse. Our analysis points to two mechanisms of epic-making: the sealing off of the epic through symbols, acclamation of heroes, and assemblage of heritage; and weaving of the epic (and the credentials of its heroes) into the narratives of the present and calls for new and greener GRs. As Patel (2013b) suggests, the GR endures, yet has not remained constant. But while the contours of these narratives have evolved over time, they have preserved their epistemological essence, which privileges modern science over experiential and local knowledge, and prioritizes yields over other social and ecological dimensions of farming.

These narratives have also protected their historical roots, which confer legitimacy and credibility to the actors deploying them. So, while Embrapa would no longer advocate for a technological package of the type disseminated in the 1970s, its authoritativeness—including in generating future sustainable solutions for tropical agriculture—is firmly connected to that past “successful” incorporation of the Cerrado, regardless of its negative impact on soils, land distribution, water resources, and biodiversity. In India, the notion of productivity with perpetuity signifies the continuity of the pursuit of yields but incorporates sustainability concerns. And while China’s scientific farming is rooted in the country’s past (and the marriage of cutting-edge science with grass-roots practice), it is no longer about state-sponsored modern input massification but about state–business partnerships for sustainable intensification.

In highlighting the discursive and political nature of the GR, this paper adds to a longstanding critique of hegemonic agricultural modernization agendas in international development that see GRs (past and present) as apolitical and technocratic endeavours, while concealing the underlying interests those endeavours seek to serve (Luna and Dowd-Urbe 2020; Moseley et al. 2015; Patel 2013b). The assemblage of GR narratives of science-led and yields-centric success is a deeply political undertaking, which concerns state-building, institutional preservation, and affirmation of certain ideas and imaginaries about scientific advancement that are aligned with the hegemonic agricultural modernization project and the interests of its dominant players. While such a view is well-established in science and technology studies (Luna and Dowd-Urbe 2020; Saha and Schmalzer 2016; Smith 2009; Stone 2019), and in the history and sociology

²⁸ The peasantry-technocracy connection was not entirely new but can be traced back to the late Imperial period and the use of agronomic science by the state as a tool for asserting legitimate rule (Bray 2008).

of science (Harwood 2013; Perkins 1990; Shiva 1992), it is often overlooked in agricultural sciences and in development studies, where historical accounts of the GR have often been partial and centred on technical fixes (Harwood 2018). International development continues to feed on narrowly framed success stories and linear transfer recipes (Blaustein 2008; Toenniessen et al. 2008; World Bank 2009). Moving towards more plural and political histories of agricultural S&T in development requires an active effort of articulating alternative historical pathways and giving voice to a more diverse set of actors (IPES-Food 2016). Agroecology has made inroads in countering the GR by valuing bottom-up, socially embedded, and ecologically sound knowledge production and innovation in agriculture. Yet, there is a gap to be filled in assembling other agricultural histories that shed light on forgotten accomplishments, milestones, and heroes, including the contributions of women that are rendered invisible by male-centric epics.

While noting similarities between the international GR epic narrative associated with American heroes and philanthropic organizations (Sumberg et al. 2012; Wright 2012) and the epic narratives of the three countries studied here, this paper did not specifically explore how domestic and international narratives intersect (and why some features of those narratives remain the same and others differ), or how this varies in each of the three countries. Although the extent of US influence has been discussed in the literature (Nehring 2016; Saha and Schmalzer 2016), there is a need for comparative analysis of the interplay between domestic and global knowledge politics in the construction of agricultural science histories and success narratives in the current geopolitics, especially as the three countries carve their space internationally as authoritative sources of expertise on agricultural modernization and development. While affirming the quality and suitability of “Southern” expertise and technology for other developing countries’ agricultures (Cabral 2016; Cheru and Modi 2013; Scoones et al. 2016), South–South scientific cooperation has seen connections established with global S&T actors, as in the collaboration between CAAS and centres of the Consultative Group on International Agricultural Research (CGIAR)—such as the International Maize and Wheat Improvement Centre (CIMMYT) and International Rice Research Institute (IRRI) (CAAS 2016). The way in which domestic epic narratives and claims of exceptionalism by Brazil, China, and India combine with the narratives and claims of global S&T actors—whose own histories are entangled with the global GR epic—is worthy of investigation. This would extend the time perspective on the GR’s “long durée” (Patel 2013b) into an analysis of present-day (dis)continuities of GR epics across national and international spaces.

Acknowledgements This paper is part of the research project Green Revolutions in Brazil, China, and India, and their echoes in South–South Cooperation in Africa, funded by the Economic and Social Research Council (grant ES/R00658X/1), United Kingdom (UK). The authors thank all research participants in Brazil, China, India, and the UK for their time and valuable insights. We are grateful to Professor Ian Scoones and Dr James Sumberg for their comments on an earlier version of this paper. We also thank the three anonymous reviewers for their thorough engagement with the paper and constructive feedback.

Author contributions All three authors made substantial contributions to the conception or design of the paper, including literature review, data collection, analysis and writing.

Funding The paper draws on research funded by the UK Economic and Social Research Council, grant reference ES/R00658X/1. Open access publication was supported by the UKRI Open Access Block Award 2021 (EP/W522788/1).

Declarations

Conflict of interest The authors declare no conflict of interest.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Abrol, Dinesh. 1983. American involvement in Indian agricultural research. *Social Scientist* 11 (10): 8–26. <https://doi.org/10.2307/3517040>.
- Aggarwal, Partap. 1973. *The green revolution and rural labour—A study in Ludhiana*. New Delhi: Shri Ram Centre for Industrial Relations and Human Resources.
- Albuquerque, Ana Christina S., and Aliomar G. da Silva, eds. 2008. *Agricultura Tropical : Quatro Décadas de Inovações Tecnológicas, Institucionais e Políticas*. - Portal Embrapa. Vol. 1. Embrapa Informação Tecnológica. <https://www.embrapa.br/acre/busca-de-publicacoes/-/publicacao/507674/agricultura-tropical-quatro-decadas-de-inovacoes-tecnologicas-institucionais-e-politicas>. Accessed 17 June 2021.
- Altieri, Miguel A., and Victor Manuel Toledo. 2011. The agroecological revolution in Latin America: Rescuing nature, ensuring food sovereignty and empowering peasants. *The Journal of Peasant Studies* 38 (3): 587–612. <https://doi.org/10.1080/03066150.2011.582947>.
- Alves, Eliseu. 2010. *Embrapa: A success story of institutional innovation. Brazilian agriculture: Development and changes*. Brasília: Embrapa Studies and Training.
- Alves, Eliseu, Elisio Contini, and José Garcia Gasques. 2008. Capítulo 2: Evolução Da Produção e Produtividade Da Agricultura

- Brasileira. In *Agricultura tropical : Quatro décadas de inovações tecnológicas, institucionais e políticas*. Portal Embrapa, 1: 67–99. Embrapa Informação Tecnológica. <https://www.embrapa.br/acre/busca-de-publicacoes/-/publicacao/507674/agricultura-tropical-quatro-decadas-de-inovacoes-tecnologicas-instituicoes-e-politicas>. Accessed 17 June 2021.
- American Society of Agronomy. 2006. 2006 World Food Prize recipients to be recognized at soils congress. EurekaAlert! 2006. http://www.eurekaalert.org/pub_releases/2006-06/asoa-2wf062306.php. Accessed 17 June 2021.
- Anseeuw, Ward. 2013. The rush for land in Africa: Resource grabbing or green revolution? *South African Journal of International Affairs* 20 (1): 159–177. <https://doi.org/10.1080/10220461.2013.780326>.
- Bajpai, Anandita. 2018. Making the new Indian citizen in times of the Jawan (soldier) and the Kisan (farmer), 1962–1965. *Comparativ* 28 (5): 97–120.
- Bakhtin, Mikhail Mikhaïlovich. 1981. *The dialogic imagination: Four essays*. Texas: University of Texas Press.
- Bardhan, Pranab. 1970. “Green Revolution” and agricultural labourers. *Economic and Political Weekly* 5 (29/31): 1239–1246.
- Bergius, Mikael, and Jill Tove Buseth. 2019. Towards a green modernization development discourse: The new green revolution in Africa. *Journal of Political Ecology*. <https://doi.org/10.2458/v26i1.22862>.
- Blaustein, Richard J. 2008. The green revolution arrives in Africa. *BioScience* 58 (1): 8–14. <https://doi.org/10.1641/B580103>.
- Bonacelli, Maria Beatriz, Marcos Paulo Fuck, and Ana Célia Castro. 2015. O sistema de inovação agrícola: Instituições, competências e desafios do contexto Brasileiro. In *Propriedade intelectual e inovações na agricultura*, ed. Antônio Márcio Buainain, Maria Beatriz Bonacelli, and Cássia Mendes, 89–109. Brasília and Rio de Janeiro: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ), Instituto Nacional de Ciência e Tecnologia em Políticas Públicas Estratégias e Desenvolvimento (INCT/PPED), IdeiaD.
- Borlaug, Norman. 2007. Editorial: Feeding a hungry world. *Science* 318 (5849): 359.
- Bräutigam, Deborah. 1998. *Chinese aid and African development: Exporting green revolution*. Basingstoke: Palgrave Macmillan.
- Bray, Francesca. 2008. Science, technique, technology: Passages between matter and knowledge in Imperial Chinese agriculture. *The British Journal for the History of Science* 41 (3): 319–344. <https://doi.org/10.1017/S0007087408000873>.
- Bustamante, Patricia Goulart, Rosa Lia Barbieri, and Juliana Santilli, eds. 2017. *Conservação e uso da agrobiodiversidade: relatos de experiências locais*. Brasília: Embrapa. <https://www.ciodaterra.com.br/conservacao-e-uso-da-agrobiodiversidade>.
- Byres, Terence J. 1981. The new technology, class formation and class action in the Indian countryside. *The Journal of Peasant Studies* 8 (4): 405–454. <https://doi.org/10.1080/03066158108438146>.
- CAAS. 2016. CAAS advances partnership with CIMMYT and IRRI. Vol. 3 (September). Chinese Academy of Agricultural Sciences. http://www.caas.cn/en/newsletter/20161/201603/intl_cooperation_201603/275309.html.
- Cabral, Lúcia. 2016. Brazil’s tropical solutions for Africa: Tractors, matracs and the politics of “appropriate technology.” *The European Journal of Development Research* 28 (3): 414–430. <https://doi.org/10.1057/ejdr.2016.13>.
- Cabral, Lúcia. 2020. Embrapa and the construction of scientific heritage in Brazilian agriculture: Sowing memory. *Development Policy Review*. <https://doi.org/10.1111/dpr.12531>.
- Cabral, Lúcia, and Xiuli Xu. 2021. Yuan Longping, the “father of hybrid rice”: A people’s scientist. Institute of Development Studies blog. <https://www.ids.ac.uk/opinions/yuan-longping-the-father-of-hybrid-rice-a-peoples-scientist/>. Accessed 1 June 2021.
- Grisa, Catia, and Sérgio. Schneider, eds. 2015. *Políticas públicas de desenvolvimento rural no Brasil*. Porto Alegre: Editora da UFRGS.
- Chen, Zhangliang. 2006. Green Revolution in China: Past and future. China Agricultural University. https://www.worldfoodprize.org/documents/filelibrary/images/borlaug_dialogue/2006/transcripts/Chen_ppt06_9444AACF05E03.pdf.
- Chen, Nancy. 2015. Consuming biotechnology: Genetically modified rice in China. In *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*, ed. Sheila Jasanoff and Sang-Hyun. Kim, 219–232. Chicago: The University of Chicago Press.
- Chen, Shi-hua, Li.-yong Cao, Shi-hua Yang, and Hu.-qu Zhai. 2004. Forty years’ development of hybrid rice: China’s experience. *Rice Science* 11 (5–6): 225–230.
- Cheru, Fantu, and Renu Modi. 2013. *Agricultural development and food security in Africa: The impact of Chinese, Indian and Brazilian investments*. London: Zed Books.
- Schmitt, Claudia, Paulo Niederle, Mario Ávila, Sabourin, Paulo Petersen, Luciano Silveira, William Assis, and Juliano Palm. 2016. *A experiência Brasileira de construção de políticas públicas em favor da agroecologia*. https://www.researchgate.net/publication/321437208_A_experiencia_brasileira_de_construcao_de_politicas_publicas_em_favor_da_agroecologia.
- Cleaver, Harry M., Jr. 1972. The contradictions of the Green Revolution. *American Economic Review* 62 (2): 177.
- Contini, Elísio. 2014. Exportações na dinâmica do agronegócio Brasileiro: Oportunidades econômicas e responsabilidade mundial. In *O mundo rural no Brasil do século 21: A formação de um novo padrão agrário e agrícola*, ed. Antônio Márcio. Buainain, Eliseu Alves, and Zander Navarro, 149–73. Brasília: Embrapa.
- Conway, Gordon. 1998. *The Doubly green revolution: Food for all in the 21st century*. Ithaca: Comstock PubAssociates.
- Cordeiro, Luiz Adriano M., Lourival Vilela, Robélio Leandro. Marchão, João. Kluthcouski, Geraldo Bueno, and Martha Júnior. 2015. Integração lavoura-pecuária e integração lavoura-pecuária-floresta: Estratégias para intensificação sustentável do uso do solo. *Cadernos de Ciência & Tecnologia* 32 (1/2): 15–53.
- Cotter, Joseph K. 2003. *Troubled harvest: Agronomy and revolution in Mexico, 1880–2002*. Westport: Greenwood Publishing Group.
- Crestana, Maria Beatriz, and Claudia de Mori. 2015. Tecnologias e inovação no agro: Algumas tendências, premências e drivers de mudanças. In *Propriedade intelectual e inovações na agricultura*, ed. Antônio Márcio Buainain, Maria Beatriz Bonacelli, and Cássia Mendes, 59–85. Brasília and Rio de Janeiro: CNPq, FAPERJ, INCT/PPED, IdeiaD.
- Cullather, Nick. 2004. Miracles of modernization: The green revolution and the apotheosis of technology. *Diplomatic History* 28 (2): 227–254. <https://doi.org/10.1111/j.1467-7709.2004.00407.x>.
- Damodaran, Harish. 2015. A living legend: Swaminathan@90.” The Indian Express (blog). <https://indianexpress.com/article/india/india-others/a-living-legend-swaminathan90/>. Accessed 13 Aug.
- Das, Raju J. 2002. The green revolution and poverty: A theoretical and empirical examination of the relation between technology and society. *Geoforum* 33 (1): 55–72. [https://doi.org/10.1016/S0016-7185\(01\)00006-9](https://doi.org/10.1016/S0016-7185(01)00006-9).
- de Oliveira, Gustavo LT. 2016. The geopolitics of Brazilian soybeans. *The Journal of Peasant Studies* 43 (2): 348–372. <https://doi.org/10.1080/03066150.2014.992337>.
- Delgado, Nelson Giordano. 2010. O papel do rural no desenvolvimento nacional: Da modernização conservadora dos anos 1970 ao governo Lula. In *Dimensões rurais de políticas Brasileiras*,

- ed. Roberto José, 17–53. Rio de Janeiro: Moreira and Regina Bruno. Mauad X.
- Deogharia, Jaideep. 2015. PM calls for second Green Revolution. *The Times of India*, 2015. <https://timesofindia.indiatimes.com/india/PM-calls-for-second-Green-Revolution/articleshow/47858305.cms>.
- Ehrlich, Paul R. 1975. *The population bomb*. River City: River City Press.
- Embrapa. 2014a. *Anos 80 - Edson Lobato*. Embrapa Memória. <https://www.youtube.com/watch?v=8d5gY4aWBp8>.
- Embrapa. 2014b. *O que a Embrapa planta, o mundo colhe*. Projeto Embrapa 40 Anos de Histórias. <https://www.youtube.com/watch?v=RLqSeEXEW0I>.
- Embrapa. 2018. *Visão 2030: O futuro da agricultura Brasileira*. Brasília: Empresa Brasileira de Pesquisa Agropecuária.
- FAEAB, and AERJ. 1984. Anais do II encontro Brasileiro de agricultura alternativa. In Petrópolis: Federação das Associações de Engenheiros Agrônomos do Brasil and Associação dos Engenheiros Agrônomos do Estado do Rio de Janeiro.
- Farmer, Bertram Hughes. 1977. *Green Revolution? Technology and change in rice-growing areas of Tamil Nadu and Sri Lanka*. Palgrave Macmillan. <https://www.palgrave.com/gp/book/9781349049387>.
- Forsyth, Tim. 2003. *Critical political ecology: The politics of environmental science*. London: Routledge.
- Fu, Yuzhu, and Cheng Yan. 2017. The performances of Chinese peasants' new life in propaganda poster of China 1949–1976. In *International Conference on Innovations in Economic Management and Social Science 2017*. Hangzhou: Atlantis Press. <https://www.atlantispress.com/proceedings/iemss-17/25873028>.
- Giraldo, Omar, and Peter Rosset. 2016. La agroecología en una encrucijada: entre la institucionalidad y los movimientos sociales, 14–37. https://www.researchgate.net/publication/308313540_La_agroecologia_en_una_encrucijada_entre_la_institucionalidad_y_los_movimientos_sociales. Accessed 17 June 2021.
- Goldman, Mara J., Paul Nadasdy, and Matthew D. Turner. 2011. *Knowing nature: Conversations at the intersection of political ecology and science studies*. Chicago: University of Chicago Press.
- Gopalkrishnan, Gita, and Mankombu Sambasivan Swaminathan. 2002. *One man's quest for a hunger free world*. Madras: Education Development Center Inc.
- Grzybowski, Cândido. 1990. Rural workers' movements and democratisation in Brazil. *The Journal of Development Studies* 26 (4): 19–43. <https://doi.org/10.1080/00220389008422172>.
- Hajer, Maarten A. 1997. *The politics of environmental discourse*. Oxford: Oxford University Press.
- Hajer, Maarten A. 2005. Coalitions, practices, and meaning in environmental politics: From acid rain to BSE. In *Discourse theory in European politics: Identity, policy and governance*, ed. David Howarth and Jacob Torfing, 297–315. Basingstoke: Palgrave Macmillan.
- Harriss-White, Barbara, and John Harriss. 2007. Green Revolution and after: The “North Arcot Papers” and long term studies of the political economy of rural development in South India. QEH Working Paper 146. Oxford: Queen Elizabeth House, University of Oxford.
- Harwood, Jonathan. 2013. Has the green revolution been a cumulative learning process? *Third World Quarterly* 34 (3): 397–404. <https://doi.org/10.1080/01436597.2013.784599>.
- Harwood, Jonathan. 2018. Another Green Revolution? On the perils of “extracting lessons” from history. *Development* 61: 43–53. <https://doi.org/10.1057/s41301-018-0174-5>.
- Holt-Giménez, Eric. 2008. Out of AGRA: The green revolution returns to Africa. *Development* 51 (4): 464–471. <https://doi.org/10.1057/dev.2008.49>.
- Holt-Giménez, Eric, and Miguel A. Altieri. 2013. Agroecology, food sovereignty, and the new green revolution. *Agroecology and Sustainable Food Systems* 37 (1): 90–102. <https://doi.org/10.1080/10440046.2012.716388>.
- Hosono, Akio, and Yutaka Hongo. 2012. *Cerrado agriculture: A model of sustainable and inclusive development*. Tokyo: JICA Research Institute.
- IPES-Food. 2015. The new science of sustainable food systems: Overcoming barriers to food systems reform. The Global Alliance for the Future of Food and IPES-Food. http://www.ipes-food.org/images/Reports/IPES_report01_1505_web_br_pages.pdf.
- IPES-Food. 2016. From uniformity to diversity: A paradigm shift from industrial agriculture to diversified agroecological systems. International Panel of Experts on Sustainable Food Systems. http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf.
- Janasoff, Sheila. 2015. Imagined and invented worlds. In *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*, ed. Sheila Janasoff and Sang-Hyun. Kim, 321–344. Chicago: The University of Chicago Press.
- Janasoff, Sheila, and Sang-Hyun. Kim. 2009. Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea. *Minerva* 47 (2): 119. <https://doi.org/10.1007/s11024-009-9124-4>.
- Jessop, Bob. 2010. Cultural political economy and critical policy studies. *Critical Policy Studies* 3 (3–4): 336–356. <https://doi.org/10.1080/19460171003619741>.
- Jørgensen, Marianne, and Louise J. Phillips. 2002. *Discourse analysis as theory and method*. Thousand Oaks: Sage Publications.
- Kesavan, P.C., and Monkombu Sambasivan Swaminathan. 2008. Strategies and models for agricultural sustainability in developing Asian countries. *Philosophical Transactions: Biological Sciences* 363 (1492): 877–891.
- Ladejinsky, Wolf. 1969. The green revolution in Punjab: A field trip. *Economic and Political Weekly* 4 (26): A73–A82.
- Lang, Tim. 2015. *Food wars*, 2nd ed. London: Routledge.
- Leach, Melissa, and Ian Scoones. 2007. *Mobilising citizens. Social movements and the politics of knowledge*. IDS Working Paper 276. Brighton: Institute of Development Studies. <https://www.ids.ac.uk/publications/mobilising-citizens-social-movements-and-the-politics-of-knowledge/>.
- Leach, Melissa, Belinda Reyers, Xuemei Bai, Eduardo S. Brondizio, Christina Cook, Sandra Díaz, Giovana Espindola, Michelle Scobie, Mark Stafford-Smith, and Suneetha M. Subramanian. 2018. Equity and sustainability in the Anthropocene: A social–ecological systems perspective on their intertwined futures. *Global Sustainability*. <https://doi.org/10.1017/sus.2018.12>.
- Li, Jiming, Yeyun Xin, and Longping Yuan. 2009. *Hybrid rice technology development: Ensuring China's food security*. 00918. IFPRI Discussion Paper. Washington DC: International Food Policy Research Institute.
- Lipton, Michael, and Richard Longhurst. 1989. *New seeds and poor people*. London: Unwin Hyman.
- Luna, Jessie K., and Brian Dowd-Urbe. 2020. Knowledge politics and the Bt cotton success narrative in Burkina Faso. *World Development* 136 (December): 105127. <https://doi.org/10.1016/j.worlddev.2020.105127>.
- McMichael, Philip. 2009. A food regime genealogy. *The Journal of Peasant Studies* 36 (1): 139–169. <https://doi.org/10.1080/03066150902820354>.
- Mengel, Aléx. 2015. Modernização da agricultura e pesquisa no Brasil: A empresa Brasileira de Pesquisa Agropecuária - Embrapa. Rio de Janeiro: Programa de Pós-Graduação de Ciências Sociais em Desenvolvimento, Agricultura e Sociedade, Universidade Federal Rural do Rio de Janeiro.

- MNW. 2018. Press Conference by Minister of Agriculture and Rural Affairs Han Changfu at the National People's Congress and the Chinese Political Consultative Conference. <http://www.mnw.cn/news/china/1953075.html>.
- Morris, Michael, Hans P. Binswanger-Mkhize, and Derek Byerlee. 2009. *Awakening Africa's sleeping giant. Directions in Development—Agriculture and rural development*. Washington: The World Bank. <https://doi.org/10.1596/978-0-8213-7941-7>.
- Moseley, William, Matthew Schnurr, and Rachel Bezner Kerr. 2015. Interrogating the technocratic (neoliberal) agenda for agricultural development and hunger alleviation in Africa. *African Geographical Review* 34 (1): 1–7. <https://doi.org/10.1080/19376812.2014.1003308>.
- National Science and Technology Commission. 1991. Ten-Year Plan for Science and Technology Development (1991–2000) and Outline of the Eighth Five-Year Plan.
- Navarro, Zander, and Eliseu Alves. 2014. Os novos desafios da Embrapa. *Estadão*, 20 August edition. <http://opiniao.estadao.com.br/noticias/geral/os-novos-desafios-da-embrapa-imp-,1546563>.
- Nehring, Ryan. 2016. Yield of dreams: Marching west and the politics of scientific knowledge in the Brazilian Agricultural Research Corporation (Embrapa). *Geoforum* 77 (December): 206–217. <https://doi.org/10.1016/j.geoforum.2016.11.006>.
- Nepstad, Daniel C., and Claudia M. Stickler. 2008. Managing the tropical agriculture revolution. *Journal of Sustainable Forestry* 27 (1–2): 43–56. <https://doi.org/10.1080/1054981080225226>.
- Pandey, Poonam. 2016. Sociotechnical imaginaries and India's crusade for nanotechnology. In *Yearbook 2014 of the Institute for Advanced Studies on Science, Technology and Society*, 83–99. Munich and Vienna: Profil. <https://www.ifz.at/ias/IAS-STSPublications/Yearbook-2014>.
- Patel, Raj. 2013a. *Stuffed and starved: From farm to fork: The hidden battle for the world food system*. London: Portobello Books Ltd.
- Patel, Raj. 2013b. The long green revolution. *The Journal of Peasant Studies* 40 (1): 1–63. <https://doi.org/10.1080/03066150.2012.719224>.
- Pereira, Arraes, Pedro Antonio, Geraldo Bueno Martha. Junior, Carlos Augusto Santana, and Eliseu Alves. 2012. The development of Brazilian agriculture: Future technological challenges and opportunities. In *Brazilian agriculture: Development and changes*, 13–42. Brasília: Embrapa Studies and Training.
- Perkins, John H. 1990. The Rockefeller Foundation and the green revolution, 1941–1956. *Agriculture and Human Values* 7 (3): 6–18. <https://doi.org/10.1007/BF01557305>.
- Perkins, John H. 1997. *Geopolitics and the green revolution: Wheat, genes, and the Cold War*. New York and Oxford: Oxford University Press.
- Petersen, Paulo, Eros Marion Mussoi, and Fabio Dal Soglio. 2013. Institutionalization of the agroecological approach in Brazil: Advances and challenges. *Agroecology and Sustainable Food Systems* 37 (1): 103–114. <https://doi.org/10.1080/10440046.2012.735632>.
- Pimentel, David, and Marcia Pimentel. 1990. Comment: Adverse environmental consequences of the green revolution. *Population and Development Review* 16: 329–332. <https://doi.org/10.2307/2808081>.
- Pingali, Prabhu L. 2012. Green revolution: Impacts, limits, and the path ahead. *Proceedings of the National Academy of Sciences* 109 (31): 12302–12308. <https://doi.org/10.1073/pnas.0912953109>.
- Pires, Mauro Oliveira. 2007. Programas agrícolas na ocupação do Cerrado. *Sociedade e Cultura*. <https://doi.org/10.5216/sec.v3i1.459>.
- Prahladachar, M. 1983. Income distribution effects of the green revolution in India: A review of empirical evidence. *World Development* 11 (11): 927–944. [https://doi.org/10.1016/0305-750X\(83\)90055-4](https://doi.org/10.1016/0305-750X(83)90055-4).
- Rao, Nitya, ed. 2015. *Ms Swaminathan in conversation with Nitya Rao: From reflections on my life to the ethics and politics of science*. New Delhi: Academic Foundation.
- Robbins, Paul. 2012. *Political ecology: A critical introduction*. 2nd edition. Critical Introductions to Geography. Oxford: Wiley-Blackwell.
- Rosset, Peter M., and Miguel A. Altieri. 2017. *Agroecology: Science and politics*. Nova Scotia: Fernwood Publishing.
- Saha, Madhumita, and Sigrid Schmalzer. 2016. Green-Revolution epistemologies in China and India: Technocracy and revolution in the production of scientific knowledge and peasant identity. *BJHS Themes* 1 (January): 145–167. <https://doi.org/10.1017/bjt.2016.2>.
- Sanchez, Pedro A., and M.S. Swaminathan. 2005. Hunger in Africa: The link between unhealthy people and unhealthy soils. *The Lancet (british Edition)* 365 (9457): 442–444. [https://doi.org/10.1016/S0140-6736\(05\)70241-5](https://doi.org/10.1016/S0140-6736(05)70241-5).
- Schallenger, Erneldo, and Iara Elisa Schneider. 2009. Políticas de colonização: Uma análise da região oeste do paran  antes e depois do golpe militar de 1964. *Revista De Estudos Sociais* 21 (1): 163–176.
- Schmalzer, Sigrid. 2016. *Red Revolution, Green Revolution: Scientific farming in socialist China*. Chicago: University of Chicago Press.
- Science Planning Committee. 1956. National Long-Term Plan for Scientific and Technological Development, 1956–1967. State Council. <http://www.most.gov.cn/kjgh/lkjgh/>.
- Scoones, Ian. 2016. The politics of sustainability and development. *Annual Review of Environment and Resources* 41 (1): 293–319. <https://doi.org/10.1146/annurev-environ-110615-090039>.
- Scoones, Ian, Kojo Amanor, Arilson Favareto, and Gubo Qi. 2016. A new politics of development cooperation? Chinese and Brazilian engagements in African agriculture. *World Development* 81 (May): 1–12. <https://doi.org/10.1016/j.worlddev.2015.11.020>.
- Sen, Amartya. 1981. *Poverty and famines: An essay on entitlement and deprivation*. Oxford: Clarendon Press.
- Seshia, Shaila, and Ian Scoones. 2003. Tracing policy connections: The politics of knowledge in the Green Revolution and biotechnology eras in India. IDS Working Paper 188. Brighton: Institute of Development Studies.
- Shiva, Vandana. 1991. *The violence of the Green Revolution: Third World agriculture, ecology and politics*. London: Zed Books.
- Shiva, Vandana. 1992. Women's indigenous knowledge and biodiversity conservation. *India International Centre Quarterly* 19 (1/2): 205–214.
- Shiva, Vandana. 2016. *Stolen harvest: The hijacking of the global food supply*. Lexington: University Press of Kentucky.
- Simoni Eidt, Jane, and Consolacion Udry, eds. 2019. *Sistemas agrícolas tradicionais no Brasil*. Vol. 3, Coleção Povos e Comunidades Tradicionais. Brasília: Embrapa.
- Singh, Manmohan. 2006. Inaugural Address at 93rd Session of Indian Science Congress - Press Release. Prime Minister's Office. <https://pib.gov.in/newsite/erecontent.aspx?relid=14717>.
- Smith, Elta. 2009. Imaginaries of development: The Rockefeller Foundation and rice research. *Science as Culture* 18 (4): 461–482. <https://doi.org/10.1080/09505430903186070>.
- Smith, Adrian, and Andrew Stirling. 2018. Innovation, sustainability and democracy: An analysis of grassroots contributions. *Journal of Self-Governance and Management Economics* 6 (1): 64–97.
- Sobha, I. 2007. Green Revolution: Impact on gender. *Journal of Human Ecology (delhi)* 22 (2): 107–113. <https://doi.org/10.1080/09709274.2007.11906008>.
- Stevenson, James R., Nelson Villoria, Derek Byerlee, Timothy Kelley, and Mywish Maredia. 2013. Green Revolution research saved

- an estimated 18 to 27 million hectares from being brought into agricultural production. *Proceedings of the National Academy of Sciences* 110 (21): 8363–8368. <https://doi.org/10.1073/pnas.1208065110>.
- Stone, Glenn Davis. 2019. Commentary: New histories of the Indian green revolution. *The Geographical Journal* 185 (2): 243–250. <https://doi.org/10.1111/geoj.12297>.
- Subramaniam, C. 1979. *The new strategy in Indian agriculture: The first decade and after*. New Delhi: Vikas Publishing House for the Development Studies Centre. <https://dds.crl.edu/crlidelivery/10185>.
- Sum, Ngai-Ling. 2009. The production of hegemonic policy discourses: “Competitiveness” as a knowledge brand and its (re-)contextualizations. *Critical Policy Studies* 3 (2): 184–203. <https://doi.org/10.1080/19460170903385668>.
- Sumberg, James, Dennis Keeney, and Benedict Dempsey. 2012. Public agronomy: Norman Borlaug as “brand hero” for the green revolution. *The Journal of Development Studies* 48 (11): 1587–1600. <https://doi.org/10.1080/00220388.2012.713470>.
- Swaminathan, Monkombu Sambasivan. 1987. Our common agricultural future. Acceptance Speech on the occasion of the presentation of the General Food World Food Prize on 6 October 1987. World Food Prize. https://www.worldfoodprize.org/en/laureates/19871999_laureates/1987_swaminathan/.
- Swaminathan, Monkombu Sambasivan. 1993. *Wheat revolution, a dialogue*. Macmillan. <http://agris.fao.org/agris-search/search.do?recordID=US201300261978>.
- Swaminathan, Monkombu Sambasivan. 2006. An evergreen revolution. *Crop Science* 46 (5): 2293–2303.
- Swaminathan, Monkombu Sambasivan. 2010. *From green to evergreen revolution: Indian agriculture: Performance and emerging challenges*. New Delhi: Academic Foundation.
- Swaminathan, Mankombu Sambasivan. 2013. Genesis and growth of the yield revolution in wheat in India: Lessons for shaping our agricultural destiny. *Agricultural Research* 2 (3): 183–188.
- Swanson, Louis E., Jr., and Kuoray Mao. 2019. Thinking globally about universities and extension: The convergence of university-based and centralized extension systems in China. *Journal of Extension* 57 (6): 1–8.
- The Economist. 2010. Brazilian agriculture: The miracle of the Cerrado. *The Economist*, 28 August 2010. <http://www.economist.com/node/16886442>. Accessed 21 June 2021.
- Thompson, John, and Ian Scoones. 2009. Addressing the dynamics of agri-food systems: An emerging agenda for social science research. *Environmental Science & Policy* 12 (4): 386–397. <https://doi.org/10.1016/j.envsci.2009.03.001>.
- Toenniessen, Gary, Akinwumi Adesina, and Joseph DeVries. 2008. Building an alliance for a green revolution in Africa. *Annals of the New York Academy of Sciences* 1136 (1): 233–242. <https://doi.org/10.1196/annals.1425.028>.
- UN. 2015. Transforming our world: The 2030 Agenda for Sustainable Development. A/RES/70/1. United Nations. <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>. Accessed 21 June 2021.
- Visvanathan, Shiv. 2003. From the Green Revolution to the Evergreen Revolution: Studies in discourse analysis. Paper presented at the IDS Seminar on Agriculture Biotechnology and the Developing World. <https://www.ids.ac.uk/files/SVCPGreenrev.pdf>. Accessed 21 June 2021.
- Wolford, Wendy. 2005. Agrarian moral economies and neoliberalism in Brazil: Competing worldviews and the state in the struggle for land. *Environment and Planning A* 37 (2): 241–261. <https://doi.org/10.1068/a3745>.
- World Bank. 2009. *Awakening Africa's sleeping giant: Prospects for commercial agriculture in the Guinea savannah zone and beyond*. Washington: The World Bank.
- Wright, Brian D. 2012. Grand missions of agricultural innovation. *Research Policy* 41 (10): 1716–1728. <https://doi.org/10.1016/j.respol.2012.04.021>.
- Xu, Xiuli, Xiaoyun Li, Gubo Qi, Lixia Tang, and Langton Mukwereza. 2016. Science, technology, and the politics of knowledge: The case of China's agricultural technology demonstration centers in Africa. *World Development* 81 (May): 82–91. <https://doi.org/10.1016/j.worlddev.2016.01.003>.
- Zhong, Xiancai. 1997. *History of Chinese agricultural thought*. Shanghai: Shanghai Academy of Social Sciences Press.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.