India's Green Revolution and Beyond

Visioning Agrarian Futures on Selective Readings of Agrarian Pasts

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The widely accepted "success" of India's green revolution in making the country self-sufficient in foodgrains has made it the model for all agrarian futures envisioned in the country. This article argues that this vision of the future is based on a selective understanding of India's agrarian past as backward and needing redemption. There is inadequate evidence to support the claim that India was food-insecure in the 1960s. Moreover, evidence suggests that India's food and nutritional insecurities today are the aftermath of the green revolution strategy promoted since the 1960s. This article is a small contribution towards comprehensively outlining that past so that we can begin to imagine a new vision for India's agrarian future.

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Policymakers have often drawn up a vision of India's agrarian future through the lens of technological revolutions, whether an ever green revolution (PTI 2017) or a second green revolution (Singh 2011). Drawing upon the language of productivity, they have recalled the original green revolution of the 1960s that is supposed to have brought forth a bounty of food, thanks to high-yielding seeds of wheat and, eventually, rice. Popular narratives suggest that India was saved from the brink of famine and destitution and that the green revolution averted a humanitarian disaster (Rajagopal 2016).

This productivity-centred paradigm consolidated as part of the green revolution has continued to be the model for all agrarian futures envisioned in the country (Raina 2015). Unfortunately, this has meant pushing for a strategy that requires extensive control over the environment. Rather than using a wide range of seed varieties across multiple crops that would fit into different agroecological niches, the monoculture model of the green revolution has promoted re-engineering of the environment to fit the needs of the single chosen seed variety—whether through plant breeding or genetic engineering.[1]

To enable a given seed variety to express its yield potential to the highest possible degree, pests, weeds, nutrients, and water have to be controlled accordingly. But this pits farmers in a race against nature. They have to constantly catch up with newly evolving pests and weeds and deal with the declining fertility of soil, which chemicals alone are unable to replace. Moreover, as the cost of cultivation increases almost every year without commensurate increases in the prices of the produce, the clamour for financial subsidies or debt relief keeps increasing. This puts farmers and the government in impossible double binds.

Farmers, in particular, are running on a treadmill and are more prone to vulnerabilities: first, in a market where they are unable to obtain remunerative prices (even when the minimum support prices [MSP] are increased by the state); second, from the state that is finding it increasingly difficult to deliver inputs like fertiliser, electricity and fuel to them on time and at a reasonable price; third, from the scientific research on new seeds and pesticides that is playing catch-up with the ever-evolving pests and genetic vulnerability engendered by single varieties; and finally due to climatic vagaries, which irrigation and modern technology are unable to overcome.

Yet, all these consequences of the green revolution model have been brushed aside as collateral damage in the race to increase productivity. Much of the criticism highlighting issues of ecological toxicity, negative health impacts and rural inequality, among others (Shiva 1992; Bhalla and Chadha 1983; Byres 1983; Gupta 1998; Patel 2012) has been dismissed as unfortunate outcomes of a policy that was necessary at that time for saving lives and leading India to the path of self-sufficiency. But why are we still on the bandwagon of productivity, if India is already food secure? Dare we ask, was India ever food-insecure, even in the 1960s, that it could not produce enough to feed itself?

This article argues that the productivity-oriented vision that makes these technological aspirations possible is based on a selective reading of India's agrarian past—one that labels it as backward and needing redemption through technology. It constructs India's agrarian history as beginning in the 1960s with the inception of the green revolution. Everything before that is lumped into one timeless static past. By re-engaging with the historical narrative that has shaped Indian agriculture, this article shows the ways in which the idea of a hungry, starving nation with its unproductive farmers was actively created and used to legitimise technological and institutional interventions of a specific kind.

It further argues that the green revolution model was never designed to solve the problem of hunger or famine, which is primarily shaped by inequity in access to food. All it gave was more wheat, which did not even form the staple diet of a majority of Indians at that time. Moreover, it did not make India self-sufficient in food, but only in wheat and rice, and that too at the cost of the rest of our plate. In the light of this, it becomes difficult to justify the enormous negative consequences arising from adopting the green revolution model, let alone base India's agrarian future on it. It is only through a comprehensive understanding of its agrarian past that we can begin to imagine a new vision and a new foundation for India's agrarian future.

Redeeming India's Backward Agrarian Past

India's agrarian history has been characterised as one of backwardness, poor technical inputs, low productivity and a capricious environment. Economic data such as 0% growth rate of agriculture from 1900 to 1947 has often been presented as evidence for this. This is not surprising.

During the precolonial era, India's agro–industrial complex produced and exported a wide range of products, including cotton and silk textiles (fine muslin), spices, sugar, rice and others, with large domestic and international trade networks, and nearly 25% of world manufacturing (Bayly 1985; Washbrook 1988). However, the backbone of Indian agriculture was broken during the 18th and 19th centuries through colonial policies that sucked out the vitality of the land and channelled the wealth to Great Britain. In collaboration with some social groups who became beneficiary intermediaries, colonial interests created pathways of unparalleled exploitation of natural resources. Cash crops like opium, jute, wheat, cotton and indigo were grown on prime agricultural land with food crops relegated to marginal areas. This was coupled with a systematic neglect of customary water harvesting and storage structures, and state take-over of the forests to harvest timber.

Colonial misery: Under conditions of free trade, the Indian farmers growing cash crops were exposed to the price fluctuations of international markets, which caused their periodic ruin. The capstone was usurious extraction of rents from the land through a variety of land tenure systems beginning with the Permanent Settlement in 1792. As the rentier economy supported by the might of the state picked up, private investment in agriculture died out (Davis 2001: 311–40; Washbrook 1994; Baker 1993). On the other hand, the common lands that were critical suppliers of food, fodder, fuel, water, and building material were appropriated by the British by renaming them as wasteland. People were converted into encroachers and denied fodder and firewood from there, even during times of famine. With punitive taxes on digging wells and revenue rates for irrigated land being 10–15 times that of dry land, it paved the way for the decay of native irrigation—thus, increasing the vulnerability during droughts (Singh 1996; Satya 1997).

During the last 30 years of the 19th century the country saw the worst famines with 16.6 million to 30 million people dying (Maharatna 1996; Davis 2001). Ironically, people died while food was being exported and banquets were thrown to celebrate the monarchy's rule. It was not a crisis of production, it was a crisis of conscience (Davis 2001). But the famines took a toll on agricultural productivity. The immense loss of cattle and bullocks, and the destruction of the pastoral economy that formed the bedrock of maintaining soil fertility, had adversely affected agricultural productivity. Such eroded soils were more vulnerable to drought (Kaiwar 2000). There was nothing to fall back on—water storage systems were in tatters; the commons were inaccessible and food stores were inadequate. The extant level of yield fell by a third to a half and that of the average life expectancy by 20% during this period (Guha 1992; Davis 1951).

However, this exploitative past has been quietly forgotten and replaced with a narrative of ignorant, unproductive farmers toiling away using ancient practices that had supposedly remained static over time. Overlain upon the thesis of the timeless, unchanging village (Jodhka 2002), this projected an image of India's agrarian milieu as sans experimentation, sans productivity, and sans technology (Parayil 1992: 738–40; Tucker 2015: 5).[2] It is only with the coming of the green revolution, that things supposedly changed. It was considered to be the starting point of a transformation to a high productivity trajectory, by providing scientific evidence of the high yields of wheat and rice.

What is missed, however, is that Indian agriculture—especially with the export of crops like wheat and jute—had recovered by the 1920s from the devastation of the late 19th century. By the time of the Great Depression of the 1930s, there were complaints of overproduction and a steep fall in price realisations. In 1934–35, the Crop Planning Conference decided that wheat production should be limited to 9.5 million tonnes and there

should be no stimulus to increase the area under wheat (Bansil 1960: 187).[3] In 1942–43—the last year of foodgrain exports, and the same year as the Bengal Famine—undivided India produced 11.2 million tonnes of wheat and exported 3 million tonnes of foodgrains (Bansil 1960: 190).[4]

This famine was the proverbial straw that supposedly broke the camel's back. With another 3 million people dying, India was once again condemned as a nation which could not produce enough food to feed itself. It took another 30 years for revisionist work to challenge this assertion.

Understanding famine: Famines in the modern world have never been about an absolute shortage of food supply. In fact, globally the world has seen recurring crises of overproduction of food for the last 100 years or more. An array of scholarship over the last few decades, beginning with Amartya Sen's (1981) work on the 1943 famine has shown that hunger and starvation are human failures rather than natural failures (Rangasami 1985; Vaughan 1987; Patnaik 1991; Vasavi 1999; Mishra 2010).[5] Famines have been driven by rising prices of food resulting from hoarding and speculation, or mismanagement of supply, making it unaffordable to the poor. Unless the prices are reduced by government action, this situation can lead to human deaths from starvation and disease. Drought and crop losses may aggravate the situation, but it is the unequal distribution of food and the inability to afford it that is culpable for the tragedy.

Even during the 1943 famine, despite halting of rice imports from Burma (due to the Japanese occupation), there was adequate food available within British India, which, if supplied to Bengal, would have reduced prices and allowed the rural households to purchase food. But, the British government was diverting food to Africa and Europe for their soldiers fighting in World War II. Further, food available within the province was secured for the cities of Calcutta and Dacca. Though food was available, the rural poor could not purchase it. Mass starvation was created in the countryside (Mukerjee 2010).

The same analysis holds true for the series of famines at the end of the 19th century. The genocide of 30 million Indians between 1870 and 1901 was due to colonial policies that exacerbated droughts, destroyed agrarian communities, exported grains in the face of hunger, and left millions to perish.[6] When people were dying of starvation, and disease afflicted the hungry bodies, the colonial officials were warned against displaying "humanitarian hysterics" (Davis 2001).

The notion that famines were a natural check on undesirable population growth, especially of the wrong kind, was the dictum taught at the East India Company's famous Haileybury College. Colonial policy reflected racist prejudices against the breeding of brown Indians like rabbits. This was the perfect marriage of Malthusianism and Social Darwinism (Davis 2001). The state refused to intervene, following the diktat that the free market was supposed to take care of things. And it indeed did by letting hoarding to go unchecked, grain prices to increase across the country, and enabling export of grains from the famine-affected areas. Ironically, the modernising railroads and telegraph ably accelerated the process. Rather than multiplying like rabbits, Indians were dying like fleas.

Independent India has never seen such colossal famine deaths (although hunger still remains a grim reality), because the government has released food stocks to increase supply, moved grains to the regions of scarcity, opened food for work relief camps, instituted price controls, and curtailed the hoarding power of traders, whenever there has been a spectre of drought. Yet, the popular understanding of famine remains trapped within the discourse that it is a natural phenomenon, which the green revolution's physical bounty has helped overturn.

Bringing the Green Revolution

At independence, India was characterised as a country that could barely produce any food throughout the 1950s and 1960s, let alone enough to feed all her people. This is grossly misleading. From 1950 to 1965, Indian agriculture witnessed a surge in productivity across all crops. With the departure of the British, agriculture was freed from the shackles of punitive land revenue demands. The demolition of the zamindari system, modest land reforms and repeal of taxes on digging wells and making improvements to the land, had given a new lease of life to farmers.

The game of numbers: Despite the effects of partition, the growth rate of agriculture was 4.6% for Punjab during 1950–64 (Bhalla et al 1990: 14). Foodgrain yields rose by 45% between 1950–51 and 1964–65 (Landy 2009) and foodgrain production increased at the rate of 3% per annum (Srivastava 1972).[7] In fact, India's food availability per capita increased from 144.1 kilograms (kg) per person per annum in 1951 to 171.1 kg per person per annum in 1961 (Planning Commission Data Bank Table 1.25).[8]

Yet, this was not recognised in the international or national discussions on food security. For instance, the World Food Budget constructed by the United States (US) government's Economic Research Service (ERS) in 1961, used only rice and wheat for its calculations, claiming that reliable data on other food crops was not available (Cullather 2010: 219). Culturally diverse, nutritious Indian diets were homogenised by mere numbers.

In 1951, India grew 19 million tonnes of millets and gram which increased to 31.1 million tonnes in 1965, almost three times the amount of wheat that had been grown.[9] Yet, wheat, which was hardly consumed locally and had been promoted as an export crop, was included in calculations. Simultaneously, lentils and oilseeds that formed a bulk of vegetarian diets almost ubiquitously across the country, let alone fish, eggs and meat, which were consumed in the highlands and coastal states, were entirely ignored. And so were the uncultivated foods sourced from common lands such as greens, berries, roots, small game, which were a significant source of nutrition in different seasons.

Further, the US ERS converted this data into calorie values and divided it by population projections. The trend showed declining availability of "food" in Asian countries over the next five years. This was then used by the US government and

the Rockefeller Foundation to argue that a world food crisis was on the way unless physical production of "food" was not increased to catch up with the predicted population increases (Cullather 2010: 219).

In the 1950s, demography had emerged as an important discipline and decolonised states facing scrutiny were evaluated using the Malthusian framework pitting food against population.[10] Rapid population growth was expected to cause high unemployment, declining incomes and economic stagnation (Sharpless 1997: 178; Perkins 1997: 121–24, 133–35). Along with pressure from international organisations, there were different threads within India that converged to provide impetus to the idea of population control at the time of independence (Connelly 2008; Nair 2011; Unger 2015).

Even the theory of demographic transition was utilised to present a scenario of alarming population projections for Asia. Mortality rates started falling in the mid-20th century due to better healthcare and sanitation rather than long-term social changes. But since countries like India were still predominantly rural and "traditional," the birth rates were not expected to fall any time soon unless drastic birth control measures were implemented (Sharpless 1997: 189–90; Cullather 2010: 39).

What this picture did not show was that the transition in Europe had taken place on the backs of exploitation of people in colonised countries. Europeans had "begun to live longer partly because people in other parts of the world were suffering deprivation and dying young" (Connelly 2008: 29). Moreover, it was a throwback to the eugenic discourse of birth control in the 1930s where selective "inferior" populations were to be controlled using new technology (Connelly 2008: 141–42). These racialised roots of demography had been suppressed, but it begged the question—why was the "population problem" only seen to be afflicting the newly decolonised third world?[11]

The PL480 imports: Popular proclamations that India was a Malthusian time bomb,[12] coupled with the fact that it was importing wheat under the Public Law 480 (PL480) from the US from 1956 onwards, were used to argue that India could not produce enough food to feed itself. By the mid-1960s, the US government was successful in creating an international consensus about growing famine conditions in India and in 1966, *The New York Times* declared that India was on a "treadmill to starvation" (cited in Cullather 2010: 223).

However, these claims had conveniently sidestepped the fact that the decision to import PL480 wheat was not because of scarcity of domestic food production. In fact, imports continued in years of high production and falling farm gate prices, reflecting the primacy of other policy considerations related to industrialisation, inflation, international trade compulsions, and market imperfections (Bansil 1960). PL480 imports were a conscious choice of policymakers in the 1950s, who found them useful in dealing with multiple issues, including (i) the need to fulfil the ration needs in the deficit areas in the country, (ii) poor marketing and transportation infrastructure and difficulty of controlling the trader lobbies[13] that was hampering foodgrain procurement, and (iii) the need to save foreign exchange and extract surpluses from agriculture for pushing industrialisation.

As government policy oscillated between allowing the free movement of food and controlling supplies, while dancing to the tune of prices (Siegel 2018),[14] PL480 imports obviated the need for protracted negotiations with surplus states. Further, since it was paid for in rupees, PL480 wheat helped save foreign exchange, while providing subsidised grain to the working-class population through the ration shop system,[15] thus, allowing industry to keep the wage bill low (Frankel 1978; Cullather 2010).[16]

The US gained from PL480 because first, it found markets for the surplus wheat of its domestic farmers (Friedmann 1982; Paarlberg 1985), and second, it helped pacify restive and expanding urban populations in developing countries through the provision of cheap food. The latter was critical to American security interests, as this move, ostensibly, prevented countries from turning communist (Perkins 1997; Gupta 1998; Cullather 2010).

This, however, generated a domestic agrarian scenario in India that was characterised by (i) a glut of imported PL480 wheat[17] that reduced the price of wheat for consumers, but hurt domestic wheat farmers as a consequence (Shenoy 1974; Kamath 1992);[18] (ii) stagnancy in the area under wheat cultivation from 1956 to 1962 and even a decline of 7% till 1966 (Shenoy 1974: 48), along with the diversion of land away from food crops, in general, to the more remunerative fibre and non-food crops; and (iii) the over dependence of the public distrubution system (PDS) on the PL480 route for both provisioning and price control (Mooij 1998; Varshney 1989).[19]

In this setting, when the US threatened to stall these imports during the mid-1960s, India found herself in a vulnerable condition. In August 1965, the US decided to put PL480 wheat shipments to India on a monthly renewable contract, subject to specific conditions, including halting of India's war with Pakistan, devaluation of the rupee, and opening up of the fertiliser market, to name a few. This shift of American foreign policy from being generous in doling out wheat to its conditional disbursal was partly because US grain surpluses had dwindled during this phase (Paarlberg 1985). Moreover, the US farm lobby had lost power to urban representatives in the US Senate and Congress and the continuation of PL480 required reframing it as a response to a desperate situation of hunger, rather than as a subsidy to the American farm lobby, which it effectively was (Cullather 2010).

This "short tether" of PL480 gave rise to the "ship to mouth" crisis, since the US had pledged only one-fourth of the grain requested for 1965–66. Despite this Indian government officials challenged the notion of a 1965 famine—there was rationing in some cities due to the war with Pakistan and localised crop failures, but famine sounded absurd, they argued (Cullather 2010).[20] India failed to weather the situation using domestic wheat supplies, not only because of the PDS's overdependence on PL480, but also because the Food Corporation of India (FCI) as the coordinating agency for nationwide procurement was unable to procure enough foodgrains due to hoarding

and speculation by traders. Prices rose further when the monsoons failed in some parts of the country resulting in localised crop failures in the kharif season (Frankel 1978).

Further, the war with China in 1962 and with Pakistan in 1965 had led to more defence spending, making foodgrain imports using foreign exchange impossible. This necessitated protracted negotiations with the Americans over several months. Finally, the Lal Bahadur Shastri government was successful in renegotiating the continuation of PL480 imports in November 1965, in return for allowing private foreign investment in fertiliser plants and the import of fertiliser, among other things (Paarlberg 1985).[21]

In 1966, India imported 8 million tonnes of wheat—the highest ever volume of import under PL480 (Paarlberg 1985: 144).[22] A drought in Bihar and a monsoon failure—for the second time—in other parts of the country, had further exacerbated the already difficult situation.[23] But, the very next year, 1967–68, however, evidenced production recovery and bumper harvests due to favourable weather, and experts started warning of the "problem of plenty" (Dasgupta 1977; Cullather 2010). Yet, India was compelled to agree to an additional import of 2–3 million tonnes of PL480 wheat that was dumped on her by the US as their surpluses had returned (Paarlberg 1985; Cullather 2010).

The miracle seeds: A series of conjunctures led M S Swaminathan to become a wheat breeder, brought him and others at the Indian Agricultural Research Institute (IARI) in touch with Norman Borlaug's work, and led to the planting of imported high-yielding Mexican seed varieties in C Subramaniam's garden in Lutyen's Delhi in December 1966 (Cullather 2010: 193–98, 226). With this, the story of the seeds began with a sputtering start.

Borlaug and Swaminathan were emphasising response to nutrients like water and nitrogenous fertiliser and disease resistance, especially to rust, keeping in mind the end-goal of increasing quantitative yields.[24] Borlaug's research in Mexico had been funded by the Rockefeller Foundation, which was working squarely within the Malthusian framework. But high fertiliser prices, lack of irrigation, and low wheat prices made it highly unlikely that farmers in India would adopt varieties that responded to external inputs, unless the state intervened to support them (Perkins 1997; Cullather 2010).

C Subramaniam learnt of the potential of these seed varieties, and inspired, in part, by the 1964 Bell Report of the World Bank that called for betting on the strong, tried to push for a "new agricultural strategy" in 1965. The strategy entailed providing cost and price incentives to individual farmers in the form of seeds, pesticides, power implements, chemical fertilisers and water—effectively, "guaranteeing profitability to the farmer"—in contrast to the earlier approach of the government focusing on community development programmes and land reforms. This was a massive shift away from the cheap import policy of the 1950s that had kept farm gate prices low and created disincentives for production.

But Subramaniam needed to import fertiliser for the new agricultural strategy to take off, which would have required diversion of precious foreign exchange resources meant for industrialisation (Frankel 1978; Cullather 2010). Unfortunately, he received little support. It was the impasse with the Americans and the worsening procurement situation at home that paved the way for the approval of the New Agricultural Strategy in November 1965.

The dissemination of the new seeds and fertilisers began in districts with sufficient access to water through the Intensive Agriculture District Programme (IADP), which had been started in 1960 with support from the Ford Foundation. High-yielding variety (HYV) seeds required farmers to invest in irrigation and purchase fertilisers, failing which the seeds would not give the desired yield. Farmers who were resourceful and "progressive", that is, typically upper caste and class, were also given extension support along with a guarantee that the government would purchase all their wheat to stock the FCI godowns and supply to the PDS, at a MSP (Frankel 1978; Cullather 2010: 201, 207).

The wheat output, which was 12.3 million tonnes in 1964–65, increased to 16.5 million tonnes in 1967–68 and further to 18.6 million tonnes in 1968–69, as more acreage was devoted to HYVs. Was this the moment of triumph? Had the Malthusian forces finally been defeated by the new technology?

In March 1968, William Gaud, director of the United States Agency for International Development (USAID), heralded the new era of plenty as a "green revolution" in contrast to the "red revolution" that was threatening to sweep across Asia in the face of the Vietnam crisis and the heightened tensions of the Cold War. Thanks to the seeds, the Americans claimed, restive masses across Asia would now be prevented from falling into communist hands (Fitzgerald 1986; Patel 2012). Modern seed technology was positioned as the saviour of a nation, its people, its democracy, its very existence.

Yet, the 1967–68 harvest across several countries was higher than normal in almost all crops, let alone wheat, primarily due to good weather which continued till 1970 (Dasgupta 1977; Patel 2012). Many commentators were talking of overproduction once again, but the credit for this sudden reversal from "inevitable" famine to all-round abundance was given to the new programme.[25]

Why wheat? It seems strange that in a nation of rice and millet eaters, the entire discussion around food security, and its fields, was hijacked by wheat. Wheat was the food of the elite. The masses ate millets.[26] The green revolution changed that.

The government procurement system gave price incentives only for rice and wheat and the PDS gave poor consumers access to cheap wheat and rice. Farmers responded by switching from millets and gram to wheat (and rice). From a high of 55.6 million hectares in 1968, acreage under millets and gram fell by half to 28 million hectares in 2006 (Planning Commission Data Bank Table 1.12). The per capita availability of wheat went up by 27.4 kg, whereas the per capita availability of millets, pulses and gram shrunk by 42 kg from 1961 to 2006.[27] This transformed staple diets across the country away from traditional millets and pulses to rice and wheat.

Over the last 40 years, India has become one of the largest importers of oilseeds and pulses, primarily from Indonesia and Myanmar. Imports fulfilled nearly 35% of India's domestic requirement of oilseeds and 15%–18% of pulses from 1992 to 2012 (Sekhar 2004; Shenoi 2003; *Hindu Business Line* 2012; Ali and Gupta 2012). The rise in the price of pulses over the last few decades has put them beyond the reach of even middle-class households. India simply traded self-sufficiency of rice and wheat for dependence of the rest of the nutrition basket. Recent research by the National Institute of Nutrition has shown that the cereal-heavy diets of the poor have contributed to an epidemic of anaemia along with creating protein malnutrition and nutrient deprivation (Shatrugna 2010).[28] In quest of food security, India has compromised on nutrition security.

Self-sufficiency or Overproduction?

Most ironically, the self-sufficiency in two cereals came at the cost of another form of dependence—the import of rock phosphate for fertilisers and petroleum for irrigation pumps and tractors. Dependence on these non-renewable and fast depleting sources of energy and minerals also made agriculture a carbon-emitting sector impacting the climate. The country did not stop being vulnerable; it became vulnerable to a different set of interests. With this, deeper ecological and existential questions have emerged.

Worse still, by the late 1970s and early 1980s, there was a crisis of overproduction and government granaries were overflowing with wheat and rice. The solution was to export the stored grain at very low prices. In effect, subsidising the poor of other countries while poor Indians continued to go hungry (Paarlberg 1985: 56–57).[29]

Further, all the input subsidies and market guarantees were going to the farmers who were already well-off—the ones who had been able to mobilise politically to successfully make demands on the government to increase the MSP—in prosperous regions in the country. Yet, they continued to face a crisis, with places like Punjab eventually becoming the hotbed of farmer suicides (Singh 2000). More problematically, large tracts of the country, such as the Deccan plateau drylands covering Vidarbha and Telangana, for instance, were entirely ignored—they received no support at all. Over the last few decades, as dryland farmers have increasingly adopted monoculture farming with tube well irrigation, the same set of crises have manifested, but with a higher magnitude.

Proponents of the green revolution argue that the new seeds have significantly increased yields on the existing arable land, thus, saving forestland from being converted into agricultural land and supporting a much higher population. Yet, Stevenson et al's (2013) calculations show that the amount of land "saved" in this way is between 18 million and 27 million hectares globally, about 2.6% to 4% of the total land area under cereal cultivation (that is, 680 million hectares) as of 2004. It is amazing how much has been lost through the toxicity of our soils, our water, our health, and our food, to achieve these meagre savings.

Even more surprisingly, these calculations compare yields through the lens of monoculture farming in a given season. But productivity of a single grain per unit of land in a given season is a misleading metric—it fails to account for multiple products (grains, fodder, soil fertility, carbon sequestration) that land can provide in the same season, and that in many places, multiple crops are grown on that same land across seasons. And what about the ability of the land to continue to produce into the future? Taking into account all this would drastically change the outcomes. The high yields of wheat have come at the cost of depleting/replacing soils, groundwater and the livestock economy in ways that are non-replenishable/non-renewable and carbon emitting.

Conclusions

Despite a plethora of evidence to the contrary, India's agrarian future, whether gene-based or drone-based, continues to be driven by a productivity-focused, technology-centric vision drawing upon the green revolution model. Alternative visions based on different kinds of crop choices, farming systems, technologies and practices, have been dismissed as fancy thoughts of armchair intellectuals, privileged farmers, foreign-funded non-governmental organisations, or traditional obscurantists.

What would it take to bring into the envisioning process the need for healthy, nutritious food, the shepherding of our soil and water resources, the livelihoods of our farmers and farmworkers, and the situated knowledge of how to put it all together? For how long will we remain shackled to a model that focuses primarily on increasing grain productivity to the exclusion of everything else? By revisiting India's agrarian history and outlining the circumstances under which the green revolution model was adopted, this article has sought to challenge this blind adherence, and hopefully open up ways to envision futures that can begin to address the needs of the country and the countryside.

NOTES

1 Despite the availability of different varieties for a single crop, farmers are growing only a handful of very popular varieties in many crops. In soyabean, for instance, the variety JS-335 was grown in approximately 90% of the soyabean growing area in Madhya Pradesh throughout the 1990s and early 2000s (Kumar 2016).

2 For a contrasting view see Howard (1943).

3 There were even a series of international conferences held by the major wheat exporting nations, including India, to discuss how to limit the production of wheat so that its price could recover (Lindsay 1931).

4 The agricultural production data for undivided India in 1942–43 is as follows: 24.8 million tonnes of rice, 20.9 million tonnes of millets and gram, and 11.2 million tonnes of wheat (Bansil 1990: 432). Further, area under wheat cultivation in undivided India in 1942–43 was 17.1 % of all area under cereals (Bansil 1990: 431).

5 Brazilian physician and public administrator Josué de Castro's book *The Geopolitics of Hunger* (1977, first edition 1952) was amongst the earliest to question simplistic Malthusian notions about food and population.

6 From the late 1700s, the death toll from famines and epidemics has been estimated at 55 million to 60 million under colonial rule (Srinivasan 2017).

7 Imports of foodgrains fell from 4.7 million tonnes in 1951 to 0.8 million tonnes in 1954 (Chopra 1988: 84–106 cited in Mooij 1998). The production of major crops (except wheat) increased as much in the 15-year pre-green revolution period (1950–65) as it did in the 25-year post-green revolution period (1965–90) (Landy 2009).

8 In 2009, the food availability per capita was 162.1 kg per year, yet no one thought there was a crisis. This amounted to 444.1 grams per day. According to the National Institute of Nutrition we need 400 grams of cereals per day along with 80 grams of pulses, 300 grams of vegetables, 30 grams of oils and 300 grams of milk, apart

from a host of micronutrients (Krishnaswamy and Sesikeran 2011: 6). See also footnote 26.

9 India grew 20.6 million tonnes of rice and 6.5 million tonnes of wheat in 1951, which had increased to 39.3 million tonnes of rice and 12.3 million tonnes of wheat in 1965 (Planning Commission Data Bank Table 1.11).

10 Thomas Malthus's famous maxim that food production grows linearly whereas population grows exponentially became the mantra driving this.

11 Ironically, the so-called population bombs of the 1960s (India and China) were lauded as facing a demographic dividend in the 2000s!

12 *Time* magazine even devoted a cover to such doomsday theories in January 1960 (Desrochers and Hoffbauer 2009).

13 Regulation and licensing of traders through the mandi system had not yet taken place—that would happen only in the early 1970s in most parts of the country.

14 Domestic procurement was never over 10% of the marketed surplus of foodgrains produced in the country.

15 The rationing system had been started by the British in 1942 to control food supplies in World War II (Shenoy 1974; Mooij 1998).

16 PL480 imports were effectively free (aid, not trade), as the rupee payments to the US were spent in India: 15% by the Americans for their expenses and 85% as domestic investment (Shenoy 1974: 241; Cullather 2010: 182).

17 India imported 50 million tonnes from 1958–66, mostly through PL480 (Mooij 1998).

18 Bansil (1960) argues that farmers were not growing more wheat or rice even throughout the 1940s and 1950s despite the government offering higher procurement prices, because cheaper rice from Burma and cheaper wheat from Australia and Canada was available to urban consumers, despite import duties.

19 From 1951 to 1966, net imports averaged 72.2% of total PDS off-take (Shenoy 1974: 260).

20 Foodgrain production had increased from 82 million tonnes in 1963–64 to 89 million tonnes in 1964–65, and dipped to 72 million tonnes in 1965–66. It increased marginally in 1966, clocking at 74 million tonnes (Planning Commission Data Bank, Table 1.11).

21 Research had shown that fertilisers improved the yields for several crops, and fertiliser companies were keen to access the Indian market.

22 This amount, however, "never satisfied more than a modest 8–10% of total national food grain consumption" (Paarlberg 1985: 144). Total (net) imports in 1966 were 10.3 million tonnes, which included trade (wheat purchased using foreign exchange) and PL480 concessionary aid (Table 6 in Chopra 1988: 388)

23 Even in Bihar, which saw trucks of imported PL480 wheat being sent to food camps that year, food production was 96% of normal in 1966, but commercial crops like jute and sugar cane were negatively affected due to lack of water and landless agricultural labourers found themselves unemployed. They were the ones most severely hit along with those unemployed in the cities (Cullather 2010: 227).

24 Other Indian scientists were much more concerned with features required by consumers such as colour, texture, "chapati quality," and taste in their breeding programme, and in addressing goals of farmers such as resistance to drought and survival in low fertility conditions (Saha 2012).

25 The quantum of improvement was as follows: increase of 8.5 million tonnes in the production of millets, pulses and gram, 7.1 million tonnes in rice and 5.1 million tonnes in wheat totalling 21 million tonnes (Planning Commission Data Bank Table 1.11). Only part of the latter was due to high-yielding varieties of seeds. Moreover, India continued to import wheat through PL480 till 1971 and through foreign exchange purchases until 1976 (Paarlberg 1985: 53–56, Randhawa 1986).

26 Millets are now being promoted as nutri-cereals and are slowly becoming the new food of the elite.

27 1961 to 2006 per capita availability in kg per person per year—wheat: 28.9 to 56.3; pulses: 25.2 to 11.8; rice: 73.4 to 72.3; millets and gram: 54.6 to 26 (Planning Commission Databank Table 1.25). In grams per person per day this is: wheat 79 to 154; pulses: 69 to 32; rice: 201 to 198; millets and gram: 149 to 71.

28 Diets also shifted away from multiple local varieties of wheat and rice to standardised varieties created by science—typically with inferior taste and less nutritive value.

29 Between 2012 and 2015 India exported 5.79 million tonnes of foodgrains to reduce excess buffer stock build up in the FCI godowns (Kumar 2015: 5).

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