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Max Ajl & Divya Sharma

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# The Green Revolution and transversal countermovements: recovering alternative agronomic imaginaries in Tunisia and India

Max Ajl <sup>1</sup> and Divya Sharma<sup>b</sup>

<sup>a</sup>Rural Sociology Group, Wageningen University, Wageningen, Netherlands; <sup>b</sup>Science Policy Research Unit, University of Sussex, Brighton, UK

#### ABSTRACT

This article outlines the visions of Tunisian and Indian dissident political thinkers and agronomists, 1950s–1980s, for decentralised food and farming systems using just technologies. Amidst ascendent US imperialism, these marginalised proposals opposed the Green Revolution model of agrarian development, illustrating broader postcolonial politics of defending political sovereignty and advancing to economic/technological sovereignty. Erasing these dissident voices enabled the legitimisation of the Green Revolution as an 'inevitable' way to ensure food security. We argue that recovering this intellectual history is critical to displace the techno-centric Green Revolution narrative, and to inform and support struggles for ecologically attuned alternatives that foreground agroecology.

#### RÉSUMÉ

Dans cet article, nous étudions les projets de systèmes de décentralisation alimentaire et agraire fondés exclusivement sur la technologie, conçus par les penseurs politiques et agronomes Tunisiens et Indiens dissidents des années 1950-1980. Dans un contexte d'impérialisme américain grandissant, ces modèles marginaux s'opposent au modèle de développement agraire de la Révolution Verte, illustrant des politiques postcoloniales plus générales de défense de la souveraineté politique et d'avancement de la souveraineté économique et technologique. La censure de ces voix dissidentes a facilité la légitimation de la Révolution Verte comme l'unique d'assurer la sécurité alimentaire. Nous affirmons la nécessité absolue de rendre sa place à cette histoire intellectuelle pour remettre en cause la représentation techno-centrée de la Révolution Verte, et pour informer et soutenir la recherche d'alternatives plus axées sur l'écologie et recentrant l'agroécologie.

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#### CONTACT Max Ajl 🖾 max.ajl@gmail.com

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# Introduction

From the onset of the Green Revolution, a project of agricultural modernisation in the formerly colonised world, scholarship has mapped its adverse economic, social and ecological impacts on farmers and workers (Griffin 1979; Bayliss-Smith, Wanmali, and Farmer 1984; Gupta 1998; Glaeser 1987; Kumar 2016; Kerr 2012). Recently, histories have posed more fundamental questions, interrogating the developmental geopolitics shaping the Green Revolution (Cullather 2010; Siegel 2018; Marchesi 2017; Subramanian 2015). These works draw attention to the politics of knowledge production and challenge innovation-centred celebratory - and critical - accounts which legitimised the Green Revolution as the only technical 'solution' available to the problem of hunger, albeit with some unintended adverse social and ecological consequences (Stone 2019). They uncover political contestations around technocratic framings of agrarian development and foreground the relationship between the technoscientific and socio-political domains (Saha and Schmalzer 2016). As Patel (2013) has recently argued, it is imperative to reframe the Green Revolution as a moment of political and theoretical struggle over forms of organising socio-ecological reproduction, to displace technology-centric hegemonic historical narratives invoking the logic of 'inevitability'.

While the erasure of alternative visions and vast diversity of agrarian practices is recognised in the new histories, the composition of these unrealised pathways and proposals for alternative forms of knowledge production articulating social, political, and economic reorganisation have received less attention. The task of recuperating intellectual histories that illustrate imaginations of ecologically attuned nationally distinctive paths of postcolonial development is particularly urgent as they can inform and bolster ongoing struggles for alternative futures that foreground agroecological knowledge and labour. In this paper, we elaborate on some visions and practices of agrarian and rural development formulated by Indian and Tunisian political thinkers and agronomists that implicitly or explicitly challenged Green Revolution *techne* (Scott 1999) and the logic of development planning centred on agricultural intensification. By highlighting such plans from the 1950s–1980s, we address Patel's (2013, 30) counterfactual question: 'what might have happened had the substantial resources used in the Green Revolution been deployed in a different way'?

Counterfactual analysis's value lies in destabilising hegemonic narratives and the terms of reference they solidify by constricting the questions that can be posed, silencing imaginaries then easily excised from the historical narrative (Davis 2002; Trouillot 2015). We deploy this method to transcend the extensive literature evaluating claims of the Green Revolution's successes and failures in addressing social inequalities and ending hunger, and whether inequality was built into the technology choices or the failure of its protagonists to address the evidence of failures (Harwood 2020). Instead, we build on scholarship that has begun to trace the alternative visions of agriculture-centred development from before or during the Green Revolution (Saha 2013; Soto Laveaga 2018; Siegel 2018). Dissident perspectives have been made invisible from subaltern domains of everyday peasant practices, episodic and/or organised protests by cultivators and farm workers and from once mainstream scientific/institutional/indigenous political spheres. Historical narratives of the Green Revolution (cf. Esteva 1996) subsequently erased them as well. Unlike subaltern voices, the work of these political thinkers and

agronomists is easily accessible in the textual archives as they were significant participants in the political debates of their time. Those we highlight excavated possibilities immanent in indigenous agricultural practices and articulated visions of agrarian development with nation-building and economic sovereignty. Intellectual history is necessary to examine ideological traces of un-walked-upon paths and the contours of our counterfactual, and to shore up the intellectual foundation for redirections of agronomic/agroecological research programs. Indeed, such 'speculative' exercises used to be a mainstay of Global South 'future studies'.<sup>1</sup> Such studies asked exactly 'what-if' the Arab region or Latin America applied different development policies towards a horizon of ecologicallyembedded basic needs provisioning, and necessarily drew on alternative/appropriate agronomic-industrial technologies of the kinds we explore here.

Methodologically, Tunisia and India provide a basis for an incorporated comparison (McMichael 1990). Decolonisation and post-colonial state building were world-historical processes constituted through linked struggles from below against the old colonial empires and their re-incorporation from above by ascendant US imperialism and its projects for constraining and moulding the direction of post-colonial development. More directly, Indian decolonisation in the shadow of China's agrarian national liberation project opened up space for world-wide decolonisation, and set the stage for a nonaligned Arab nationalism to emerge, one whose suppression scarred Tunisian decolonisation. Because of the national movements' compositions, containment/exclusion of the peasantry, and their alignment with US geopolitics and US geo-technics, each government was able to settle, albeit not without internal struggle, on technological 'revolution from above.' Globally, the US's enduring fear of large-scale agrarian revolution moulded the objective of averting Red Revolutions in India and Tunisia, transforming them into 'models' of Asian/African capitalist developmentalism, in particular through bridling sovereign industrialisation and even more, through the Green Revolution. We trace the struggle against this project through the ideas we examine which converged on political and material decentralisation and enacting autonomy in historically specific idioms. In this sense our comparison shows the structuring role of thinking around sovereign development and how the post-colonial 'development project' (McMichael 1996) faced internal challenge on and against the hegemonic terms of development itself. Critically these ideological counter-movements prefigure the contemporary agroecology/liberation struggles in the Global South as they positioned the ecological question at the centre of postcolonial agrarian transformation and sovereign development.

For this article, we draw on archival and secondary analysis of USAID, Ford and Rockefeller Foundation interventions framing the historical trajectories of Indian and Tunisian postcolonial development planning, centred on food/agrarian reforms. We analyse the work of four emblematic post-colonial thinkers – Azzam Mahjoub, Slaheddine el-Amami, R. H. Richharia, and J. C. Kumarappa – who proposed alternative integrated technical, ecological, and social visions of agrarian development in the 1950s-1980s. We focus on two political economists (Mahjoub in Tunisia and Kumarappa in India) and two agronomists (Amami in Tunisia and Richharia in India) to illustrate that distinctive indigenous development thought was present in various disciplinary and institutional spheres. Technocratic framings of agrarian development were being challenged not only by political thinkers but also within the scientific sphere by agronomists. While standard Green Revolution narratives often frame ecological degradation as an unintended consequence, these thinkers positioned socio-ecological relations as intertwined and inherent to realising conceptions of national sovereignty. In recovering this archive and reading it against the top-down history of development practice, we show how suppressing alternatives and instituting distinct regimes of knowledge has been a purposive political choice, not an inevitability.

The article is structured as follows. Section one analyses US foreign policy during decolonisation's dawn, examining US food aid as social containment, part of a broader project of state-formation and developmental steering resting on regional foundation stones. We argue the Green Revolution was US strategy's logical outgrowth, embedding dependency and pushing differentiation through the technologies it claimed would deliver development. Section two is an intellectual history of heterodox agronomic thought in the two countries, framing these thinkers as counter-hegemonic intellectuals to the dominant development framework. We trace ideological or direct continuities between such criticisms and contemporary Indian and Tunisian thinkers and struggles which resist and build amidst the Green Revolution's aftershocks. Finally, we discuss how proposals for such alternative modernities undergird present and possible post-colonial solidarities.

# **Postcolonial social containment**

US orientation to decolonisation emerged amidst the Cold War's structuring framework, as the US sought to prevent decolonising states from converting political liberation to economic liberation through internally-articulated and sovereign development (Elliott 1955; Kolko and Kolko 1972). From above, China and the USSR weighed on the US containment strategy. From below, they informed Tunisian/Indian internal struggle over the outlines and texture of 'development.' While Nehru articulated a clear policy of nonalignment, he admired China and was being ideologically courted by the Soviet Union, making India a critical epicentre of the Cold War (Engerman 2013). Indeed, India's agricultural strategy's conception and implementation were politically fraught. From the late 1940s to 1960s, Nehruvian socialist planning focused on establishing heavy industries accompanied by rural institutional reforms including land reforms and decentralised village-based community development programs. There were significant contestations within the ruling regime led by the Congress party, and between federal and provincial governments on development planning's direction (Siegel 2018). Rural landowning elites who dominated provincial governments subverted such reforms. The first and second 5-year plans in the 1950s focused on rapid industrialisation, and increasing agricultural productivity by providing incentives to small holders and agricultural labourers through land and tenancy reforms, and employing labourintensive techniques to raise yields. They contained traces of a Gandhian vision of decentralised rural development. But for the most part, amidst the demobilisation of the peasantry, they were a scaffolding for sacrificing agriculture to promote heavy industries, even as three-quarters of India's export income came from the countryside - primarily jute, cotton exports and leather goods (Cullather 2010, 180).

Tunisian decolonisation, 9 years later, was not simply a case "similar" to India but part of a decolonisation sequence which India helped compose, and which took form in the shadow of the 1955 Bandung Conference, where Nehru played a prominent role. While non-alignment and the potential of a smallholder path glimmered as planning alternatives, conscious attempts to stymie and subvert such alternatives were at hand in a process of imperial learning. From 1955 to 1956, Habib Bourguiba, the country's first president, a liberal, a Francophile moderniser, and against land distribution. had put a stopper in the Arab nationalist bottle and had collaborated with the French to destroy Indian-aligned and Bandung-inspired rivals in the national liberation movement - the millenarian nationalist pastoralist and small-holder Youssefites, the guerrilla troops of Salah Ben Youssef, who looked ever-more to nationalist Cairo after the 1955 Bandung Conference (Ajl 2019a). Bourguiba's main post-Youssefite opposition was the syndicalist General Union of Tunisian Workers (UGTT), with no basis amongst the small peasantry. Late 1956 saw Bourguiba forestalling the union's attempts to organically fuse with the increasingly liberal Neo-Destour. He quashed burbling attempts to put in place agrarian reforms from within the government and the UGTT. The Tunisian government briefly flirted with huge cash outlays to support rural development clusters in the Centre and South. But from 1958 onwards, Bourguiba embraced the Eisenhower Doctrine, and Tunisia became a model for anti-Communist developmentalism, which the US eagerly supported. Aid did not erect the structures of a modernising elite. But it did reinforce them, throttling impulses from the trade unions or the hinterlands for radical transformation.

As the UGTT pushed decentralised cooperatives, the government face pressure, inside and out, to shift to hybrid models of agrarian development which would allow it to intensify production. Such pressures were another component of the decolonisation/postcolonial development sequence. Amidst ideological pressure from China (Ajl 2022), Algeria, and Egypt, and the example of Cuba, the government emplaced its cooperative model, based on capital-intensive production in the northern cereal belt, alongside price suppression for cereals. Such technologies poorly suited the marginal lands which the cooperatives enfolded. Given the threat of expropriation and price scissor effects – input costs increasing faster than producer prices – larger landholders were reluctant to intensify as prescribed, causing production shortfalls, compensated by PL-480 aid (Makhlouf 1968).

# The Green Revolution and US strategic interventions

We now turn to the larger framework of US agricultural planning, as the Green Revolution emerged to complement US policies that encouraged dependent industrialisation and sought to avoid wide-scale agrarian reform akin to China's, a bugbear that shaped US post-colonial containment strategy. Overall, the food regime literature has illustrated food and agriculture's centrality to the shift from British hegemony to US hegemony, shaped by Cold War politics. Tunisia and India saw nearly simultaneous food-aid inflows, as post-colonial governments veered away from feeding their populations by breaking the back of feudal landownership. The aid policy foundered amidst US concerns that aid as geopolitical containment and scaffolding was hitting the limits of US surplus production. Agricultural intensification, using a standardised pattern of hybrid cereal monocultures with copious synthetic agrochemicals – which William Gaud labelled the 'Green Revolution' – was this transition's keystone (Friedmann 1982). Peasant farms were to be transformed into capitalised family farms dependent on inputs

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including knowledge produced outside the farms based on the US model of agrarian modernisation (cf. Kloppenburg 2005). It meant to further stabilise rural social differentiation, end the dream of Red revolutions and demands for land redistribution, to set the stage for industrial development. By producing enough food, countries might dispel the spectre of political unrest posed by rising populations outpacing production, causing hunger, and, in the words of the US National Security Council (NSC), 'sudden crises of confidence in peaceful change, to violence, to political instability, and to receptivity to ideological panaceas' (Perkins 1997, 119; NSC 1963, 1).

With China and the USSR looming, articulated development models including improving and intensifying agrarian production and imperilling private land ownership seemed ever-more-alluring to post-colonial states. US planners uneasily looked over their shoulders at Communist Eurasia: 'Taken together, the Soviet Union, Eastern Europe and Communist China committed an annual average of something over \$100 million in recent years. They had over 3,000 technicians in the field in 1964–1965' (NSC 1963, 3). The question was not merely apolitical development, but development's world-systemic effect, and who would shape qualitative production shifts. If Communist developmental diplomacy deepened, it could nudge recipient countries closer to the geo-economic orbit of non-US and autarkic trading zones.

Looking worriedly at this spectre, the NSC proposed a one-third increase in agricultural investment from fiscal year 1966–1967 – over 50 percent higher than 1965, to \$512 million. Planners perceived aid primarily as technology transfer. They replaced cereal and soy grants with gifts and loans of fertiliser, other materiel, and expertise. They considered 'fertiliser plants ... and finance[e] research for better and more nutritious crops.' Furthermore, 'In determinations of food aid, emphasis will be given to each country's efforts to develop its food capabilities – either through agricultural development or improved capacity to buy in world markets' (NSC 1963, 3). In 1967, there was a US wheat shortfall for foreign aid. The US compensated with other cereals or concessionary sales from other NATO allies. The NSC linked this provisioning to the threat of declining per capita food availability, the harbinger of the red wind, or the diversion of 'scarce foreign exchange from development purposes to food purchases,' which would slow 'economic growth in the LDC's [*sic*]' (NSC 1963, 4).

Planners uneasily glanced at the lines of food output and food demand, the second creeping above the first. The NSC rejected tapering food aid despite incipient US incapacity to fulfil swelling needs. Less spending on endogenous fixed capital formation would slow development – which was the prophylaxis against Communism – and less food would lead to 'malnutrition, misery, and violence,' the sequence symptomatic of creeping Communism (NSC 1963, 6). Slacking domestic capital formation constrained development. Thus, they sought to intensify such postcolonial states' strengths in cereal farming, to remove restraints on growth.

Enter the Green Revolution. Yield increases were fundamental, secured by price policy, land tenure reform, and materiel: improved seed, pesticides, irrigation, and fertiliser. Fertiliser was a near-obsession, a potent multiplier of capital: 'A key to this effort ... is fertiliser. \$1 million of fertiliser can yield enough grain to feed 200,000 people for a year; \$1 million of wheat will feed only 70,000 people for a year ' (NSC 1963, 8). They reduced political problems to a series of equations for US planning to balance. USAID focused on technicist innovations in lieu of and to immunise the social body from

social change, especially in the agrarian sector. Absent from NSC proposals were landtenure reforms or investing in locally specific agricultural extension and rural development plans.

Whether such capital came from the USA or in-country, productivity-enhancing investment was preferable to long-run cereal inflows. Such plans were silent on their underlying assumptions and consequences. First, dependency would not end. Fertiliser imports would replace cereal imports. Second, alternative productivity-enhancing investments that would not induce permanent dependency links went unconsidered – the Gandhian-inspired or landrace-linked alternatives we trace below. Third, the consequences of shifting a relatively ecologically embedded cereal production system into a globalised, industrialised, and entropic one were – literally – unthought. And fourth, whether such technologies were socially neutral or would impact the country into which they were injected did not yet enter the planning of US national security bureaucrats.

Against this background, the Green Revolution arrived in Tunisia. In 1966, the Tunisian Ministry of Agriculture, alongside the International Centre for Maize and Wheat Improvement (CIMMYT), USAID, and the Ford Foundation, initiated the Wheat Project. Funds came from the local currency derived from US loans and PL-480, which had financed seed and machinery imports. It aimed to make Tunisia selfsufficient in wheat within five years, in line with Bourguiba's productivist exhortations, the mantra of Tunisian planning (Johnson, Fikry, and Ferguson 1983). From the outset, the plan was oriented to larger more capitalised farms, neglecting smaller ones in the Tunisian Tell, and the Centre/South's barley and hard wheat plots. Mexican semi-dwarf wheats were introduced in lieu of Tunisian landraces, assuming higher-yielding varieties would induce farmers to plant more. Simultaneously, the government bumped up floor prices for durum and soft (or bread) wheat hoping to encourage more farmers, above all in the northern 'modern' sector, to plant more of the latter crop.<sup>2</sup>

In India PL-480 food aid and subsequent US technocratic interventions narrowed the space for ongoing political contestations in the 1960s, which could have led to a different trajectory for agrarian and rural transformation (Siegel 2018). The package of price incentives, market support, credit, and input subsidies which enabled groundwater mining, was much more critical than the overhyped hybrid seed varieties in increasing yields (Subramanian 2015). Like in Tunisia, agricultural intensification concentrated in certain regions, with provisioning for perennial irrigation and certain select cereal varieties, predominantly wheat and rice.

# Consequences

We now turn to the Green Revolution's consequences. Because Tunisia is uneven geographically, with sharply distinct biomes and patterns of land ownership, consequences varied. There was 'increased economic activity': purchased inputs and using iron engines to farm, alongside more 'disposable income' for farmers (Johnson, Fikry, and Ferguson 1983, 22). The evidence was increased consumption of prepared foods. Increased economic activity and disposable income meant the further commodification of production, not qualitative increases in living standards. Low producer prices for wheat and subsidised bread were boons to the industrial sector and the 'urban community' boosting

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'industrial development ' (Johnson, Fikry, and Ferguson 1983, 23). The USAID retrospective, *Tunisia: The Wheat Development Program*, claimed farm mechanisation as one of its trophies, adding, 'The demand for mechanisation has been stimulated by the shortage of labour required for use of animals in ploughing,' and the need for 'quick seed-bed preparation ... particularly important when fertiliser is being used.' The combine harvester had 'freed the greatest amount of labor' (Johnson, Fikry, and Ferguson 1983, 25). There had been land concentration: more titles in the hands of 50 ha-plus units, fewer in those smaller than 50 ha, reflecting how technologies favoured the former farmers. Dolefully, the report noted many farmers could not 'keep up' with the new technology. One consequence was an intensification of the 'already vast' rural exodus, inducing, some 'labor scarcity' in the countryside (Johnson, Fikry, and Ferguson 1983, 26). Adding a gender gloss, the report noted:

The change in food consumption patterns of farm families increased the availability of farm women for farm and other employment and is said to have had an adverse effect on the quality of farm family diets. The positive effect is that women are playing a more important economic role on the farm and in off-farm employment. Rural migration of men has increased unemployment in urban areas, but the remittances of those who are employed abroad to their farm families has added to farm incomes. (Johnson, Fikry, and Ferguson 1983, 29)

Under 'lessons learned' the report noted self-sufficiency was a mirage. The report urged ongoing efforts to grow irrigated crops for export and to supply hotels and tourists (Johnson, Fikry, and Ferguson 1983, 29). In the Northwest, through the mid-1980s, extensive production prevailed with only limited infiltration of more intensified methods. The colonial bequest of cereal-fallow went from 91 to 77 percent of the arable land from 1962 to 1980. In 1976, 87 percent of the peasantry took home less than 500 TND per year. Half earned less than 100 TND (Dimassi and Zaiem 1984). Women, with access to the waged labour market, left the breeding of hens and bees by the wayside. Sides of roads where eggs and honey used to be sold became barren. Men who used to manage home gardens no longer did so by the mid-1980s. Artisanal home-production of pottery or home weaving of wool gave way to aluminium and store-bought clothing, amidst feminisation of rural labour (Amrouni 1985, 289ff).

In India scholars have documented rising class, caste, and regional inequality, and to a lesser extent ecological degradation, since the Green Revolution's early decades (Frankel 1971; Farmer 1977; Shiva 1989). Mechanisation accelerated after the HYV package arrived, neutralising the effects of increased availability of wage work in agriculture due to multiple cropping (Rao 1994). As Cullather (2010, 230) suggests, these empirical studies contradicted the grand narrative of an American-engineered historic turnaround in Asia's food supply in the 1960s. Productivity surges in wheat and rice were short-lived. Increasing land under wheat and rice cultivation by displacing coarse grains, oilseed, and pulses did not improve the poor's nutritional outcomes. As Kumar (2016, 98) suggests the public subsidies and procurement incentives could have facilitated the production of diverse crops with extant seed varieties grown by small and marginal farmers country-wide and supported the improved varieties Indian scientists were developing for equitable and ecologically sustainable outcomes (Kumar 2016, 98). The energy

crisis and high petroleum prices in the early 1970s made fertiliser factories and oil pump sets for groundwater extraction expensive (Cullather 2010, 248).

By the late 1960s caste and class conflict re-incanted the spectre of a Red revolution. Immediately following the onset of the Green Revolution, the Naxalbari movement emerged in West Bengal (Banerjee 1984). More sporadic conflicts elsewhere reflected the experience of caste oppression amidst seeming abundance and accelerated inequality in Green Revolution regions (Mencher 1974; Frankel 1971). But the presence of permanently attached labour, caste-based patrimonial relations, availability of migrant labour, and partial proletarianisation curtailed a widespread organised struggle by agrarian workers (Byres 1981; Harriss 1982). With growing rural unrest, in the 1970s the ruling regime under Indira Gandhi adopted a populist strategy and launched poverty alleviation programs to quell the growing disillusionment with the promise of rural development (Gupta 1998). Middle and large farmers in the north-western Green Revolution belt became a class for itself. Their demands for higher input subsidies and prices reinforced the US industrial model of agriculture (Brass 2014). Critically as Gupta (1998, 74) points out, the terrain of populist politics illustrated the continuing 'struggles over meaning and direction of development,' specifically the role of agriculture.

#### Ideological countermovements

Across the Third World, post-colonial and radical developmentalist agronomists looked with unease and dissatisfaction at agronomic practices, and their inability to achieve economic liberation. Farming techniques pioneered in the temperate and wetter soils of the core and implicated in colonial histories of commodification of agricultural knowledge could not be grafted to the very different ecological tableaus of the periphery (cf. Kloppenburg 2005). Dispossessed from land and/or the capacity to cultivate, peasants went to the slums (Menon 2015), soils were swept to the seas, and debt and food dependence mounted alongside escalating rural inequality. Amidst the restructuring of the natural and social landscape, some natural and social scientists resisted, and advocated for alternative development trajectories. While we focus on proposals for agrarian transformations, they were often implicitly or explicitly connected with developing decentralised regionally appropriate forms of manufacturing and articulated alternative imaginaries of rural-urban relations. The thinkers we highlight recognised and explicitly opposed the uneven accumulation and social exploitation that was germane to ecologically extractive forms of agricultural intensification and industrialisation. Their alternative proposals for socially and ecologically just and appropriate organisation of rural production, could not be permitted within post-colonial states implementing top-down capitalist plans of agricultural modernisation and were therefore suppressed.

# The Tunisian school of popular agronomy

In Tunisia, criticism of the Green Revolution emerged through two branches tracing back to the same trunk: dependency theory, or the transfer of value from the periphery to the core (Dussel 1988). Samir Amin was dependency's primary purveyor in the Arab-African context. He was influenced by the national liberation movements, especially in China and Vietnam. He criticised modernisation theory in his 1957 dissertation, not published until over a decade later (1974). By then, he had started to reject the neutrality of technology (Amin 1994, 65). He and even more so, Ismail-Sabri Abdalla, a major influence on Tunisian thinkers, called for paying much more attention to the technologies of development (1976). They urged internally articulated industrial models, meant to mimic models of core development, wherein industry would provide inputs for farming and consumer goods for the countryside and the countryside would provide food for the cities and primary inputs for industrial processing (Amin 1970, 225–227).

Economists like Mahjoub, likewise influenced by the Chinese model, pushed such thinking further, and pointed out that imitation and transfer of the dominant technologies had not imported development - in many ways a chimera even in the First World - but had institutionalised maldevelopment. Mahjoub's earlier work had focused on *longue duree* Tunisian industrial underdevelopment (1983b). Working in parallel with a global dissection of technology, he showed how technologies reflected the world and wants of their makers, and tended to reinforce oppression (Noble 1978). For Mahjoub, the consequences were plain: 'regression of consumer crops, growing food dependence, growing unemployment and the degradation of eco-systems' (Mahjoub 1983a, 39-40). The peasant world slowly evaporated as its people were deracinated, in flight to France or Tunis's and Sfax's littoral slums. Knowledge flowed out from the countryside, chemicals abraded the ecology, the small peasantry were 'pauperised,' and what was left of the world of the peasants was derided as 'traditional,' trapped in the tar of backwardness. Mahjoub clarified the challenge was also epistemological: the peasantry was unable, from the modernisers' perspective, to offer 'coherent technological propositions' (1983a, 40). Mahjoub drew on Jacques Ellul's and Lewis Mumford's technology criticism. He saw modernising technics as unsuited to a Third World country like Tunisia, since the motor force of industrialisation had led to a concentration of wealth. Mahjoub saw the connection between such technologies and the Westernised elite's dismissal of agrarian reform. They could not apprehend a peasantcentred developmental path (1982, 13). Furthermore, in a bit of agro-ecology and nature's matrix thinking avant la lettre (Perfecto, Vandermeer, and Wright 2009), Mahjoub called for uses of technology which would allow for 'prudent management of resources and the environment,' and saw agrarian systems not as factories-in-thefields, but as 'cultivated eco-systems' (1983a). Finally, he pointed out that in 'the modes of production called "traditional" there existed the knowledge 'which must be the base, both instrumentally and conceptually, of any development' (Mahjoub 1982, 51).

He called for satisfying peasant needs, and developing technology according to the 'satisfaction of needs determined socially,' asking, finally, 'Which technologies appropriate to which needs and for what development?' (Mahjoub 1982, 54–55, 59). Although he was in conversation with the 'basic needs' approach to development, alongside other regional scholars, he called for revising the technological paradigm, since 'traditional' systems had adequately catered to those same needs. Tunisian dependency theory called for restoring the appropriate technologies of the countryside and its people to the developmental toolkit. In so doing it laid the basis for breaking from the modernisation episteme. The dependency lineage was likewise present in the other strand of heterodox thought which addressed Tunisia: that of the radical agronomists (Ajl 2018). The most creative amongst them was Slaheddine el-Amami, who developed a prescient criticism of technology focused on the 'traditional' world of the peasant and showed how prevailing institutions, state action, and technologies were laying waste to the peasantry (Ajl 2019b). He saw that the Green Revolution ruptured the capacities of the peasants to preserve and propagate seedstock:

Broken by the competition of merchants of foreign seeds which inundate the local market. In effect, the local seeds have not benefited from the reorganization of innovation within the domain of selection and multiplication, because of the reality that agronomic research is linked to large foreign conglomerates which produce seeds. (El-Amami 1982, 16)

The hybridisation process was built into Tunisia's research infrastructure. It had become 'integrated to the international circuit of Mexican wheat' - the Green Revolution. The problem extended beyond control of how given grains were grown, bred, and selected. Barley, suitable for the semi-arid expanse extending from the southern reaches of the Tell to the central steppes, had c. 1978 not been the object of research. The study had fixated on more-commodified soft wheat. It had also gone to durum wheat, a latecomer to Green Revolution breeding programs, but only by necessity, since consumers disliked and producers distrusted Mexican soft wheats (El-Amami 1982, 16). Amami, writing alongside J. P. Gachet and fellow Tunisian agronomist Taher Gallali, attacked the sectoral conception of agriculture, wherein each type of production was conceived in isolation, and then imported technology applied to the problem - a mechanic's view of farming. As part of this mechanistic outlook, parts could be freely brought into the native agricultural system. Corn and fowl were brought in to create Tunisian industrial aviculture ex nihilo. They noted the Green Revolution's homogenising and modernising ambitions, and how existing farming systems, building on colonial anti-ecological practices, threatened erosion and degradation. In place of such irresponsibility, they mapped out what should be grown where in Tunisia - ecologically appropriate agriculture and plantings. The North would be re-christened Tunisia's granary, flatlands planted in cereal, and the tenuous hillsides sown in hardier forage crops and permanent prairies - perennials, not annuals. Barley would bloom across the serer Centre and South for human and animals. Integrated pasturing and occasional supplementary irrigation, barley in drier zones, and careful planting in the flood zones could abolish the food dependency which had been the Green Revolution's raison d'etre (El-Amami, Gachet, and Gallali 1979).

Messaoud Boudhiaf identified a metabolic rift and a broken nitrogen cycle as one of the fruits of the 'modern' Green Revolution wheat system (Schneider and McMichael 2010). Precolonial peasant farming fell a bit short vis-à-vis productivist expectations. But there was continuous fertilisation through pasturing, and pastured fallows shielded the land from water-based and eolian erosion. The modern system led to parasites, the organic elements were insufficiently restored to the soil, and humus protection and formation was not assured. He wanted planting to be sensitive to the needs of the land and appropriate to Tunisia's biomes, with cereals returned to their age-old lands, north of the Dorsal which cut across the northern third of Tunisia. He called for a bouquet of measures to replace toxic metabolically unsound monocultures with polycultures: small hydraulics, pasturing, forage crops. Technical and social rifts went hand-in-hand. Mechanisation propelled migration as capital replaced labour. Boudhiaf demanded the state step in, open channels so credit could flow to the smallholders, and do a land-to-the-small-tiller agrarian reform (Boudhiaf 1982).

#### Dissenting agronomy in India

We now turn to Indian heterodox agronomic thought. Known as a Gandhian economist, J. C. Kumarappa, a leader in the anti-colonial nationalist movement, was important in outlining a developmental vision that directly challenged Eurocentric modernisation in the first two decades after independence until his death in 1960. Unlike many other economic nationalists, he rejected the idea that industrialisation should be the pathway for independent India's development to recover from colonial rule (Govindu and Malghan 2016, 26). Non-violence was the guiding framework within which Kumarappa situated the alternative economic organisation of decentralised production and consumption. For him, the history of imperialism illustrated that overproduction of particular commodities and excessive use of and competition for non-renewable inputs generated violence. If India followed the path of large-scale industrialisation, there would be no place for meaningful democracy (Kumarappa 1951).

In the plan envisioned for independent India, Kumarappa argued that basic needs – food, clothing, and shelter were to be the priority areas, then village industries. His vision emphasised radical decentralisation of political power, social equity and village level self-sufficiency for building an ecologically regenerative 'economy of permanence' (Kumarappa 1958). He conceptualised such an economy within the broader ethical framework of non-violence and a systematic critique of how industrial-imperial economies perpetuated braided violence against humans and nature (Kumarappa 1944, 1958, 1951; Govindu and Malghan 2016). A decade before the Green Revolution's onset, Kumarappa cautioned against artificial fertilisation that would exhaust soil fertility and kill earthworms, and warned against the deployment of tractors running on oil. He called for continued use of 'manpower, animal power, windmill power' and framed dependency broadly, beyond the import of food grain, and wrote: 'it is perilous to depend on imported motive power for our food production' (1951, 37-38). He criticised American methods of farm production for being wasteful, and critically, linked them to the imperial grabbing of fossil fuels and land. As Govindu and Malghan (2016) highlight, Kumarappa presciently warned that the growing US intervention in Community Development Programs through international foundations was harmful for rural reconstruction and would reduce them to extension programs, harming Indian agriculture (cf. Sinha 2008).

Sustainable agro-ecological farming practices, Kumarappa argued, could only thrive alongside just prices for producers and dismantling of exploitative and dehumanising labour practices. He criticised 1940s–1950s government policies wherein the state and interests of consumers determined food prices. Furthermore, in his vision which was offered as an alternative to alienated labour fostered by industrialisation and mechanisation, a sustainable food system would be a part of a broader set-up of labour-intensive village industries providing living wages for all, and enabling regenerative use of materials. As he writes, 'in village industries there is possibility of human development of the worker himself' (Kumarappa 1951, 28–29). He rejected the idea that investment

in large-scale industries was a pathway for economic reconstruction to address colonial underdevelopment through deindustrialisation. The Green Revolution concretely foreclosed, then, not just alternative visions of agrarian transformation centred on decentralised agronomic practices and land redistribution, but also this broader vision that is now recognised as the precedent of post-growth thinking (Gerber and Raina 2018).

The work of R. H. Richharia, an eminent rice scientist who was a part of the mainstream Indian scientific establishment, exemplifies an alternative but marginalised agronomic research agenda.<sup>3</sup> He directed the Central Rice Research Institute, the key agency for rice research in the mid-1960s. His plan centred on developing regionally appropriate varieties, embedded within agronomic practices that required low external inputs and built on farmers' knowledge. Working with adivasi farmers early in life influenced his thinking and vision. He developed a technique called clonal propagation, which improved indigenous rice germplasm by instilling hybrid vigour in them (Richharia 1962).

In 1963, research on rice using clonal propagation was underway across regional centres in India. The program was shut down and Richharia removed to make way for the International Rice Research Institute (IRRI)-led dwarf rice varieties HYV program. He had raised concerns about imported rice material from IRRI, on account of their pronounced susceptibility to diseases and pests and interference from foreign institutions in shaping research agendas more generally (Dogra and Riccharia 1991, 30-32). After being moved to a regional centre in the Chattisgarh region, Richharia continued with his research agenda, leading a program that collected 17,000 rice cultivars, developing indigenous tall and dwarf high yielding varieties, and drought-resistant, early maturing varieties with different taste profiles - for instance, Chilka rice used by Adivasis for breadmaking, or *khowa* rice which tasted like dried milk – compatible with peoples' socio-cultural preferences (Dogra and Riccharia 1991, 36). In the mid-1970s, he conducted experiments that showed how some indigenous varieties, when cultivated using local practices, performed better than HYVs, with much lower doses of fertilisers and no plant protection chemicals. Unlike HYV dwarfs, these indigenous varieties were not 'fighting against their environments' (Dogra and Riccharia 1991, 39). This program was also shut down after Richharia refused to pass on the collected indigenous rice germplasm to IRRI under World Bank pressure (cited in Dogra and Riccharia 1991, 41).

By 1983, amidst wide acknowledgement of the Green Revolution's failures, particularly with respect to rice, Richharia drafted a plan entitled 'A Specific Plan of Action for Increase in Production of Rice,' in response to a request by Indira Gandhi for a different agricultural strategy, amidst clarity that the productivity gains of the Green Revolution were short-lived.<sup>4</sup>

Richharia suggested that rice productivity remained unstable and stagnant because HYV dwarfs were unsuitable for most local Indian environments, most of which were rain-fed, experiencing frequent droughts. HYVs' success was limited to a few irrigated regions. Even in irrigated regions like Punjab they were highly susceptible to diseases and pests that could not be controlled under heavy fertilisation and irrigation (cf. Shiva 1989). By enabling HYVs to replace indigenous varieties, including several high-yielding ones, Indian planners transformed Indian agriculture into being 'factory-oriented' and neglecting 'inexpensive local resources' (in Dogra and Riccharia 1991,

61). Like Kumarappa, his concerns about sovereignty were not limited to a narrow conception of homogenising nationalism. He writes,

Self-generating economy and building up of local resources alone offers a permanent solution in rice and not outside support which would always be limited, conditional and uncertain. Local resources would also include forestry and animal husbandry (for farm power and soil fertility) to restore imbalance, being created in the environmental ecosystem in the typical rice areas. Organic and ecological faming with which the farmers are familiar and which they prefer, finds little place in our research and planning process after 1965. (In Dogra and Riccharia 1991, 61)

Richharia was critical of 'wide adaptation' (plant types that were supposed to have high yields across diverse environments) that was at the core of the international wheat-breeding program of Norman Borlaug supported by the Rockefeller Foundation. Borlaug claimed that certain tropical wheat varieties could be grown anywhere in Central and South America, the Middle East, and South Asia with increased fertiliser use (Baranski 2015). Baranski (2015) argues that it was not only the Mexican hybrid wheat varieties that were introduced with the Green Revolution in India. More fundamentally, the tenet of wide adaptation and breeding under artificially constructed favourable conditions became entrenched in agricultural research practices. This tenet was in direct contravention to Richharia's model of *in situ* plant breeding adapted to specific regional ecologies. Borlaug and his supporters credited wide adaptation for increasing yields across different agronomic conditions, even as the yield increase was only possible with synthetic fertiliser and irrigation in monocultural plantations (Baranski 2015). Wide adaptation was the ideal techne for propagating the US ideology of standardised resource-intensive farming, wherein capital replaced labour. While Indian scientists such as BP Pal and MS Swaminathan allied with Borlaug to lobby for wide adaptation in wheat cultivation, the domain of rice research and cultivation was much more contested in the 1960-70s. The limitations of wide adaptability were evident with IR8 rice in South Asia (Farmer 1977; Saha 2012). Unlike wheat where aggregate yields increased, IR8 did not work across the much more diverse ricegrowing regions of India.<sup>5</sup>

Richharia's proposal called for resuming location-specific breeding programs that developed indigenous rice varieties, which had stalled in 1964-65. A critical part of this plan was decentralised research practice that involves farmers from inception. He called for setting up farmers' rice centres (*Kisani Dhan Kendra*) that would provide experimental plots for farmers to work with local varieties. Given concerns about biopiracy, Richharia suggested these centres could act as custodians of local rice cultivars and argued for *in situ* preservation. At these centres, farmers would be trained in techniques such as clonal propagation to multiply their local varieties that can be used with their local agronomic practices. While not opposed to use of nitrogenous fertiliser in low quantities if 'growers were responsive,' he writes, 'agronomic practices such as *biasi*,<sup>6</sup> rotation of crops, mixed cropping, will remain common and will not be disturbed, emphasis being on the use of organic manures, such as compost, green manure, neem cakes and oil cakes etc.' (in Dogra and Riccharia 1991, 76). To support such a strategy, the role of public extension workers would have to shift away from a narrow focus on yields to a broader agenda of building disease and drought resistance, and being attentive to their compatibility for cooking and the nutritional quality of crops. Such decentralised agronomic research and practices were commensurate with the broader Gandhian vision of rural development that was a part of early Indian planning debates in India that were pushed off the political agenda and subsequently became invisible in narratives of the Green Revolution.

# Conclusion

Indian and Tunisian resistance to the Green Revolution model of agrarian development was articulated within the broader postcolonial politics of defending political sovereignty, and advancing to economic and technological sovereignty, in part through self-reliant and articulated development models. In Tunisia, political economists and agronomists adopted the framework of dependency analysis. In India, proposals for alternative organisation of social economy were expressed in the Gandhian idiom of autonomy and nonviolence emphasising decentralisation. The four thinkers we discuss are varied in their agendas and the groups they are addressing, that reflect their political, temporal, regional and disciplinary differences. Yet, the common strand among their work is the underpinning critique of extractive forms of colonial developmentalism embedded in and enacted through particular technologies, attention to socio-economic and critically ecological specificities for development planning and revaluing the knowledge and labour of smallholders and workers. These articulations that we discuss are perhaps just some among many other invisible narratives of dissent to colonial modernisation that need to be recovered, given the general dearth of intellectual histories of alternative development pathways. By mapping these articulations, we aim to highlight the political dimensions of socio-ecological degradation, and how they intersect across different postcolonial geographies. We thereby show how alternatives to post-colonial development were a worldsystemic phenomenon, and such development was intrinsically and perpetually contested.

Capitalist socio-ecologies are deliberately engineered to prevent different languages of valuation and alternative techno-scientific practices from emerging through substantive democracy. In this respect, we illustrate how strategic US interventions through aid policy not only institutionalised the Green Revolution agrochemical treadmill, but show the friction and opposition to this process. It involved marginalising existing and emerging alternatives directly or indirectly, through eliminating supportive infrastructure and reshaping ecologies. In Tunisia in the 1960s, this meant underinvestment in decentralised cooperative infrastructures, and viewing UGTT attempts to build up rural coops not as a partner but as a rival, while ignoring dissident economists and planners who called for land-to-the-tiller agrarian reforms or rural policies that built from smallholder knowledge. Agrarian reform haunted planners throughout the late 1950s and early-to-mid 1960s, and planning occurred as politicians and practitioners alike, with eagerness or apprehension, restructured Tunisian land tenure without fundamental land redistributions. In India, marginalisation, suppression, and exclusion meant disciplining demands for land reforms, marginalising scientists like Richharia, and narrowing political discourse around development to increase yield productivity for national food grain self-sufficiency and growth.

We add to the growing literature that highlights these geopolitical interventions – so far mostly in India and Mexico – by calling for greater attention to counter-movements, which suggest what could have been. These counter-movements denaturalise the Green Revolution's inevitability, often reinforced by not only proponents but also critics that have largely focused on documenting adverse impacts of the HYV package on increasing inequality or the lack of access or diffusion of technology to small farmers as a cause of poverty (Das 2002). In this way, we draw attention to the imperial logics embedded within Green Revolution techne (cf. Eddens 2019), transcending the universalising tropes of scientific versus traditional agriculture. Thinking through counter-movements and critiques makes visible specific alternative plans, and highlights recurrent political questions around techno-scientific knowledge production and practices during the 'long Green Revolution' (Patel 2013). In India and Tunisia, critiques centred on who controls the breeding of seeds, purposive choice of crops and varieties compatible with specific ecologies and promoting social equity, research agendas and practices that are responsive and accountable to farmers and work with and not against the environment and the role of agriculture in broader economic organisation. Furthermore, thinkers such as Kumarappa and Mahjoub advocated macro-level planning to enable substantive economic and political decentralisation.

Even as these intellectual counter-movements have faded from Green Revolution histories, the spectre of their practices and visions are visible within proliferating contemporary agroecological struggles. In India, agroecological movements' regional diversity prefigures the politics and ethics of decentralised democracy with varying emphases on seed saving practices, regeneration of biodiverse farming, development of chemical free, low-input agronomic practices and confronting social hierarchies shaped by place-based histories (Khadse et al. 2018; Brown 2016; Meek 2014). Some of these struggles invoke the Gandhian agrarianism concretised by thinkers such as Kumarappa and others and work in collaboration with aligned dissident agricultural scientists (Prasad et al. 2012). In 'bread basket' Northern regions like Punjab where Green Revolution monocultures of hybrid wheat and rice have degraded the socio-ecological landscape, memories and imaginations of past farming practices play a crucial role in building an agroecological politics (Sharma 2017). In Tunisia, there are ongoing horizontal and state-supported seed-exchanged networks and research programs to preserve landrace durum and barley seeds, research and documentation projects concerning such experiments, and a renaissance of interest in food sovereignty and development models (Ayeb 2017). Furthermore, land takeover in Jemna, a southern oasis, has placed peasant land ownership back onto the political map (Krichen 2019).

Such programs clarify that the political sociology of the Green Revolution is an unfinished tale, not merely a teleology of techno-capitalist triumph. It is not merely a chronicle of the juggernaut of progress piling up wreckage but also an account of wounded but farfrom-destroyed practices of life and reproduction which live on not merely in memory and historical archives but in day-to-day forms of farming, everyday practices and memories, which must be central to a just development path for the countries of the South.

#### Notes

1. Abdalla 1983; Herrera 1971.

- 2. Durum is a type of wheat grown primarily in rain-fed plots across North Africa. It is suitable for couscous and is essentially a different product than the more common soft or bread wheat which dominates global wheat hectarage.
- 3. As Saha (2012, 146, 167) points out there is little material available on Richharia's work and other dissenting scientists, as the focus has been limited to Indian scientists who collaborated in instituting the Green Revolution strategy. It is mostly journalistic and activists' accounts that have preserved the legacy of such dissenting agronomists. The analysis in this article primarily draws on a book written by a journalist, Bharat Dogra (1991) documenting the life and work of Dr. Richharia. Also, see Meena Menon, 'The Grain Story', *The Hindu Business Line*, 2 July 2001, https://www.thehindubusinessline.com/2001/07/02/stories/10020309.htm (accessed 25 March 2019); and Claude Alvares, 'The Great Gene Robbery', *Illustrated Weekly of India*, 23 March 1986, http://www.vijayvaani.com/ArticleDisplay.aspx?aid=2137 (accessed 25 March 2019); and Shiva (1989).
- 4. The text of this plan is reproduced in its entirety as an Appendix in Dogra (1991).
- 5. There was growing recognition of the need for research in plant breeding appropriate for rain fed and dryland areas within the international agricultural research institutions in the 1970s and 1980s. This recognition partly acknowledged critics of the Green Revolution and it reflected the experiences of growing interventions in the Middle East (Baranski 2015, 198–208).
- 6. *Biasi* refers to a rice cultivation practice of beushening, which involves direct seeding in high stress environments.

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# **Notes on contributors**

*Max Ajl* is a postdoctoral fellow at Wageningen University's Rural Sociology Group and an associated researcher with the Tunisian Observatory for Food Sovereignty and Environment. He writes on post-colonial theories of development and Tunisian national liberation, as well as Arab agrarian questions.

*Divya Sharma* is a lecturer of Sustainable Development at the Science Policy Research Unit, University of Sussex. Her research and teaching focus on postcolonial rural transformations and agrarian struggles in India, changing landscapes of work/labour, and political ecology of food and agriculture.

# ORCID

*Max Ajl* http://orcid.org/0000-0002-1422-1010

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