

# THE POLITICAL ECOLOGY OF AGRICULTURE 4.0 IN ITALY: TOWARD A GREEN AGROEXTRACTIVIST MODEL?

## ***La ecología política de la agricultura 4.0 en Italia: ¿hacia un modelo agroextractivista verde?***

*A Ecologia política da agricultura 4.0 na Itália:  
rumo a um modelo agroextrativista verde?*

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### **Abstract**

This article explores the political ecology of agricultural digitalization in Italy, situating it within the broader debate on green capitalism and agro-extractivism. Far from representing a neutral phase of technological modernization, the digital transition in agriculture –promoted within the framework of the EU’s *twin green and digital transition*– embodies a further development in the commodification of nature and labor. Based on a preliminary analysis of the impacts of agricultural digitalization policies in Italy, the article examines how these policies address the structural contradictions of the agroindustrial model in the Italian context. It argues that digital agriculture functions as a reformist strategy that adapts to, rather than resolves, an increasingly deep socio-ecological crisis, reinforcing trends of land concentration, labor precarity, and environmental degradation. By framing these dynamics through the lens of agro-extractivism, the article highlights the intersections between the twin ecological and digital transition in agriculture and this regime of accumulation, contrasting them with a just transition perspective centered on the reproduction of socio-ecological life rather than the technological intensification of production.

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### Resumen

Este artículo explora la ecología política de la digitalización agrícola en Italia, situándola en el marco más amplio del debate sobre el capitalismo verde y el agroextractivismo. Lejos de representar una fase neutral de modernización tecnológica, la transición digital en la agricultura –promovida en el marco de la *doble transición verde y digital* impulsada por la Unión Europea– constituye un desarrollo adicional en el proceso de mercantilización de la naturaleza y del trabajo. A partir de un análisis preliminar de los impactos de las políticas de digitalización agrícola en Italia, el artículo examina cómo estas políticas enfrentan las contradicciones estructurales del modelo agroindustrial en el contexto italiano. Sostiene que la agricultura digital funciona como una estrategia reformista que se adapta, en lugar de resolver, a una crisis socioecológica cada vez más profunda, reforzando las tendencias de concentración de la tierra, precariedad laboral y degradación ambiental. Desde la perspectiva del agroextractivismo, el artículo destaca las intersecciones entre la doble transición ecológica y digital en la agricultura y este régimen de acumulación, contraponiéndolas a una visión de transición justa centrada en la reproducción de la vida socioecológica y no en la intensificación tecnológica de la producción.

**Palabras clave:** Agricultura digital, agroextractivismo verde, Italia, doble transición verde y digital en Europa, ecología política del trabajo.

### Resumo

Este artigo explora a ecologia política da digitalização agrícola na Itália, situando-a no contexto mais amplo do debate sobre o capitalismo verde e o agroextrativismo. Longe de representar uma fase neutra de modernização tecnológica, a transição digital na agricultura –promovida no âmbito da *dupla transição verde e digital* da União Europeia– representa um avanço adicional no processo de mercantilização da natureza e do trabalho. Com base em uma análise preliminar dos impactos das políticas de digitalização agrícola na Itália, o artigo examina como essas políticas enfrentam as contradições estruturais do modelo agroindustrial no contexto italiano. Argumenta-se que a agricultura digital atua como uma estratégia reformista que se adapta, em vez de resolver, a uma crise socioecológica cada vez mais profunda, reforçando padrões de concentração fundiária, precarização do trabalho e degradação ambiental. Ao enquadrar essas dinâmicas sob a lente do agroextrativismo, o artigo evidencia as intersecções entre a dupla transição ecológica e digital na agricultura e esse regime de acumulação, contrapondo-as a uma perspectiva de transição justa centrada na reprodução da vida socioecológica, e não na intensificação tecnológica da produção.

**Palavras-chave:** Agricultura digital, agroextrativismo verde, Itália, dupla transição verde e digital na Europa, ecologia política do trabalho.

## Introduction<sup>2</sup>

Agriculture is not only central to the production of food and raw materials, but also plays a crucial role in the historical reconfiguration of relations between capital, society, and nature (Moore, 2008; Taşdemir Yaşın, 2022). The global crises of 2007–2009 reactivated a new cycle of agrarian development and food regime transformation (McMichael, 2012; Benegiamo, 2022). In the wake of multiple global challenges –including increasingly insecure food systems and the failures of past development policies (World Bank, 2007)– policy responses converged on a *triple-win* vision: agricultural development was expected to drive an integrally beneficial transition, simultaneously advancing climate goals, food security, and social well-being.

Within this framework, food systems became key sites of experimentation with new productive paradigms promoted under the banner of the *green economy*, *smart agriculture*, and the *bioeconomy*. This was evident both in the central role of primary agricultural production in the expansion of biofuel markets, and in the growing importance of technological, financial, and digital instruments in the transition toward a more sustainable agroindustrial model (Abergel, 2011; ETC Group, 2010; Taylor, 2017). Twenty years later, digitalization –framed within climate-smart agriculture and Agriculture 4.0– has increasingly been framed as a cornerstone solution to render agri-food systems more efficient, productive, and sustainable (Clapp and Ruder, 2020; FAO, 2020).

These developments reflect broader shifts in capitalist modes of production and accumulation, alongside an evolution of green capitalism dynamics (Leonardi and Benegiamo, 2021; Benegiamo and Leonardi, 2025). The latter can be seen as a form of climate governance that promotes markets as vehicles for social and ecological development while promoting the growing casualization and exclusion of labor (Tienhaara, 2014; Scales, 2017; Leonardi, 2019). In the last twenty years, this approach has intensified the commodification of land and biological processes, both as ‘new’ means of production (Boyd, *et al.* 2001; Battistoni, 2017) and as strategies of market diversification through the creation of tradable assets. This has been

<sup>2</sup> The research for this article was funded by the University of Pisa under the Research Project «Global Crisis, Democracy, and Socio-Ecological Transition» (PRA-University Research Projects) by the European Union-Next Generation EU, project PRIN PNRR 2022 “Di-JUST: Digital Food and Just Transition. Sustainability and Labour in Agriculture 4.0” (code P2022X3MWR, CUP I53D23006850001).

understood as a further phase in the commodification of nature (Smith 2007) and as the consolidation of a speculative frontier in which ecological limits are reframed as opportunities for capital accumulation (Cooper, 2008; Pellizzoni, 2023).

Though unable to produce substantial mitigation effects or significantly reduce emissions, green capitalism has nonetheless fostered new processes of dispossession and exclusion, as well as renewed rounds of land and green grabbing (Fairhead, Leach, and Scoones, 2012; Borrás, *et al.* 2011; Bruna, 2022; Benegiamo, 2025). These processes haudermining rural livelihoods and deepening the casualization and precarization of agricultural labor, and further entrenching agro-extractivist logics (Alonso-Fradejas, 2021).

These developments have also highlighted the need to bridge political ecology and critical agrarian studies in order to better understand the impact of green capitalism in rural contexts, and its consequences for both agrarian policies and the agrarian question (Borrás, 2016; Borrás, *et al.* 2021). This article takes up this perspective by examining the recent framing of a twin digital and green transition in the Italian context, where digitalization is presented as a central tool for combining the classical capitalist imperatives of profitability and efficiency with transition objectives such as mitigation, adaptation, and environmental preservation. It builds on preliminary results of a research project exploring the interconnection between just transition and digital transition in the agrarian context<sup>3</sup> (Benegiamo, *et al.* 2023). In line with this framing, the article examines the Italian case through the lens of socio-ecological reproduction, showing how digitalization in agriculture is tied to labor causalisation and ecological collapse embedded, revealing a broader process of agro-extractivization in Italian agriculture.

The concept of agro-extractivism has gained significant traction in critical literature as a lens through which to interpret contemporary agricultural transformations. It has been increasingly invoked to describe “*the predatory expressions of the fossil-fuel driven, large-scale, capital-intensive extractivist capitalist farms*” (Veltmeyer and Ezquerro-Cañete, 2023, 1678). Yet, its analytical clarity and scope of application remain contested. In particular, its relevance for examining processes beyond postcolonial contexts

<sup>3</sup> DiJust – Digital Food and Just Transition: Sustainability and Labour in Agriculture 4.0. PRIN PNRR 2022 project (code P2022X3MWR), funded under the NextGenerationEU program. Lead institution: University of Pisa, in collaboration with University of Calabria, University of Bologna.

—especially in Europe and Southern Europe— remains debated (Narotzky, *et al.* 2025; Corrado, *et al.* 2025). At the same time, grassroots organizations and movements are increasingly adopting the concept as a framework to interpret current agri-business dynamics. In this sense, my attempt, as an Italian scholar who has often drawn on Latin American debate and who is currently writing for a Mexican journal, is also to highlight points of contact and convergence between different territories and actors—particularly between agroecological and anti-extractivist movements in Europe and Latin America. To better engage with this perspective, next section builds on key assumptions in the debates on extractivism and agro-extractivism to analyze the entanglement between social reproduction and the unfolding of a green extractivist logics in agrarian development.

The second section turns to the unfolding of digitalization policies in Italy, showing how digitalization is framed as a reformist alternative to a large-scale industrial agricultural model in crisis—a model propped up by public funds in an attempt to adapt to the very ecological and social problems it has produced. We argue that digitalization neither repairs ecologically damaged territories nor addresses labor as a central issue. Instead, it disproportionately benefits larger, more predatory enterprises while systematically excluding agroecological alternatives from the debate. The conclusion brings these threads together, arguing that it is precisely in this space of inefficacy and exclusion that the extractivist pattern of contemporary agricultural transformations takes shape.

Methodologically, the article is based on a desk analysis of industrial planning toward the digitalization of the agrarian sector. However, the results and discussion are also informed by key findings from the DI-JUST project, which is currently finalizing data validation and preparing a comprehensive report for publication. The project conducted semi-structured interviews and field visits, with a total of 75 interviews carried out with selected stakeholders across three contexts: the viticulture sector in Tuscany (Chianti and Colli del Candia), characterized by small, high-quality wine farms increasingly reliant on migrant labour; the tomato supply chain in Puglia (province of Foggia), marked by large-scale intensive production and precarious seasonal work; and the industrial tomato district of Emilia-Romagna (provinces of Piacenza and Parma), where established agroindustrial firms combine permanent and seasonal labour within hybrid systems of direct and sub-contracted employment.

## 2. Digitalisation, extractivism and social reproduction

Often referred to as *smart agriculture* or *Agriculture 4.0* –terms that are distinct yet commonly used interchangeably– digital agriculture conveys the idea of greater integration of data-based technologies and tools across the various stages of agricultural production, closely tied to increasing automation framed within the broader paradigm of Industry 4.0 (Wolfert, *et al.* 2017; Bucci, *et al.* 2018; Trendov, *et al.* 2021). The idea, built on the earlier notion of *precision agriculture*, gained wider attention in the 2000s framed as a potentially transformative paradigm within political debates on food system governance and sustainable agrarian transition, both in Europe and globally. Within this framework, digitalization –as part of climate-smart agriculture and Agriculture 4.0– emerged as a key solution to make agri-food systems more efficient, productive, and sustainable.

The idea of a necessary transition of food systems –tied to the question of their security– has also been widely debated in Europe (Pellizzoni, *et al.* 2025). These objectives became even more urgent following the second major global crisis to hit food systems in the 2000s: the COVID-19 pandemic and the Russia-Ukraine war. Within this context, the European Green Deal assigns a central role to digital agriculture in ecological transition and sustainable growth. EU member states have explicitly envisioned “a smart and sustainable digital future for European agriculture and rural areas,” and a wide range of policies, instruments, and funds are currently directed toward agricultural digitalization (European Commission. 2020). The Farm to Fork strategy, a key pillar of the Green Deal, likewise emphasizes research and innovation –digital innovation in particular– as essential to building sustainable food systems.

Such perspectives align with the vision of *ecological modernization* that has guided ecological transition since the 1980s (Pimbert, 2015). These trajectories are also embedded in the more recent evolution of the green capitalism paradigm, exemplified by the rhetoric of the *twin transition*, which posits digitalization and ecological transition as deeply interdependent processes.

Scholars have warned that digitalization may threaten farmers’ livelihoods through knowledge dispossession, loss of autonomy, and new forms of data and land grabbing (Pimbert, 2015; Rosén, *et al.* 2017; Fraser, 2019; Barrett. *et al.* 2020; Hackfort, 2021; Prause, 2021; Rolandi, *et al.* 2021; Stone,

2022). In this article, I examine the extent to which digitalization is also tied to the propagation of extractivist logics driven by green and agroindustrial objectives.

The notion of agro-extractivism emerged in Latin American debates on extractivism and neo-extractivism (Gudynas, 2010; Svampa, 2019). Initially, it designated a model of agriculture operating as “*extractivism in agriculture*”: the large-scale removal of soil, water, and biomass –primarily for export–with minimal local transformation and severe social and environmental costs. Rather than “industrializing” the countryside, corporate-controlled plantation agriculture concentrates value chains in the hands of a few multinational corporations and detaches production from domestic economies. The concept was embedded in critical debates on neo-extractivism, coined to critique development strategies based on raw material export, including those pursued by progressive governments (Acosta, 2011; Svampa, 2019).

The expansion of this model, which accelerated during the 1990s, was driven by the neoliberal turn in the global political economy, and further intensified in the 2000s by the “green” neoliberal shift–particularly through biofuel policies and tree plantations. Although frequently promoted as climate-friendly solutions and vehicles of sustainable development, these initiatives gave rise to what Alonso-Fradejas (2021) terms *life-purging agro-extractivism*, revealing how agro-extractivism is deeply entangled with the current ecological and social crisis.

In line with these developments, debates on extractivism and agro-extractivism have expanded, extending their applications to diverse contexts (McKay, *et al.* 2023; Veltmeyer and Ezquerro-Cañete, 2023; Ye, *et al.* 2020; Chagnon, *et al.* 2022; Benegiamo, 2025). In their literature review, Veltmeyer and Ezquerro-Cañete (2023) emphasize that agro-extractivism is best understood as a form of agrarian accumulation based on predatory rather than labor-inclusive logics, rooted in the intensive and extensive exploitation of natural resources, and producing devastating –often irreversible– socio-environmental consequences. Unlike classical agroindustrial models, it is marked by the underdevelopment of productive forces and by reliance on monopolistic logics, extractive technologies, economies of scale, and financialization as mechanisms of profit. This distinction between extractivism and industrial agriculture is crucial, as it prevents a simplistic conflation of technology with extractivism.

A related issue concerns the opportunity to extend the notion of extractivism beyond specific flex crops and the plantation model. It is undeniable

that in postcolonial contexts agro-extractivism manifests in continuity with the legacy of colonial plantation economies, through large-scale monocultures of commodity crops such as soy, palm oil, or eucalyptus. Yet focusing solely on this dimension may obscure broader tendencies of the agroindustrial sector to restructure globally around extractivist logics. In this sense, in addition to the specificity of the combination of intensive/extensive pattern of production, the debate on extractivism and agro-extractivism has focused on the specific relationship that extractivism engages with the components of social reproduction, including labour and ecological sustainability. (Ye, *et al.* 2020). Re-centering the question of social reproduction is therefore crucial to illuminate current trajectories of agro-extractivism, linking them to a political ecology of labor exploitation and clarifying their entanglement with contemporary transition policies.

This paper engages with the idea that, from a political ecology perspective, green agro-extractivism denotes a broader development paradigm defined by its specific relationship to socio-ecological reproduction (Leff, 2015). It manifests in ecological crises at the territorial level and climate pressures at the global level, while simultaneously driving the precarization of agrarian labor and undermining alternative ways of inhabiting rural territories, including both traditional farming systems and agroecological models. In this sense, agro-extractivism functions as an analytical lens for tracing capital concentration, transformations in labor relations, and processes of ecological degradation –not as a mere correlate but as a central logic of accumulation.

Although the European context lacks the direct colonial plantation legacy that has shaped agro-extractivism elsewhere, recent debates suggest that agricultural transformation policies in Southern Europe may nonetheless reproduce similar dynamics. These considerations are particularly relevant in the Italian case, where digitalization has been promoted as a cornerstone of agrarian modernization and ecological transition. As the next section shows, the Italian experience highlights how the digital paradigm is embedded within broader agro-extractivist logics, reinforcing existing inequalities in labor relations and land structures rather than overcoming them.

### 3. Digital Agriculture and the Twin Transition in Italy

Digitalization –particularly in the form of Precision Agriculture (PA) and automation– has become a cornerstone of Italy’s governmental strategy for agrarian development. PA was first introduced in Italian public policy through the “Industry 4.0” National Plan (Law No. 232/2016), which included dedicated measures for the agri-food sector. The following year, the Ministry of Agriculture and Forestry (renamed Ministry of Food Sovereignty by the current government led by Giorgia Meloni)<sup>4</sup> issued the *Guidelines for the Development of Precision Agriculture in Italy* (Italian Government, 2017). Within this framework, PA was identified as a strategic tool for achieving the 2014-2020 priority objectives of the European Rural Development Fund under the Common Agricultural Policy, where the sustainability–innovation nexus was strongly emphasized. Precision technologies were thus framed as a preliminary step toward the transition to Agriculture 4.0: a highly digitized, automated, and interconnected agri-food system characterized by interoperability and traceability, particularly through the integration of Internet of Things (IoT) applications. This perspective was further confirmed in the Italian Recovery and Resilience Plan (NRRP) approved in 2021, which places digitisation and precision agriculture as an integral component of sustainable agriculture, as characterised in the mission ‘Green Revolution and Ecological Transition’. In line with this objective, the NRRP argues that: ‘farmers need to rapidly transform their production methods and make better use of new technologies, particularly through digitalisation, to achieve better environmental outcomes, increase climate resilience and reduce and optimise input use’ (Italian government, 2021, 122).

Despite these ambitions, nearly a decade later the adoption of digital technologies in Italian agriculture remains limited and highly uneven. Public incentives and a variety of development projects have sought to promote their uptake, yet diffusion has been slow. The most widespread applications concern automatic and semi-automatic guiding systems and variable-rate technologies (VRT), often associated with GNSS, satellite-based production maps, and various types of sensors for soil characterization, irrigation management,

<sup>4</sup> In the neo-sovereignist discourse of the Italian far right, the notion of *food sovereignty* diverges significantly from its meaning within international peasant movements such as La Vía Campesina. Rather than emphasizing farmers’ rights, agroecology, and global justice, it is reframed in terms of national autarky and the defense of *Made in Italy* products, turning a concept of grassroots resistance into a tool of nationalist agricultural policy.

and crop monitoring (e.g., vegetation indices). These devices are increasingly combined with on-field weather stations and integrated into decision-support tools, forecasting models, and inter-machine communication systems.

A major barrier to adoption lies in the territorial configuration of Italian agriculture, which is poorly suited to machinery originally designed for large-scale, extensive farming systems such as those in North America, where the approach was first developed. Moreover, the sector remains structurally fragmented and dominated by small and medium-sized enterprises, for which the investments required by digital technologies are difficult to sustain and amortize over the medium term. These results are in line with international research showing that the economic convenience of digital adoption is closely tied to farm size and cultivated area (Wolfert, *et al.* 2017). In Italy, this is reflected in an uptake concentrated among large-scale farms—those able to make structured investments and, above all, to benefit from public funds. Yet, evidence from the field suggests that ecological motivations are largely absent. Instead, digital tools are primarily deployed as strategies of cost optimization and to intensifying agrarian resource extraction by compressing the time of labor and boosting its productivity.

#### **4. Socio-Ecological Implications: Labor, Land, and ecological sustainability**

We will return to this aspect later; for now, it is important to stress how this dynamic unfolds alongside two broader structural trends reshaping Italian agriculture: the steady decline in the number of farms and the simultaneous increase in average farm size.

The 2020 national census recorded 1.1 million farms—one-third fewer than in 1982 and less than half the 3.1 million of 2000 (CREA. 2021). Many of those remaining are at risk of closure (around 11% according to the Council for Research in Agriculture and Analysis of Agricultural Economics: CREA)<sup>5</sup> or operate at a loss. Small and very small farms (under 10 ha) are the ones exiting or shrinking, while large farms (over 50 ha)—though only about 51,000—managed nearly half of Italy's agricultural area in 2020. Consequently, despite the accelerated exit of many farmers, the total cultivated area has not declined, but average farm size has increased.

<sup>5</sup> CREA is the leading Italian national research agency for agri-food supply chains. Supervised by the Italian Ministry of Agriculture, Food Sovereignty and Forests (Masaf).

Taken together, these data point to a pyramidal restructuring: the exit of small and vulnerable farms and the consolidation of larger ones. This restructuring has direct implications for both labor and land management. On the labor side, Italian agriculture increasingly relies on non-family wage work, with a significant share performed by irregular and over-exploited, migrant workers. The European Union itself acknowledges that “numerous seasonal workers are employed under short-term contracts, with little job security and social security coverage,” and that many live in conditions comparable to “modern forms of slavery” (Augère-Granier, 2021, 6). The systematic resort to a low-cost and blackmailable labor force is accompanied by the expulsion of previously employed workers and the erosion of welfare and protective mechanisms.

With regard to land management, subcontractors (*contoterzisti*) –firms that do not own land but provide machinery and technological services– have assumed a growing role. This model enables subcontractors to assemble the management of multiple terrains, often displacing traditional ownership-based cultivation. In some cases, contractors effectively become the sole managers of farmland, shifting entrepreneurial risk away from landowners. The 2017 Italian Guidelines explicitly assigned a central role to these actors, while recent CREA report (2021) interpret subcontracting as a sign of the sector’s professionalization-linked to the expanded use of advanced machinery and to potential gains in occupational safety and environmental performance through more precise input application. At the same time, subcontracting is framed as a structural response to the decline of young farmers and the progressive aging of the rural workforce, both of which make the continuation of farming activities increasingly difficult.

This also aligns on field results which indicates that automation –such as autonomous tractors and smart machinery– is often invoked by large farmers as a response to what they term the “labor crisis,” understood both as the exodus from low-wage agricultural employment and as the growing resistance of migrant labor unions and collectives. A second domain of interest in these technologies concerns their potential to enhance the adaptive capacity of agriculture to sudden climatic shifts and increasingly unpredictable seasonal patterns. These dynamics suggest that the digital paradigm, rather than repairing damaged socio-ecological systems, enhancing climate mitigation, or enabling a genuine ecological transformation of agrarian and food systems, manifests instead as a reformist strategy aimed at adapting

the sector to an ongoing and deepening socio-ecological crisis –while carrying the very risk of further entrenching it.

Indeed, the hundreds of seasonal workers –often migrants– who harvest and process the food that reaches Italian tables remain invisible in official narratives of the green and digital transition, as do their struggles and demands. This invisibilization reflects a broader dynamic analyzed in critical research on digitalization and automation (Casilli, Vora). As Atanasoski and Vora (2019) argue, the promise of liberation through technology is built upon the erasure of undervalued labor performed by subjects systematically relegated to the margins: racialized, feminized, and precarized workers who are denied any voice in shaping imaginaries of progress. The ideal of automation is therefore constructed on historical hierarchies that define who is deemed worthy of liberation from labor, and who must remain confined to new forms of invisible exploitation. This is confirmed by the fact that, in policy discourses and institutional framings, the emblematic subject of the digital transition is not the farmworker but rather a new entrepreneurial –managerial figure. This figure embodies a predatory vision of labor and of human– nature relations, standing in stark contrast to models rooted in cooperation and socio-ecological repair.

Moreover, despite repeated policy claims about the need to reduce and optimize water consumption, Italy is experiencing a steady increase in irrigated areas, particularly in the north. This trend is driven largely by adverse climatic conditions –rising temperatures and shifts in rainfall seasonality– that have extended irrigation to areas historically not irrigated, such as vineyards and olive groves (CREA, 2022, 365). Against this backdrop, the ecological and mitigation effects of digital technologies remain to be demonstrated. No national validation system currently exists, and international research offers contrasting results regarding their capacity to optimize input use and reduce ecological impacts-effects that may in any case be offset by the intensification of production. It is worth recalling, in this regard, CREA's own reports, which note that:

The smaller farms use water more sparingly and, given the unfavourable climatic trends, are oriented towards crops that are not very water-demanding, even if less profitable; only the larger farms equip portions of the SAU for irrigation depending on the investments to be made. (CREA, 2022, 365).

In sum, the Italian case illustrates how the green and digital transition, rather than challenging the structural contradictions of the agroindustrial model, tends instead to reproduce and deepen them—reinforcing land concentration, labour precarity, and environmental stress. In this sense, Italy provides a paradigmatic example of how the political ecology of digitalisation is entangled with a wider crisis of socio-ecological reproduction, exposing the limits of reformist approaches that conflate technological innovation with sustainability.

## 5. From Green Capitalism to a Just Transition

This article moved from the idea that the digitalization of agriculture, far from representing a mere technological advancement in farming systems, should be understood as a socio-economic process deeply intertwined with the *green extractivist* evolution of capitalism, in a context marked by multiple and systemic socio-ecological crises. It has also shown how this approach shapes public policy, orienting it toward the allocation of public incentives to private actors, who are made responsible for carrying out the transition process.

By reading the ongoing transformations in Italian agriculture through the lens of political ecology, this article has sought to illuminate how agricultural development, increasingly guided by the imperative of digitalization, unfolds within a broader dynamic of capitalist restructuring. This dynamic is defined by a specific material relationship between top-down transition strategies, socio-ecological reproduction, and new forms of commodification of nature.

Within the transformations affecting the contemporary agroindustrial regime of production, the materiality of this process can be captured through the notion of *agro-extractivism*: a form of agricultural development that “drives a process of impairing destruction through a ‘productive’ model that is labor-poor, culturally insensitive, burdensome, and reliant on unpaid work, while building environmentally and socially toxic landscapes” (Alonso-Fradejas, 2021, 128). Taken together, these dynamics outline the *political ecology of a crisis of social reproduction* in late capitalism.

More specifically, the digitalization of agriculture in Italy reveals the ambivalent role of social reproduction. On the one hand, its transformation becomes directly embedded within production logics: new abstractions of value configure new “natures” associated with uneven forms of exploitation.

On the other hand, the promise of a green capitalism capable of harnessing the generative capacities of nature and technology for an abundant, flourishing future is contradicted by a present marked by impoverishment and ecological devastation.

This resonates with Cooper's (2008) analysis, according to which speculative expectations of a new capitalist ecological regime capable of overcoming the "geochemical limits of the Earth" have coincided with the material devaluation of social reproduction. The capitalist drive to "put life to work" has, in turn, entailed new patterns of devaluation of both human and non-human lives. Along similar lines, Kasia Paprocki (2022) has argued that climate change governance has taken the shape of what she terms anticipatory ruination, "a discursive and material process of social and ecological destruction in anticipation of real or perceived threats" (Kasia Paprocki, 2022, 1). This process, she argues, is particularly evident in agrarian contexts, where climate crisis narratives shape contemporary responses and their impacts in ways that consolidate and reconfigure multiple inequalities-social, environmental, racial, and gendered.

Similarly, within the twin green and digital transition, public policies rely on private actors as the main drivers of change, channeling public incentives toward them. Rather than investing in the collective infrastructures necessary to sustain a socio-ecological transformation (Benegiamo, *et al.* 2023), Italian strategies frame digitalization around individual entrepreneurs, reproducing a "modernizing" vision of innovation-led growth.

Many farmers' organizations have denounced these dynamics as actively undermining small-scale agriculture, based on the assumption that larger actors-thanks to their investment capacity and technological know-how-are better equipped to manage the consequences of climate change. This narrative, central to climate-smart agriculture (Anderson, 2019), echoes the logic underpinning the *land grabbing* phenomenon of the early 2000s in several African countries, where smallholders –already weakened by decades of neoliberal policies– were expected to cede space to large agribusinesses, deemed more capable of integrating land into global agri-industrial value chains.

Similarly, in the Italian context, despite widespread recognition of the vulnerabilities of the national agricultural system, digitalization is not being proposed as a strategy to reverse these trends. Rather, it functions as a tool to enhance the competitiveness of already dominant actors-resulting,

for the vast majority, in greater precarity and exclusion. The proliferation of low-wage labor, environmental degradation, and the growing exposure of Italian agriculture to ecological risks and disasters together constitute the material counterpart of a renewed insistence on the “potential” of integrating nature into global circuits of capitalist value. The effects of this process must be examined at the level of the *socio-ecological relations* that sustain the political economy –and political ecology– of the so called twin transition.

To conclude, it is nonetheless important to note that a growing interest in a just transition approach is emerging within Italy’s agri-food sector. Such an approach, however, should not be understood merely in its conventional sense –as compensation for job losses or as a buffer against the social costs of the green transition– but as a call for a broader transformation that repositions social and ecological reproduction at the center of agricultural policy and practice. This would therefore require breaking with the extractivist logic underpinning both green capitalism and digital modernization, shifting the focus from technological optimization and productivity gains to the reparation of socio-ecological relations-valuing care, interdependence, and collective forms of knowledge and labor. Only by confronting the structural roots of agro-extractivism and reclaiming the political meaning of transition as a process of justice and redistribution can digitalization become part of an emancipatory project rather than a new frontier of accumulation.

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