Platform Intelligence in Agriculture

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Abstract—**This paper considers the current challenges of agriculture in historical retrospect. As in all activities, agriculture is orchestrated by information governance systems. They have evolved along history following a rather regular trend of disembedding and concentration, disembedding of information from its origin in the physical world and concentration under the control of increasingly powerful market actors. The current challenges of agriculture, whether environmental, health, or culture-related, can be shown to relate to blind spots of the information systems. We consider the potential of intermediation platforms, that are increasingly in control of multi-sided markets in increasingly more sectors, to reshape the view systems have, making them more holistic, able to deal with what was previously neglected as externalities. We first consider the issue theoretically, and then illustrate with the claims of real actors towards a systemic intelligence of agriculture.**

Index Terms—**Platform intelligence, two-sided markets, epistemic infrastructure, cybernetic regulation, intermediation platforms, algorithmic governance**

I. Introduction: The Crisis as a Crisis of Intelligence

IS not the current agricultural crisis only a crisis of intelligence? Agriculture faces tangible and urgent challenges, ranging from the transgression of planetary boundaries [1] and the deterioration of public health [2] to the structural inability to feed the global population equitably [3]. These physical manifestations are the downstream results of a specific orchestration of agricultural markets. The way markets are orchestrated is itself based on an informational architecture that determines what is visible and what is ignored. This is the topic of the present paper. To understand such a mismatch, we must look beyond human cognition: intelligence is here defined as the capacity of any system, whether it is biological, technical, or social, to process information from its environment in order to orient its action [4].

When applied to the agricultural economy, the market acts as such an intelligent system. It is a distributed information-processing architecture that aggregates millions of dispersed signals ranging from local harvest yields to global demand. The form the intelligence of agricultural markets takes is historically constrained by the technical objects available to structure it. While agriculture operates in direct contact with complex natural and social environments, the technologies available at a given period offer some intelligence, limited by design. Fundamental technologies of the past such as the static cadastre or the telegraphic price signal for instance, would be incapable of processing the resulting complexity we are facing today.

Historical analysis reveals a regular and systematic trend towards progressive disembedding. In other words, market intelligence became increasingly abstract, separating the economic signal from the tangible reality it controlled. For example, a ton of cereals of a certain quality becomes a commodity that loses all connection with its producer. This is a trend that the contemporary era seeks to correct through traceability. Because the market could not "sense" the environmental spheres, it could not integrate them into its decision-making. This trajectory of disembedding continued into the biological realm itself. With the advent of the genetically modified organism (GMO) and the patenting of living organisms, the logic of abstraction penetrated the seed. The intelligence here was no longer just about communicating price, but about codifying life: the genetic information was legally separated from the physical plant, transforming the seed from a reproducible organism into a unit of intellectual property.

This historical trajectory of disembedding has profound physical implications. By prioritizing the circulation of the signal (the standardized price or patent) over the complexity of the living entity, the market organized a radical disconnection. This informational architecture, designed for the instrumental optimization of commercial flows, systematically filtered out the biological and social costs of production. Consequently, the global agri-food system today faces a series of structural challenges that are effectively the "blind spots" of this legacy intelligence.

First, the environmental challenge is the direct result of an economic calculation that treated nature as an infinite resource rather than a finite system. Because the agricultural market's eyes were blind to ecological degradation, agriculture became both a major driver of climate change and its primary victim [5]. Within the planetary boundaries framework [6], this lack of systemic integration has made intensive agriculture the principal driver for exceeding Earth's stability thresholds, particularly regarding biodiversity collapse [7] and the disruption of nitrogen and phosphorus cycles [1]. The environmental crisis is thus a failure of systemic perception: the industrial intelligence is not structured in order to internalize the feedback loops of its own biophysical foundations.

Second, the sanitary challenge stems from an informational separation between production methods and public health outcomes. As the market is optimized for yield and standardization, it ignores the invisible accumulation of toxicity. This

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failure to trace the long-term impact of chemical inputs (pesticides and antibiotics) created the crisis now formalized by the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) under the One Health concept [8]. By treating the field as an isolated production unit, the system generated sanitary backlashes, such as antimicrobial resistance and zoonoses, that migrate up the value chain to the consumer. The sanitary crisis illustrates an informational blindness to complex biological interdependencies, where the system's intelligence lacks the necessary traceability to link chemical inputs with their long-term metabolic outcomes.

Third, the socio-cultural challenge arises from a logic of standardization that renders local singularities economically illegible. According to the FAO, the industrial model's reliance on economies of scale threatens family farming, which represents over 90% of the world's 608 million farms and produces 80% of global food value [9][1]. This competition is not merely economic but cultural: as the market imposes uniform standards to facilitate global liquidity, it erases the diversity of localized agricultural and culinary practices, transforming a pillar of civilization into a generic productive sector. This socio-cultural erosion is effectively a crisis of recognition: an intelligence optimized for global legibility is structurally incapable of processing the information-rich value of localized diversity.

Finally, the challenge of allocative inefficiency highlights the structural failures of an information-poor market. This inefficiency manifests in two dimensions. Physically, it appears as food waste: according to the FAO, approximately one-third of global food production is lost or wasted [11]. This is the product of rigid informational categories that classify "non-standard" biomass as having zero value, transforming valid nutrients into waste. Economically, this inefficiency manifests as information asymmetry [12]. Just as the market is blind to the utility of "ugly" fruit, the farmer is often blind to the true market value of inputs, creating an opacity that prevents optimal economic decision-making. Thus, the legacy intelligence fails to allocate both physical resources (food) and capital efficiently. The structure of optimization is at stake [13].

These challenges are the structural consequences of the agricultural information system inherited from the industrial era. By prioritizing, since the telegraphic revolution, an intelligence of signal circulation (the standardized price) over the complexity of the thing (the living entity), the market organized a radical disconnection. This architecture, designed for the instrumental optimization of commercial flows, structurally ignores the physical, biological, and human limits of the real world. Because the market could not "sense" these environmental and social spheres, it could not integrate them into its decision-making. These disparate crises are symptoms of a singular intelligence gap: a fundamental mismatch between the high-dimensional complexity of the living world and the low-resolution informational architecture inherited from the industrial era.

It is within this context of rupture that this article proposes to study the role that digital platforms can, and further could, play in the re-orchestration of agricultural markets. In economic terms, platforms are operators orchestrating two-sided or multi-sided markets [14]. Two-sided markets allow distinct groups of agents, such as producers and consumers, to interact via a common infrastructure. The specificity of contemporary agricultural platforms lies in their ability to progressively integrate additional sides into the market: they no longer merely connect the buyer and the seller, but now will be able to integrate the soil, the climate, the machine, or the consumer as data-producing agents.

Intermediation platforms have radically changed two-sided markets in many areas, revolutionizing everyday life, communication, knowledge, business, as well as politics and government [15]. Platforms constitute a fundamental shift from previous intelligence modes of markets and more generally social arrangements. They are fundamental actors, working potentially exclusively on the intangible informational part of exchanges.

Platforms thus represent a fundamental transformation of economic intelligence. Unlike previous technologies (such as the cadastre) which froze reality into static commodified categories, the platform deploys a particular form of cybernetic intelligence [16]. It is an intelligence that constantly corrects its trajectory based on the results of its own actions and the changes, both endogenous and exogenous, that occur in its environment. It has the capacity to ingest highly granular information streams and process them via dynamic feedback loops. Thanks to this architecture, the platform claims to operate a re-embedding of the market within its context. By connecting previously siloed informational spheres within a single computational system, it offers the potential (at least in theory) to execute the necessary trade-offs to address agricultural externalities. This shift mirrors the transition from simple "cyber-physical systems" to "cyber-physical-social systems" (CPSSs), where the integration of social and environmental feedback allows for a "parallel intelligence" capable of optimizing beyond mere economic efficiency [17].

We define platform intelligence as the algorithm behind the "invisible hand" of Adam Smith. It encompasses the specific computational and cognitive capacity that emerges from the unique informational architecture of digital platforms. The intelligence of such systems lies in their ability to process a vast array of variables and navigate complex trade-offs that were previously externalized or ignored by markets. While the traditional market was governed by the "invisible hand", namely a decentralized coordination mechanism where individual decisions aggregate into broader economic outcomes, platform intelligence monitors and controls individual and collective behaviors.

In this regime, market coordination is transformed into an engineered, intentional orchestration. This intelligence is structurally inseparable from the platform architecture itself. Because platforms function as multi-sided intermediaries, they occupy a privileged vantage point that allows them to ingest

[1] While the FAO states family farms produce over 80% of the world's food in value terms, this figure heavily relies on local staples in developing markets. Some researchers [10] suggest the volume share is closer to 53% when strictly accounting for global caloric supply.

disparate data streams from the soil, the machine, the climate, and the consumer simultaneously. This process is rooted in datafication: the systematic translation of biological and social "noise" into a uniform computational language. Without the architectural gravity that pulls siloed information into a single processing loop, the cybernetic regulation of agricultural externalities would remain technically impossible.

Platform intelligence operates as a fundamental function of a cyber-physical-social system. While CPSS provides the broad, macroscopic lens to apprehend the interplay between society, technology, and the environment, platform intelligence describes the specific nervous system of the markets hosted by these platforms. It is the mechanism through which the parallel intelligence of the CPSS is applied to economic and ecological orchestration.

The objective of this article is not to provide an exhaustive inventory of every digital tool in agriculture, but to uncover the core mechanisms of platform intelligence and how they are leveraged to reconfigure the agri-food system. We ground our analysis in a historical study to grasp the transformation that platform intelligence represents for agricultural markets.

Methodologically, our contemporary analysis focuses on the narratives deployed by these platforms. We study how the actors construct a discourse around the mechanisms of platform intelligence as a remedy for the industrial crisis; we do not seek to verify the technical veracity or performance of these algorithms, but rather to analyze the structural shift in power, truth, and market logic that these claims represent.

Consequently, the central question guiding our analysis is to determine to what extent this new manner of orchestrating information and exchanges allows for the reconfiguration of the structural challenges facing the agri-food system, and what new blind spots this algorithmic regime of truth is likely to engender.

To answer this question, our analysis proceeds in three stages. First, we retrace the history of agricultural intelligence, analyzing the trajectory of market intelligence from the deployment of the telegraph to the codification of the GMO. We demonstrate that each of these technological shifts produced a specific regime of intelligence: by optimizing the circulation of abstract signals (such as standardized prices or genetic intellectual property), these systems generated intense knowledge about specific variables while non-intentionally obscuring the complexity of the socio-biological context in which they were embedded. Second, we characterize the contemporary phenomenon of platforms, defining how their cybernetic architecture and capacity for granular data capture theoretically allow for a "re-embedding" of the market in its environment. Third, we evaluate the promises of these architectures in the face of global challenges, spanning from the environmental solutions of Climate FieldView and xarvio to the normative framework of AtSource, and the economic counter-power of the Farmers Business Network (FBN). Finally, we will conclude by discussing the ambivalence of this transformation. While platform intelligence offers a technical remedy to industrial externalities, it simultaneously concentrates power in ways that raise critical questions regarding technological sovereignty and geopolitical control.

II. The History of Agricultural Intelligence

We consider intelligence as a constructed interaction between a subject (the market or the state) and reality, which can be mediated by technical objects. In this framework, agriculture is itself a complex sociotechnical system that actively modifies the living world. Intelligence, therefore, is the apparatus that links the economic sphere (which demands standardization) to this biophysical sphere (which is inherently variable). It is a strategy of legibility: an operational capacity to decipher the inherent complexity of the living world and translate it into a language that economic and administrative coordination can process.

A. The Epistemic Constraint

Consequently, what the actor "sees" is strictly limited by how it measures. Every regime relies on an epistemic infrastructure, a framework of tools (maps, telecommunications, and standards) that determines the granularity of available information. This infrastructure acts as a filter, selecting which biophysical realities become signals. As James C. Scott argues, the central power can only govern what it makes legible through simplification [18]. The history of agricultural intelligence is thus the history of the tools used to render the complexity of the living world computable.

The master trend of this history is a movement toward abstraction or disembedding [19]. To scale from local interactions to national and global systems, intelligence had to detach itself from the "thick" description of local reality to focus on the "thin" transmission of standardized signals.

Crucially, this abstraction of information enabled a structural division of control. As long as the market relied on physical inspection, information remained tied to the material product; the producer, being the only one in contact with the soil, held a natural advantage in knowledge. The standardization of data broke this link [20]. By converting the harvest into mobile metrics (grades and statistics), information became an asset manageable independently of the farming act. This is a prerequisite, a necessary condition, for the commodification of tangible assets. Such separation allowed for the rise of specialized organizations that do not farm but control agricultural reality through data. On the private side, this created commodity exchanges; on the public side, it built administrative states. The disembedding of data is the technical condition that transferred the power of market coordination from the field to the office.

To understand the mechanics of this disembedding, we will examine three decisive epistemic infrastructures that successively reconfigured agricultural reality: the cadastre, which rendered the territory legible for the state; the telegraph, which synchronized market time for the exchange; and the GMO, which internalized standardization directly into the biological code.

B. The Static Regime: The Cadastre

The first major epistemic infrastructure of the modern market is the cadastre. Before the state or the bank could trade or tax agricultural value, they first had to define the unit of production itself. Prior to modern surveying, land tenure was governed by a vernacular complexity: "thick" local arrangements where possession was defined by physical landmarks or customary use, remaining opaque to distant observers. The cadastre, utilizing triangulation and geometric mapping, replaced this fluid social reality with a standardized abstraction. It imposed a mathematical grid onto the biophysical landscape, transforming vague possessions into theoretically precise parcels defined by immutable coordinates.

This geometric simplification instituted a specific regime of visibility that James C. Scott terms legibility [18]. By freezing the boundaries of the field, the state renders the territory taxable, while the market gains the ability to treat land as a fixed legal asset. As Hernando de Soto demonstrates, it is this formal representation that allows “dead capital” (the physical soil) to enter the financial circuit as collateral, converting the earth into a tradeable title [21]. However, this intelligence achieves stability only by suppressing the dynamic nature of the territory. The cadastral grid structurally ignores the biological flux, shifting soil compositions, seasonal flood lines, and informal commons, ultimately freezing the continuous ecological process into a static legal geometry to ensure transaction security.

C. The Signal Regime: The Telegraph

The second major epistemic infrastructure involves the mastery of time and quality. This occurred through the convergence of the grain elevator and the telegraph, which together orchestrated the transition from the sack to the stream.

Historically, grain trading was an identity-based transaction where buyers physically inspected specific sacks of wheat at local fairs, making the object’s presence the prerequisite for trust. As William Cronon demonstrates, the industrial scaling of the Chicago market necessitated a radical rupture: the invention of grading standards (e.g., No. 2 Red Winter Wheat) [20]. These standards dissolved the physical identity of the farmer’s harvest, mixing it into a common silo with that of thousands of others, and replacing the specific sack with a generic entitlement to a quantity of a certain grade.

This physical abstraction permitted a radical organizational specialization within the value chain. Because the commercial flow of ownership was now distinct from the physical flow of matter, market roles could unbundle. The trader could now deal purely in abstract risk within the futures pit (the exchange arena where standardized paper contracts, rather than physical grain, are bought and sold), never handling a single kernel; the logistician could focus entirely on the efficiency of storage and transport; and the producer was pushed toward the specialized role of an input provider, strictly focused on hitting the volume and grading standards required by the system.

This separation was the necessary condition for a new regime of visibility dominated by the telegraph. Because the grain was now a standardized commodity, the price emerged as the supreme unit of intelligence. The telegraph allowed this signal to circulate almost instantly, creating a synchronized global market where a price change in Liverpool could instantaneously reconfigure the value of a harvest in Illinois. However, this efficiency came at the cost of a total erasure of biological history. The “golden stream” that flowed from the elevators was memoryless: the grading system transmitted physical characteristics but stripped away all contextual information regarding who grew it or how the soil was treated. The intelligence of this regime maximized liquidity and velocity, but it did so by severing the informational link between the consumer and the producer’s practice.

D. The Intelligence of the Code

While the telegraph dematerialized the exchange of the commodity, a third form of intelligence, namely the intelligence of the code, attempted to internalize this abstraction into the biological asset itself. Through the advent of biotechnology, this specific epistemic framework views nature not merely as a resource to be harvested, but as a code to be edited.

In this configuration, agricultural intelligence shifts from a “biological lottery” (traditional breeding based on phenotypic selection) to a logic of informational determinism. Legally crystallized in the USA by Diamond v. Chakrabarty (1980) [22], this view reclassifies the organism. It ceases to be strictly a product of nature and becomes a human invention if its genetic code is deliberately modified. Where this intelligence is deployed, it offers the capacity to “hack” nature’s operating system by isolating a functional DNA sequence (a trait) and inserting it into another organism, treating the living world as a programmable substrate.

This technical capacity enables a radical rupture: the conceptual separation of the seed into “hardware” and “software”. As analyzed by Jack Ralph Kloppenburg Jr., the physical biomass (the germplasm) is treated as a mere delivery vehicle, while economic value is captured entirely by the genetic trait (the software) [23]. This distinction allows for the application of industrial intellectual property logic to self-replicating life. As affirmed in Bowman v. Monsanto (2013), the farmer in this system is positioned not as the owner of a harvest, but as the licensee of a proprietary technology [24].

This form of intelligence produces a specific type of visibility: genetic reductionism. It offers microscopic clarity regarding the genetic sequence and its encoded traits (yield potential and chemical resistance). However, by focusing entirely on the gene, this logic risks structurally blinding the market to the field. Critics argue that the systemic complexity of the agroecosystem, notably composed of its soil microbiology, pest evolution, and local biodiversity, is sidelined in favor of a technological fix. The intelligence is deep (molecular), but it is debated whether it is too narrow to capture the complex interactions between the programmed asset and its chaotic environment.

E. The Continuity of Rationalization

The cadastre, the telegraph, and the code are not the sole moments where intelligence reconfigured production. The history of agriculture is a continuous succession of epistemic infrastructures, and our analysis, far from exhaustive, is only illustrative.

Long before modern bureaucracy, the scribes of Ancient Egypt had already established a rigorous “accounting of the organic", managing temple granaries through negative interest rates to calculate the depreciation of stored grain [25].

The Dutch Golden Age pioneered a "circular intelligence" of nutrient recycling [26], while the colonial plantation standardized labor and biology into a linear extraction machine long before the industrial factory [27]. Finally, the scientific rupture of the 19th century further deepened this trajectory: Justus von Liebig's Law of the Minimum reduced soil complexity to a chemical inventory [28], paving the way for the Haber-Bosch process to bypass biological limits entirely [29].

These diverse historical configurations confirm a singular master trend: the progressive disembedding of agricultural value from its socio-ecological context. Whether through the scribe's ledger, the futures contract, or the genetic edit, the historical vector has consistently moved toward greater abstraction, rendering the complex interactions of the living world into discrete manageable signals. The cadastre, the telegraph, and the GMO are not isolated inventions, but decisive milestones in this long genealogy of control. By systematically separating information from its material substrate, they established the epistemic foundation upon which the digital platform is now built.

III. The Specificity of Platform Intelligence

We now turn to the contemporary reconfiguration of this landscape by a new actor: the digital platform. This transition represents a structural shift in how economic coordination is achieved.

The digital platform represents the latest stage in a lineage of informational infrastructures that have reshaped agricultural markets. To grasp the depth of the historical rupture they introduce, we must conceive of the platform primarily as an informational infrastructure. In economic theory, they are described as operators over two-sided or multi-sided markets. They are distinct organizations, potentially fully informational, designed to facilitate interactions between two or more distinct groups of agents, such as producers and consumers, buyers and sellers, who interact via a common intermediary in a given network.

This structure marks a fundamental departure from the industrial logic that preceded it. In their analysis of this platform revolution, Parker et al. [30] conceptualize the traditional model as a "pipeline" economy. The pipeline logic relies on a linear production chain, where value is created by efficiently transforming raw inputs into finished outputs. In the pipeline model, the firm's growth is structurally constrained by the capital cost of owning physical assets and the marginal cost of producing each additional unit. The emergence of platforms represents a shift from this linear model to a networked economy. In this new configuration, value is created not by controlling the means of production, but by facilitating exchange. The firm shifts from being a producer of goods to being an orchestrator of interactions.

Because the platform creates value through connection rather than production, it adopts an asset-light model. This is illustrated by the canonical examples of the digital economy: Uber operates the world's largest taxi network while owning no vehicles, just as Airbnb creates the largest hospitality marketplace without owning real estate, and in both cases with a very limited workforce.

As Evans and Schmalensee analyze, the platform resides exclusively on this information layer [31]. Its core function is to act as a matchmaker. By orchestrating interactions through code and data, the platform focuses entirely on reducing the transaction costs, also called the "friction", that prevent buyers and sellers from finding each other. By remaining distinct from the physical delivery of the service, the platform optimizes the flow of information that makes the physical exchange possible.

Although the capacity to connect different kinds of actors is not native to the digital world, modern platforms built on digital technologies dramatically increase the capacity to extract information out of each interaction. This heightened extraction capability thereby facilitates the connection of new market sides into the platform ecosystem. This digital intermediation ensures that every interaction on the platform leaves a permanent record. Unlike physical marketplaces where information evaporates after the transaction, the platform passively captures every click, movement, or transaction, transforming these behavioral flows into a standardized, machine-readable asset.

Consequently, platforms are structurally optimized for massive data generation. Unlike traditional methods that require active extraction, the platform's informational infrastructure effortlessly produces data as a side-effect of its operation. This capacity for data generation underpins a unique economic model. As illustrated by the search engine (e.g., Google), the primary interaction, namely connecting a user performing a search on one side with content on the other side, is typically offered for free.

The economic viability of the system rests entirely on a derived market (advertisers), which is fueled by the behavioral data extracted during that initial interaction. A series of secondary two-sided markets can be derived from the initial two-sided market of the search engine, such as the auction-based AdWords market. In addition, new sides can be added to an initial two-sided market involving new stakeholders. It is this specific multi-sided architecture that enables the platform to overcome the fragmentation of the linear model: by capturing data in one sphere and applying it in another, it operates a systemic integration, connecting domains that were previously isolated, as well as creating new domains that did not exist in the past.

It is precisely because the platform resides exclusively on this intangible informational layer that it creates a radical spatial disembedding. By breaking the traditional link where knowledge production and application were geographically bound, the platform introduces a structural divide between the scale of generation and the scale of processing. On the one hand, data generation remains deeply local, dispersed, and granular, occurring in the specific field, during a specific ride, or at a specific point of purchase. On the other hand, data processing is delocalized and centralized globally in the cloud.

This computational concentration is the defining feature of the platform's architecture, and it is the condition of possibility for its intelligence. By decoupling the place of origin from the place of calculation, the platform aggregates dispersed local data into centralized servers. This centralization enables the deployment of intelligent processing at scale. It allows for the application of massive computational power over extremely large datasets that would be technically impossible at the local level. In this configuration, the platform functions as a "learning machine": the data are utilized to train probabilistic models, creating a virtuous cycle where the platform's usage directly feeds the intelligence of its system, which in turn can attract more users.

The structural position of the platform dispels the myth of the neutral intermediary. While classical liberal economics relied on the metaphor of the "invisible hand" [32] to describe the decentralized, spontaneous coordination of market forces, balancing supply and demand, the platform, on the other hand, operates through a concrete algorithm. Even if the "perfect market" has always been an ideal and moreover strongly controversial, the platform fundamentally alters the nature of coordination. It replaces dispersed market dynamics with a centralized orchestration. This shift is conceptualized by Rouvroy and Berns in Ref. [33]. The platform is never passive; by defining protocols, ranking criteria, and interface designs, it acts directly on the field of possibilities. It imposes an architecture of choice [34], either by subtly guiding behavior through the design of the digital environment, or by structurally enforcing compliance through code [35].

This governance represents a fundamental transformation of economic intelligence. Unlike previous technologies (such as the cadastre) which froze reality into static categories to govern it, the platform deploys a cybernetic intelligence, mastering the science of control and communication in systems [16]: it is an intelligence that constantly corrects its trajectory based on the results of its own actions through feedback loops.

Consequently, platforms possess the capacity to ingest highly granular information streams, effectively moving from statistical sampling to an exhaustive logic [36], process them immediately, and adapt the market parameters in real-time. In this configuration, the platform acts as a steersman that constantly corrects the trajectory of interactions based on live data. This logic is exemplified by mechanisms such as Uber's surge pricing, which Rosenblat and Stark describe as a form of "algorithmic management" [37], where the system modulates incentives in real-time to align dispersed agents with the platform's goals. Thanks to this architecture, the market ceases to be a fixed space of exchange and becomes a responsive, adaptive organism. It achieves what Hartmut Rosa defines as "dynamic stabilization" [38]: a state where the system maintains its structural integrity not by standing still, but through constant acceleration and continuous adjustment to feedback.

This steering capacity might create a fundamental structural conflict, often described as the "judge and party" problem. This occurs when the platform acts simultaneously as the infrastructure operator (the judge) and a competitor on that same market (a party). This risk is born directly from the informational asymmetry inherent to the platform model. Because the platform possesses a "God's eye view" of the entire market, it can exploit proprietary third-party data to identify successful trends and high-margin opportunities. This dynamic is best illustrated by the case of Amazon [39]. Investigations by the European Commission have highlighted how the platform can utilize non-public data from independent sellers to launch competing "copycat" products and manipulate visibility algorithms to favor its own inventory (a practice of self-preferencing) [40].

In this scenario, the platform drifts from its role as a neutral intermediary towards a logic of asymmetric value capture. It leverages its cybernetic capabilities not to optimize the system for all participants, but to structurally favor its own interests. This transformation compromises the competitive neutrality of the marketplace. It plays a non-negligible role in the tremendous growth of platforms' capitalization, the fastest and the highest in history.

The specific form of platform intelligence offers a potential resolution to the structural crisis of the industrial model. Historically, industrial agriculture has operated on a linear logic: a unilateral injection of inputs to maximize outputs, often ignoring the complex ecosystemic consequences [41]. This linearity is precisely what generates negative externalities [42]. Because the system lacks feedback loops to measure environmental impact in real-time, it cannot adapt, leading to soil degradation and resource inefficiency [43].

In this context, the cybernetic intelligence of the platform appears as a structural remedy. By closing the loop between action and consequence, a cybernetic model promises to transform agriculture from a rigid linear chain into a responsive, adaptive ecosystem. Theoretically, this capacity to capture data and adjust parameters in real-time allows for the internalization of externalities that the linear model previously ignored [44].

The central question is therefore: how is this promise articulated? We will analyze the discursive claims of major agricultural platforms. By examining how they present their value proposition, we aim to understand how they leverage this concept of platform intelligence to position themselves as the necessary architects of a sustainable agricultural future.

IV. The Promises of Platforms in Agriculture

Historically, the organization of agricultural markets has been built upon a dual movement of centralization and disembedding [19]. To gain efficiency and liquidity (evolving from local fairs to global commodity exchanges), the market had to perform an abstraction of reality. The singular field became a standardized productive unit, and the harvest a commodity, a process historically illustrated by grain standardization in Chicago [20]. While this reductionism allowed for a tremendous acceleration of exchanges via specialized institutions, it engendered a major epistemic segmentation [18]. Agricultural, sanitary, and environmental spheres are treated in distinct informational silos. This fragmentation prevents the grasping of systemic interactions within the living world, thus transforming complex ties into negative externalities (pollution and health risks) ignored by economic calculation [45].

The emergence of digital platforms marks a rupture in this trend, driven by a new form of comprehension: platform intelligence. This intelligence achieves a paradoxical feat. It combines the disembedding necessary for global exchange with a capacity for the extremely granular re-territorialization of information, all while connecting users from distinct spheres. Through massive data capture, the platform claims to reintegrate local complexity (the soil, the gesture, and the human) into the global equation, thus promising to overcome the informational flaws inherited from the industrial model. It is upon this capacity for synthesis that the promises to resolve agriculture's major contemporary challenges rest, ranging from the environmental challenge (e.g., Bayer/xarvio) to the socio-cultural challenge (e.g., Olam) for instance.

The following case studies (Climate FieldView, xarvio, AtSource, and FBN) have been selected to represent a functional typology of platform intelligence, illustrating on which mechanisms the narratives of these platforms are based in order to address the structural crises of the agri-food system.

Basing our study on the value proposition of agricultural platforms and platform mechanisms, we analyze how these architectures attempt to re-internalize these externalities with platform intelligence, while questioning the new blind spots that this algorithmic regime of truth might engender. Interestingly, in the case of agriculture, platforms tend to be in the hands of powerful legacy actors, unlike in most sectors where platforms are mostly developed by new digital corporations [46]. However, to capture, host, and synthesize these massive global data streams, these legacy agribusinesses remain structurally dependent on generalized hyperscale cloud infrastructures, primarily Amazon Web Services (AWS) and Microsoft Azure. Agricultural platform intelligence thus operates as an epistemic application layer built atop the foundational computing power of transnational technology conglomerates[2].

A. Climate FieldView and Carbon Markets

Ecosystems like ForGround by Bayer[3], which rely on the informational infrastructure of the Climate FieldView platform[4], claim to address the challenge of carbon emissions by decoupling information from the physical storage of carbon and connecting farmers with third-party companies seeking to compensate their emissions[5].

Climate FieldView is a platform founded in 2006. Initially acting as a weather insurance provider capable of ingesting climate data to automatically indemnify against hazards[6], the platform specialized in precision agriculture and risk management in 2011. It was acquired in 2013 by Monsanto (for $930 million), which was itself acquired by Bayer in 2018.

Today, Climate FieldView acts primarily as a complex multi-sided platform, functioning as the central node of a dynamic and fluid ecosystem. Its primary structural role is to resolve the fragmentation of the physical layer. By acting as a universal interoperability layer, the platform standardizes data flows from a wide array of heterogeneous machinery and hardware manufacturers. This technical translation effectively de-siloes the farm's physical operations, converting diverse mechanical actions into a single, machine-readable data stream. This consolidation is the prerequisite for the platform's intelligence: it transforms the farm from a collection of isolated equipment into a coherent, computable environment where biological and mechanical variables can be cross-referenced at scale.

Second, it orchestrates a constantly evolving constellation of third-party partners. Beyond the farmer side, it orchestrates interactions between a multiplicity of distinct market sides. The partner ecosystem[7] is designed as an open architecture, mediating connections with a diverse and expanding array of actors. These include, but are not limited to satellite imagery providers, financial and insurance institutions, farm management software, and input distributors, all of whom plug into the infrastructure to refine their prescriptions or assess risk. It is within this architecture that the ForGround by Bayer program is deployed. This specific service positions itself on a precise market side: the relationship between farmers (supply of sustainable practices) and giants of the agri-food industry (demand for carbon reduction)[8].

For these industrialists, exemplified by Perdue AgriBusiness in its partnership with ForGround to decarbonize its grain supply chain[9], the economic stake is the management of Scope 3 emissions. Defined by the Greenhouse Gas Protocol as all indirect emissions occurring in the value chain[10], these represent the vast majority of an agrifood giant's carbon footprint. Consequently, the reduction of these emissions becomes a direct strategic imperative to comply with increasingly stringent climate reporting regulations. However, these firms historically faced structural informational opacity: even when they maintained commercial relations with producers, they had no verifiable visibility on the reality of agronomic prac-

[2] The structural dependency of these agricultural firms on cloud computing is explicitly documented in corporate architectural releases. For instance, see Microsoft's documentation on Azure Data Manager for Agriculture co-developed with Bayer. Accessed on 12 March 2026. Available at: https://azure.microsoft.com/en-us/blog/announcing-microsoft-azure-data-manager-for-agriculture-accelerating-innovation-across-the-agriculture-value-chain/. Also see Amazon Web Services' technical case studies detailing Bayer Crop Science's reliance on AWS AI/ML services. Accessed on 12 March 2026. Available at: https://aws.amazon.com/blogs/machine-learning/accelerating-data-science-innovation-how-bayer-crop-science-used-aws-ai-ml-services-to-build-their-next-generation-mlops-service/.

[3] Bayer AG. ForGround by Bayer. Accessed on 8 January 2026. Available at https://bayerforground.com/.

[4] Climate LLC. Climate FieldView platform. Accessed on 8 January 2026. Available at https://climate.com/en-us.html.

[5] Bayer AG. Bayer launches ForGround, a digital platform to connect farmers and companies. Press release, August 2022. Accessed on 8 January 2026. Available at https://www.bayer.com/en/us/forground.

[6] Alexia Tsotsis. The Climate Corporation raises $50M for Big Data Driven Weather Insurance. TechCrunch, June 2012. Accessed on 31 January 2026. Available at https://techcrunch.com/2012/06/14/founders-fund-leads-the-climate-corporations-colossal-50m-funding-round/.

[7] Climate LLC. Climate FieldView partners. Accessed on 8 January 2026. Available at https://climate.com/en-us/partners.html.

[8] Bayer AG. ForGround for companies. Accessed on 8 January 2026. Available at https://bayerforground.com/companies.

[9] Bayer AG. Bayer launches groundbreaking collaboration with Perdue AgriBusiness to reduce carbon emissions and increase sustainability in the food value chain. Press release, 21 September 2022. Accessed on 6 March 2026. Available at https://www.bayer.com/en/us/regenerativefarming.

[10] World Resources Institute and World Business Council for Sustainable Development. Corporate value chain (Scope 3) accounting and reporting standard. Technical report, Greenhouse Gas Protocol, 2011. Accessed on 6 March 2026. Available at https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf.

tices (such as no-till farming), making any large-scale payment for environmental services impossible.

The ForGround by Bayer platform (launched in August 2022) serves as the operational interface of this ecosystem, acting as the digital gateway that hosts and executes the Bayer Carbon Program. While ForGround functions as the broader orchestration layer connecting the actors, the Carbon Program constitutes the specific financial instrument embedded within it. Through this integration, the platform claims to enable farmers to receive financial compensation by sequestering carbon in their soil[11]. The measurement of this sequestered carbon and its subsequent sale rely on precise platform mechanisms: the disembedding and aggregation of information, and the connection (matchmaking) between different market sides.

The operational reality of this compensation relies on protocols such as the Nori Croplands Methodology[12], which Bayer explicitly adopts to quantify its credits as detailed in its mandatory carbon market disclosures[13]. This protocol illustrates the specific intelligence of the platform: the disembedding of the agricultural act into data and its aggregation into a tradable probability. Instead of physically measuring carbon in every square meter of soil, the system constructs a digital twin of the field by cross-referencing machine telemetry captured via the FieldView Drive, such as precise planting dates, tillage intensity, and harvested yield, with satellite imagery verifying biomass continuity and local pedoclimatic data. These inputs are fed into a biogeochemical model (specifically the Soil Metrics engine) which simulates the biological process, thereby claiming the capacity to convert a complex ecological interaction into a standardized asset; in this configuration, the validity of the carbon relies not on physical extraction, but on algorithmic simulation.

It is precisely in this modeling capacity that the specificity of platform intelligence lies. Whereas classical agronomic intelligence proceeds by tangible observation of carbon sequestered in the soil, through direct and local measurements by taking soil samples, platform intelligence operates by modeling based on vast datasets harvested and aggregated by the platform itself. It ingests data streams that were previously siloed (the machine, the satellite, and the soil) to produce new information which is the sustainable proof of practice. This is where the specificity of platform intelligence intervenes. To overcome the prohibitive cost of physical soil measurement, the program does not remunerate a biological result observed (outcome-based), but a certified agronomic practice (practice-based). The platform's intelligence transforms a behavioral action (like direct seeding) into a financial asset, relying on statistical models to estimate the corresponding carbon sequestration. It thus allows the monetization of a probability of impact without ever needing to confirm the material presence of carbon in the soil.

This form of intelligence reconfigures carbon measurement by substituting probabilistic truth for tangible truth. Where physical measurement constitutes an economic obstacle (prohibitive cost and scalability), platform intelligence deploys a "calculated truth" acceptable to the market because it is aligned with international certification standards. It validates sequestration not by weighing the carbon, but by certifying, thanks to its algorithms, the consistency between the agricultural practices recorded by the FieldView Drive and climate models.

Finally, platform intelligence standardizes to make exchange possible. By treating each farm via the same data protocols, it transforms local and singular agricultural practices into fungible carbon assets, capable of circulating on global markets (Scope 3). This technical architecture allows for the conversion of a complex biological reality into market liquidity.

This case illustrates probabilistic asset intelligence. By substituting algorithmic modeling for physical measurement, the platform transforms a biological process into a standardized, tradable financial asset, enabling the market to "price" an otherwise invisible environmental outcome.

B. *BASF xarvio and the Optimization of Biodiversity*

The BASF xarvio platform also claims to address a global challenge through platform intelligence. By mobilizing spatial data, xarvio asserts it can act against biodiversity collapse and limit chemical pollution by rationalizing the use of inputs according to the actual productivity of the soil. As detailed in its sustainability solutions, the platform deploys algorithms to create "buffer zones" and "biodiversity windows" (such as flowering strips) directly within the field map, thereby integrating ecological preservation into the productive logic[14]. Furthermore, by utilizing variable rate application (VRA) maps, the system claims to reduce crop protection volumes by ensuring that chemicals are sprayed only where biologically necessary, thus positioning the algorithm as the guarantor of a balance between intensive production and environmental stewardship[15].

The platform proposes that farmers chemically treat areas with high yield potential, while setting aside unprofitable zones to convert them into habitats favorable to biodiversity (flower strips or buffer zones). This service is made possible only by the platform's specific capacity to articulate two scales of reality: on the one hand, global information, consisting of standardized agronomic models (general laws of plant growth, climatic, and epidemiological histories) that define theoretical potential; and on the other hand, extremely granular information (specific soil composition and real-time

[11] Bayer AG. Bayer launches ForGround, a digital platform to connect farmers and companies. Press release, August 2022. Accessed on 8 January 2026. Available at https://www.bayer.com/en/us/forground.

[12] Nori. Nori Croplands Methodology. Technical report, Nori Carbon Removal Marketplace, January 2020. Accessed on 6 March 2026. Available at https://assets.ctfassets.net/8b5bledpz9uj/1BRUD1uTArQcViKwtyhHM9/71f2470d5191631bd919b09fdd4990b5/Nori_Croplands_Methodology_1.4.pdf.

[13] Bayer AG. Compliance with voluntary carbon market disclosures act, February 2025. Last updated in February 2025. Accessed on 6 March 2026. Available at https://bayerforground.com/carbon-market-disclosures.

[14] BASF Agricultural Solutions. Biodiversity: integrating nature into crop protection. Accessed on 8 January 2026. Available at https://agriculture.basf.com/global/en/sustainable-agriculture/climate-smart-farming/biodiversity.html.

[15] BASF Agricultural Solutions. How digital farming contributes to sustainability. Accessed on 8 January 2026. Available at https://agriculture.basf.com/global/en/sustainable-agriculture/how_digital_farming_contributes_to_sustainability.html.

biomass status) that embodies the singularity of the terrain. The promise of platform intelligence lies in this contextualization: it sells the ability to dynamically adjust the global theoretical model so that it adapts optimally to the contingencies of local reality.

To perform this arbitrage between the local and the global, xarvio's intelligence claims to construct a digital twin of the plot. According to its technical documentation, the system hybridizes historical data, specifically utilizing up to 15 years of biomass history derived from Sentinel-2 satellite imagery[16] and crowdsourced data from the xarvio SCOUTING application, where the company asserts that millions of farmers feed the algorithm with photos of diseases and pests[17]. The platform promotes this cross-referencing of field observations with proprietary agronomic models as a synthesis that allows it to no longer view the field as a homogeneous unit, but as a mosaic of micro-zones with heterogeneous potentials. In this discursive framework, platform intelligence is presented as a predictive capability: xarvio claims it can anticipate future yield for each micro-zone and calculate the optimal trade-off between chemical investment and ecological set-aside based on these projected yields[18].

This predictive capacity enables a radical reconfiguration of the market transaction between BASF and its farmer clients. With its HEALTHY FIELDS offer, xarvio claims to no longer sell fungicides, where the farmer would bear the risk of application, but to guarantee a disease-free plot for a fixed price per hectare. As described in the product's value proposition, the company commits to a specific agronomic result: if the disease strikes despite the platform's recommendations, the farmer is compensated, thereby shifting the operational risk entirely from the user to the algorithm[19].

This shift from the sale of a product to the sale of a result relies on a feedback loop over which the platform has total control. It controls the entire cybernetic chain between observation and decision. It captures and aggregates data via satellites and sensors, prescribes action by sending modulation maps directly to the terminals of connected machines, manages product stocks, and verifies the result a posteriori. If disease occurs despite the prediction, the system's intelligence self-corrects via an insurance compensation mechanism. Ultimately, the intelligence absorbs the biological risk thanks to the statistical power of its models. The platform promises to minimize uncertainty for the farmer, thus making ecological optimization economically rational.

xarvio exemplifies cybernetic agronomic intelligence. By constructing a digital twin that cross-references global models with local granularity, the platform re-orchestrates the field as a mosaic of heterogeneous potentials, enabling it to internalize biological risk and integrate biodiversity directly into the market's productive logic.

C. *Olam and the Socio-Cultural Challenge*

Platforms such as AtSource claim to overcome the socio-cultural challenge of agriculture by imposing new behavioral norms on their users. Launched in 2018 by the Olam Group (then Olam International), the platform now serves as the digital infrastructure for its specialized food ingredients business, Olam Food Ingredients (ofi). This distinction marks the structural transition from the physical brokerage of commodities which is the traditional domain of Olam, toward the provision of data-driven sustainability services orchestrated by ofi[20].

Designed as a business-to-business (B2B) platform, AtSource acts as the informational layer through which ofi manages a complex multi-sided market. It aggregates data from approximately 5 million smallholder farmers distributed mostly in the Global South (Africa, Asia, and Latin America), who provide both the raw material (coffee, cocoa, and cashew nuts) and the raw socio-environmental data regarding production conditions, tracking over 350 specific metrics including income indicators, access to education, and carbon footprint[21]. By doing so, the platform connects these producers to multinationals such as Nestlé, Mars, or Unilever. These clients do not only buy crops from ofi, they also utilize the AtSource interface to manage their Scope 3 emissions and zero-deforestation mandates.

For instance, Nestlé explicitly relies on the AtSource digital footprint calculator to monitor carbon reduction in its agroforestry projects, using the platform's data to validate its Net Zero trajectory[22]. Similarly, Mars, through its subsidiary KIND, leverages ofi's platform insights to co-create regenerative action plans for its almond supply chain[23]. Finally, Unilever integrates metrics from the ofi ecosystem directly

[16] BASF xarvio. FIELD MANAGER: data management and analytics. Accessed on 8 January 2026. Available at https://ag.xarvio.com/global/field-manager/data-management-and-analytics. To construct a 15-year historical biomass baseline, xarvio relies on a hybridization of satellite sources rather than solely on the Sentinel-2 constellation (whose first satellite launched in 2015). As illustrated in technical documentation, achieving this temporal depth requires integrating recent high-resolution Sentinel-2 imagery with older archival data from the Landsat program of the USA. This hybridization illustrates a critical structural dependency: agronomic platforms like xarvio act as an epistemic meta-layer that synthesizes agricultural meaning, while relying heavily on underlying, generalized cloud infrastructures such as AWS, to host and format these massive, heterogeneous global data streams. This division of labor is explicitly confirmed in technical case studies co-authored by BASF and its cloud provider. See: Julian Blau and Antonio Rodriguez. How xarvio Digital Farming Solutions accelerates its development with Amazon SageMaker geospatial capabilities. AWS Machine Learning Blog, 1 December 2022. Accessed on 12 March 2026. Available at https://aws.amazon.com/blogs/machine-learning/how-xarvio-digital-farming-solutions-accelerates-its-development-with-amazon-sagemaker-geospatial-capabilities/.

[17] BASF Digital Farming. xarvio SCOUTING introduces new precision feature for pheromone trap analysis. Press release, 31 March 2022. The document's corporate profile states that the application has been downloaded more than 6 million times, a user base whose generated data is used to train the machine learning models. Accessed on 9 March 2026. Available at: https://www.basf.com/global/en/media/news-releases/2022/03/p-22-185.html.

[18] BASF xarvio. FIELD MANAGER: variable rate seeding and maps. Accessed on 8 January 2026. Available at https://ag.xarvio.com/global/field-manager/seeding.

[19] BASF xarvio. HEALTHY FIELDS: guaranteed crop health for a fixed price. Accessed on 27 January 2026. Available at https://ag.xarvio.com/global/healthy-fields.html.

[20] Olam International. Taking agricultural sustainability mainstream—Olam launches AtSource. Press release, April 2018. Accessed on 27 January 2026. Available at https://www.olamgroup.com/content/dam/olamgroup/files/uploads/2018/04/Taking-agricultural-sustainability-mainstream-Olam-launches-AtSource.pdf.

[21] AtSource. What is AtSource? data and metrics. Accessed on 8 January 2026. Available at https://www.atsource.io/atsource.html.

into its "regenerative agriculture principles" to track water restoration projects, effectively making the AtSource data stream a prerequisite for market participation[24].

Beyond this architecture, Olam's platform intelligence is characterized by three mechanisms that reconfigure the relationship between the global buyer and the local producer. First, data gathering relies on a massive deployment of human infrastructure in the first mile. Unlike platforms designed for industrialized agriculture which automatically ingest machine data streams, Olam must digitize informal contexts via the proprietary tool Olam Farmer Information System (OFIS). This data collection relies on a massive deployment of field agents equipped with tablets to spatially map each individual producer. Each plot is outlined by GPS and associated with a detailed socio-economic profile. This granularity transforms a vague geographical zone into a database of identified individuals, making the territory legible and administrable by the algorithm. This rendering of visibility operates a first major relational rupture: it breaks the traditional anonymity of the wholesale market to place each producer under the direct digital oversight of the global value chain, thus removing the screen of opacity that historically separated the buyer from the seller.

Next, this knowledge confers a prescriptive dimension upon the platform. By structuring the market around precise indicators, the platform exercises normative power. Access to the global market becomes conditioned on strict compliance with rules encoded in the algorithm[25]. These requirements cover social fields (prohibition of child labor and formalization of contracts), environmental fields (zero deforestation, ban on GMOs, and hazardous inputs), and managerial fields (obligation of traceability and land tenure proofs). If satellite analysis cross-referenced with field data reveals non-compliance, the producer can be excluded from the circuit. Platform intelligence acts here as an instrument of long-distance governance, disciplining local practices to align them with consumer ethics.

Finally, socio-environmental data are disembedded to become an autonomous product, valuable on other sides of the market. On the one hand, it is sold to brands as proof of corporate social responsibility (CSR) compliance. On the other hand, this intelligence allows Olam to forge strategic partnerships with development agencies such as the German Agency for International Cooperation (GIZ)[26]. In this framework, the platform provides access to its database to allow funding bodies to monitor the effectiveness of their aid programs. Social data thus become a monetizable asset with both private and public actors. Olam's platform represents a normative form of intelligence. The system "senses" the socio-biological reality of the first mile to filter it through a digital protocol of requirements. Here, the intelligence of the system is expressed through its ability to automatically align dispersed, informal agricultural practices with global sustainability standards, making compliance a prerequisite for economic existence.

D. FBN and Value Chain Economic Efficiency

The FBN platform claims to address the challenge of economic efficiency in the agricultural value chain by specifically attacking price opacity and information asymmetry that disadvantage producers vis-à-vis input suppliers[27]. Founded in 2014 in Silicon Valley by Amol Deshpande and Charles Baron, FBN deliberately positions itself as a break from the vertical models of agrochemical giants. Initially conceived as an agronomic data-sharing network to enable peer benchmarking, the platform has evolved to become a complex market infrastructure. Today, FBN acts as a bottom-up aggregation platform. On its upstream side, it federates a community of over 120,000 farmers (mainly in North America) who voluntarily share their commercial data (seed invoices and crop protection receipts) and agronomic data (yields)[28]. On its downstream side, it uses this aggregated intelligence to connect its members directly to generic input manufacturers, financial services, and insurers, thus bypassing traditional distribution networks[29]. It operates an intermediation aimed at restoring information symmetry, transforming isolated individual data into a collective bargaining power.

Beyond its technical architecture, FBN's platform intelligence is distinguished by a bottom-up approach that mobilizes three specific mechanisms to correct market inefficiencies. First, data collection relies on a contributive crowdsourcing mechanism based on the principle of reciprocity. To access the network's intelligence, the farmer must actively contribute by sharing their own commercial data (seed invoices and crop protection receipts)[30]. FBN digitizes and structures heterogeneous administrative documents: members upload photos of physical paper invoices, which are then

[22] ofi. Nestlé and ofi launch global agroforestry partnership in largest collaboration yet. Press release, April 2025. Accessed on 8 January 2026. Available at https://www.ofi.com/en-us/news-and-events/press-release/nestle-and-ofi-launch-global-agroforestry-partnership-in-largest-collaboration-yet.

[23] KIND. KIND almond acres initiative: regenerative agriculture pilot report. Technical report, KIND, 2023. Accessed on 8 January 2026. Available at https://www.kindsnacks.com/media-center/press-releases/kind-snacks-announces-major-sustainability-milestones-journey-scale-regenerative-agriculture-across-its-almond-supply-chain.

[24] ofi. ofi partners on forest resilience with Unilever's Knorr. Press release, July 2022. Accessed on 8 January 2026. Available at https://www.ofi.com/en-us/news-and-events/press-release/ofi-forest-to-farm-sustainability-partnership.

[25] Olam International. AtSource sustainability requirements (version 2.0). Technical report, Olam International, 2024. Accessed on 9 March 2026. Available at https://www.atsource.io/content/dam/olam/atsource/methodology/methodology-pdfs/AtSource-Sustainability-Requirements-2.pdf.

[26] Olam Agri and GIZ. Launching carbon offsetting rice emissions (core) project. Olam Agri press release, August 2025. Accessed on 8 January 2026. Available at https://www.olamagri.com/news/press-release/launching-carbon-offsetting-rice-emissions-project-with-giz-to-reduce-rice-farming-emissions-in-nigeria.

[27] Harvard Business School Digital Initiative. Farmers Business Network: disrupting one farm at a time. Harvard Business School Digital Innovation and Transformation, 2018. Accessed on 8 January 2026. Available at https://d3.harvard.edu/platform-digit/submission/farmers-business-network-disrupting-one-farm-at-a-time/.

[28] Farmers Business Network. FBN expands AI-powered platform. FBN press release, July 2025. Accessed on 8 January 2026. Available at https://www.fbn.com/community/blog/fbn-expands-ai-powered-platform.

[29] Farmers Business Network. FBN Direct: buy ag chemicals and seeds online. Accessed on 8 January 2026. Available at https://www.fbn.com/direct.

scanned by the platform to extract product names and unit prices[31]. The platform's intelligence here consists of transforming a multitude of private and confidential data into a common and anonymized knowledge base, allowing members to benchmark their costs against a national average[32].

Next, the processing of this data aims for comparative benchmarking. FBN articulates the local micro-economic reality with a global market truth. The platform's intelligence seeks to reveal the economic reality hidden from its users by confronting singular data (a farmer's isolated invoice) with a global statistical reference (the national average price)[33]. Via its Price Transparency tool, it thus exposes unjustified discrepancies linked to Zone Pricing (geographic price discrimination). Platform intelligence transforms individual data embedded in an opaque local negotiation into powerful, disembedded, and globalized statistical information[34]. It allows the farmer to move from the status of an isolated agent to that of an informed agent, capable of instantly situating their local purchasing performance in relation to the global reality of the market.

Finally, this radical transparency serves as a lever to reconfigure the value chain. Data are not only visualized, it is operationalized to break market asymmetries. FBN uses this collective intelligence to feed its own marketplace, FBN Direct, by specifically sourcing generic products that invoice analysis has revealed as being overpriced by legacy players[35]. This mechanism triggers a commercial feedback loop: the accumulation of data allows for the precise identification of "economic rents" (excessive margins), guiding the procurement strategy of the FBN Direct platform. By slashing these prices, the platform attracts new users, which further enriches the database and further refines the precision of market intelligence. Data intelligence acts here as a self-sustaining informational countervailing power, forcing the market to progressively tend toward optimal price efficiency.

This case demonstrates a form of platform intelligence based on bottom-up data aggregation. By transforming fragmented local data into a collective statistical reference, the platform's intelligence acts as a countervailing power, correcting information asymmetries and forcing a re-orchestration of the value chain toward greater price efficiency.

[30] Farmers Business Network. How can I access chemical price transparency? Accessed on 8 January 2026. Available at https://www.fbn.com/community/faq/how-can-i-access-price-transparency.

[31] Farmers Business Network. Unlock price transparency: upload invoice tool. Accessed on 8 January 2026. Available at https://www.fbn.com/direct/upload-invoice.

[32] Harvard Business School Digital Initiative. Developing a digital farmers' network to create pricing transparency, 2019. Accessed on 9 March 2026. Available at https://d3.harvard.edu/platform-digit/submission/developing-a-digital-farmers-network-to-create-pricing-transparency/.

[33] Farmers Business Network. 2025 US agricultural chemical price transparency report. FBN Research Blog, February 2025. Accessed on 9 March 2026. Available at https://www.fbn.com/community/blog/2025-us-ag-chem-price-transparency-report.

[34] Farmers Business Network. Data value returned: how FBN turns data into profit. Accessed on 8 January 2026. Available at https://www.fbn.com/en-ca/about/data-value-returned.

[35] Farmers Business Network. FBN Direct: buy agricultural chemicals and seeds online. Accessed on 8 January 2026. Available at https://www.fbn.com/direct.

E. The Diversity of Platform Configurations

However, restricting our analysis to these hegemonic actors would obscure the structural diversity of the platformization of agriculture. The deployment of platform intelligence adopts heterogeneous configurations depending on the territorial context. In the Global South, ecosystems like Fasal in India demonstrate how this intelligence bypasses traditional infrastructural deficits. By deploying low-cost Internet of Things (IoT) sensor networks specifically designed for horticulture, Fasal democratizes "precision intelligence" for smallholders, optimizing water usage and predicting pests in highly fragmented markets [47].

All these architectures share a common epistemic function. They all act as new coordination mechanisms that attempt to resolve the failures of the industrial market. By rendering the complexity of the field legible, manageable, and tradeable, they confirm that the current transition is not merely a technological upgrade, but a fundamental re-orchestration of how agricultural value is defined and distributed.

V. Conclusion: The Geopolitics of the Digital Twin

The trajectory of agricultural intelligence, from the static cadastre to the cybernetic platform, reveals a profound transformation in the nature of production. As we have shown, the current crisis of the agri-food system, which is characterized by environmental degradation and sanitary blindness, is structurally linked to the "informational deficits" of the industrial market. By prioritizing the circulation of abstract price signals over the complexity of the living world, the legacy infrastructure organized a form of systemic ignorance. In this context, the emergence of platform intelligence appears as a powerful technical corrective. By deploying a cybernetic architecture capable of capturing granular data and closing the feedback loop between the market and the field, platforms prefigure a potential structural shift. They point toward the potential emergence of what Wang et al. define as a cyber-physical-social system [48]. By promising to progressively integrate social behaviors and market dynamics directly into the biological model, these architectures offer the theoretical capacity to "re-embed" the economy into its reality, rendering the invisible costs of production computable, and therefore manageable.

The emergence of the digital twin represents the logical conclusion of the disembedding process analyzed in our historical section: the platform's virtual surrogate completes the separation of agricultural management from its material substrate.

However, this technical resolution comes at the cost of a radical political displacement. While Wang et al. envision an AgriVerse based on decentralized sovereignty and federated intelligence [48], the current industrial reality is moving toward a hyper-centralization of agronomic truth in the hands of a few corporate hegemons. The ambivalence of this transformation lies in the fact that while the platform remedies the blindness of the market, it does so by instituting a regime of hyper-centralization. The "invisible hand" of the liberal market, which theoretically dispersed decision-making power among millions of independent agents, is replaced by the "digital hand" of the algorithm, which concentrates the power of coordination within a few proprietary infrastructures.

This shift represents a transition from resolving information asymmetry to establishing a proprietary epistemic monopoly, where the platform dictates the parameters of "agronomic truth". These orchestrators bypass the distributed intelligence of the market to institute a regime of algorithmic enclosure, where the farmer's land remains private while their decision-making becomes an extracted corporate asset. As demonstrated by the normative metrics of the Olam case, platforms may shift the arbiter of sustainable practice from the local experience of the producer to the centralized statistical models of the orchestrator.

This shift raises a fundamental question of technological sovereignty. As agricultural decision-making becomes increasingly dependent on prescriptive algorithms, the autonomy of the farmer acts as a facade. If the producer must rely on the Bayer's algorithm to know when to plant, on xarvio's prescription to treat disease, and on Olam's metrics to sell their harvest, the locus of control shifts from the farm to the cloud. The farmer retains the legal ownership of the land (the hardware), but the platform captures the cognitive ownership of the operation (the software). We witness a new form of enclosure: not the fencing of the commons as in the 18th century, but the enclosure of decision-making.

Finally, this concentration of intelligence engenders a critical geopolitical risk [49]. Agriculture is not a standard economic sector; it is the biological foundation of national security. Historically, states have always sought to control their food supply through public stocks and sovereign policies. Today, however, the "epistemic sovereignty", the very capacity to know the state of the harvest, is migrating toward transnational private actors. As Marks demonstrates, the control of this "information nexus" has always been the defining characteristic of capitalist power [50]. When a platform like Climate FieldView ingests real-time telemetry from millions of hectares across the Americas, Europe, and Brazil, it arguably possesses a more precise and predictive vision of global food security than the United States Department of Agriculture or the European Commission. As our analysis of platform intelligence has shown, the total disembedding of agricultural knowledge results in a state of cyber-dependency, where the producer's ability to interact with the biophysical world is now entirely mediated by the "architectural gravity" of transnational technology conglomerates.

In this new configuration, the strategic asset is no longer just the grain, but the digital twin of the grain. The nation or corporation that controls the servers hosting these digital twins controls the simulation of the future food supply. Consequently, the challenge for the 21st century is to determine who owns the agronomic truth. If the intelligence that guides the hand of the farmer is hosted on servers outside their national jurisdiction and optimized by algorithms opaque to public scrutiny, then food security becomes a matter of cyber-dependency. The crisis of intelligence thus ultimately reveals itself as a crisis of power: the struggle to determine who, between the state, the farmer, and the platform, holds the right to program the metabolism of the world.

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References

[1] W. Steffen, K. Richardson, J. Rockström, S. E. Cornell, I. Fetzer, E. M. Bennett, R. Biggs, S. R. Carpenter, W. de Vries, C. A. de Wit et al., Planetary boundaries: Guiding human development on a changing planet, *Science*, 2015, 347(6223), 1259855.

[2] W. Willett, J. Rockström, B. Loken, M. Springmann, T. Lang, S. Vermeulen, T. Garnett, D. Tilman, F. DeClerck, A. Wood et al., Food in the Anthropocene: The EAT-*Lancet* commission on healthy diets from sustainable food systems, *Lancet*, 2019, 393(10170), 447–492.

[3] FAO, IFAD, UNICEF, WFP, and WHO, *The State of Food Security and Nutrition in the World 2023*. Rome, Italy: FAO, 2023.

[4] J. Dewey, *The Quest for Certainty: A Study of the Relation of Knowledge and Action*. New York, NY, USA: Paragon Books, 1929.

[5] IPCC, *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*. Geneva, Switzerland: IPCC, 2019.

[6] J. Rockström, W. Steffen, K. Noone, Å. Persson, F. S. Chapin III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber et al., Planetary boundaries: Exploring the safe operating space for humanity, *Ecol. Soc.*, 2009, 14(2), 32.

[7] IPBES, *Global Assessment Report on Biodiversity and Ecosystem Services*. Bonn, Germany: IPBES, 2019.

[8] FAO, UNEP, WHO, and WOAH, *One Health Joint Plan of Action* (*2022–2026*). Geneva, Switzerland: World Health Organization and Food and Agriculture Organization, 2022.

[9] FAO, *The State of Food and Agriculture 2024: Value-Driven Transformation of Agrifood Systems*. Rome, Italy: Food and Agriculture Organization of the United Nations, 2024.

[10] V. Ricciardi, N. Ramankutty, Z. Mehrabi, L. Jarvis, and B. Chookolingo, How much of the world's food do smallholders produce, *Global Food Secur.*, 2018, 17, 64–72.

[11] FAO, *Moving Forward on Food Loss and Waste Reduction*. Rome, Italy: Food and Agriculture Organization of the United Nations, 2019.

[12] J. E. Stiglitz, Information and the change in the paradigm in economics, *Am. Econ. Rev.*, 2002, 92(3), 460–501.

[13] S. Grumbach and O. Hamant, How humans may co-exist with Earth? The case for suboptimal systems, *Anthropocene*, 2020, 30, 100245.

[14] J.-C. Rochet and J. Tirole, Platform competition in two-sided markets, *J. Eur. Econ. Assoc.*, 2003, 1(4), 990–1029.

[15] T. O'Reilly, Government as a platform, *Innovations: Technology, Governance, Globalization*, 2011, 6(1), 13–40.

[16] N. Wiener, *Cybernetics: Or, Control and Communication in the Animal and the Machine*. Paris, France: Hermann, 1948.

[17] X. Wang, J. Yang, Y. Wang, Q. Miao, F.-Y. Wang, A. Zhao, J.-L. Deng, L. Li, X. Na, and L. Vlacic, Steps toward industry 5.0: Building "6S" parallel industries with cyber-physical-social intelligence, *IEEE/CAA J. Autom. Sin.*, 2023, 10(8), 1692–1703.

[18] J. C. Scott, *Seeing Like a State*. New Haven, CT, USA: Yale University Press, 1998.

[19] K. Polanyi, *The Great Transformation: The Political and Economic Origins of Our Time*, 2nd ed. Boston, MA, USA: Beacon Press, 2001.

[20] W. Cronon, *Nature's Metropolis: Chicago and the Great West*. New York, NY, USA: W. W. Norton, 1991.

[21] H. de Soto, *The Mystery of Capital*. New York, NY, USA: Basic Books, 2000.

[22] U.S. Supreme Court, Diamond v. Chakrabarty, 447 U.S. 303 [Online], https://supreme.justia.com/cases/federal/us/447/303/, 8 January 2026.

[23] J. R. Jr. Kloppenburg, *First the Seed*. Madison, WI, USA: University of Wisconsin Press, 2004.

[24] Supreme Court of the United States, Bowman v. Monsanto Co., 569 U.S. 278 [Online], https://supreme.justia.com/cases/federal/us/569/278/, 8 January 2026.

[25] B. J. Kemp, *Ancient Egypt: Anatomy of a Civilisation*, 2nd ed. London, UK: Routledge, 2006.

[26] J. de Vries and A. van der Woude, *The First Modern Economy: Success, Failure, and Perseverance of the Dutch Economy*. Cambridge, UK: Cambridge University Press, 1997, 1500–1815.

[27] S. W. Mintz, *Sweetness and Power: The Place of Sugar in Modern History*. New York, NY, USA: Viking, 1985.

[28] J. von Liebig, *Organic Chemistry in its Applications to Agriculture and Physiology*. London, UK: Taylor and Walton, 1840.

[29] V. Smil, *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production*. London, UK: MIT Press, 2004.

[30] G. G. Parker, M. W. van Alstyne, and S. P. Choudary, *Platform Revolution: How Networked Markets are Transforming the Economy and How to Make Them Work for You*. New York, NY, USA: W. W. Norton & Company, 2016.

[31] D. S. Evans and R. Schmalensee, *Matchmakers: The New Economics of Multisided Platforms*. Boston, MA, USA: Harvard Business Review Press, 2016.

[32] A. Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations*. London, UK: W. Strahan and T. Cadell, 1776.

[33] A. Rouvroy and T. Berns, Gouvernementalité algorithmique et perspectives d'émancipation, *Réseaux*, 2013, 177(1), 163–196.

[34] R. H. Thaler and C. R. Sunstein, *Nudge: Improving Decisions about Health, Wealth, and Happiness*. New Haven, CT, USA: Yale University Press, 2008.

[35] L. Lessig, *Code and Other Laws of Cyberspace*. New York, NY, USA: Basic Books, 1999.

[36] V. Mayer-Schönberger and K. Cukier, *Big Data: A Revolution That Will Transform How We Live, Work and Think*. London, UK: John Murray, 2013.

[37] A. Rosenblat and L. Stark, Algorithmic labor and information asymmetries: A case study of Uber's drivers, *Int. J. Commun.*, 2016, 10, 3758–3784.

[38] H. Rosa, *Social Acceleration: A New Theory of Modernity*. New York, NY, USA: Columbia University Press, 2013.

[39] L. M. Khan, Amazon's antitrust paradox, *Yale Law J.*, 2017, 126(3), 710–805.

[40] European Commission, Antitrust: Commission sends statement of objections to Amazon for the use of non-public independent seller data and opens second investigation into its e-commerce business practices, IP/20/2077 [Online], https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2077, 8 January 2026.

[41] IPES-Food, From uniformity to diversity: A paradigm shift from industrial agriculture to diversified agroecological systems [Online], https://www.ipes-food.org/_img/upload/files/UniformityToDiversity_FULL.pdf, 8 January 2026.

[42] TEEB, TEEB for agriculture & food-scientific and economic foundations. Geneva, Switzerland: UN Environment, 2018.

[43] C. S. Holling, *Adaptive Environmental Assessment and Management*. Laxenburg, Austria: Wiley, 1978.

[44] S. Grumbach and O. Hamant, Digital revolution or anthropocenic feedback, *Anthropocene Rev.*, 2018, 5(1), 87–96.

[45] M. Callon, An essay on framing and overflowing: Economic externalities revisited by sociology, *Sociol. Rev.*, 1998, 46(S1), 244–269.

[46] M. Sauvagerd, M. Mayer, and M. Hartmann, Digital platforms in the agricultural sector: Dynamics of oligopolistic platformisation, *Big Data Soc.*, 2024, 11(4), 1–16.

[47] P. V. Kadam, The digital harvest: How Indian Agri-startups are driving sustainable agriculture through IoT [Online], https://kuey.net/index.php/kuey/article/view/10417, 8 January 2026.

[48] X. Wang, M. Kang, H. Sun, P. de Reffye, and F.-Y. Wang, DeCASA in AgriVerse: Parallel agriculture for smart villages in metaverses, *IEEE/CAA J. Autom. Sin.*, 2022, 9(12), 2055–2062.

[49] G. Glasze, A. Cattaruzza, F. Douzet, F. Dammann, M. G. Bertran, C. Bômont, M. Braun, D. Danet, A. Desforges, A. Géry et al., Contested spatialities of digital sovereignty, *Geopolitics*, 2023, 28(2), 919–958.

[50] S. G. Marks, *The Information Nexus: Global Capitalism from the Renaissance to the Present*. Cambridge, UK: Cambridge University Press, 2016.

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