



AI- and robotics-driven reconfiguration of a traditional industry: Business model innovation in agriculture 4.0

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ABSTRACT

Agriculture 4.0 is introducing digital tools – especially AI and robotics – into farming. More importantly it is transforming one of the world's most traditional industries, a sector historically anchored in manual labor, tacit knowledge, family-values, product-centric exchange, and deeply sedimented social practices. AI, robotics, connected machinery, and data infrastructures challenge these foundations by shifting agricultural work from human observation, experiential judgment, and field-based execution toward algorithmic monitoring, automated recommendation, and increasingly autonomous operations. Drawing on business model theory, our conceptual study explains how Agriculture 4.0 moves farming from historically embedded, hardware-centered arrangements toward data-driven, service-based, and platform-orchestrated models of value creation, delivery, and capture. We develop an integrative framework and propositions that specify six central transformations: rise of data-driven business models, persistent business model experimentation, strategic realignment through platforms, recurring and outcome-based revenue logics, duality of platform-enabled scaling and platform dependency, and governance challenge of balancing openness with control. By theorizing Agriculture 4.0 as the business model transformation of a traditional industry, our study advances research on digital transformation, platform ecosystems, business model innovation, and sociotechnical disruption. Our framework shows that disruption in traditional sectors requires more than superior technology or economic promise. It gains force only when novel organizational arrangements become accepted as legitimate alternatives to established practices, identities, and sectoral logics.

1. Introduction

The growing integration of AI is profoundly transforming agriculture, a sector historically anchored in manual labor, tacit knowledge, and socially embedded routines (Ahoa et al., 2026; Padhiary et al., 2024; Sharma & Chandola, 2025). Increasingly embedded in machinery, connected equipment, and data infrastructures, AI shifts farming toward more predictive, automated, and continuously coordinated modes of production (Bouncken et al., 2026). The concept of Agriculture 4.0 specifies this integration of cyber-physical systems, connectivity, and algorithmic control across agricultural value-creation activities and infrastructures (Uyar et al., 2024) promising improvements in precision, timeliness, and resource efficiency (Ahmed & Shakoar, 2025; Padhiary et al., 2024).

For example, sensor-equipped machinery, cloud-based analytics, and

AI-enabled decision-support systems are increasingly coupled with robotics that translate digital intelligence into field-level execution (Uyar et al., 2024). Computer vision enables machinery and robotic platforms to detect weeds, diagnose diseases, and assess crop maturity directly in the field (Assimakopoulos et al., 2024; Storm et al., 2024). Agriculture 4.0 shifts agricultural business models from product-centered arrangements toward service-based and platform-mediated forms of value creation, delivery, and capture (Bouncken, 2026). AI triggers substantial changes in firms' value architectures (Bahoo et al., 2023; Bouncken et al., 2021; Jorzik et al., 2024; Kanbach et al., 2024) and thus Agriculture 4.0 raises questions about value architectures through which firms create, deliver, and capture value, hence their business models (Teece, 2010, 2018; Zott & Amit, 2007, 2010).

Yet, despite growing interest in AI-enabled transformation, existing research offers limited insight into how AI reconfigures business models

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in traditional industries. Hence, the question is: How does Agriculture 4.0 reshape business model innovation?

Our study addresses this void by developing an integrative conceptual analysis. Our theorizing is based on two complementary theoretical lenses. The value creation-delivery-capture framework (Teece, 2010, 2018) explains what elements of agricultural business models are transformed through AI and robotics. The activity-system perspective (Amit & Zott, 2001, 2010; Zott & Amit, 2007) explains how these transformations occur through reconfiguration of interdependent activities, actors, and governance arrangements. Together, these perspectives provide a multi-level explanation of Agriculture 4.0 business model innovation, linking value architecture, activity-system design, and ecosystem coordination.

Our theorizing shows how core technological drivers of Agriculture 4.0 give rise to servitization and platformization as two central pathways of business model transformation. By synthesizing these developments with business model value creation-delivery-capture framework (Teece, 2010, 2018), activity-system perspective (Amit & Zott, 2001, 2010; Zott & Amit, 2007), and drawing on platform literature, we develop a conceptual framework and a set of propositions that explain how agriculture is moving from experience-based, product-centered arrangements toward service-oriented, platform-mediated, and increasingly data-driven forms of value creation, delivery, and capture. In doing so, we advance understanding of Agriculture 4.0 while explaining why coordination increasingly takes place through platform infrastructures. Further, we offer an analytical template for other traditional sectors undergoing profound sociotechnical and business model transformation. Fig. 1 shows our conceptual view. Farming routines are being reconfigured toward data-driven, autonomous, feedback-looped production driven by technological developments,

industry and climate change, and by incumbent opportunities and competitive pressures.

In general, our study advances theory by revealing Agriculture 4.0 beyond a technological upgrade only to a systemic transformation of business models in a sector long rooted in manual labor, tacit knowledge, and socially embedded routines. We explain how AI, robotics, connectivity, and data infrastructures motivate a shift from experience-based and product-centered arrangements toward data-centric, service-oriented, and platform-mediated forms of value creation, delivery, and capture.

First, data becomes a central strategic resource of Agriculture 4.0. Connected machinery, software, and analytics become integrated into agricultural activity systems. Thus, competitive advantage increasingly depends on the ability to generate, combine, and govern data rather than on master hardware.

Second, we distinguish between two core transformational pathways. Service-oriented models extend physical products with data-driven services, shifting value delivery from discrete transactions toward recurring revenues and continuous customer engagement. Platform-based models, in turn, reorganize agricultural ecosystems through digital infrastructures that enable interoperability, data exchange, and coordination across heterogeneous actors. Together, these pathways explain how Agriculture 4.0 transforms historically embedded agricultural practices into digitally coordinated business model architectures.

Third, our study adds to theory by conceptualizing digital transformation as a reconfiguration of business models and sociotechnical systems, rather than as technology adoption alone. Agriculture 4.0 therefore contextualizes understanding how emerging technologies reorganize industries around ecosystems, services, platforms, and data-

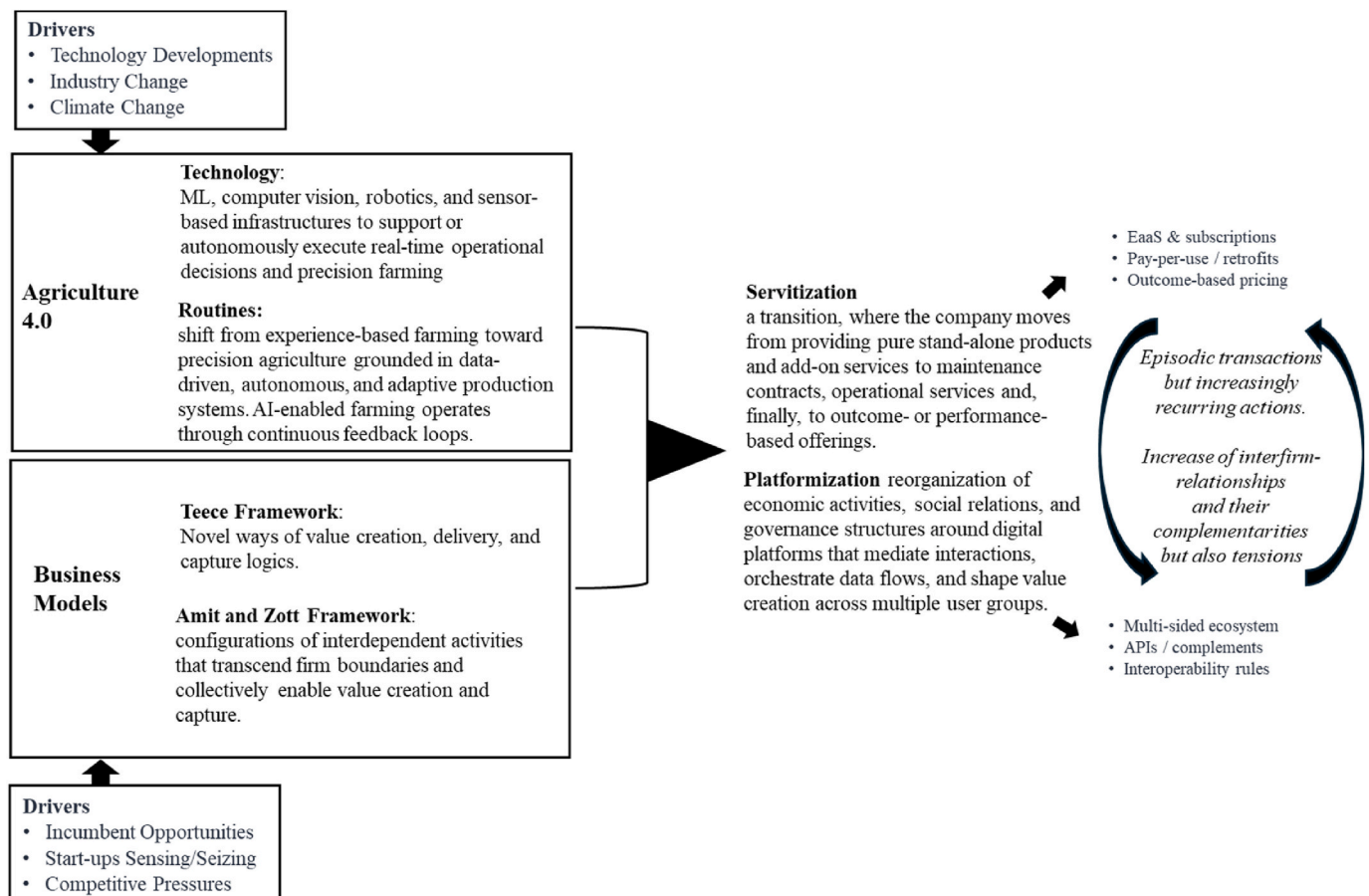


Fig. 1. Directions of business model change in agriculture 4.0.

based control.

2. Conceptual background

2.1. Agriculture 4.0: reshaping agricultural systems

Agriculture 4.0 combines machine learning, computer vision, robotics, and sensor-based infrastructures to enable real-time and increasingly automated precision farming (Padhiary et al., 2024). Telematics, connected sensors, cloud computing, big data, and AI form its technological core, supporting continuous field data collection, predictive analytics, remote diagnostics, and automated operations (Finger, 2023; Javaid et al., 2022; Padhiary et al., 2025; Raj & Prahadeeswaran, 2025; Spagnuolo et al., 2025). Machine learning strengthens decisions across tasks such as irrigation, spraying, and crop monitoring by identifying complex patterns in large datasets, while computer vision enables robots and autonomous machinery to detect weeds, diagnose disease, and assess crop maturity directly in the field (Jordan & Mitchell, 2015; Padhiary et al., 2024; Shamshiri, 2024; Spanaki et al., 2021). Agricultural robots, including autonomous tractors, precision weeding systems, and robotic harvesters, operate as cyber-physical systems that integrate sensing, decision-making, and actuation in complex, variable field environments. (Bechar & Vigneault, 2016).

Machinery providers increasingly combine equipment with proprietary software and data-driven services, creating hybrid product-service-platform offerings (Finger, 2023; Padhiary et al., 2025; Spagnuolo et al., 2025). As a result, agricultural data ecosystems are emerging as a key coordinating infrastructure that connects technologies and actors, and supports the productivity, efficiency, and sustainability ambitions of Agriculture 4.0 (Duguma & Bai, 2024; Maffezzoli et al., 2022; Raj & Prahadeeswaran, 2025).

Hence, Agriculture 4.0 disrupts traditional, socially embedded and experience-based farming that may be guided by family firm logics toward smart precision agriculture grounded in data-driven, autonomous, and adaptive production systems (Bouncken & Schmitt, 2022; Wolfert et al., 2017). In addition, the fusion of machinery, data, and services opens space for new business models.

2.2. Business model architecture and design

Business models are a central concept in management research because they explain how firms organize activities and translate strategy into economic value (Shamim et al., 2025). For the current research, a business model view allows understanding how firms reconfigure activities, relationships, and value mechanisms in response to technological change. While definitions vary, business models are generally understood as specifying how firms create value, deliver it to customers, and capture value in the form of revenues and profits (Laudien et al., 2024; Teece, 2010).

Value creation refers to a firm's ability to develop offerings that customers perceive as valuable and is shaped by its resources, capabilities, and organizational arrangements, as well as by how effectively these elements are combined (Teece, 2010).

Value delivery concerns how firms transfer created value to customers and ensure that the value proposition is realized in practice. It comprises the channels, partnerships, customer relationships, and governance structures through which firms reach customers, enable access to offerings, and support their ongoing use (Teece, 2010, 2018). Effective value delivery makes created value accessible, scalable, and meaningful, linking innovation to value capture (Teece, 2010).

Value capture refers to how firms secure value from their offerings in the form of revenues and profits. It depends on the alignment of the value proposition, cost structure, and revenue model, as well as on the firm's capacity to appropriate returns from innovation. Key mechanisms include pricing, revenue design, intellectual property protection, and

control over complementary assets that reduce imitation and profit erosion. In this sense, value capture links innovation to monetization and longer-term competitive advantage (Chesbrough & Rosenbloom, 2002; Teece, 2010, 2018).

Yet business models are dynamic constellations of interdependent elements that must fit internally such as organizational structures, managerial systems, and capabilities needed to support them (Laudien & Pesch, 2019) and align with external conditions (Baden-Fuller & Haefliger, 2013; Martins et al., 2015). Firms struggle with radical business model changes that demand substantial organizational and cultural adaptation.

The *activity system view* (Amit & Zott, 2001, 2010; Zott & Amit, 2007) frames business models as configurations of an interdependent activity system that specifies content, structure, and governance of activities performed by the firm and its partners. Content captures which activities are performed, structure how they are linked and sequenced, and governance who performs them. This perspective stresses external alignment and coordination of interdependent activities across a wider ecosystem. By focusing on activity interdependencies and design themes such as novelty, efficiency, complementarities, and lock-in, it provides a useful lens for understanding business model innovation and differentiation (Amit & Zott, 2001, 2010; Zott & Amit, 2007).

Business model innovation is a key source of disruption, growth, and sustained firm performance in dynamic environments (Cesinger et al., 2018; Kraus et al., 2022). However, its processes differ substantially across firms, as they are shaped by firm-specific strategic choices and contextual conditions (Laudien & Daxböck, 2017). Importantly, prior research suggests that business model innovation unfolds across multiple organizational levels (Andreini et al., 2021; Bouncken & Fredrich, 2016; Fredrich et al., 2022).

2.3. Business models and the servitization and platformization trends

"Servitization is [...] a transition, where the company moves from providing pure stand-alone products and add-on services to maintenance contracts, operational services and, finally, to outcome- or performance-based offerings (Kohtamäki et al., 2020, p. 3). Firms may vary in the extent, combination, and value chain position of their service offerings, each requiring aligned business model reconfigurations (Forkmann et al., 2017; Frank et al., 2019).

Service-oriented digital business models enact servitization by linking physical products with digital services, data analytics, maintenance, and performance-based offerings that support recurring revenues and stronger customer outcomes (Baines et al., 2009). The product-service system captures encapsulate it with a value proposition built around value-in-use rather than conventional ownership-based exchange. Enabled by connectivity, software, and analytics, firms can monitor product use, deliver outcome-oriented services, and scale advanced offerings more efficiently. As a result, customer relationships move from episodic transactions to ongoing service engagement, while new revenue logics become possible (Kohtamäki et al., 2020).

Platformization describes reorganization of economic activities, social relations, and governance around digital platforms that mediate interactions, coordinate data flows, and shape value creation across multiple user groups (van Dijck et al., 2018). While platforms are not a new phenomenon, digital technologies have significantly expanded their reach, functionality, and strategic importance. They are increasingly important vehicles of business model innovation distinguishing platform based value creation from traditional linear value chain (Täuscher & Laudien, 2018).

Digital platforms often occupy a central position in digital ecosystems (Constantinides et al., 2018). Built on shared standards and interoperability, they act as intermediaries that connect internal and external actors and enable information exchange, product development, and the matching of supply and demand (Veile et al., 2022). A platform can therefore be viewed as a hardware-software foundation that configures

technical standards, interfaces, and governance rules through which third-party complementors are enabled to develop complementary offerings. Platforms then facilitate recombination of previously separate products and services into new value propositions and business models. Platform owners and complementors thereby form ecosystems whose performance depends on effective governance, continuous coordination, and active complementor participation (Gawer & Cusumano, 2014).

Innovation platforms, whether situated within supply chains or spanning industry boundaries, furnish a technological core and distribution infrastructure that mobilize complementors to develop additional offerings and thereby enhance system-level value. Their success depends on the ability of platform owners, such as OEMs, to attract complementors, (Reischauer et al., 2024). Complementors (firms or individual users) will only join a platform when participation offers value. Platform owners therefore need to govern carefully, including whether access is exclusive, as in arrangements where content providers commit to a single digital media service, or non-exclusive, allowing complementors to affiliate with multiple platforms depending on the incentives and constraints in place.

Transaction platforms generate value by mediating exchanges of existing goods, services, or information among distinct participant groups, such as buyers and sellers or service providers and users. Through network effects, their usefulness grows with the number of participants, the breadth of functionality, and the richness of content. They usually monetize through transaction fees, advertising revenues, or a combination of both, making active participation in exchanges a central condition of value capture (Gawer, 2021).

Platform-based business models revolve around digital platforms that enable interactions among multiple user groups, such as producers, consumers, and service providers, and create value through network effects. They orchestrate ecosystems through standardized interfaces, data governance, and algorithmic coordination (Gawer, 2014).

3. Conceptual development

3.1. Agriculture OEM based business model innovation

In conventional OEM business models, value creation is anchored primarily in engineering and manufacturing capabilities (Adner & Kapoor, 2010; Hampshire, 2010). Competitive advantage derives from machine performance, durability, and incremental product improvements, with customer value assessed largely at the point of purchase.

In Agriculture 4.0, sensors, connectivity, and analytics transform machinery into data-generating assets, while AI-enabled functionalities convert field variability into actionable intelligence. Value creation becomes increasingly data-driven and system-based (Ahmed & Shakoor, 2025). It no longer resides in hardware quality alone, but in the OEM's ability to combine equipment with software, data, and agronomic expertise in solutions that perform across heterogeneous farming contexts. What is being transformed, therefore, is not only the technical basis of agricultural production but furtherly the historically sedimented and socially embedded practices through which farming has long been organized (Finger, 2023). Differentiation shifts toward integrative capability stacks that link sensing, analytics, automation, and complementary services in adaptive and repeatable ways (Bouncken et al., 2026).

Value delivery likewise moves beyond the traditional logic of discrete transactions, dealer-based support, and repair events. Under Agriculture 4.0, delivery extends across the entire operating lifecycle of equipment and becomes increasingly continuous, relational, and infrastructure-dependent (Bouncken et al., 2026). Connected machinery allows OEMs to provide diagnostics, software updates, performance monitoring, user support, and digitally enabled features that can be activated or adjusted over time (Padhiary et al., 2024). Delivering value therefore depends less on one-off exchange and more on a coordinated service architecture spanning internal units, dealers, digital platforms,

and external complementors (Bouncken, 2026). At the same time, it reshapes how agricultural work is enacted in practice, as activities historically guided by farmer experience, seasonal routines, and field-based improvisation become increasingly mediated by data flows, digital recommendations, and interoperable infrastructures (Raj & Prahadeeswaran, 2025).

Interoperability becomes a core delivery condition, because digital value can only be realized when tools, brands, and data environments connect effectively in practice (Uyar et al., 2024). Value delivery is thus redefined as the ongoing orchestration of performance, usability, and contextual fit across evolving socio-technical farming practices (Bouncken et al., 2026).

Value capture also undergoes fundamental change. Traditional OEM revenue models depend primarily on equipment sales, with additional income from parts and repairs. Sometimes the OEM also are family firms that are interested in the preservation of family firm heritage, logic, and the preservation of family wealth over time (Cesinger et al., 2016; Mensching et al., 2014). Agriculture 4.0 enables alternative monetization logics tied to access, usage, and digitally enabled functionality, including subscriptions, licensing, pay-per-use arrangements, and service contracts (Bouncken, Friedrich, & Kraus, 2020; Teece & Linden, 2017). Some of these models may be at odds with family firm values. Value capture accordingly shifts toward recurring revenue streams that depend on sustained engagement with the installed base and the continued embedding of digital services in everyday farm operations (Bouncken et al., 2026; Laudien & Pesch, 2019). Yet, the shift may not always take place when strong family firm values hinder its transformation.

The monetization shift is not economically neutral, because it is intertwined with changing control over agricultural knowledge, decision processes, and the infrastructures through which farming is conducted (Laudien & Daxböck, 2016). Capture increasingly depends on control over key complements, including interfaces, access rights, and data governance rules that shape how third-party services connect to the OEM's infrastructure. Such mechanisms can stabilize revenues and deepen customer relationships, but they also introduce governance tensions related to transparency, portability, dependency, and lock-in, especially in a sector where farming has historically been rooted in local autonomy, practical experience, and socially embedded routines.

Thus, Agriculture 4.0 transforms the historically embedded social practices through which farming has long been organized (Bouncken, 2026; Bouncken et al., 2026). From an activity-system perspective, this shift is expressed in the reconfiguration of interdependent activities across firm and ecosystem boundaries, rather than in the mere addition of digital features (Clauss et al., 2020; Daxböck & Laudien, 2014). The transformation involves reorganizing activities and their coordination in ways that reshape how agricultural solutions are developed, delivered, and monetized (Bouncken et al., 2025).

Accordingly, activity content expands beyond machinery design and manufacturing to include data- and software-centered activities such as sensing, integration, modeling, decision support, automation provisioning, and interoperability management. These activities become more tightly connected to operational use, so that improvement and differentiation increasingly depend on data accumulation and iterative refinement rather than on hardware replacement cycles alone. At the same time, the activity architecture grows more interdependent across actors, requiring coordinated contributions from OEMs, dealers, platforms, agronomic experts, and complementors. Value creation therefore depends on aligned interfaces, reliable data exchange, and clearly defined service responsibilities.

Monetization, in turn, becomes increasingly contingent on participation in the system, as subscriptions, feature licensing, service contracts, and performance-based arrangements rely on ongoing service provision and the governance of data and interfaces (Bouncken et al., 2026). Competitive advantage thus depends less on isolated product superiority than on how effectively firms design and govern their

activity systems, including the rules for complementor participation and the allocation of control and accountability.

Equipment-as-a-Service enables farmers to use tractors, harvesters, and other expensive machinery through subscription, pay-per-use, or outcome-based models instead of purchasing them outright. It serves particularly relevant for seasonal machines, where shared access can raise utilization while reducing capital burdens for farmers and generating recurring revenues for agritech OEMs (IMARC Group, 2025). More broadly, Equipment-as-a-Service is a servitization model in which manufacturers retain ownership of the asset and combine hardware with complementary services in integrated product-service offerings (Benedettini, 2025). Its variants include use-oriented and result-oriented product-service systems as well as pay-per-use and product- or everything-as-a-service models.

Pay-per-use models allow farmers to access machinery functions and services as needed rather than purchasing full functionality upfront. This is especially relevant where usage intensity varies across farms, seasons, or tasks, making flexible access more attractive than full ownership. For manufacturers, such models shift revenue generation from one-time sales toward service-based income tied directly to utilization. More generally, pay-per-use services allow customers to pay only for actual usage rather than for the product as a whole (Gebauer et al., 2017, p. 916). One example is Grimme, which offers farmers software-based machine functions and services through its online portal myGRIMME, with payment linked to actual use rather than upfront purchase (GRIMME Skandinavien A/S, 2019).

Subscription models give farmers access to connected machinery functions, software, and digital services through recurring payments rather than one-time purchases (Ahmed & Shakoar, 2025). This is particularly relevant as manufacturers increasingly embed connectivity, analytics, and upgradeable features into tractors, combines, and implements (Bouncken et al., 2026). For OEMs, such models shift revenue generation toward more predictable recurring income while also enabling longer-term digital relationships with customers.

More broadly, subscription models are market offerings in which customers and providers engage on an ongoing basis to provide access, usage, or outcomes in exchange for periodic fees (Kowalkowski & Ulaga, 2024, p. 441). John Deere illustrates this logic by combining machinery with connectivity and telematics through JDLink and Operations Center, while offering certain advanced functions through paid features, annual licenses, or per-acre pricing (Deere & Company, 2025a, 2025b). AGCO follows a similar path through its Fuse ecosystem and AGCO Connect, which turn equipment into connected data platforms and are monetized through subscription tiers, remote diagnostics, dealer-linked services, and add-on analytics tools (AGCO Corporation, 2019). In both cases, subscription logic extends the manufacturer-customer relationship beyond discrete transactions and turns occasional service interactions into ongoing digital engagement.

Outcome-based models tie payment to the results generated in use rather than to ownership or mere access. Farmers pay based on measurable outcomes such as yield performance, harvested volume, or efficiency gains delivered by the equipment and related services (Lončar et al., 2023). For OEMs, this shifts monetization closer to realized customer value and strengthens the link between technology performance and revenue generation.

More generally, outcome-based models are arrangements in which providers offer integrated solutions and are compensated according to the outcomes those solutions produce in ongoing use situations (Hou & Neely, 2018, p. 2103). One example is Blue River Technology's See & Spray, now part of John Deere's precision agriculture portfolio, which uses AI-based vision to enable targeted plant protection. John Deere's Application Savings Guarantee reflects this logic by charging a per-acre fee only when the technology generates measurable herbicide savings, thereby aligning payment with realized field-level benefits rather than with a one-time sale (Deere & Company, 2025a).

Taken together, equipment-as-a-service, pay-per-use, subscription,

and outcome-based models show how Agriculture 4.0 reconfigures business models into tightly coupled activity systems of value creation, delivery, and capture. On the value-creation side, these models combine machinery with software, connectivity, and analytics to provide operational capability rather than mere asset ownership. Value delivery also shifts from isolated transactions toward a mix of flexible access and continuous service, allowing farmers lower upfront costs, more incremental adoption, and closer alignment with actual workflows. In turn, value increasingly resides not in the machine alone but in ongoing access to digitally optimized farming processes. These models therefore depend on coordinated ecosystems in which manufacturers, dealers, platforms, and complementors jointly deliver value through digital engagement, workflow integration, and service coordination (Bouncken & Kraus, 2022). Their effectiveness ultimately rests on interoperability across hardware, software, and organizational actors in highly variable agricultural environments.

Fig. 2 shows the OEM development in overview.

3.2. Agriculture 4.0 innovation platforms

Major technology firms increasingly view agriculture as a strategic field for expanding their digital offerings. By providing cloud infrastructure, AI capabilities, and data-analytics solutions tailored to farming, they extend their reach into the sector while deepening control over the foundational infrastructures on which Agriculture 4.0 depends. This, in turn, reinforces platform-driven consolidation. Examples include Amazon Web Services' agricultural marketplace for analytics and software solutions, Microsoft's Azure FarmBeats and Azure Data Manager for Agriculture, and Google Cloud's collaborations on generative AI tools for farm management and decision support (BASF SE, 2024; Expert AWS, 2023; World Economic Forum, 2025).

Agritech start-ups further accelerate this shift by developing specialized tools and applications that can be integrated into these digital environments. At the same time, established firms such as Bayer and John Deere increasingly invest in or collaborate with such ventures to secure access to emerging technologies and embed them within their own platform architectures (Bayer AG, 2023; Deere & Company, 2023). Bayer's LifeHubs and LEAPS illustrate how incumbents support start-ups in areas ranging from digital agriculture to biological and regenerative solutions, while John Deere's Operations Center and Startup Collaborator Program show how OEMs build broader innovation ecosystems around their platforms (Bayer AG, 2023; TechTour, 2025). The 2025 Startup Cohort included, for example, Presien that develops on-machine AI solutions to improve safety and productivity or Landscan, which combines soil and remote sensing data into analytics to optimize land and resource management (Deere & Company, 2025a).

Together, these developments highlight that Agriculture 4.0 is influenced by a wider platform ecology in which technology firms, start-ups, and incumbents jointly reorganize innovation and value creation.

Agriculture 4.0 illustrates how modular and architectural innovations interact, with cumulative changes reshaping both firm-level business models and the broader agricultural ecosystem. Viewed through the lens of Foss and Saebi (2017), innovation platforms in Agriculture 4.0 primarily function as mechanisms of architectural business model innovation, while simultaneously enabling modular and, in some cases, radical change. At a modular level, platforms such as Bayer's LifeHubs or John Deere's Startup Collaborator Program allow start-ups to contribute discrete technologies, applications, and services that enhance specific business model components without immediately altering the overall architecture. Innovation platforms act as architectural anchors that systematically channel modular experimentation into broader, potentially radical business model transformation in Agriculture 4.0.

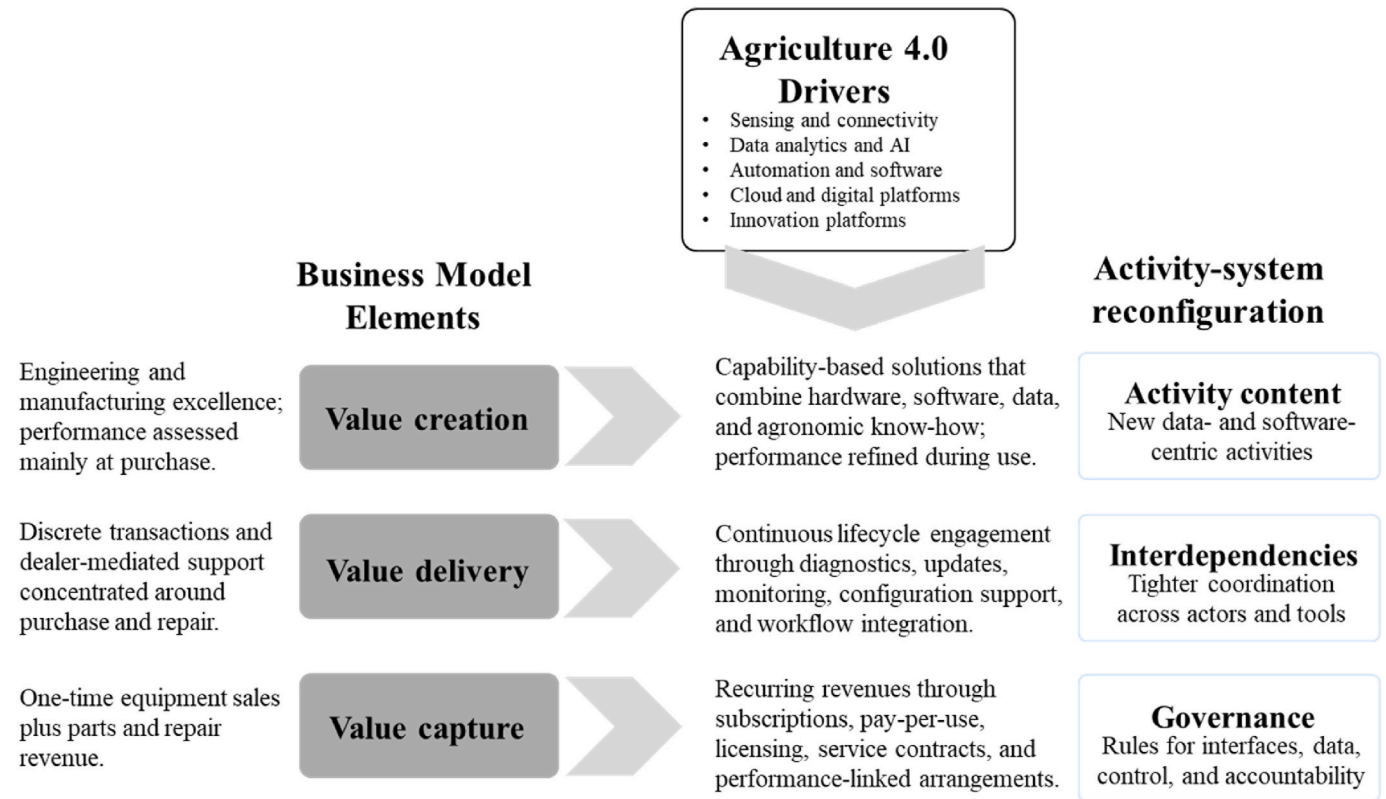


Fig. 2. OEM focused transformations in Agriculture 4.0.

4. Discussion

4.1. Integrated platforms in agriculture 4.0

The transformation of incumbent agritech firms (e.g., John Deere) implies a broader reorganization of how value is created, delivered, and captured in Agriculture 4.0 (Bouncken et al., 2026). Digitalization creates the technological basis for service- and platform-oriented business models that support more continuous, scalable, and resilient revenue generation beyond cyclical equipment sales (Frank et al., 2019; Kohtamäki et al., 2020; Veile et al., 2022).

We argue that incumbent agritechs are not simply reacting to farmers' demand for integrated solutions but are proactively redesigning their business models to orchestrate digital-mechanical service ecosystems. This is because the ecosystems combine connected machinery, agronomic data, analytics, and complementary services (Finger, 2023; Wolfert et al., 2017). Within this ecosystem logic, value creation is increasingly based on the generation of intelligence through sensing, data analytics, automation, and interoperability embedded in iterative workflows and cross-season learning processes (Duguma & Bai, 2024; Uyar et al., 2024) guiding data-driven value creation and ecosystem coordination (Bahoo et al., 2023; Jorzik et al., 2024).

Value delivery becomes more continuous and relational through remote diagnostics, software updates, workflow integration, and dealer-supported service coordination that embed digital benefits in daily farm operations (Kohtamäki et al., 2020; Laudien et al., 2024). Value capture shifts from episodic transactions toward recurring and outcome-linked revenues, including subscriptions, pay-per-use arrangements, and performance-based contracts (Gebauer et al., 2017; Hou & Neely, 2018; Kowalkowski & Ulaga, 2024). These mechanisms align revenues more closely with realized farm-level outcomes while lowering farmers' upfront investment burden.

From an activity-system perspective, Agriculture 4.0 reorganizes content, structure, and governance of interdependent activities across

machinery providers, software actors, dealers, and complementors (Amit & Zott, 2001, 2010; Zott & Amit, 2007). Data becomes a central coordinating resource, while interoperability and platform integration become essential conditions for scalable value creation and delivery (Constantinides et al., 2018; Gawer & Cusumano, 2014). AI-enabled business model innovation and data-centric value creation literature argues that digital technologies transform value architectures by making data a strategic resource. Accordingly, we propose:

Proposition 1. *The increasing integration of AI and robotics technologies in agriculture drives the emergence of data-driven business models.*

We further argue that service-based and platform-based architectures create conditions for scalable monetization, raise switching costs, and deepen lock-in by combining hardware, software, services, and accumulated data within integrated ecosystems (Cusumano et al., 2019; Gawer, 2021). Innovation platforms reinforce these developments as channels for continuous business model experimentation.

As start-up technologies are incorporated into incumbent platforms, they expand the innovation space, speed up development of new services, and embed exploratory solutions within existing operational and platform structures (Gawer & Cusumano, 2014; Reischauer et al., 2024). Thus, innovation platforms support service- and data-driven business models while actively shaping the emergence of new ecosystem configurations that become key to competitive advantage in Agriculture 4.0.

Agriculture 4.0, accordingly, is a layered transformation at multiple levels. Incremental and modular innovations, including data-driven revenue models, AI-enabled services, and digital partnerships, modify individual business model elements (Andreini et al., 2021; Foss & Saebi, 2017). More far-reaching architectural changes alter how activities are linked and governed across connected machinery, platforms, and ecosystem actors (Veile et al., 2022; Zott & Amit, 2010). In some instances, these shifts lead to radical business model innovation as agritech firms transition from equipment-centered sales logics to platform-based and performance-oriented models that redefine

industry roles and mechanisms of value capture (Frank et al., 2019; Kanbach et al., 2024).

Innovation platforms are pivotal in this process because they are the architectural anchors for modular experimentation while channeling these innovations into broader ecosystem-level reconfigurations (Constantinides et al., 2018; Gawer, 2014). By lowering barriers for complementors and facilitating distributed innovation processes (van Dijk et al., 2018; Yoo et al., 2010), digital platforms stimulate ongoing experimentation, recombination, and ecosystem-based innovation. The cumulative interaction of these dynamics leads to our next proposition, which is grounded in platform innovation and business model literature emphasizing modular and complementor recombination, and architectural change.

Proposition 2. *The layered transformation associated with Agriculture 4.0 stimulates pipelines for ongoing business model experimentations.*

Firms that successfully realign their business model components around integrated platform-based activity systems are better positioned to create, deliver, and capture value in increasingly interconnected agricultural ecosystems (Teece, 2010, 2018). In contrast, firms that remain focused primarily on hardware risk losing strategic relevance as value increasingly migrates toward software, analytics, interoperability, and ecosystem orchestration capabilities (Constantinides et al., 2018; Gawer, 2021).

From an activity-system perspective, competitive advantage increasingly depends on how effectively firms coordinate interdependent activities across hardware, software, services, and ecosystem actors rather than on isolated product innovation alone (Amit & Zott, 2001, 2010; Zott & Amit, 2007). Platform-based ecosystems strengthen complementarities, enable network effects, and create opportunities for lock-in through accumulated data, integrated workflows, and ongoing service relationships (Cusumano et al., 2019; Rochet & Tirole, 2003). At the same time, firms that orchestrate platforms gain infrastructural power through control over interfaces, standards, and data governance mechanisms, allowing them to shape ecosystem participation and value appropriation (Plantin et al., 2018; Yoo et al., 2010).

The transformation also reflects the broader shift from linear value chains toward ecosystem-based and service-centered business models in digital environments (Täuscher & Laudien, 2018; Veile et al., 2022). As connected machinery, analytics, and AI-enabled services become increasingly interdependent, strategic positioning depends less on ownership of physical assets alone and more on the ability to orchestrate continuous data flows, interoperability, and collaborative innovation across heterogeneous actors (Bouncken & Kraus, 2022; Klerkx et al., 2019). Accordingly, Proposition 3 builds on platform ecosystem and activity-system research, which highlights ecosystem orchestration, complementarities, and network effects as sources of competitive advantage.

Proposition 3. *Firms that realign their business model components around integrated, platform-based activity systems strengthen their strategic position, while hardware-focused firms risk losing ground to actors capturing value through software, data, and orchestration capabilities.*

4.2. Platformization: blessing and curse

Platforms constitute the structural backbone of Agriculture 4.0 business models. They connect hardware, software, and complementary services while linking farmers, dealers, software providers, and start-ups into coordinated activity systems of value creation, delivery, and capture (Gawer, 2014; Veile et al., 2022). Platforms restructure agricultural production away from historically socially and culturally entrenched practices, locally embedded knowledge, and experience-based routines toward increasingly data-mediated, interoperable, and continuously coordinated forms of organizing. This re-order has important business model implications.

Interoperability, connectivity, and continuous data exchange across machinery, sensors, analytics, services, and platforms move value creation away from discrete products and toward system-level intelligence, predictive capability, and adaptive automation (Finger, 2023; Wolfert et al., 2017). From an activity-system perspective (Zott & Amit, 2010), Agriculture 4.0 expands the content of business models by adding sensing, telematics, data acquisition, AI-enabled analysis, and algorithmic optimization, while also reconfiguring their structure by linking these activities more tightly across firms, technologies, and use contexts (Amit & Zott, 2001, 2010; Zott & Amit, 2007).

Value delivery correspondingly becomes more continuous and infrastructure-dependent, relying on workflow integration, remote monitoring, lifecycle services, and iterative feedback loops that embed digital functionality into ongoing farming operations (Kohtamäki et al., 2020; Teece, 2018). Agriculture 4.0 therefore alters how agricultural work is organized, coordinated, and governed across a wider ecosystem. These developments as well as servitization and outcome-based business model literature, which explains the shift from transactional revenues toward recurring and performance-linked value capture, inform our Proposition 4 that extends Proposition 1.

Proposition 4. *Agriculture 4.0 moves value capture toward subscriptions, pay-per-use, and outcome-oriented arrangements, transforming revenue models from episodic hardware sales into recurring, data-enabled streams.*

Servitization, enabled by platforms, is central to this transition. OEMs increasingly convert product-centered offerings into service-rich, platform-mediated solutions that bundle machinery with telematics, software functionalities, analytics, and predictive maintenance, and support (Baines et al., 2009; Frank et al., 2019). By embedding services within platform architectures, firms extend engagement beyond the point of sale and align value capture more closely with use, performance, and outcomes (Gebauer et al., 2017; Hou & Neely, 2018). Subscription models, pay-per-use services, and outcome-based arrangements thereby transform revenue generation from episodic hardware transactions into recurring, data-enabled income streams (Kowalkowski & Ulaga, 2024). These developments also deepen customer integration into platform ecosystems and increase switching costs through accumulated data histories, interoperable workflows, and continuous service relationships (Cusumano et al., 2019; Rochet & Tirole, 2003).

For farmers, these models can lower entry barriers, reduce capital intensity, and provide access to advanced capabilities through more flexible arrangements. At the same time, they deepen dependence on digital infrastructures and shift control over data, interfaces, and service conditions toward actors that orchestrate the platform (Klerkx et al., 2019). Changes extend beyond individual firms. Platformization in agriculture creates efficiency and innovation benefits, while redefining governance of farming practices, ecosystem participation, and value appropriation (Finger, 2023; Macpherson et al., 2022; Rose et al., 2021). Structural risks emerge, platform owners occupy privileged ecosystem positions by controlling interfaces, interoperability standards, and access to data and complementary services (Plantin et al., 2018; Yoo et al., 2010). Digital tools embed farmers in platform ecosystems characterized by dense technological and organizational interdependencies, reducing autonomy and shifting adoption toward ecosystem-level configurations of capabilities, rules, and power relations (Van Der Burg et al., 2019). As users and data contributors within these ecosystems concerns about dependency, data ownership, bargaining power, and governance rise (Bronson & Knezevic, 2016; Carolan, 2017). AI-driven decision-making reinforces these dynamics by repositioning farmers as supervisors of algorithmic systems, thereby intensifying challenges of trust, accountability, and transparency and highlighting the need for explainable AI in agriculture (Barredo Arrieta et al., 2020). As network effects strengthen with growing participation, ecosystems can create lock-in through accumulated data histories, integrated workflows, and continuous service relationships (Cusumano et al., 2019; Rochet & Tirole, 2003).

Digital platforms coordinate interactions across heterogeneous actors, thereby expanding opportunities for modular innovation and ecosystem-level value creation (Gawer, 2014; Veile et al., 2022). Innovation platforms further stimulate experimentation and recombination by enabling start-ups to develop complementary applications and AI-enabled services that can be integrated into broader agricultural systems (Reischauer et al., 2024; van Dijck et al., 2018). Start-ups benefit from access to incumbent platforms and installed user bases, but simultaneously become dependent on platform governance structures, pricing mechanisms, and technical standards controlled by dominant actors (Gawer, 2021). Thus, platformization simultaneously enables ecosystem-wide value creation while reinforcing asymmetries in value appropriation and control. While they lower transaction costs, facilitate third-party innovation, and provide access to advanced digital capabilities without large upfront investments, they increase power asymmetries and dependencies, especially at the expense of farmers and start-ups. We aggregate the benefits and risks into **Proposition 5** that draws on digital platform governance literature.

Proposition 5. *Platformization in Agriculture 4.0 creates a dual dynamic of ecosystem enablement and ecosystem dependency.*

4.3. Platform economics and platform governance

Agricultural platforms operate as multi-sided markets characterized by strong network effects, economies of scale, and centralized governance over standards and interfaces (Rochet & Tirole, 2003). Platforms enhance analytical precision and provide increasingly granular decision-support services for farmers and service providers while reinforcing existing power asymmetries. Farmers and smaller providers become dependent on platform owners for access to data, technological compatibility, and market visibility. Because platform owners control key technological infrastructures and standards, they have significant power to shape technical and participation conditions, economic relationships, and strategic choices (Plantin et al., 2018). Consequently, farmers' autonomy declines and their bargaining positions weakens, particularly where platform governance privileges interests of large agribusinesses and technology firms (Bronson & Knezevic, 2016; Carolan, 2017).

As more users, service providers, and data sources join, platform value grows, reinforcing lock-in effects. Interoperability initiatives allow farmers to operate machinery across brands while accessing shared data services, expanding platform reach and analytical integration. Yet these arrangements also concentrate data and decision-making capabilities within a small number of dominant platforms, which increasingly define the rules of engagement and the distribution of value across agricultural ecosystems.

The dual role of platforms, as both enablers and gatekeepers, raises critical questions of ecosystem governance. Platform owners occupy structurally advantaged positions, controlling essential digital infrastructure, data flows, and access rules (Carbonell, 2016; Wiseman et al., 2019). This concentration of control can reinforce power asymmetries, reduce interoperability, and constrain farmer autonomy, thereby limiting the strategic and operational flexibility of dependent actors. Participation in incumbent-led platforms accelerates market access and adoption but also imposes dependence on platform governance, pricing mechanisms, and algorithms for start-ups and smaller service providers. As a result, effective ecosystem orchestration becomes a central managerial challenge: creating, delivering, and capturing value increasingly relies not only on technological capabilities but also on governance structures, interface management, data stewardship, and mechanisms that ensure equitable participation across ecosystem actors (Klerkx & Begemann, 2020; Yoo et al., 2010).

Platformization in Agriculture 4.0 reflects a critical tension between openness and control. Open, interoperable platforms promote experimentation, third-party innovation, and collaborative problem-solving,

lowering adoption barriers and enabling farmers, start-ups, and other actors to co-create value across brands and organizational boundaries (Minerbo et al., 2021). Open standards and cross-brand interoperability allow farmers to choose solutions that fit their operational needs, integrate diverse tools and data sources, and reduce lock-in. Such openness supports ecosystem-level innovation and lowers adoption barriers, enabling farmers and third-party providers to flexibly combine solutions that fit context-specific operational needs (Minerbo et al., 2021).

However, excessive openness may weaken firms' ability to appropriate value and maintain strategic control over data, algorithms, interfaces, and customer relationships. More controlled ecosystems allow platform orchestrators to protect proprietary technologies, enforce quality standards, stabilize system performance, and capture a larger share of ecosystem revenues (Cusumano et al., 2019).

In contrast, highly controlled or closed ecosystems enable platform owners and dominant agritech firms to protect proprietary algorithms, enforce quality standards, capture a larger share of revenue, and maintain competitive advantage (Cusumano et al., 2019). However, excessive control can limit choice and interoperability, constrain innovation, reinforce power asymmetries and dependencies, and weaken farmers' long-term bargaining positions (Carbonell, 2016; Wiseman et al., 2019). Algorithmic filtering and proprietary data governance can lock users into specific ecosystems, potentially undermining adaptive, context-specific decision-making and limiting cross-platform analysis (Tian et al., 2021). Yet, algorithmic filtering in smart farming also enhances efficiency by sifting through large volumes of sensor and equipment data to identify critical anomalies, maintenance needs, and priority tasks. By highlighting actionable insights and automating recommendations, these systems support real-time adjustments in operations, optimize resource use, and improve productivity, operational efficiency, and overall farm management.

Innovation platforms support value co-creation by integrating scientific, technological, and local knowledge into embedded AI systems, but they also structure participation through platform-specific rules, languages, and competencies. It brings an openness-control dilemma: while openness through interoperability and shared-data access broadens participation and enhances co-creation, platform owners retain control via proprietary standards, governance mechanisms, and required competencies such as AI literacy.

When participation is conditioned on technical fluency or compliance with platform logics, co-creation risks reinforcing power asymmetries, shifting platforms from inclusive spaces of joint value creation to mechanisms of selective value capture. This openness-control dilemma requires careful design of business model activity systems and governance mechanisms. Ultimately, the equilibrium between openness and control is shaped by governance choices, standards, and institutional pressures, determining how benefits and risks are distributed within the agricultural digital ecosystem. Effective ecosystem orchestration requires balancing flexibility, scalability, interoperability, and appropriability while maintaining sufficient openness to attract complementors, support innovation, and ensure ecosystem adoption (Teece, 2018; Veile et al., 2022).

Governance mechanisms such as interoperability standards, interface rules, data-access arrangements, complementor policies, and explainability requirements become central tools for managing this balance (Gawer & Cusumano, 2014; Spanaki et al., 2021). Ultimately, competitive advantage depends not only on technological superiority, but on how effectively firms govern interdependent ecosystems of actors, technologies, and data flows while balancing openness and control across heterogeneous stakeholders. From the former, we develop our last proposition rooted in platform governance and ecosystem management research emphasizing the strategic balance between openness, innovation, appropriability, and control. Below, Fig. 3 illustrates an integrated view of our propositions and our conceptual model.

Proposition 6. *To deal with the openness-control dilemma in platforms,*

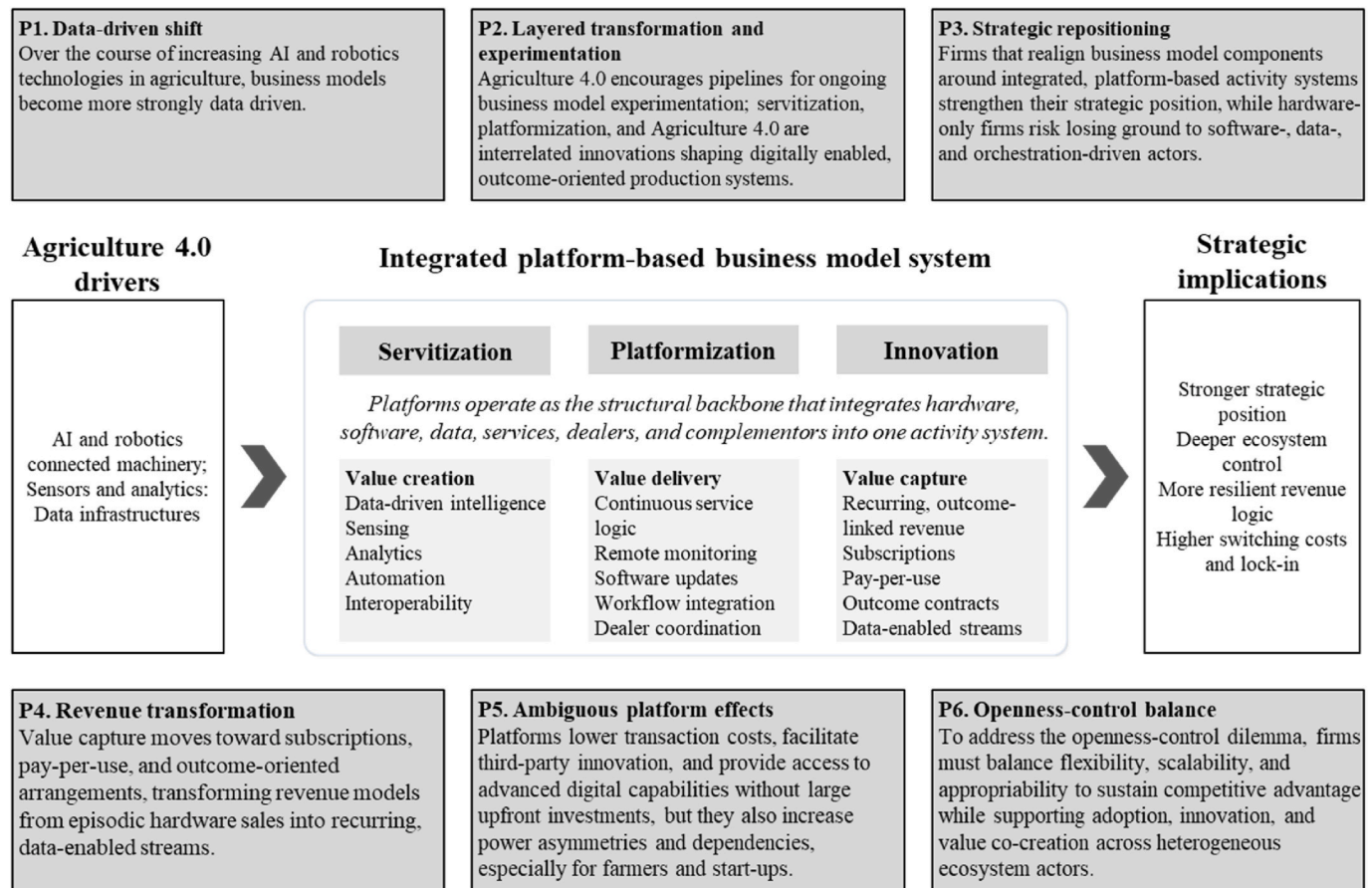


Fig. 3. Contextualized propositions.

firms must balance flexibility, scalability, and appropriability to sustain competitive advantage while supporting adoption, innovation, and value co-creation across heterogeneous ecosystem actors.

5. Limitations and research agenda

While this study provides a systemic perspective on Agriculture 4.0, platformization, and business model transformation, several limitations should be acknowledged. First, the analysis is conceptual, synthesizing insights from literature on smart farming, platforms, and business model innovation rather than testing relationships.

Empirical validation across diverse agricultural contexts is necessary to test and refine our theoretical propositions, particularly regarding how modular, architectural, and radical business model innovations unfold in practice and interact with ecosystem governance structures. Our research agenda is structured around four interconnected themes: (1) legitimacy of AI-enabled value creation, (2) legitimacy of continuous and infrastructure-based value delivery, (3) legitimacy of novel value-capture mechanisms, and (4) legitimacy of platform governance.

Future research could extend our conceptual model by examining how the different propositions jointly illuminate the legitimacy challenges of Agriculture 4.0 business model innovation. While our propositions specify how Agriculture 4.0 reconfigures value creation, value delivery, value capture, and ecosystem governance, future studies could investigate how these transformations become perceived as appropriate, desirable, and socially acceptable in a field historically anchored in autonomy, ownership, embodied expertise, and locally embedded routines (Suchman, 1995). Three broader research agendas appear particularly promising.

First, future research could examine how AI-enabled value creation

becomes legitimate when agricultural work shifts from embodied practice toward data-mediated intelligence. Our earlier propositions suggest that Agriculture 4.0 expands value creation by embedding sensing, telematics, AI-enabled analysis, and algorithmic optimization into machinery, connected equipment, and data infrastructures. This transformation moves agricultural production away from discrete physical tools and toward continuously coordinated systems of prediction, automation, and adaptive decision-making. Viewed through a legitimacy lens, this transformation raises questions not only about technological performance but also about how new forms of expertise and decision-making gain social acceptance. Future research could therefore investigate how farmers, dealers, advisors, and technology providers evaluate the appropriateness of such data-mediated value creation and achieve legitimacy (Deephause & Suchman, 2008).

A central question is whether AI-enabled analytics are perceived as extending farmers' expertise or as displacing the tacit, experiential, and locally embedded knowledge that has historically defined competent farming and that enfold trajectories (Bouncken & Tiberius, 2023). (Pragmatic) Legitimacy may be achieved when AI systems visibly improve operational reliability, resource efficiency, and agronomic outcomes while preserving farmers' sense of control and practical judgment. Conversely, legitimacy may be in question when data-driven systems appear opaque, standardized, or insufficiently sensitive to local conditions. This tension points to a broader issue: the compatibility of AI-enabled value creation with established understandings of what constitutes competent and trustworthy farming (.).

In this agenda, one would link the value creation propositions to legitimacy-as-perception (Bitektine, Gillespie, & Lange, 2025; Bitektine & Haack, 2015; Haack et al., 2021) by asking how new technological functionalities become socially accepted within traditional evaluative

frames inspired by tradition (Cancellieri et al., 2022; Cattani et al., 2017) and how they depart from common templates (Taeuscher et al., 2021). One might ask which role family firms and their values plays here.

Beyond the acceptance of technologies themselves, future research could also examine how legitimacy dynamics shape the emergence of new organizational actors and business models. New ventures may emerge that align or depart from the traditional modes of operation, reshape what constitutes competent farming, and how legitimacy is constructed in AI driven agriculture (Bouncken, Kraus, & Martínez-Pérez, 2020; Tiberius et al., 2020). Taken together, this research agenda highlights legitimacy as a critical mechanism through which technological innovation becomes embedded—or resisted—in agricultural practice.

Second, future research could investigate how continuous, infrastructure-dependent value delivery becomes legitimate across agricultural ecosystems. Our propositions indicate that Agriculture 4.0 reconfigures value delivery by embedding digital functionality into ongoing farming operations through workflow integration, remote monitoring, predictive maintenance, software updates, dealer support, and lifecycle services. This shift transforms value delivery from an episodic transaction into a continuous co-relationship between farmers, OEMs, dealers, software providers, and platform orchestrators (Aslam & Bouncken, 2026). As a result, legitimacy concerns extend beyond individual technologies to the broader infrastructures and interorganizational relationships through which value is delivered. Future research could examine how agricultural actors on different levels (Bitektine & Haack, 2015; Haack et al., 2021) judge the legitimacy of this more permanent infrastructural (co)embeddedness that does not cohere with traditional more autonomous behavior and tacit knowledge of traditional industries and the strong role of family firms in there (Aslam & Bouncken, 2026; Cancellieri et al., 2022; Cattani et al., 2017).

On the one hand, continuous service relationships may be perceived as valuable because they increase reliability, reduce downtime, and provide timely support during critical production windows, thus addressing functional needs (Bitektine et al., 2025a, 2025b; Gelman et al., 2026). On the other hand, they may be evaluated as intrusive or restrictive when they create dependence on proprietary infrastructures, remote diagnostics, or platform-specific service conditions, and again limit functional needs that can be seen as an input to perceived legitimacy (Bitektine, Gillespie, & Lange, 2025; Suddaby et al., 2017).

These contrasting evaluations suggest that legitimacy may depend not only on technical performance but also on how relationships of dependence and control are governed. This agenda could therefore explore how legitimacy depends on service reliability, transparency, responsiveness, data stewardship, and the continued role of trusted local intermediaries. It would also clarify how dealers, advisory organizations, and agricultural educators mediate the legitimacy of digitally delivered services by translating platform functionality into practical, field-level relevance. Such research would highlight intermediaries as critical legitimacy brokers that connect digital infrastructures with locally embedded agricultural practices. Hence, it can advance the role of intermediaries in building perceived legitimacy (Bitektine & Haack, 2015; Haack et al., 2021). Taken together, this agenda shifts attention from the legitimacy of individual technologies to the legitimacy of the service ecosystems through which digital value is continuously delivered.

Third, future research could examine how new value capture models become legitimate when Agriculture 4.0 moves from the trajectories of ownership-based exchange toward recurring, data-enabled revenue streams (Bouncken & Tiberius, 2023). This shift raises legitimacy questions because it changes not only how firms generate revenue, but also how farmers access, control, and evaluate agricultural technologies. Proposition 4 suggests that Agriculture 4.0 moves value capture toward subscriptions, pay-per-use, and outcome-oriented arrangements, transforming revenue models from episodic hardware sales into recurring,

data-enabled streams. Future research could investigate under which conditions farmers perceive these models as fair, useful, and appropriate rather than as opaque, extractive, or autonomy-reducing (Bitektine et al., 2025a, 2025b; Gelman et al., 2026). At the center of this agenda is the tension between flexibility and access on the one hand and concerns about dependence and loss of control on the other.

Subscription-based analytics, predictive maintenance, and performance-based contracts may lower entry barriers and provide flexible access to advanced capabilities. Yet they also challenge established assumptions and perceptions of legitimacy about machinery ownership, control over production assets, and independence from external providers (Cancellieri et al., 2022; Cattani et al., 2017). Accordingly, future research could examine which governance mechanisms help reconcile novel revenue models with traditional expectations of ownership and autonomy. Specifically, how legitimacy is shaped by pricing transparency, contractual flexibility, perceived value-for-money, data rights, reversibility, and the distribution of risks between farmers and platform providers. Such research illuminates how economic and moral evaluations interact when users assess emerging business model arrangements. It would deepen business model research by showing that value capture innovation requires not only economic feasibility, but also moral and pragmatic acceptance among users whose evaluations are shaped by traditions of ownership, self-reliance, and operational autonomy. Taken together, this agenda suggests that the success of data-enabled value capture models depends as much on their perceived legitimacy as on their economic efficiency.

Fourth, future research could address how platform governance becomes legitimate amid the dual dynamic of ecosystem enablement and ecosystem dependency. Proposition 5 highlights that platformization in Agriculture 4.0 simultaneously enables ecosystem-wide value creation and reinforces dependency on platform owners that control infrastructures, standards, interfaces, and data governance. This duality suggests that platform legitimacy depends not only on the value platforms create, but also on how power and control are exercised within agricultural ecosystems. Future research could therefore examine when platform governance is perceived as necessary orchestration and when it is interpreted as excessive control. Platforms may gain legitimacy when they lower transaction costs, facilitate third-party innovation, enable interoperability, support start-up participation, and provide farmers with access to advanced digital capabilities without large upfront investment. From this perspective, legitimacy emerges when platform governance is viewed as enabling collective value creation rather than constraining participant autonomy.

Yet their legitimacy may erode when they intensify lock-in, weaken bargaining positions, restrict interoperability, obscure data ownership, or privilege the interests of dominant agribusiness and technology firms (Bitektine et al., 2025a, 2025b; Gelman et al., 2026). A central research question is therefore how governance arrangements balance ecosystem coordination with the autonomy and bargaining power of participating actors. This agenda could then compare open, hybrid, and proprietary platform architectures to understand how different governance arrangements influence perceptions of fairness, autonomy, inclusion, and value distribution. Such comparisons would help identify, which governance mechanisms foster trust and legitimacy across heterogeneous ecosystem participants. It would also connect platform research with legitimacy theory by showing how ecosystem dependency becomes accepted, contested, or resisted by farmers, start-ups, dealers, and complementors. This agenda positions legitimacy as a key mechanism through which platform governance shapes the stability and evolution of agricultural ecosystems.

Taken together, these four agendas extend the full set of propositions by shifting attention from the economic and technological mechanics of Agriculture 4.0 business model innovation to its social evaluation. Our research agendas suggest that the future of AI-driven agricultural platforms depends not only on superior functionality, recurring revenue potential, and ecosystem scalability, but also on whether new

arrangements for value creation, delivery, capture, and governance are perceived as legitimate within a traditional field. In this sense, legitimacy becomes a central condition for whether Agriculture 4.0 business models diffuse broadly, remain confined to specific user groups, or trigger resistance against platform-mediated forms of agricultural production.

Finally, future research should adopt more explicit multi-level and longitudinal approaches to examine the interplay between individual behavior, ecosystem governance, and institutional environments. At the micro level, research could investigate how AI literacy, managerial capabilities, and trust influence adoption and usage behavior. At the meso level, future work could analyze ecosystem orchestration, complementor relationships, and governance structures. At the macro level, comparative institutional studies could explore how regulation, standardization regimes, and market concentration shape the evolution of Agriculture 4.0 ecosystems. Methodologically, longitudinal case studies, platform usage analytics, configurational approaches, and network analyses could provide valuable insights into how ecosystem relationships and governance arrangements evolve over.

6. Conclusion

Agriculture 4.0 is best understood not as a technological upgrade, but as a systemic reorganization of agricultural business models. AI, robotics, and digital platforms are shifting the sector from product-centric and historically embedded sociotechnical practices toward data-driven, service-based, and platform-mediated value architectures. In this transition, competitive advantage increasingly derives from orchestrating ecosystems of connected machinery, software, analytics, and complementary actors rather than from hardware alone. This transformation, however, is deeply ambivalent. The same platforms that enable innovation, interoperability, and recurring value creation also concentrate control over data, interfaces, and ecosystem participation. As a result, Agriculture 4.0 simultaneously expands opportunities for new forms of value creation and intensifies questions of dependency, lock-in, and governance.

Our study contributes a conceptual framework that explains how servitization and platformization jointly reshape value creation, delivery, and capture in agriculture. In doing so, it highlights that the central challenge of Agriculture 4.0 is not only technological adoption, but the design of business models and governance arrangements that determine how value, power, and autonomy are distributed across the agricultural ecosystem. We provide a template for understanding how emerging technologies reorganize industries around ecosystems, services, platforms, and data-based control.

CRedit authorship contribution statement

Ricarda B. Bouncken: Writing – review & editing, Writing – original draft, Conceptualization. **Beate Cesinger:** Writing – review & editing, Writing – original draft.

Declaration of competing interests

We have nothing to declare.

Data availability

No data was used for the research described in the article.

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