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Configuring Business Models in Diversified Cropping Systems

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Abstract

Agricultural systems are under increasing pressure to transition towards more sustainable practices that balance ecological, economic, and social objectives. Diversified cropping systems are widely promoted for their potential to enhance biodiversity, improve soil health, and increase resilience to climatic variability, yet their adoption remains limited. Existing research suggests that this is not only due to agronomic challenges but also to the difficulty of creating the economic and social conditions needed to sustain diversified farming within constrained market and institutional environments. Here, we examine how farmers organize these conditions during agroecological transition. Using a qualitative multiple-case study of farmers implementing diversified cropping systems, we examine how they configure activities, relationships, and value creation, delivery, and capture, and how these organizational arrangements are shaped by agronomic conditions, market dynamics, and institutional constraints. Here we identify five business model configuration logics, namely Farmer-to-Consumer, Producer-to-Partner, Raw-to-Processed, Local-to-Community, and Biodiversity-to-Bulk, that represent distinct organizational pathways through which farmers sustain diversified cropping systems. We show that these logics emerge from different ways of organizing value creation, delivery, and capture rather than from differences in sustainability ambitions. Instead, they reflect how farmers align their resources, capabilities, and networks with ecological, market, and institutional conditions. This study demonstrates that business model configuration logics provide a novel framework for explaining how farmers create the economic and social conditions needed to sustain diversified cropping systems during agroecological transition. These findings advance research on business models and sustainability transitions while offering practical insights for farmers, advisors, and policymakers seeking to strengthen the long-term viability of diversified cropping systems.

Keywords

Business model configuration logics; Diversified cropping systems; Agroecology; Farming systems

1 Introduction

Agricultural systems face increasing pressure to balance ecological integrity, economic viability, and social responsibility in response to climate change, biodiversity loss, resource constraints, and growing societal expectations for sustainable food production (Pretty et al., 2018; Willett et al., 2019; Rockström et al., 2009; Wilson, 2007). Addressing these challenges requires farm-level adaptation and system redesign in which ecological and economic objectives are jointly managed while fostering broader processes of agricultural innovation and sustainability transition (Tittonell, 2013; Duru et al., 2015; Klerkx & Begemann, 2020; Pigford et al., 2018). Consequently, diversified cropping systems are increasingly promoted as agroecological strategies that enhance biodiversity, improve soil health, and strengthen resilience (Tamburini et al., 2020; Wezel et al., 2013). Strip cropping, one form of diversified cropping in which different crops are grown in adjacent strips within a field, illustrates both the ecological potential of diversification and the organizational changes required to implement it.

Despite these benefits, diversified cropping systems present important organizational and economic challenges. They often require additional labor, knowledge, and coordination while reducing opportunities for economies of scale (Kremen and Miles, 2012; Tamburini et al., 2020; Darnhofer et al., 2010). Although research has demonstrated their potential to improve yield stability, resource-use efficiency, and pest and weed regulation (Lithourgidis et al., 2011; Duchene et al., 2017), adoption remains shaped by farmer motivations, institutional conditions, innovation processes, and environmental considerations (Morel et al., 2020; Klerkx & Begemann, 2020; Schut et al., 2016). Farmers therefore respond differently to similar sustainability challenges, resulting in diverse ways of organizing diversified cropping systems within broader innovation and institutional contexts (Carlisle et al., 2019; Ingram, 2017; Darnhofer et al., 2016; Schut et al., 2015). While previous research has primarily examined agronomic performance and adoption drivers, much less is known about how farmers organize their activities, relationships, and exchange arrangements to create the economic and social conditions needed to sustain diversified cropping systems.

This gap is particularly relevant in the Netherlands, where agriculture has historically been characterized by specialization, scale enlargement, and export-oriented commodity production (Council for the Environment and Infrastructure, 2013; de Haas, 2013; van der Heide et al., 2011). Although this model has generated high productivity, it has also contributed to environmental pressures and institutional path dependencies that constrain agroecological alternatives (Ruysenaars et al., 2021; Dirkx et al., 2014; Vink & Boezeman, 2018). As diversified cropping systems emerge within these highly specialized structures, their long-term viability depends not only on ecological performance but also on farmers' ability to develop organizational arrangements that create and capture value. Because many environmental and societal benefits remain insufficiently rewarded through conventional markets, farmers often rely on collaborations, alternative market channels, innovation support structures, and

institutional support to sustain these systems (Klerkx & Begemann, 2020; Darnhofer, 2020; Morel et al., 2020; Schut et al., 2016; Muradian et al., 2009). Yet, limited attention has been paid to how farmers translate these conditions into viable organizational arrangements at the farm level.

To address this gap, this study adopts a business model perspective, which conceptualizes how organizations create, deliver, and capture value through the configuration of activities, relationships, and resources (Zott et al., 2011). While farming systems research provides valuable insights into the interactions between biophysical, technical, and socio-economic components of farming systems (van Ittersum et al., 2007; Duru et al., 2015), it offers less explicit understanding of how farmers organize production, market relationships, and value capture to achieve long-term viability. We therefore conceptualize **business model configuration logics** as recurring ways in which farmers organize value creation, delivery, and capture to reconcile ecological and economic objectives under different farm and contextual conditions. These logics are not mutually exclusive farm types but organizing principles that farmers may combine and adapt to sustain diversified cropping systems under different farm and contextual conditions. Using a qualitative multiple-case study, this research addresses the following questions:

- (1) What business model configuration logics do farmers develop to create the economic and social conditions needed to sustain diversified cropping systems? and*
- (2) Which farm-level and contextual factors shape the emergence and evolution of these configuration logics?*

This study contributes to the literature in three ways. *First*, it extends research on diversified cropping systems beyond agronomic performance and adoption by explaining how farmers organize value creation, delivery, and capture to sustain diversified farming. *Second*, it advances understanding of farm heterogeneity by showing that farmers pursue distinct business model configuration logics to reconcile ecological and economic objectives under different ecological, market, and institutional conditions. Rather than representing a single model of agroecological transition, diversified cropping systems are sustained through multiple organizational pathways. *Third*, the study contributes to business model and sustainability transition research by demonstrating how business model configuration logics emerge from the interaction between farm-level resources, sustainability objectives, and broader contextual conditions. In doing so, it provides a framework for understanding how diversified cropping systems can become organizationally and economically viable while contributing to more resilient agricultural systems.

2 Materials and methods

2.1 Background materials

This section develops the theoretical framework used to analyze business model configuration logics in diversified cropping systems. Drawing on the business model literature, this study conceptualizes value creation, delivery, and capture as the fundamental mechanisms underpinning business model design and situates this perspective within agricultural contexts characterized by ecological complexity and heterogeneity among farmers. The section provides the conceptual foundation for examining how different configurations emerge and how they can be compared across cases. The framework examines how different logics emerge and are combined within farm-level business models.

2.1.1 Business Models

The business model concept refers to the architecture through which an organization creates, delivers, and captures value (Teece, 2010; Zott & Amit, 2009). In the business model literature, these three dimensions are considered central. Value creation refers to how organizations mobilize resources, capabilities, activities, and partnerships to generate value for customers and other stakeholders. Value delivery concerns how these offerings are provided to customers through organizational activities, processes, and channels. Value capture refers to how firms generate returns from these activities through revenue models, cost structures, and profit mechanisms (Osterwalder & Pigneur, 2010; Massa et al., 2017). Business models are therefore understood as systems of interconnected activities through which organizations coordinate resources, relationships, and exchanges to create value for different stakeholders (Zott & Amit, 2009). A business model encompasses the firm's value proposition, the resources and capabilities mobilized, the activities and processes undertaken, and the mechanisms for revenue generation and cost management (Osterwalder and Pigneur, 2010). It also links strategy to implementation by explaining how firms compete in the market and how technologies support value creation and capture (Baden-Fuller & Morgan, 2010; Verstraete & Jouison-Laffitte, 2011). Literature emphasizes that business models are not fixed structures but can be adapted through managerial decisions and organizational change (Massa et al., 2017). This perspective highlights the need to align business model elements with changing market conditions and organizational capabilities (Foss & Saebi, 2017; Chesbrough & Rosenbloom, 2002; Amit & Zott, 2001).

2.1.2 Business Model Configuration Logics

Recent business model research increasingly adopts a configurational perspective. While a business model describes the overarching architecture through which a firm creates, delivers, and captures value, business model configuration logics refer to recurring ways in which this architecture is implemented through combinations of activities, resources, and organizational choices (Zott & Amit, 2010; Massa et al., 2017). Rather than assuming a single optimal design, this perspective emphasizes that multiple viable configurations may emerge under different organizational and contextual conditions (Foss & Saebi,

2016; Massa et al., 2017). However, existing research has focused primarily on manufacturing, digital platforms, and other established organizational settings, providing limited understanding of how business model configuration logics emerge in primary agricultural production.

Diversified cropping systems provide a particularly relevant context for extending this perspective because organizational arrangements are shaped by ecological complexity, uncertainty, path dependency, and interactions among multiple actors (Darnhofer et al., 2010; Ingram, 2017). Farmers operate within constraints arising from previous investments, established market relationships, inherited production systems, and limited labor or financial resources, while business model development depends on coordination among farmers, buyers, processors, advisors, and policymakers (Turner et al., 2015; Menary et al., 2019; Schiller et al., 2019; Wojtynia et al., 2021). Consequently, organizational arrangements are shaped by both farm-level resources and broader institutional and market conditions. This perspective is consistent with the principle of equifinality, which suggests that there is no single optimal way to organize value creation, delivery, and capture. Instead, multiple business model configuration logics may provide equally viable pathways for achieving similar sustainability objectives under different conditions (Fiss, 2007; Meyer et al., 1993). This study examines how these business model configuration logics emerge in diversified cropping systems.

2.1.3 Factors shaping Configurations for Diversified Cropping Systems

Business model research shows that organizations operating under similar conditions may develop different configurations, reflecting alternative ways of organizing value creation, delivery, and capture (Teece, 2010; Massa et al., 2017). These configurations are shaped by both internal resources and capabilities and by external factors such as network relationships, market conditions, institutions, and infrastructure (Amit & Zott, 2001; Foss & Saebi, 2016; Zott & Amit, 2009). Although these insights have rarely been applied to diversified cropping systems, they provide a useful lens for understanding how farmers organize their activities under different ecological, economic, and institutional conditions. Research on diversified cropping systems has primarily focused on diversification as a strategy for income stabilization and risk reduction, while highlighting substantial variation in farm strategies and outcomes (Morris et al., 2017). However, the organizational processes underlying this variation remain poorly understood. In particular, limited attention has been paid to the resources, capabilities, and contextual conditions that shape the development of different business model configuration logics among diversified farms (Grande, 2011). As a result, diversification is often examined as a livelihood or production strategy rather than as a distinct way of organizing value creation, delivery, and capture activities (van der Ploeg et al., 2005). Recent research highlights that diversified farming systems are shaped by historical trajectories and path dependencies rather than being designed from a blank slate (Sabatier et al., 2026). Farmers' organizational choices are influenced by prior investments, established market relationships, inherited production systems, and socio-technical lock-ins. Understanding

variation in business model configurations therefore requires attention to both current farm conditions and the historical factors that shape them.

2.2 Methods

This study applies a qualitative multiple-case study approach to examine how farmers organize the economic and social conditions needed to sustain diversified cropping systems through different business model configuration logics. A case study methodology was selected because it enables an in-depth examination of complex organizational phenomena within their ecological, market, and institutional contexts, capturing how farmers configure activities, relationships, and value creation, delivery, and capture under real-world conditions (Stake, 1995; Dubois & Gadde, 2002). Case studies are particularly well suited to investigating emerging sustainability practices, as they facilitate the integration of empirical insights with theoretical development while allowing concepts to evolve iteratively throughout the research process (Ragin, 1992; Thomas, 2011).

2.2.1 Sampling of cases

The research sample consists of 16 farmers, primarily drawn from a Dutch subsidized project called CropMix (n.d.) on the implementation of diversified cropping systems. Initially, 23 consortium farmers engaged in diversified cropping systems were approached; 13 participated in interviews, while 10 either did not respond or declined the request. To complement this sample, three additional farmers were included through snowball sampling based on recommendations from participating farmers: one in the early stages of adopting diversified cropping systems and two who had discontinued such practices. Table 1 provides an overview of the case studies, including farm size, year of adoption, main crop types, and strip width.

Table 1 Overview case studies

#	Farm Size (ha)	Year farm started diverse cropping system	Main Crop Types	Strip Width (meters)
1	51	2018	Lupine, grain/legume mixture, spelt wheat, potato and corn	3
2	36	2019	Onions, sugar beets, potatoes and grains	21
3	7	2021	Potatoes, onions, wheat and sugar beets	39
4	72	2023	Alfalfa, wheat, peas, pumpkins, potatoes, onions, carrots, parsnips and red beets	9
5	140	2020	Potato, pumpkin, green beans, chicory, wheat	3-6
6	125	2018	Grains (various), rapeseed, sunflowers, quinoa, linseed, field beans, lucerne	0.75 – 9
7	2	2020	Potatoes, grass clover, cabbage, leeks, onions, legumes, root vegetables, fruit crops	1.6

8	20	2016	White/red/pointed cabbage, fennel, herbs, beans, pumpkins, barley	3
9	5	2020	Apples, pears, plums, potatoes, onions, cabbage varieties, sweet potatoes, carrots	1.5
10	10	2022/2023	Emmer (red, white, black), rye varieties	9
11	5	2020	Oats, legumes (soybeans, chickpeas), dry beans, flax, pumpkins, herbs	3–6
12	100	2017	Grass, oats, broccoli, parsnips, potatoes, onions, sweet corn, field beans	6
13	50	2005	Potatoes, sugar beets, winter wheat, summer rapeseed and flat crops	3
14	2	2019	Potatoes, onions, red beet, common wheat/oats/mixed crop	3
15	70	2019	Potatoes, sugar beets and grain	27
16	10	2019	Asparagus, rhubarb, cardoon, artichokes, different kind of vegetables, fruits, nuts and herbs	<= 3

2.2.2 Data Collection

The primary source of empirical data consisted of in-depth semi-structured interviews. An interview protocol was designed to explore how farmers organize the economic and social conditions needed to sustain diversified cropping systems through different business model configuration logics. Questions focused on value creation, delivery, and capture, stakeholder relationships, and contextual influences such as market access, logistics, and policy constraints. To understand farmers' organizational choices, interviews first identified diversification practices (e.g., strip width and crop combinations) and then explored the reasoning behind these decisions and their implications for farm organization, collaboration, and market positioning. By focusing on concrete decisions and experiences, the interviews generated rich empirical insights and strengthened construct validity (Flick, 2000; Yin, 2018). Follow-up questions were used to further examine adaptation processes and collaborative arrangements. All interviews were recorded, transcribed, and conducted using a consistent interview protocol.

To strengthen validity, multiple sources of evidence were combined through triangulation (Patton, 2002). Project documentation, websites, media materials, and reports provided contextual information on farm characteristics, organizational arrangements, and institutional settings, and were used to corroborate interview findings. This strengthened the credibility of the analysis and supported a more comprehensive understanding of how different business model configuration logics emerge and evolve within diversified cropping systems.

Table 2 Overview of Data Sources, Time Frame, and Analytical Use

Type of data	Source	Time span	Description	Analytical purpose
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Interview data	16 semi-structured interviews with farmers	Feb–Sept 2025	Interviews focused on e.g. diversification strategies, motivations, challenges, market relations	Primary empirical material for identifying key themes and patterns
Media content	3 podcasts and 5 sector media articles	Feb 2025–Feb 2026	Public discussions and narratives on e.g. diversified cropping systems, regenerative practices, sector challenges	Contextualization of interview data and comparison with broader sector discourse
Farm websites	Websites and social media profiles of participating farms (14 in total)	Feb 2025–Feb 2026	Information on farm activities, products, market channels, and organizational characteristics	Verification and supplementation of interview data
CropMix Project documentation	Internal reports and meeting notes	Jan 2025–April 2026	Primary documentation capturing iterative decision-making, stakeholder interactions, implementation adjustments, and fieldwork reflections	Used for process tracing, triangulation of interview findings, and analysis of knowledge development
Interview data from related CropMix project cases	Interview materials shared within the research project (5 interviews / summaries)	Jan–Jul 2025	Complementary empirical material from related cases within the same project	Triangulation and enrichment of interpretations
Informal conversations with chain partners	Informal discussions with chain actors, e.g. experts, researchers (approx. 5 interactions)	Feb 2025–Feb 2026	Contextual insights gathered during fieldwork and project activities	Contextualization and interpretation support (not used as primary coded data)

2.2.3 Data coding and analysis

After conducting and transcribing the 16 semi-structured interviews, the transcripts were imported into MAXQDA (VERBI Software, 2024) for systematic coding. Data analysis was organized around the two research questions. To address the first research question, which examines business model configuration logics in diversified cropping systems, we followed the Gioia methodology (Gioia et al., 2012; Figure 1). First-order concepts were coded closely to the interviewees' own language to preserve participants' perspectives. Through iterative comparison across cases, recurring codes were grouped into second-order themes capturing broader patterns in how farmers create, organize, and retain value. These themes were subsequently categorized into the business model dimensions of value creation, value delivery, and value capture. Following Amit & Zott (2001), value creation was treated as the core of the business model, while value delivery and value capture represented the organizational and transactional mechanisms supporting and monetizing that core. These aggregate dimensions constitute the final level of the coding structure shown in Figure 1 and reflect a deductive analytical step grounded in established theory. At the same time, the coding process remained open to inductive insights emerging from the empirical data.

To derive the business model configuration logics, we conducted a cross-case analysis following established comparative case study approaches (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). We first developed case summaries that synthesized how each farmer created, delivered, and captured value. The cases were then systematically compared to identify recurring patterns across these dimensions. Business model configuration logics were derived inductively from recurring and internally consistent combinations of value creation, delivery, and capture observed across multiple cases.

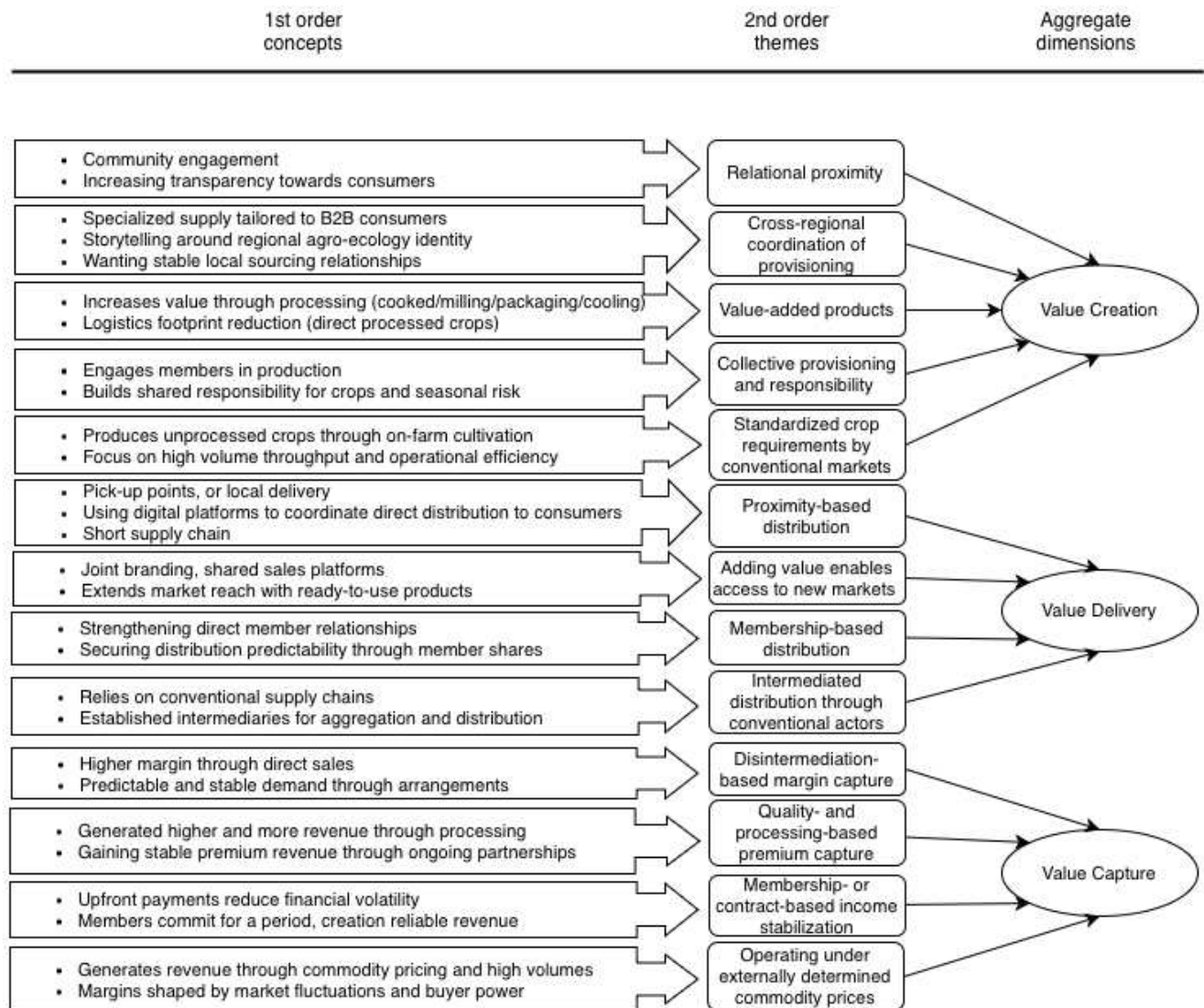


Figure 1 Data structure for BM types

The second research question focused on the factors that shape the business model configuration logics used by farmers implementing diversified cropping systems. The coding process followed a similar iterative structure; however, in this case, the aggregate dimensions were inductively derived from the empirical data rather than predefined theoretical constructs. These aggregate dimensions represent the final level of the coding structure, as shown in Figure 2.

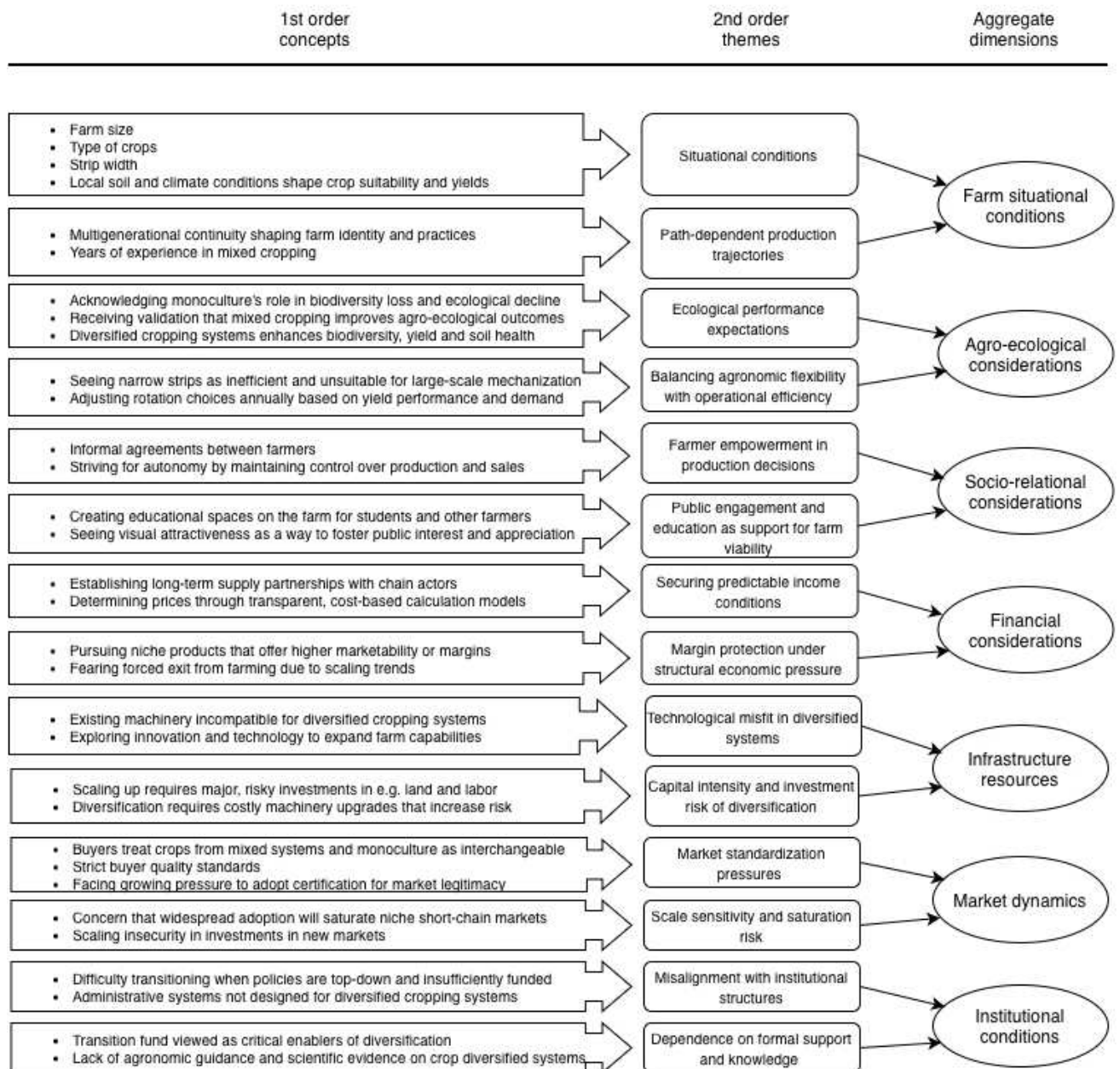


Figure 2 Data structure for variation factors

3 Results and discussion

This section presents the results of our analysis of how farmers organize the economic and social conditions needed to sustain diversified cropping systems. First, a cross-case analysis identifies recurring patterns across the studied farms, forming the basis for the identification and characterization of five organizational pathways. These pathways are interpreted through distinct business model configuration logics, which are subsequently discussed in relation to the existing literature, highlighting how our findings align with, extend, and refine previous research. The second subsection examines the farm-level and contextual factors shaping the emergence and development of these organizational pathways.

3.1 Business Model Configuration Logics

The cross-case analysis revealed five business model configuration logics that represent the main pathways through which farmers integrate diversified cropping systems into viable farm and market arrangements. Figure 3 summarizes these configuration logics together with their corresponding value creation, delivery, and capture mechanisms.

Farmer-to-Consumer	Producer-to-Partner	Raw-to-Processed	Local-to-Community	Biodiversity-to-Bulk
Value creation Relational proximity	Value creation Cross-regional coordination of provisioning	Value creation Value-added products	Value creation Collective provisioning and responsibility	Value creation Standardized crop requirements by conventional markets
Value delivery Proximity-based distribution	Value delivery Adding value enables access to new markets	Value delivery Adding value enables access to new markets	Value delivery Membership-based distribution	Value delivery Intermediated distribution through conventional actors
Value capture Disintermediation-based margin capture	Value capture Disintermediation-based margin capture	Value capture Quality- and processing- based premium capture	Value capture Membership- or contract-based income stabilization	Value capture Operating under externally determined commodity prices

Figure 3 Typology of Business Model Configurations Based on Value Creation, Delivery and Capture

Table 3 shows how these business model configuration logics are represented across the cases. Rather than relying on a single logic, many farmers combine multiple logics.

Table 3 Overview of Business Model configurations per Case

Case study	Farmer-to-Consumer	Producer-to-Partner Model	Raw-to-Processed	Local-to-Community	Biodiversity-to-Bulk
1		✓	✓		
2		✓			
3					✓
4	✓		✓		✓
5	✓	✓	✓		✓
6	✓	✓	✓		
7	✓	✓			
8	✓		✓		✓
9				✓	
10	✓	✓			
11	✓	✓			
12					✓
13					✓
14					✓
15					✓
16		✓			

3.1.1 Farmer-to-Consumer

The Farmer-to-Consumer configuration is characterized by the direct linking of diversified production systems to consumers, allowing ecological and social benefits to be recognized and rewarded through market exchange. In our results, *value creation* is grounded in **relational proximity**, where direct interaction, transparency, and visible crop diversity become important sources of value. Similar to Kremen and Miles (2012) and Tamburini et al. (2020), value is created not only through agricultural outputs but also through trust, consumer engagement, and the communication of ecological benefits. Our findings further show that farm visits, educational activities, and personal interactions enable farmers to translate biodiversity and ecological production practices into valued product attributes. *Value delivery* relies on **proximity-based distribution** through farm collection, local pick-up points, and subscription systems that maintain close producer-consumer relationships. Consistent with research on short food supply chains (Prost et al., 2023), geographical and relational proximity strengthen trust and transparency. In our cases, digital tools mainly supported coordination, while value delivery remained embedded in localized distribution networks and face-to-face interaction. *Value capture* is primarily achieved through **disintermediation-based margin capture**. By reducing dependence on intermediaries, farmers retain a larger share of product value and gain greater control over pricing. This reflects the view in business model literature (Chesbrough, 2009; Osterwalder & Pigneur, 2010), that value capture is closely linked to the organization of value creation and delivery. In our study, direct market access enables farmers to better reflect production costs, labor requirements, and ecological practices in product prices, while reduced reliance on conventional supply chains can strengthen economic autonomy and reduce exposure to market volatility (Darnhofer, 2014). Together, these

findings suggest that the viability of diversified cropping systems depends not only on production practices, but also on farmers' ability to capture value from ecological and social differentiation (Muradian et al., 2009).

3.1.2 Producer-to-Partner

This configuration integrates diversified cropping systems into coordinated value chain relationships. *Value creation* is driven by **cross-regional coordination of provisioning**, with farmers aligning production schedules, crop portfolios, and cultivation decisions to the needs of restaurants, retailers, and processors. As emphasized by Meynard et al. (2018), collaboration and coordination emerge as critical elements of diversified value chains. In our cases, however, coordination functions not only as a supporting mechanism but also as a source of value creation by enabling continuity of supply, product specialization, and quality standards that match buyer requirements. Value creation is therefore embedded in collaborative planning processes that connect production decisions to downstream market needs. *Value delivery* is organized through mechanisms whereby **adding value enables access to new markets**. Shared sales initiatives, regional branding arrangements, and collaborative distribution structures allow farmers to reach professional buyers that would be difficult to access individually. This reflects Prost et al.'s (2023) observation that diversification depends on organizational arrangements beyond the farm gate. Within our cases, value delivery extended beyond logistics alone, as traceability, regional identity, and communication of production practices strengthened buyer connections while maintaining producer visibility throughout the supply chain. Collective coordination thus enabled access to differentiated markets. *Value capture* is primarily achieved through **disintermediation-based margin capture**. Although intermediary actors remain involved, long-term sourcing relationships and negotiated agreements provide greater price stability and market security than anonymous commodity markets. Sustainability, traceability, and regional identity enabled farmers to capture price premiums while reducing exposure to market volatility. Rather than eliminating intermediaries altogether, disintermediation involved building closer and more coordinated relationships that allowed farmers to retain a larger share of the value generated.

3.1.3 Raw-to-Processed

The configuration is characterized by the integration of processing activities within diversified cropping systems. *Value creation* is based **on adding value** such as milling, cooking, drying, cooling, and packaging, which increase shelf life, convenience, and product differentiation. This reflects broader discussions of diversification beyond primary production (Prost et al., 2023). In our cases, processing enabled farmers to shape the destination and purpose of their products more actively than in conventional commodity markets, creating value through products that better match market demand. *Value delivery* is characterized by the principle that **adding value enables access to new markets**. Processing allows products that may be difficult to market fresh to enter alternative sales channels,

including retailers, supermarkets, restaurants, and institutional buyers. As such, processing functions not only as a production activity but also as a mechanism for market access. By extending shelf life and reducing perishability, it lowers logistical constraints and expands market opportunities that would otherwise be unavailable for raw agricultural products. *Value capture* is primarily achieved through **quality- and processing-based premium capture**. Through sorting, cleaning, packaging, and processing, farmers increase product usability and market value, enabling higher prices than for unprocessed commodities. The importance of value addition for improving farm income has also been noted by Meynard et al. (2018). In our study, processing further created revenue opportunities for products with limited fresh-market potential, reducing waste while increasing overall value capture.

3.1.4 Local-to-Community

The Local-to-Community configuration is characterized by the integration of collective relationships between farmers and community members. *Value creation* is based on **shared provisioning and responsibility**, whereby production, risk, labor, and consumption are distributed across farmers and members. This reflects research showing that diversified farming systems generate social, ecological, and economic value simultaneously (Duru et al., 2015; Wezel et al., 2013). In our cases, value extended beyond food production to include volunteer participation, knowledge exchange, stewardship, and collective responsibility for agricultural outcomes. *Value delivery* relies on **membership-based distribution**, where committed participation links production and consumption. Regular collection moments and predefined household commitments create a predictable distribution system in which demand is secured before production takes place. Repeating the results on farm systems research on managing uncertainty through social arrangements (Tittone, 2013; Darnhofer et al., 2016), this approach reduces demand uncertainty while maintaining strong connections between members and seasonal production dynamics. Value delivery is therefore embedded in long-term social commitments rather than conventional market exchanges. *Value capture* is achieved through **membership- or contract-based income stabilization**. Rather than depending on price premiums or sales volumes, farmers secure predictable income through membership fees, shared risks, and upfront commitments. Our findings therefore broaden conventional views of value capture by showing that financial stability can be as valuable as margin maximization. In this configuration, value capture is rooted in collective commitment and revenue security rather than market-driven pricing mechanisms.

3.1.5 Biodiversity-to-Bulk

The Biodiversity-to-Bulk configuration is characterized by the incorporation of diversified cropping systems into conventional market structures. *Value creation* is organized around the **volume, quality, and uniformity standards** required by wholesalers, cooperatives, and processors. This challenges the assumption that diversification necessarily requires alternative marketing arrangements. In our cases, practices such as crop rotations, mixed plantings, and biodiversity-enhancing measures primarily

functioned as agronomic strategies rather than sources of market differentiation, leaving value creation closely tied to buyer-defined standards and efficiency requirements. *Value delivery* relies on **conventional intermediaries**, with cooperatives, wholesalers, and processors coordinating aggregation, storage, transport, and distribution. As commonly observed in commodity supply chains, downstream actors largely determine product flows, limiting farmers' influence over marketing and final sales destinations. Value delivery is therefore characterized by scale, efficiency, and standardization rather than relational proximity. *Value capture* is primarily determined by **externally set commodity prices**. Rather than relying on branding, differentiation, or direct relationships, farmers depend on broader market dynamics to generate income. This reflects the influence of market concentration and path dependency in agricultural systems described by Darnhofer (2014) and Sabatier et al. (2026). In our cases, revenues depended largely on production efficiency, scale, and cost management, while existing market relationships, infrastructure investments, and production systems reinforced participation in commodity markets. Consequently, value capture remained strongly dependent on external market conditions rather than farm-specific differentiation strategies.

3.1.6 Combining different business model configuration logics

The patterns in Table 3 show that farmers frequently combine multiple business model configuration logics rather than relying on a single logic. *First*, the Biodiversity-to-Bulk logic often coexists with more differentiated logics such as Farmer-to-Consumer or Raw-to-Processed, allowing farmers to combine stable volume-based income with higher-margin market channels. *Second*, processing activities frequently complement both Farmer-to-Consumer and Producer-to-Partner logics by extending the marketability of crops across multiple value channels. *Third*, although some farms are characterized by a dominant logic, particularly Biodiversity-to-Bulk or Local-to-Community, elements of other logics are often present. These findings suggest that the identified logics are best understood as recurring organizational patterns rather than mutually exclusive business models. Farmers combine and adapt different logics to balance ecological objectives, market opportunities, and operational constraints according to their specific farm context. This observation is consistent with business model research, which conceptualizes business models as systems of interdependent activities (Chesbrough, 2009; Osterwalder & Pigneur, 2010), and with farming systems research, which emphasizes that farmers manage portfolios of activities under biophysical, economic, and institutional constraints rather than optimizing a single production strategy (Tittonell, 2013; Darnhofer et al., 2016; van Wijk et al., 2009). The findings also extend diversification research by showing that diversification involves not only combining crops and production activities but also combining different ways of organizing value creation, delivery, and capture (Duru et al., 2015; Wezel et al., 2013).

3.2 Factors for variation in business models

Our analysis indicates that not all business model configuration logics are equally feasible for every farmer. Rather, the logics that become prominent within a farm's business model are shaped by the interaction between internal and external factors. Internal factors include farm characteristics such as size, crop diversity, strip width, labor availability, skills, financial resources, agroecological conditions, and socio-relational considerations. External factors include infrastructure and processing facilities, market dynamics, and institutional and regulatory conditions that enable or constrain particular organizational arrangements. Together, these factors shape the business model configuration logics that farmers are able to develop, reflecting the interaction between farm-specific resources and broader environmental conditions emphasized in farming systems research (van Ittersum et al., 2007; Tiftonell, 2013). Accordingly, the business model configuration logics identified in this study should be understood as context-dependent organizational responses rather than universally applicable strategies. Even farms operating under similar agroecological conditions may develop different configurations because they differ in their resources, capabilities, networks, market opportunities, and institutional support.

3.2.1 Internal factors

3.2.1.1 *Farm situational conditions*

Farm situational conditions play a central role in explaining why farmers gravitate toward different business models, as they shape not only production capacity and marketing feasibility, but also crop choice and yield rotations. Specific **situational conditions**, particularly **farm size**, are especially decisive factors; however, their influence is closely intertwined with **the type and number of crops** cultivated, as well as with how **crops are harvested at different moments across the season**. Smaller farms often operate with limited volumes per crop and therefore rely on cultivating a wide range of crops simultaneously, resulting in lower yields per crop but greater overall diversity and a more continuous supply over time. This approach aligns closely with Farmer-to-Consumer, where variety becomes a key means of capturing value. As farmer 6 explained, who operates in the Farmer-to-Consumer configuration:

“All the growers I meet there use strip cropping, because they grow a wide variety: between 20 and 30 different crops. That way, they can fully stock their market stalls and supply everything themselves”

In contrast, farms with larger cultivated areas often generate volumes that exceed what can be absorbed through direct channels. These farmers therefore tend to engage with longer chain models such as wholesalers or supermarkets, where they have stable demand for large quantities. In some cases, farmers aim to market all their products directly to consumers, but the scale of their production can make this

difficult, as the volumes produced exceed what can realistically be sold through direct channels alone. As farmer 4 operating both Farmer-to-Consumer as Biodiversity-to-Bulk configurations explained:

“These are very interesting, short-chain customers, and that's growing.... However, less than 3% of what we produce goes into them. It does generate a good turnover, because within that short chain, you can also capture all the margins that other parties would otherwise get. We are a fairly large-scale, shared farm. We have 72 hectares in total. So, we can't sell everything directly to consumers. We simply produce too much for that.”

Finally, **multigenerational identity combined with diversified cropping experience shapes path dependency**, but not in a deterministic way. Farmers inherit production systems, market relations, and investments that influence later business model choices. Consistent with Sabatier et al. (2026) and Darnhofer (2014), business model development occurs through gradual adaptation rather than radical redesign. Some farmers build on inherited resources to develop more diversified and direct market models, while others remain oriented toward the stability of conventional supply chains and market their outputs through configurations such as Biodiversity-to-Bulk. This suggests that path dependency can act as both a constraint and an enabler, shaping which diversification opportunities become feasible over time.

3.2.1.2 Agro-ecological considerations

Ecological performance expectations shape not only the adoption of agro-ecological practices, but also farmers' business model configurations, as climate and environmental pressures challenge the conventional large-scale systems. A key dimension of these expectations **concerns biodiversity loss associated with monocropping**. Farmers problematize the ecological consequences of monocropping and explicitly link these concerns to a reorientation of their farming approach, affecting both how value is created and how it is communicated to the market. As farmer 10 explains:

“Yes, we started doing it primarily for biodiversity. We saw the iconic large-scale and in our eyes, there is a very important story of reduced diversity in it. And then we started to promote that and with us the eco plow also came. That was then for the soil and so one thing led to another.”

These ecological considerations drive changes that extend beyond agronomic practices alone and lead to a configuration of the source of system viability, where **biodiversity and soil health** become central product attributes. This, in turn, steers farmers towards business model configurations that rely on differentiation and closer market relations, such as Farmer-to-Consumer or Producer-to-Partner, rather than the Biodiversity-to-Bulk.

At the same time, diversified cropping systems introduces tensions with the efficiency-oriented configurations. Practices such as strip cropping reduce compatibility and could be seen as **inefficient and unsuitable for large-scale mechanization**, limiting the viability of high-volume, mechanized production models. As a result, farmers who have invested in large-scale equipment face difficulties adapting to smaller cropping systems, which can reinforce reliance on Biodiversity-to-Bulk. As farmer 15 points out:

“Three meters or 27 meters, if you go from large scale to small scale strip cropping, you lose efficiency. If you go from 27 meters to 3 meters, it becomes very difficult.”

In addition, crop rotations are adjusted annually in response to yield performance and market demand, increasing management complexity and creating a trade-off between agronomic flexibility and operational efficiency. Farmers who prioritize flexibility, resilience, and responsiveness to variable outputs are more likely to adopt Farmer-to-Consumer or Local-to-Community configurations, where product diversity and sustainability narratives create value. In contrast, farmers who prioritize efficiency, standardization, and compatibility with existing machinery tend to rely on Biodiversity-to-Bulk configurations, which depend on uniform production and stable volumes. This reflects agroecological research highlighting the biodiversity, resilience, and ecosystem benefits of diversified farming systems (Kremen & Miles, 2012; Tamburini et al., 2020), while suggesting that ecological objectives shape not only production practices but also business model choices. At the same time, these choices illustrate the challenge identified by Meynard et al. (2018): diversified systems must operate within infrastructures and markets that remain geared toward standardization and scale.

3.2.1.3 Socio-relational considerations

Socio-relational considerations shape business model choice by determining whether farmers can build direct interaction, maintain trust-based relationships, and make social visibility as part of value creation. These conditions differ across configurations and influence which models are feasible. **Informal agreements between farmers** play an important role particularly in short and hybrid chain models, such as Producer-to-Partner or Local-to-Community configurations. Informal collaboration enables coordination of production, sharing of knowledge and machinery, and collective risk management without formal contracts, particularly within localized networks. When farmers invest in **creating immersive educational spaces**, they tend to choose Farmer-to-Consumer Model, where direct interaction with visitors, consumers or even other farmers become a core element of the source of system viability. In these configurations, social engagement becomes an integral component of value creation. A focus on **striving for autonomy** further reinforces this choice. Farmers who prioritize control over production, pricing, and narratives are more likely to adopt Farmer-to-Consumer configurations, as these minimize dependence on powerful chain actors and allow greater self-determination. Similarly, when farmers can capitalize on **visual attractiveness** of the farmed landscape, they are more likely to engage

in Farmer-to-Consumer or Producer-to-Partner configurations, where visibility and public appreciation strengthen direct relationships with consumers. As illustrated in this part:

“At least the citizens who cycle here see it and stop to look and take pictures. That’s very nice, so that worked well.”

In contrast, when such socio-relational conditions are limited, farmers tend to rely on Biodiversity-to-Bulk configurations, where products enter anonymous supply chains and relational value is difficult to capture, as farmer 4 emphasized:

“We had to say, “Yes, in a supermarket somewhere in Germany,” but then you don't know if it's ours. We still sell a large portion of our products to an anonymous market. And that's a real shame, because then the story gets lost. But we are increasingly focusing on the short supply chain.”

The findings further reinforce the importance of social capital in agricultural innovation and diversification processes. Previous studies have emphasized that networks, trust, and collaboration facilitate knowledge exchange and support transitions towards more sustainable farming systems (Prost et al., 2023; Turner et al., 2015). Our findings suggest that socio-relational resources influence not only diversification processes themselves but also the business model configurations that become feasible. Relationships with consumers, neighboring farmers, and local communities provide important mechanisms through which farmers can create legitimacy, communicate source of system viability, and reduce dependency on anonymous market structures. Social relationships therefore function not merely as supporting conditions but as strategic resources within business model development.

3.2.1.4 Financial considerations

Financial considerations shape farmers’ business model choice by influencing how farmers balance risk, returns, and control over income streams. Rather than focusing only on absolute income, farmers evaluate stability, price transparency, and long-term security. When farmers prioritize **establishing long term supply partnerships**, they are more likely to adopt Biodiversity-to-Bulk configurations. Stable relationships with processors, or retailers reduce market uncertainty and provide predictable outlets for large volumes, even if this limits price premiums. As farmer 8 explained:

“I want to have long-term relationships with buyers, right? ... I do want a bit more certainty in those kinds of things.”

In contrast, when farmers prioritize **transparent, cost based calculation models**, they tend to adopt Farmer-to-Consumer or Producer-to-Partner. These configurations allow prices to reflect production costs and labor inputs more accurately, which is particularly important in diversified cropping systems

where standard pricing does not capture complexity. When farmers are **pursuing niche products**, they are more likely to combine this with configurations, such as Farmer-to-Consumer or Producer-to-Partner, where they can communicate product uniqueness and capture higher margins, as emphasized:

“They rely on being the only ones offering a unique product, supplying a specific restaurant or niche. That allows them to charge a higher price, and they do well with that.”

However, niche positioning also involves higher demand uncertainty, making them less suitable for farmers managing large volumes and standardized crops, who may instead rely on Biodiversity-to-Bulk Model. Finally, responses to **scaling trends** further shape business model choice. When farmers seek security within existing structures, they may move towards or remain in biodiversity-to-bulk configurations. In contrast, when such pressures are perceived as a threat to viability, farmers may deliberately shift towards Farmer-to-Consumer or even Raw-to-Processed, that reduce dependence on dominant actors. As illustrated here:

“Everyone is focused on the large-scale farming market, but in the end, the farmer does not benefit at all. Scaling up only leads to more farmers quitting.”

The findings add nuance to debates on economic viability in diversified farming systems. While diversification is often expected to enhance resilience and profitability, previous studies show that financial outcomes remain highly context dependent and shaped by market access and revenue structures (Meynard et al., 2018; Darnhofer et al., 2016). Our results suggest that farmers differ not only in the amount of value they seek to capture, but also in the mechanisms through which financial security is achieved. Some prioritize stable market outlets and predictable demand, whereas others emphasize price transparency, niche marketing, and greater control over value capture. Economic sustainability within diversified cropping systems therefore appears to be achievable through multiple business model pathways rather than a single optimal approach.

3.2.2 External factors

3.2.2.1 Infrastructure resources

Infrastructure resources shape business model choice by enabling or constraining specific pathways. The configuration of machinery, technology, land, labor, and on-farm facilities determines which models are feasible. When farmers engage in **exploring innovation and technology to expand farm capabilities**, such as on-farm processing, storage, and adaptable machinery they are more likely to adopt value-retention configurations, such as Raw-to-Processed, where combining activities increases value capture and supports autonomy. When infrastructure is optimized for scale and efficiency, farmers tend to adopt Biodiversity-to-Bulk configurations, as large machinery and standardized systems require high and stable volumes and align with long-chain markets.

Diversification poses a different infrastructural challenge. When it requires specialized or parallel equipment, farmers face higher complexity and capital exposure. Moreover, **existing infrastructure is frequently optimized for monoculture or bulk production and becomes incompatible with diversified cropping systems**, creates lock-in effects that limit transition towards alternative configurations. As farmer 11 noted:

“In a large monoculture courgette field, you can harvest mechanically... In strip farming, I can’t do that. I have to harvest differently, with a wheelbarrow and some crates.”

The importance of infrastructure resources corresponds with previous research identifying machinery, storage, and processing facilities as critical constraints in diversification processes (Meynard et al., 2018). However, our findings suggest that infrastructure does more than constrain production choices. It also influences which business model configurations are feasible by enabling or restricting specific mechanisms of value creation, value delivery, and value capture. This observation supports arguments by Prost et al. (2023) that diversification should be understood as an organizational challenge extending beyond primary production and involving broader resource configurations throughout the value chain.

3.2.2.2 Market dynamics

Market dynamics shape business model choices by determining whether diversification is recognized and rewarded within existing market structures. When diversified cropping systems is **treated as interchangeable with monoculture**, and buyers prioritize **standardized attributes such as size, appearance, and delivery volumes**, farmers are more likely to adopt Biodiversity-to-Bulk, as these align with price-driven, volume-oriented markets:

“Those buyers won’t say, ‘Oh, that’s nice you’re growing in strips, here’s a few cents more for your product’”

In contrast, farmers seeking to differentiate products based on ecological value are more likely to adopt Farmer-to-Consumer configurations, where direct interaction helps translate production practices and crop diversity into value. Certification further shapes this choice. When market access depends on formal certification, farmers tend to engage in Biodiversity-to-Bulk configurations, where certification functions as both a market requirement and a mechanism for reducing uncertainty. For example, retailers and supermarkets often require certification to verify compliance with standards such as organic production. Where direct relationships can substitute for formal certification, farmers are more likely to adopt short-chain models based on trust and transparency. As Farmer 4 noted:

“Last year, we were still left with some of our carrots because there was far too much production, and too little demand. And with Demeter certification, you simply have a broader sales opportunity.... So that's a real loss. But with the way we grow and the story of our company, we've noticed that we definitely reach consumers directly. A certain group of consumers is very interested in what we do. And even five years ago, when we started this and launched [farm name], we were immediately approached quite a lot, asking, "Oh, interesting, where can we buy your vegetables?"”

While niche and short-chain may reward diversity, farmers expressed concern that broader adoption would quickly saturate these short-chain markets. When farmers rely on niche strategies, they tend to adopt Farmer-to-Consumer or Producer-to-Partner configurations, but these depend on limited and exclusive demand, as noted by another farmer:

“Actors “rely on being the only ones offering a unique product”, but at the same time warned that “if we all start doing that, we will destroy their market””

This concern is closely linked to **scaling insecurity and investments in new markets**. When farmers anticipate market saturation or unstable demand, they often adopt hybrid configurations that combine differentiation with more stable, volume-based channels. This reflects broader observations that agricultural markets reward standardization, consistency, and scale rather than ecological complexity (Meynard et al., 2018; Wezel et al., 2013). In our study, farmers frequently struggled to translate ecological benefits into economic value within conventional markets, while niche and short-chain markets were themselves constrained by limited demand. The findings therefore suggest that the viability of diversified cropping systems depends not only on production innovation, but also on markets that recognize and reward diversification.

3.2.2.3 Institutional conditions

Institutional conditions shape business model choice by determining which transitions are supported, administratively manageable, and considered legitimate within policy frameworks. When farmers face **difficulties attempting to transition toward diversified production or alternative business models under policy frameworks perceived as top-down, fragmented, or insufficiently funded**, they are more likely to remain in Biodiversity-to-Bulk or Producer-to-Partner configurations, which align with existing support structures. Transitions toward Farmer-to-Consumer, Local-to-Community, or Raw-to-Processed involve upfront investments and temporary income losses making experimentation financially risky. As one farmer explained:

“The risk is so high, and no one pays you to take that risk. We invest a huge amount, and at the end of the day we just want to be able to pay the bills and make a living.”

Administrative systems further differentiate business model choice. When these systems are designed around simplified production and single market outlets, farmers tend to adopt standardized, long-chain configurations to reduce reporting complexity. In contrast, models based on diversification and multiple channels, such as Farmer-to-Consumer, become less feasible due to higher administrative burdens. When farmers face a **lack of guidance and reliable knowledge on how to redesign rotations, manage biodiversity, and maintain yields under more complex systems**, they are more likely to remain in Biodiversity-to-Bulk configurations, as these rely on established and proven practices, as farmer 13 noted:

“A proven system. So why go through all the trouble to change it? ... Then someone who doesn’t plow says, ‘I get about the same yield.’ Well, then why do it? Why take the risk?”

In contrast, when institutional support is accessible, flexible, and aligned with diversification, farmers are more likely to adopt short-chain and alternative configurations, as financial and knowledge barriers are reduced. This highlights the broader role of institutions in enabling or constraining business model innovation. Consistent with agricultural transition research emphasizing the importance of policy support, advisory systems, and innovation networks (Weber & Rohrer, 2012; Turner et al., 2015; Wojtynia et al., 2021), our findings suggest that institutional arrangements shape not only the adoption of diversified cropping systems but also the feasibility of particular business model configurations.

4 Concluding remark

This study identified five organizational configuration pathways through which farmers create the economic and social conditions needed to sustain diversified cropping systems during agroecological transition: Farmer-to-Consumer, Producer-to-Partner, Raw-to-Processed, Local-to-Community, and Biodiversity-to-Bulk. These pathways are underpinned by distinct business model configuration logics that reflect different ways of organizing value creation, delivery, and capture. The findings show that farmers pursuing similar sustainability goals develop markedly different organizational strategies depending on how they align their resources, capabilities, and networks with ecological, market, and institutional conditions. Rather than following a single trajectory, farmers adopt and adapt multiple pathways that respond to the opportunities and constraints of their operating environments. By linking diversified cropping systems with a business model perspective, this study demonstrates that the viability of agroecological transitions depends not only on ecological performance but also on how farmers organize the economic and social conditions that enable diversified farming to persist over time. The identified organizational pathways, and the business model configuration logics that underpin them, provide an analytical framework for understanding these organizational choices and the factors that shape them. These insights can inform more context-sensitive policy and advisory support aimed at strengthening the long-term viability of diversified farming systems. Future research could build on

these findings by examining how organizational pathways and their underlying business model configuration logics vary across regions, evolve over time, and relate to economic, environmental, and social performance outcomes. Such work would further advance our understanding of how diversified cropping systems can contribute to resilient and sustainable food systems.

4.1 Theoretical Implications

Taken together, the findings contribute to the literature in three ways. *First*, they extend research on diversified cropping systems beyond adoption and performance outcomes by identifying five business model configuration logics through which farmers organize value creation, delivery, and capture (Morel et al., 2020; Morris et al., 2017). The findings demonstrate that diversification is not associated with a single organizational approach but can be pursued through multiple business model configuration logics that may coexist and be combined within individual farms. This highlights that diversification involves not only changes in production systems but also diverse ways of organizing economic activities around those systems. *Second*, the findings contribute to discussions of farm heterogeneity by showing that farmers operating under similar agroecological and institutional conditions can configure their business models differently to reconcile ecological and economic objectives (Ingram, 2017; Darnhofer et al., 2016). Rather than following a common transition pathway, farmers combine and prioritize different business model configuration logics according to their resources, capabilities, networks, and contextual opportunities. These challenges simplified distinctions between conventional and alternative farming systems and suggests that multiple organizational pathways can coexist within diversified cropping systems. *Third*, the findings extend business model research to diversified cropping systems by showing how business model configuration logics emerge from the interaction between farm-level resources, sustainability objectives, and contextual constraints. Consistent with business model literature, organizational arrangements are shaped by the interaction between internal resources, network relationships, and external conditions (Amit & Zott, 2001; Foss & Saebi, 2016; Zott & Amit, 2010). Rather than resulting solely from differences in sustainability ambitions, the configuration logics identified in this study reflect how farmers align ecological goals with available resources, market opportunities, and institutional conditions. Conceptualizing these patterns as configuration logics helps explain why farms with similar sustainability objectives may nevertheless organize value creation, delivery, and capture in markedly different ways. More broadly, the findings contribute to discussions on agricultural transitions in the Netherlands. Previous studies have argued that the scale and export orientation of the Dutch agri-food system create tensions between economic performance and ecological sustainability (Council for the Environment and Infrastructure, 2013; Berkhout et al., 2018; Van Egmond et al., 2018; Wojtynia et al., 2021). While transition pathways are often framed in terms of technological innovation or agroecological redesign, the results suggest that business model development constitutes an equally important dimension of change. In line with sustainability transition research emphasizing multiple pathways and context-dependent processes of change (Geels, 2019;

Köhler et al., 2019), diversified cropping systems appear to develop through multiple coexisting business model configuration logics that reflect different combinations of ecological design, market integration, and value chain coordination.

4.2 Practical Implications

The five configurations offer practical guidance for farmers, advisors, and policymakers by clarifying the types of conditions under which each business model is likely to be viable and how models can complement or evolve into one another. Table 4 provides an overview of the practical implications of the five configurations, specifying the contextual conditions that support each business model type and indicating potential complementarities or transition pathways between configurations.

Table 4 Practical Implications of the Five Business Model Configurations

Business Model Configuration	Most Suitable When Farms...	Complementary or Evolving Models
Farmer-to-Consumer	• Are small or medium sized and located near population centers • Rely on transparency, and direct interaction to create value • Benefit from flexible production and regular consumer contact	• Combines naturally with Producer-to-Partner Model • Can evolve toward Raw-to-Processed when farms add simple processed goods
Producer-to-Partner	• Benefit from shared logistics and coordinated supply • Work with restaurants, retailers, or institutional buyers • Operate effectively through co-branding or pooled products	• Fits well with Raw-to-Processed when partners collaborate on processing or joint branding • Connects to Farmer-to-Consumer when local consumer value regional identity
Raw-to-Processed	• Have access to processing capacity • Aim to stabilize income through differentiated or shelf-ready products • Supply consistent quality for premium or niche markets	• Links to Farmer-to-Consumer through direct sales of processed goods • Links to Producer-to-Partner through collective processing or co-development
Local-to-Community	• Prioritize social relationships, community engagement, and shared responsibility • Operate through memberships, subscriptions, or cooperative structures	• Can transition into Producer-to-Partner when community networks expand
Biodiversity-to-Bulk	• Operate at larger scales with mechanized, standardized production • Supply commodity chains requiring uniformity and volume • Align with long-chain logistics and bulk procurement systems	• Connect with Producer-to-Partner through coordinated logistics • Can evolve into Raw-to-Processed models to expand market access, diversify retail offerings, and capture higher margins through processing and value addition

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Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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