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Harvesting Value! Exploring How Climate-Smart Agriculture Practices Change Farm Business Models in Europe

Christopher Galgo Jr.[1] | Gohar Isakhanyan[2] | Jos Bijman[1] | Verena Otter[1] | Marilena Gemtou[3]

[1]Business Management and Organisation Group, Wageningen University and Research, Wageningen, the Netherlands | [2]Wageningen Social & Economic Research, Wageningen University and Research, Wageningen, the Netherlands | [3]Department of Natural Resources Development and Agricultural Engineering, Agricultural University of Athens, Athens, Greece

Correspondence: Christopher Galgo Jr. (christopher.galgo@wur.nl)

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ABSTRACT

Climate-smart agriculture (CSA) is essential for sustainable farming. However, the adaptation of farm business models (BM) for widespread CSA implementation in Europe remains underexplored. This article investigates how CSA practices change or innovate farm BMs. Applying a multiple case study design based on 30 semistructured interviews with farmers across five European countries, we implement a BM value framework and BM change typologies to uncover the underlying management mechanisms. Findings reveal that CSA practices trigger incremental BM changes rather than radical BM innovations, improving operational efficiency and environmental benefits. Although value creation and delivery are enhanced, value capture faces unresolved challenges. Effective BM changes require improved value propositions and better capture mechanisms. The study contributes to the CSA literature by providing empirical evidence on the pathways of BM change, clarifies the BM change and BM innovation distinction, and broadens the scope from technological improvements to business strategies needed for sustainable farming practices.

1 | Introduction

The simultaneous achievement of SDG 2 "Zero Hunger" and SDG 13 "Climate Action" remains a critical challenge for the global food system (The World Bank 2015, 2024b; United Nations 2024a, 405). Despite its high development status, Europe is one of the regions showing regression in sustainable food system development (United Nations 2024b). Farmers struggle to comply with increasingly strict environmental regulations, while they face uncertainty due to volatile weather conditions. Compounding these pressures, farmers sense unfairness as they experience a diminishing share of value-added on their farming product relative to other actors in the food chain (Copa-Cogeca 2024; Matthews 2024). This perceived unfairness has fueled sociopolitical tensions, evident in recent farmers' protests across several EU Member States, highlighting their vulnerability during the transition process towards a climate-smart food system (Alvi et al. 2020; Matthews 2024; von Gehren et al. 2023).

Climate-smart agriculture (CSA) offers an integrated approach to address the interlinked challenges of food security and climate change (The World Bank 2024a). Although EU policy agendas such as the Common Agricultural Policy and the Green Deal foster CSA practices, implementation rates continue to remain rather low. Farmers mainly focus on those practices necessary for obtaining subsidies, due to barriers at the farm and sector levels (Gemtou et al. 2024; Pedersen et al. 2024). A key barrier to diffusion is the difficulty in demonstrating the value of the practices (Long et al. 2017). Although CSA holds potential for creating economic, environmental, and social value, these values are not realized as farmers face difficulties in bringing sustainable value to the market (Hansson et al. 2023). Farmers continue to struggle with implementing CSA profitably into their businesses, often as a result of not understanding how to integrate sustainable solutions into their existing business models (BMs) and not knowing what new BMs are feasible (Ulvenblad et al. 2018; Ulvenblad et al. 2019).

Research on BMs in the agrifood sector is relatively new (Barth et al. 2021; Tell et al. 2016) and builds primarily on the strategy and innovation literature (Baden-Fuller and Haefliger 2013; Bohnsack et al. 2014; Boons and Lüdeke-Freund 2013). Existing studies underscore the crucial role of new BMs in facilitating the diffusion of CSA technologies (Groot et al. 2019; Long et al. 2017) and highlight the role of key enablers such as intermediaries who support farmers in the uptake of CSA technology (Long et al. 2016). However, the literature has not paid attention to how CSA implementation changes or innovates the existing farm BMs. This is remarkable, given that the value created by CSA implementation fundamentally depends on how well the practices integrate with the farm's existing way of creating, delivering, and capturing value. Addressing this gap is significant as it may provide insights into how CSA-created value is delivered and captured. Such insights may also provide farmers with guidance on how to alter their existing BMs to accommodate CSA practices without compromising economic viability.

Additionally, the BM literature is predominantly focused on CSA technologies, referring to drones, software, and remote sensing (e.g., Groot et al. 2019; Kirina et al. 2022; Senyolo et al. 2023), neglecting the BM implications of CSA practices. CSA practices encompass comprehensive methods, strategies, and approaches that integrate CSA technologies, aimed at increasing productivity, enhancing resilience, and reducing greenhouse gas emissions (Erekalo et al. 2024). This technological focus leads to disproportionate attention to technology enablers' perspectives on farmers' experiences, ultimately reducing farmers to binary categories of adopters and nonadopters (Glover et al. 2019; Smith et al. 2021) rather than recognizing them as strategic actors navigating complex BM adaptations when implementing CSA.

To address these gaps, our study posed the following research question: How does the implementation of CSA practices change or innovate the BMs of farms? The study used an embedded multiple case study design, using data gathered through semistructured interviews with farmers. Each case is represented by a farm implementing CSA practice. Within each case, we examined the components of the existing BM—value creation and delivery, value proposition, and value capture—and the types of BM changes due to the implementation of CSA practices. We use the value-oriented BM framework by Richardson (2008) to describe the existing BMs of the farms and the typology of BM change by Santos et al. (2015) to identify and describe the changes in the existing BMs.

Our study contributes to theory and practice in several ways. For theory development, it provides comprehensive empirical evidence on how CSA practices change or innovate the BMs of farms. This evidence reveals patterns that establish links between the types of BM change and implementation challenges, advancing our understanding of how the implementation of sustainable solutions affects farms from a BM perspective. The study also advances the debate on the distinction between BMC and BMI, two concepts often used interchangeably in the BM literature. Additionally, we address key criticisms of the CSA literature by exploring CSA practices and highlighting the business challenges of farmers when seeking to implement CSA practices. For practice, our findings offer guidance for farmers seeking to adopt CSA practices by helping them prioritize key aspects needed to realize the value of their CSA practices and better assess their implementation strategies. The identified support mechanisms can offer guidance for policymakers in designing targeted support.

The rest of the paper is structured as follows. Section 2 presents the theoretical framework; Section 3 presents the methodology; Section 4 presents the results; Section 5 presents the discussion, contribution, and limitations; and Section 6 presents the conclusion and future research direction.

2 | Theoretical Framework

The existing literature establishes the role of new BMs as mechanisms to facilitate the adoption or diffusion of CSA technological innovations (Groot et al. 2019; Kirina et al. 2022; Long et al. 2017). Meanwhile, the BM has also been used as an analytical tool or as a unit of analysis to identify barriers and drivers of BMs for CSA technologies (e.g., Partalidou et al. 2018; Sivertsson and Tell 2015). To explore how CSA implementation changes existing farm BMs, our study uses two complementary frameworks together for a comprehensive lens: the value-oriented BM framework by Richardson (2008) and the typology of BMC by Santos et al. (2015).

2.1 | Value-Oriented BM Framework

The BM framework by Richardson (2008) offers a lens for analyzing the value orientation of existing BMs of farms, focusing on three core components: the value creation and delivery, value proposition, and value capture. The value creation and delivery comprise how the farm creates and delivers value to its customers and the source of its competitive advantage, particularly its resources and capabilities, activity system, and position in the value network. The value proposition describes the farm offering, its target customer, and the basic strategy to win customers and gain a competitive advantage. Lastly, the value capture focuses on how the farm generates revenue and profit. Although Richardson's (2008) BM framework enables identifying which of the BM components change due to CSA implementation, it does not allow for revealing the nature and extent of these changes.

CSA practices are aimed at improving farm productivity and income, reinforcing the resilience of farms, mitigating production risk and vulnerability, reducing greenhouse gas emissions, and improving soil quality (De Pinto et al. 2020; Lipper et al. 2017; Steenwerth et al. 2014). Implementing such practices may change one or more of the three components of Richardson's (2008) BM framework. For example, CSA practices such as the use of cover and catch crops, crop rotation, and intercropping systems change value creation by optimizing resource use, such as water and fertilizers; reducing resource use in weed control (Grzebisz et al. 2022; Jensen et al. 2020; Rivière et al. 2022); and improving soil health and biodiversity. Additionally, practices like integrated pest management or precision chemical weeding could reduce herbicide use by up to 100% with no yield reduction (Hamouz et al. 2013). Implementing integrated pest management practices changes the value proposition by enabling farms to differentiate their products as low-pesticide or pesticide-free, targeting a market segment that values environmentally responsible production methods (Durham and Mizik 2021). The CSA practice climate-smart fertilization may change the value capture mechanisms of the farm through the reduction in costs when the use of a variable rate of *N* application reduces up to 10% total cost and 8%–19% reduction in N fertilizer utilization (Fabiani et al. 2020).

2.2 | BM Change Versus BM Innovation

The business literature is still inconclusive on what constitutes business model change (BMC), particularly in the context of sustainable agriculture practices, and is often used interchangeably with business model innovation (BMI) (Geissdoerfer et al. 2018). In our study, the term BMI distinctly refers to the conceptualization and implementation of a new BM. This could be the development of entirely new BM, the diversification into an additional BM, the acquisition of a new BM, or the transformation from one BM to another (Geissdoerfer et al. 2018, 406). In contrast, BMC involves strategic adjustments in the existing BM, such as linkages to other firms, organizational boundaries, or geographic locations of production and sales (Santos et al. 2015).

The distinction between BMC and BMI is crucial in understanding the impact of CSA implementation as both approaches present distinct challenges and opportunities. BMC builds on existing BMs and may require farms to navigate organizational inertia and path dependencies while benefitting from established legitimacy (Massa and Tucci 2013). For instance, a farm transitioning to implement intercropping systems must overcome resistance from established routines like addressing pests with chemicals, fertilizer use, retraining workers, and modifying existing supplier relationships. In contrast, BMI implies that farms face greater uncertainties (Massa and Tucci 2013). For example, farms implementing manure and slurry management to diversify into new BMs by creating value from waste may face uncertainties about technology effectiveness, regulatory requirements, and market viability while needing substantial new resources and capabilities (Karlsson 2019).

The typology of BMC by Santos et al. (2015) provides a systematic way to examine changes among BM components by distinguishing four types of BMCs: reactivating, relinking, repartitioning, and relocating. *Reactivating* occurs through the addition or removal of key farm activities, such as when implementing no-tillage practices requires the use of different plant varieties and other soil monitoring practices (Skaalsveen and Clarke 2021). *Relinking* occurs through alterations in linkages between activities and connections with other firms, for instance, when new CSA practices require the purchase of different inputs (Weituschat et al. 2023 or open up different marketing channels, such as adding online sales (Carmona et al. 2021). *Repartitioning* occurs when insourcing or outsourcing leads to changes in the organizational boundaries, for example, when feed is self-produced to increase the autonomy of the farm (Faux et al. 2025). *Relocating* involves shifting the physical location of firm activities, such as when farms add crop production in other climate zones to be able to produce year-round (Skarbø and Vandermolen 2016).

Each type of change can be interpreted as a unique pathway for CSA implementation. The importance of understanding these types of changes lies in their strategic and operational implications (Santos et al. 2015). Reactivating, for example, often requires incremental and operational adjustments to the farm's day-to-day activities. In contrast, repartitioning and relocating are more disruptive, involving significant shifts in organizational structure and external relationships. Understanding these changes allows the design of targeted strategies, ensuring that farms have the resources and incentives needed to integrate CSA into their BM (Kaine et al. 2024).

The combination of the value-oriented BM framework and the typology of BMC provides a systemic framework for analyzing how the implementation of CSA practices changes the existing BM. By analyzing whether CSA primarily changes value creation, value delivery, and/or value capture, and whether it manifests as reactivating, relinking, repartitioning, or relocating activities, this framework helps to understand the options for and barriers to the implementation of CSA practices into the existing BM.

3 | Methodology

The study was conducted as part of the Horizon Europe BEATLES project (Behavioral Change Towards Climate-smart Agriculture; https://beatles-project.eu). We employ an embedded multiple case study design, appropriate for exploratory research and understanding contemporary phenomena in real-life contexts (Yin 2018). Each case is represented by a farm implementing specific CSA practices; within each case, we examine the types of changes in each of the components of the existing BM, that is, in the value proposition, the value creation and delivery, and the value capture. Through in-depth investigation, this approach captures the nuances and contextual factors influencing the phenomenon. To operationalize this approach, semistructured interviews were conducted. Such interviews are widely used in case studies to explore complex phenomena within a specific context and gain a deep understanding of participants' perspectives (Bhalla et al. 2023; Naz et al. 2022).

3.1 | Case Selection

The selection of farms for this study was informed by the BEATLES project, which established five pilots representing five diverse agricultural systems across European regions. The five systems are wheat production in Lithuania, dairy farming in Germany, apple production in Spain, pig farming in Denmark, and onion and potato farming in the Netherlands. These agricultural systems represent the major production systems in the EU, accounting for 45% of agricultural land and forming the backbone of EU agricultural exports. This diversity enabled a comprehensive analysis of how CSA practices trigger different types of changes in the components of the BM of farms across varied agricultural contexts. Farms implementing at least one CSA practice were purposively selected within the pilots to ensure diversity in CSA practices. Respondents were farmers who are either the owner or the manager of the farm, with comprehensive knowledge of the BM, farm history, and specifics of CSA implementation. This selection approach ensures that participants can provide detailed insights into the integration of CSA practices within their BMs. The CSA practices analyzed in each case are elaborated in Table 1.

3.2 | Data Collection

Thirty semistructured interviews were conducted from February to May 2024, distributed over Denmark (6), Germany (4), Lithuania (10), the Netherlands (5), and Spain (5). Interviews lasted 35–90 min (average of 41 min) and were conducted with farmers who are either the owner, part owners, or managers and who have comprehensive knowledge of farm operations and CSA implementation. CSA implementation periods spanned from 2000 to 2023, providing longitudinal insights into the integration of practices. Farm sizes varied significantly across countries, ranging from 10 to 2200 ha, with the following averages: Denmark (457 ha), Germany (51 ha), Lithuania (371 ha), the Netherlands (175 ha), and Spain (30 ha). Compared with the average size of an EU agricultural holding (17.4 ha) in 2020 (Eurostat 2022), our sample shows an overrepresentation of large farms across all countries.

For the semistructured interviews, an interview guide was developed by the authors containing three main sections: (1) introduction and background information, (2) CSA practices and technologies used on the farm, and (3) changes in the BM components due to the implementation of CSA practices (see Appendix S1). To address potential concerns about the reliability of retrospective accounts for earlier implementation, we employed concrete questions about specific BM component changes, such as changes in customer targeted, ways of engaging with customers, resources, investments, cost structure, partnerships, sources of revenue, key activities, actors performing these key activities, and linkages of these activities, rather than general BM questions. Ensuring that the respondents are owners and/or managers who have been involved since the initial CSA implementation provides firsthand accounts that enhance reliability. More importantly, our focus on the type of changes rather than precise implementation timelines reduces our dependence on exact temporal accuracy. The guide was developed in English, was iteratively refined within the research team, and was pretested. Recruitment of respondents was done in collaboration with local partners in the BEATLES project, who were also the interviewers. Making use of local partners addressed the challenges that can be anticipated in qualitative research in a cross-national setting (Fryer 2019), particularly finding appropriate respondents and obtaining sufficient depth and detail in qualitative data. A protocol outlining practicalities, including a text for the invitation, instructions to recruit respondents, and informed consent forms, was developed to support the interviewers. Before conducting the interviews, approval by an ethics review committee was obtained, and a 1.5-h training of interviewers was done. The interviews were conducted either in person or using Microsoft Teams and were recorded with the respondents' consent. Notes from the interviews were also taken by the interviewers. Recordings of the interviews were stored safely and uploaded to the project's storage system. The recordings were then transcribed using TRINT and Microsoft Word and translated to English using DeepLPro. Transcript quality was ensured through interviewer verification and interview notes.

3.3 | Data Analysis

The study employed codebook thematic analysis (Braun et al. 2019), an analytical method that integrates structured a priori coding with the flexibility to refine codes during the analytical process. This approach was instrumental in identifying which component of the BM is changed and the type of BM changes. Figure 1 provides an overview of the entire data analysis process.

The analysis began with the development of the codebook using the components of the existing BM according to Richardson (2008) and the typology of BM changes by Santos et al. (2015) as provisional codes to guide the analysis. Guided by the codebook, the first author simultaneously engaged with data familiarization and incorporated the technique of data reduction in thematic analysis (Miles and Huberman 1994) to focus the analysis on the most relevant information. Data reduction helped manage the vast amount of data collected through the interviews, allowing for a focused and comprehensive examination of the most pertinent data in relation to the research question (Miles and Huberman 1994). The resulting interview dataset was systematically coded by the first author on paper, identifying themes aligned with the theoretical framework. To enhance reliability, the initial coding progress was discussed with the co-authors to ensure that coding remained consistent with the study's theoretical foundations and the research objectives.

A critical step in the analysis involved revising and defining the identified themes. This step revealed difficulties in distinguishing between changes, outcomes, and value. For instance, although “improved soil health” was reported by a respondent as a change in value creation, we did not consider it a change in BM but rather an outcome of a change in value creation activities. This distinction required an iterative refinement process to accurately categorize changes in the BM. Furthermore, this nuanced understanding allowed for a clearer differentiation between the changes in BM, consistent with the Santos et al. (2015) typology and the outcomes of those changes.

4 | Results

Analysis of CSA implementation across 30 European farms reveals patterns in how CSA implementation changes farm BMs. This section presents the empirical evidence across cases for BM changes by types according to Santos et al. (2015), observed for each key BM component following Richardson (2008). The results are summarized in Table 2.

TABLE 1 | Background of the interviewees.

Farm identifier	CSA practice	Year of CSA implementation	Farm size in fte/ha	Country
F1	Manure and slurry management	2001	13/370	Denmark
F2	Manure and slurry management	2009	17/Not disclosed	Denmark
F3	Manure and slurry management	2013	12/500	Denmark
F4	Conservation agriculture and feeding legumes	2018	7/500	Denmark
F5	House improvement, ventilation, and space	2020	Not disclosed	Denmark
F6	Manure and slurry management	2009	Not disclosed	Denmark
F7	Organic farming	2006	2.5/70	Germany
F8	Holistic livestock management	2013	Not disclosed	Germany
F9	Holistic livestock management	2007	Not disclosed/19.3	Germany
F10	Holistic livestock management	Not disclosed	1.5/64	Germany
F11	Intercropping	2023	2/220	Lithuania
F12	Intercropping	2023	1/30	Lithuania
F13	No-tillage system	2021	1/55	Lithuania
F14	No-tillage system	2015	1/100	Lithuania
F15	No-tillage system	2007	2/270	Lithuania
F16	No-tillage system	2019	2/220	Lithuania
F17	No-tillage	2021	Not disclosed	Lithuania
F18	Wetland management	2019	2/220	Lithuania
F19	Renewables	2021	77/2200	Lithuania
F20	Variable rate fertilization	2023	Not disclosed	Lithuania
F21	Precision irrigation and integrated pest management	2018	2/150	Netherlands
F22	Integrated pest management	2019	Not disclosed	Netherlands
F23	Integrated pest management and precision fertilization	2018	Not disclosed	Netherlands
F24	Integrated pest management	2022	Not disclosed	Netherlands
F25	Integrated pest management	Not disclosed	4.5/200	Netherlands
F26	Organic farming	2008	Not disclosed	Spain
F27	Organic farming	2000	Not disclosed	Spain
F28	Mixed farming	Not disclosed	> 80/> 50	Spain
F29	Organic farming	2021	3/> 10	Spain
F30	Floral bands	2021	Not disclosed	Spain

4.1 | Changes in Value Creation and Delivery

Analysis shows that CSA implementation primarily leads to reactivating changes in farms' value creation and delivery, though the nature and complexity of these changes vary systematically across farming contexts and CSA practices. Lithuanian wheat farms implementing intercropping and no-tillage demonstrate reactivating changes through changes in resource management and operational processes by integrating catch and cover crops, reducing or eliminating dependence on herbicides and chemical fertilizers (F26, F11), removing traditional activities like plowing and harrowing (F3), and developing more sophisticated planning approaches (F12). As one Lithuanian farmer (F12) explained: "There is actually more planning

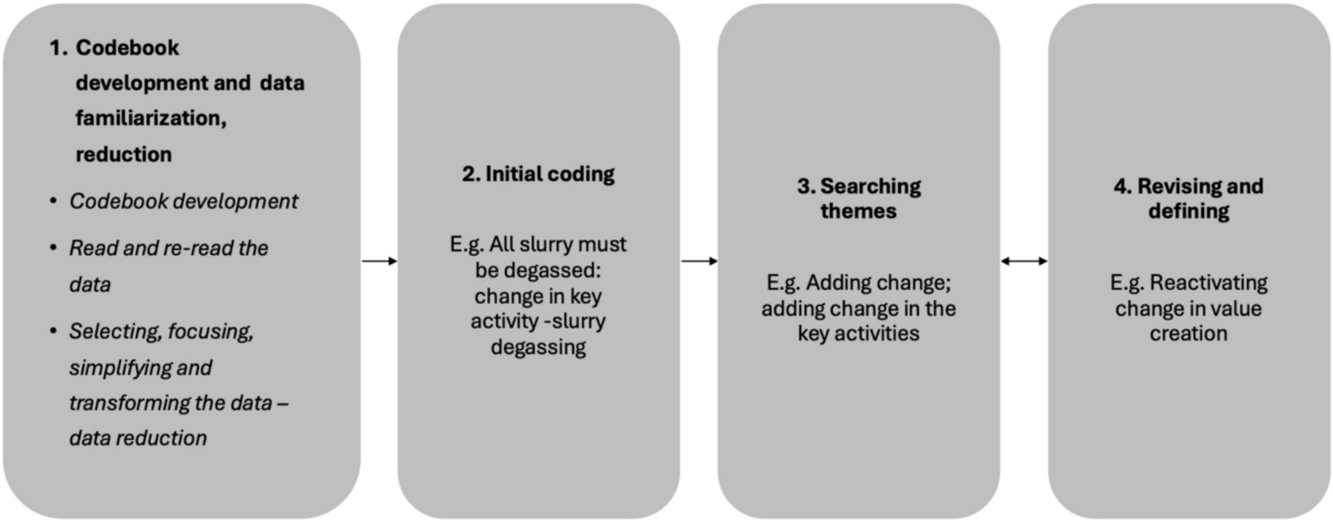

FIGURE 1 | Codebook thematic analysis based on (Braun et al. 2019).

involved, more time to plan and then to choose the crops that are right for you and that are good for you and that are useful." In onion and potato farming, Dutch farms that implement precision irrigation (F21), precision fertilization (F23), and integrated pest management (F21, F22, F23, F24, F25) demonstrate reactivating changes through resource optimization. Precision technologies optimize the application of fertilizers based on soil analysis and lead to reduced reliance on chemical pesticides and improved crop health monitoring with more consultation with advisors. Similar changes were noted in apple farms in Spain implementing organic farming (F26, F28, F30) and mixed farming practices (F29), where farmers reported closer attention to crop health and consciously reduced the use of crop protection products. In pig farming, Danish farms implementing house improvement practices primarily demonstrated reactivating changes through the installation of advanced ventilation and purification systems (F5). Danish pig farms implementing manure and slurry management practices reactivated farm operations by installing new slurry containers with technologies for slurry ejection and the construction of a biogas facility and introducing entirely new processes for slurry collection, preparation, and delivery (F1, F2).

Beyond reactivation changes, relinking changes were also reported by farms. Pig farms in Denmark implementing manure and slurry management practices partner with biogas facilities, changing where slurry is delivered and processed (F3) or with other farmers (F1, F2), creating new interdependencies. An apple farm in Spain (F29) also reported relinking changes that involve the adjustment of activities such as grazing in terms of timing and method to optimize benefits. Partnerships were another hallmark of relinking changes, where collaboration is established with other farmers to share investments and resources, changing activity connections (F28).

Repartition changes were observed in an apple farm in Spain (F28), where functions such as distribution are now integrated in farm operations: "Initially, we had to rely on external logistics, but it was complicated and expensive. Transport companies would look down on us for sending just a few crates, charging us a lot, and often not delivering on time. We realized this was not sustainable. So, we built our own distribution network, with refrigerated vans and a warehouse" (F28). Across cases, CSA implementation that results in changes in the value creation and delivery creates new value for the farm either through the optimization of farm operations, improving work environment (F6), (feed) efficiency gains (F4), environmental outcomes such as improved soil quality and biodiversity (F11, F12, F25), and reduction in soil erosion and water and soil pollution (F16, F18).

Despite significant benefits, CSA implementation shows challenges to the existing BM, particularly in terms of initial investment (F7, F8, F13), partnerships (F2, F3, F28), and risk management (F7, F24). Implementation required farms to develop new capabilities and allocate resources to activities that may not have immediate outcomes, posing challenges to the implementation of CSA practices. As noted by an apple farmer in Spain, "The conversion never, never, never justifies the effort, the dedication, everything that organic farming entails. That is why there are a lot of people who do not spend more than one or two years of dedication to it" (F28). Lastly, results reveal that implementation of CSA practices is motivated by compliance with regulatory requirements for maintaining the farms' social license to operate (F1, F2, F3, F5, F8) and the access to subsidies for maintaining farm operations (F7, F9, F18). Although farmers expressed strong interest in conducting their business for sustainability, most of the farmers interviewed made sure to point out that implementation of the CSA practices on the farm is motivated by these factors rather than purely strategic business rationale. As explained by a Danish pig farmer (F2), "Acidification of slurry in the sow stable was required for obtaining and achieving the required environmental approval" (F2).

4.2 | Changes in Value Proposition

Although most CSA practices reactivate farm activities and, in a few instances, alter linkages or organizational boundaries, relatively few lead to changes in the existing value proposition. Notable cases of the latter were reported by apple farms in

TABLE 2 | Key changes in the business model components due to CSA implementation.

Cases and CSA practices	Type of BM change	The farm's BM		
		Value creation and delivery	Value proposition	Value capture
Wheat production in Lithuania				
Intercropping	Reactivating	•	—	•
No-tillage	Reactivating	•	—	•
Wetland management	Reactivating	•	—	•
Variable rate fertilization	Reactivating	•	—	•
Onion and potato farming in the Netherlands				
Precision fertilization	Reactivating	•	—	•
Integrated pest management	Reactivating	•	•	•
Precision irrigation	Reactivating	•	•	•
Organic dairy farming in Germany				
Holistic livestock management	Reactivating	•	—	•
	Repartitioning	•	—	—
	Relinking	•	—	—
Organic farming	Reactivating	•	—	•
	Relocating	•	—	•
Pig farming in Denmark				
Manure and slurry management	Reactivating	•	—	•
	Repartitioning	•	—	—
	Relinking	•	—	—
House improvement-ventilation and space	Reactivating	•	—	•
Conservation agriculture	Reactivating	•	—	•
	Relocating	•	—	—
Apple farming in Spain				
Organic farming	Reactivating	•	•	•
	Relinking	•	—	—
Mixed farming	Reactivating	•	•	•
	Repartitioning	•	—	—
Floral bands	Reactivating	•	—	•

Note: The table summarizes the types of BM changes when implementing CSA practices across different farming systems. Each CSA practice may trigger multiple types of business model changes (reactivating, repartitioning, relinking, or relocating) affecting different business model components. The symbol (•) indicates where farmers reported a type of change to a specific business model component, and (—) indicates where no changes were reported.

Spain implementing organic farming practices (F26, F28, F30) and onion and potato farms in the Netherlands implementing integrated pest management practices (F22, F23, F24, F25). The cases reveal examples of how farms attempt to translate operational improvements into market value. Through certification schemes, such as Organic Agriculture Europe Label and On the Way to PlanetProof Label, farms differentiate their products. This approach reveals an important tension between standardization and innovation. As articulated by a potato farmer (F25), "Certification is not necessarily the solution. Certification often means standardization, which can hold back the grower" (F25). For an apple farmer (F28), certification was seen as a partial solution, validating some climate-smart practices but failing to highlight the full extent of the farm's efforts, finding difficulty in effectively conveying the advantages of their specific practices. "If you can show the value of the fact that you are using vegetable coverings within organic farming, that this product ... Look, I think that is very difficult. Very difficult" (F28).

For a Dutch potato farm (F21), a change in the value proposition has led to diversification into additional BMs, that is, choosing to sell directly to consumers instead of a trader. In this diversification, the farm has also reactivated the use of social media and meetings to promote products and showcase the advantages of their farming practices, introducing a different logic to how they communicate value to customers. The new BM strengthened its market position and bargaining power with customers, where crop quality, yield, and premium prices are secured. "First, they come to us like we have those five varieties. You can grow them for us and for this price. And now it's the other way around. Now, we said we want to like we would like to grow those varieties for you. But we want to get this price because we can guarantee them" (F21).

However, the process of adopting this new BM was not a straightforward task. As pointed out by the farmer (F21), adoption required the development of new marketing capabilities, customer relationships, and huge investments. Additionally, the farmer pointed to policy challenges that hindered broader adoption. "Well, that's actually with every innovation thing, there is no (supportive) policy. So the government always says no it's not possible to implement them. And yeah, that's basically the biggest challenge" (F21).

4.3 | Changes in Value Capture

In terms of value capture, most of the CSA practices across the cases led to reactivation changes, which mostly manifested through operational efficiencies and cost reduction. Farms implementing holistic livestock management in Germany (F8, F9), conservation agriculture in Denmark (F4), and intercropping and no-tillage practices in Lithuania (F11, F12, F14) demonstrate this pattern through reduced input costs and improved resource efficiency. "There are big savings on machinery costs, better soil conditions, the soil drains water very quickly" (F4). However, these changes often prove insufficient to justify the substantial investment required for most CSA implementation, revealing temporal misalignment between costs and benefits: significant upfront costs versus gradual realization of operational benefits. As an organic farmer in Spain (F28) noted, "The conversion never, justifies the effort, the dedication, everything that organic farming entails. That is why there are a lot of people who do not spend more than one or two years of dedication to it" (F28).

This finding reveals the structural challenges in value capture, where, despite successful operational modifications and clear environmental benefits, many farms still struggle to secure premium prices that would recover their investments. As articulated by a potato farmer in the Netherlands: "You can't impose infinite measures when the grower gets the same price... Growers are going to walk along the edge, pushing the limits of what is feasible" (F25). This challenge appears particularly acute for a farmer in Spain implementing organic farming (F28), noting, "But the economic issue, I tell you, is very hard, very hard for farmers. And they are really suffocating us. There are fewer and fewer people. People are leaving the sector. Especially in the last few years, it is really being very complicated" (F28). This finding reveals critical interdependencies between value creation and value capture. Farms that successfully modify their operations for sustainability often find these improvements insufficient for enhanced value capture without corresponding changes in buyer relationships and value propositions. In rare cases, some farms reported innovative approaches that allowed effective value capture. For instance, Danish pig farms implementing manure and slurry management have created new revenue markets by creating value from waste (F1) or entering carbon farming markets (F4). This observation highlights how successful sustainability transitions may require simultaneous modifications across multiple BM elements or even BMI.

5 | Discussion, Implications, Contribution, and Limitations of the Study

Our empirical investigation of how CSA implementation changes farm BMs reveals several important theoretical insights that advance both the BM and CSA literature. By examining the mechanisms through which CSA practices change the components of the existing BM across different agricultural contexts, the study addresses critical knowledge gaps and provides implications for accelerating CSA implementation.

5.1 | CSA Implementation and BMC

Our results challenge current assumptions about how farms integrate sustainable practices into their operations. The existing literature suggests the need for BMI towards sustainable food system transition (Donner and de Vries 2021). This suggestion largely assumes farmers have the necessary resources, skills, and knowledge for BMI, overlooking significant barriers that complicate the BMI process (Ulvenblad et al. 2018). This is problematic because the BMI process is complex and often involves a high degree of risk (Ulvenblad et al. 2018). Our findings reveal a more nuanced reality in the context of implementing CSA practices, addressing a significant gap in our understanding of how sustainable practices such as CSA are implemented into existing BMs. The results show that CSA practices are implemented through BMC rather than BMI. This result justifies more attention to the difference between BMC and BMI. Although some authors suggest that changes in two BM elements qualify as BMI (Lindgardt et al. 2015), our analysis reveals that the key distinction lies not in the number of elements changed, but in whether the change introduces new logic for creating, delivering, and capturing value. For example, farms implementing intercropping or no-tillage achieved operational efficiencies and environmental benefits through changes in both value creation and value capture. However, these changes enhanced rather than replaced the core farming logic. Alterations in the BM components are introduced but are still within the framework of the existing BM. In other words, farms continue to produce the same crop but with modified farming practices. In contrast, BMI emerges when farms create entirely new BMs with a different underlying logic. Farms that diversified into biogas production to create value from waste, or that entered carbon markets, are examples of BMI.

Direct comparisons across cases are challenging because of the distinct nature of practices—from intercropping to manure management. However, we find that CSA practices trigger distinct patterns of change across BM components, with reactivating changes in value creation and delivery and in value capture being more prominent. Reactivating changes in the value proposition through differentiation strategies were more limited but reveal an important theoretical tension between standardization and innovation, namely, a myopia in organizational culture from ticking the boxes that hamper sustainable innovation (Moxen and Strachan 2000). Although operational efficiencies and environmental outcomes are created, our results reveal a persistent challenge in sustainable value creation where potential value does not always equal realized value (Koistinen et al. 2018). Because of significant investments required, farms continue to struggle with capturing the expected economic value of the environmental outcomes. This challenge appears particularly acute in cases where farms (could) achieve significant environmental outcomes but lack adequate incentives (e.g., price premiums) to sustain CSA practices in their business. This finding may suggest that barriers to effective value capture extend beyond farm-level constraints to include broader systemic and structural factors in agricultural value chains and policy landscapes. This aligns with Klingenberg et al. (2022) on the impact of digitalization on value capture in agricultural value chain contexts, in which the authors highlight that value capture for farmers may depend on competition dynamics and on policies and regulations. Similarly, on digital transparency in agrifood supply chains, Otter and Robinson (2024) found that power imbalances in agri-food chains leave farmers with low value capture, making them reluctant to adopt transparency initiatives.

Meanwhile, our results also present notable cases where farms successfully addressed the challenge around value capture through BMI. For example, Dutch farms implementing precision irrigation and integrated pest management practices initially altered their operations but later utilized short food supply chains to capture value from their CSA implementation. Similarly, Danish farms moved beyond operational modifications to diversify into new revenue streams through biogas production and carbon farming. This could suggest a potential progression in sustainability transition—from initial BMC to eventual value capture through BMI, acknowledging the role of new BMs (Long et al. 2017). This finding provides empirical evidence for Bidmon and Knab's (2018) conceptual work linking BMs and societal transition by demonstrating how BMs also play different roles in CSA transition. Bidmon and Knab (2018) have identified three roles that BMs play in transitions: (1) as part of the sociotechnical regime reinforcing stability, (2) as intermediates facilitating technological breakthroughs, and (3) as nontechnological innovations building new regime elements. In our cases, CSA practices, rather than technologies per se, function as the niche innovation, whereas BMC serves as an intermediary enabling farms to adapt their operations without fundamental restructuring. Meanwhile, the progression to BMI represents a shift to nontechnological niche innovation, where farms create entirely new value mechanisms that extend beyond the CSA practices. This temporal progression, from BMC facilitating CSA implementation to BMI creating new value systems, reveals how BMs enable individual farm practices to scale up and contribute to broader agricultural system transformation.

Given the complexity of the BMI process, however, we highlight the importance of partnerships and collaborations, which have proven to be a successful strategy in the BMI process and in dealing with its barriers. Our findings complement the work of Pellegrini et al. (2023), who have shown how agri-food SMEs successfully enter new markets through technology-driven BMI.

5.2 | BMC, Implementation Challenges, and Support Mechanisms

Our analysis further demonstrates that challenges in the implementation of CSA practices are determined by the type of BM changes that are triggered by the CSA practice. Understanding the BM changes can inform the design of more effective support interventions. Across all cases, CSA practices that create reactivating changes present implementation challenges centered around new operational capabilities. These challenges suggest the need for supportive mechanisms focused on capability development and on financing the transition towards CSA (Fusco et al. 2020). CSA practices creating relinking changes, exemplified by manure management systems in Danish pig farms, face different challenges focused on partnership development and activity coordination. Such challenges require support mechanisms oriented towards facilitating partnership development and providing frameworks for activity coordination, which can be supported by platforms as highlighted by Guareschi et al. (2020), Isakhanyan et al. (2024), and Polge and Pagès (2022). Finally, practices requiring repartitioning changes, as seen in organic farming cases in Spain, present challenges in reorganizing organizational boundaries and restructuring value chain relationships. These farms had to develop new capabilities in direct marketing, establish new distribution channels, and manage more complex stakeholders. Support mechanisms for these changes need to focus on organizational development and value chain restructuring (Mwongera et al. 2019), including assistance in developing new market channels and support for certification processes (Asseldonk et al. 2023). These findings extend previous work on BM change by linking the type of BM changes to CSA implementation requirements and support strategies. By analyzing the existing BMs, the findings deepen the importance of understanding how integrating sustainability practices changes the BMs, supporting Yang et al.'s (2017) emphasis on the importance of BM analysis in developing new BMs and sustainability transitions. Furthermore, the findings emphasize the role of supportive business environments in CSA implementation, reinforcing a conclusion of recent systematic reviews on the crucial role of government support and stakeholder involvement and networks to unburden farmers in investing in CSA (Fusco et al. 2020; Gemtou et al. 2024; Isakhanyan et al. 2024).

5.3 | Contributions, Implications, and Limitations of the Study

This study makes several contributions to both theory and practice. For theory development, our results fill the knowledge gap in the literature around the lack of insights on the specific mechanisms through which the implementation of CSA practices changes the BMs of farms. Although previous studies recognized the importance of BMs for CSA diffusion, our research provides comprehensive empirical evidence on how farms modify BM components when implementing diverse CSA practices across multiple contexts of European agriculture. This evidence establishes clear linkages between the types of BMC and implementation challenges, extending the Santos et al. (2015) BM typology to the sustainable agriculture context. Our results demonstrate that CSA practices are successfully implemented through strategic changes in the BMs, providing new insights into how sustainable solutions are integrated into established operations. This finding challenges assumptions in the sustainability literature that suggest that sustainable solutions trigger radical BMI. Additionally, this finding clarifies the ambiguity between BMC and BMI, revealing a more fundamental distinction between changes in current BMs and changes that introduce a new logic of creating, delivering, and capturing value. Furthermore, our results expand the primarily technology-focused literature to encompass broader farming practices and highlight farmers' experiences when implementing CSA to address key criticisms in CSA literature raised by Glover et al. (2019) and Smith et al. (2021), thus providing a more holistic understanding of sustainable agriculture transitions.

For practice, farms seeking to adopt CSA practices can draw insights from the empirical evidence provided to help in prioritizing what is needed to realize the value of CSA practices and to more effectively transform BMs towards sustainability. Our analysis reveals that improved value propositions and diversifying into new value capture models can help harvest economic value from CSA implementation. This BMI process, which presents complexity and a high degree of risk, can be supported through collaborative strategies to ensure outcomes are recognized and valued appropriately. Furthermore, our evidence is useful for farms to assess implementation strategies, and the identified support mechanisms can offer guidance for policymakers in designing targeted support.

Although our study provides these contributions to the literature, some limitations should be acknowledged. Our findings are based on the experiences of large European farms, which potentially limit generalizability to smaller operations or other agricultural contexts, particularly those in developing economies where institutional and market conditions differ significantly. The sampling strategy relied on farms participating in the BEATLES project, which might be more innovative than average European farms. The study also relied on self-reported outcomes from farmers, which may not fully capture the outcomes created because of BMC. Here, incorporating life cycle assessments could help validate the findings and provide a more robust analysis of CSA implementation outcomes. The cross-sectional nature of our data limits our ability to track how BM changes and reported outcomes have evolved over time. Furthermore, although our study covered major agricultural systems in Europe, future research could benefit from including other farming systems to provide additional insights for CSA implementation.

6 | Conclusion and Future Research Direction

This study advances our understanding of how CSA implementation changes the farm's existing BM, providing both theoretical insights and practical implications. Three key conclusions emerge. First, although CSA practices trigger different types of BM changes, creating positive operational and environmental outcomes, value capture presents a persistent challenge and is crucial for wider implementation. Second, we distinguish BMI from BMC on the basis of whether the changes introduce a new logic for value proposition, value creation and delivery, and value capture. Third, the type of BM changes triggered by CSA practices largely determines implementation challenges, offering insights for designing targeted support mechanisms that can accelerate CSA implementation.

Building on our findings, future research may explore the development of BMs that maximize value capture from CSA implementation. Investigating the inherent tensions in CSA implementation (e.g., balancing short-term costs with long-term resilience and reconciling stakeholder interests) may also provide critical insights to develop viable BMs that meet environmental, social, and economic goals. Although we have focused on BM theory to understand how CSA alters existing BMs, future studies could benefit from applying transition theory or the innovation maturation framework to provide complementary perspectives, particularly examining the conditions that enable farms to advance from incremental BMC to radical BMI across different contexts. Drawing on literature that highlights collaborative approaches as a key strategy in approaching the complexity of BMI, future research should explore collaborative multistakeholder approaches in the development of new BMs.

Author Contributions

Christopher Jr. Galgo: conceptualization, methodology development, data collection coordination, data curation, formal analysis, writing – original draft preparation (lead), writing – review and editing, project administration. **Gohar Isakhanyan:** writing – review and editing, writing – original draft preparation (support), supervision, conceptualization, methodology, project administration. **Jos Bijman:** writing – review and editing, writing – original draft preparation (support), supervision, conceptualization, methodology. **Verena Otter:** writing – review and editing, writing – original draft preparation (support), supervision, conceptualization, methodology. **Marilena Gemtou:** writing – review and editing, conceptualization, project administration.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Appendix S1:** Semistructured interview guide.