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Selection of incentives for a business strategy based on crop diversification

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Abstract

Aim of study: This study proposes a crop diversification innovative business model based on stakeholder preferences towards different incentive alternatives.

Area of study: South-East Spain.

Material and methods: Citrus intercropping practices in South-East Spain has been used as case study. Stakeholders' preferences for crop diversification incentives were investigated by using a multicriteria approach, and those results were integrated into the development of a business model canvas.

Main results: Including crop diversification practices as environmental practices within the operational programmes of producer organizations is seen the most preferred incentive over which the business model canvas is developed.

Research highlights: The establishment of business opportunities for crop diversification practices would facilitate the overcoming of adoption barriers along the agrifood value chain and would promote health and sustainable food systems.

Additional keywords: AHP; business model canvas; Mediterranean agroecosystem; intercropping; crop diversification.

Abbreviations used: AHP (Analytic Hierarchy Process); CAP (Common Agricultural Policy); O&M (Operation and Maintenance)

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Introduction

The growing concern about the relationship between human and planet health has motivated political initiatives to cope with a more sustainable food system. The European Green Deal, configured as the roadmap to make the economy of the European Union more sustainable, represents one of these initiatives. As such, "farm to fork" and "biodiversity" strategies lead the transition from traditional agrifood systems towards more sustainable models. They are based on harmonizing food systems with the current needs of the planet, while satisfying a growing demand for healthy and balanced food and protecting and recovering the functioning of ecosystems (Castillo-Díaz et al., 2023). However, the adoption of such strategies entails some changes in production models with expected negative impact on the current agri-food sector, mainly related to the loss of yields and producers' revenue. Therefore, farmers could face a loss of competitiveness on national and international markets that, together with an increase in farm input prices, could compromise food security (Barreiro-Hurle et al., 2021).

In this context, crop diversification emerges as an alternative agricultural practice to the conventional specialized monoculture option as it is capable of achieving a sustainable and fair food production system (Rosa-Schleich et al., 2019). Crop diversification refers to agricultural practices based on the maintenance of "multiple sources of production and varying what is produced across farming landscapes (intercropping) and over time (crop rotation)" (IPES-Food, 2016). These practices can be implemented as cover crops, crop rotation, intercropping or multiple-cropping (Maitra et al., 2021). As such, they can also be easily integrated with current alternative agricultural systems aimed to optimize environmental and economic aspects of agroecosystems by using the available resources more efficiently (Flores & Sarandon, 2004).

Crop diversification practices provide a variety of environmental and social benefits. These practices can potentially reduce the environmental impact of intensive monoculture through better environmental performance (Reyes et al., 2021). The main environmental benefits relate to soil health and erosion reduction (Cuartero et al., 2022). Regarding monocropping, diversification has a positive effect on soil organic carbon and soil nitrogen contents without affecting significantly to the crop yield (Morugán-Coronado et al., 2020). Besides this, biodiversity, crop resilience and pest control can also be enhanced (Hunt et al., 2019). A positive effect of diversification (rotations and intercropping) on soil microbial biomass and fungal abundance (Morugán-Coronado et al., 2020), as well as on beneficial bacteria (Özbolat et al., 2023), is also shown in the literature.

On the demand side, citizens also value food produced by using crop diversification practices. Society is willing to pay an extra expenditure to buy foodstuff produced by diversified cropping systems, being aware that these production systems enhance biodiversity and ecosystem services provision. Specifically, Alcon et al. (2020) found that non-market environmental and socio-cultural benefits associated with crop diversification reached more than €1,000 per hectare and year in citrus orchards in SE Spain. Furthermore, Rossi et al. (2023) found non-market benefits between 52 and 212 €/ha associated with environmental benefits of nutrition tools combined with crop rotations scheme and others practices in arable land in northern Italy. In Finland, Latvala et al. (2021) estimated that Finnish consumers value the benefits of diversification in €245 per hectare and year household annually for typical rainfed crops and forages.

Given the benefits that crop diversification provides to the whole society (Alcon et al., 2024), it would be expected a wider demand of this cropping system from the consumers. However, there is a lack of farmers incentives that could overcome this lock-in situation, from up-to-down-stream of the food value chain, so that the adoption of crop diversification practices is promoted across Europe. Indeed, crop diversification practices may imply greater labour needs in farms, while only reducing market risk for farmers, but without a clear income gain in the short-term (Martin-Gorriz et al., 2022). Farmers tend to be reluctant to change current gross margins for environmental benefits (Bonke et al., 2021) whilst they do not perceive the viability of diversification practices (Weituschat et al., 2022). However, not only financial constraints become relevant for farmers dealing with the adoption of crop diversification practices, but also cognitive, social and dispositional factors may play a significant role for addressing farmers' intention for adopting sustainable practices (Dessart et al., 2019). As such, when famers perceive some environmental benefits from crop diversification practices, they may show a positive attitude to their adoption (Bonke & Musshoff, 2020). However, this is not enough to ensure the transition pathway from monocropping to crop diversification practices.

The adoption of crop diversification practices would require the development and implementation of incentives that motivate their acceptability, not only for farmers, but also along the agrifood value chain. From the public side, eco-schemes are proposed in the last reform of the Common Agricultural Policy, enhancing the provision of agroecosystem services and going beyond the greening requirements and the voluntary agri-environmental schemes stablished in the previous legislative framework (Dessart et al., 2019). In contrast, from private initiatives, labels and certifications have been also tested for products differentiation, but with variable results depending on the consumer segment explored, and not always effective (Dong & Jiang, 2022). Therefore, adoption incentives would be the key factor over which business models for crop diversification are built.

Crop diversification business models seek to make the innovation of crop diversification into an attractive alternative business option not only for farmers but also the different linkages of the agrifood value chain. Despite numerous definitions of business models in business and

economic academy, all of them highlight the importance of enterprises to create, deliver and capture value from their customers, and so the architecture and infrastructure that settle it (Richardson, 2008). Going into a step forward, sustainable business models aim to create value, not only for customers, but also for the entire society, including also environmental values (Boldrini & Antheaume, 2021). Crop diversification is therefore seen as an alternative towards the integration of environmental, social and economic benefits. Actually, crop diversification provides revealed environmental and social benefits, but require a real business model that allows to deep into the economic benefits and makes it attractive for stakeholders along the agrifood value chain. Hence, crop diversification business models might be seen as an attractive strategy for agrifood stakeholders to create, deliver and capture the differentiated value of crop diversification compared with monocropping practices, so that it is adopted by farmers in the short- and long-term.

In this context, this paper aims to identify crop diversification adoption incentives to develop a crop diversification innovative business model based on the stakeholder preferred incentive and define the key changes to attend in the business model transition. To this end, citrus intercropping practices in south-east Spain has been used as case study, where a two-step procedure has been applied. The first step comprises the investigation of stakeholder preferences for crop diversification incentives. The second one consists in developing a business model canvas, to identify key elements in the business transition to crop diversification and meet the business opportunity for crop diversification practices.

This paper contributes to the extant literature on crop diversification, mainly based on agronomy, crop physiology, crop ecology and environmental disciplines, by explicitly considering stakeholder preferences for crop diversification adoption along the agrifood value chain. Also, this study contributes to enhance knowledge regarding incentives for supporting the adoption of crop diversification practices, which, combined with a business model canvas, make welfare gains based on a participatory process. As such, the contribution of the manuscript also encompasses business model innovation for sustainability, seeking for the transformation of traditional monocropping business models into innovative crop diversification ones. All this can be potentially used by farmers, agricultural companies along the food value chain and public managers to guide public and private agricultural policies aimed to promote health and sustainable food systems by developing technical and economics instrument to promote the transition.

Methodology

Incentives to ensure the transition pathway from monocropping to intercropping practices in irrigated citrus crops in south-east Spain are evaluated by agrifood stakeholder consultation, addressing consumers, farmers, and public administration perspective. Even though farmers become key actors for ensuring the adoption of crop diversification practices, growing their adoption rates along time is contingent to consumers and agrifood stakeholder acceptability for diversified farming products. In sum, incentives selected from the stakeholder consultation process are used for identifying the key changes in the transition from conventional monocropping and so developing crop diversification business models aiming to enhance its adoption. A two-step approach was used. The first step uses AHP for ranking transition incentives, while in the second step a canvas methodology was developed for the preferred incentive selected in the first step.

Case study description

The field experiment-based case study is performed in a commercial mandarin orchard. It is located in the Region of Murcia (SE Spain), in the Mediterranean South pedoclimatic region an area characterized by semiarid climate conditions with increasing water scarcity (mean annual precipitation of 231 mm). Temperature is usually mild in winter and high in summer (mean annual temperature of 17.5 ºC). Due to these conditions, evapotranspiration is very high (annual potential evapotranspiration of 1300 mm). Production system is commonly based on intensive irrigated citrus monocrop with intensive tillage and integrated farming system (Alcon et al., 2017).

The mandarins supply chain in the area are duals. Domestic consumption is mainly distributed through two value chains: traditional value chain [wholesale supplier – wholesale dealer – retailer] and modern value chain [wholesale suppliers – retailer]. The UK and other European nations receive 43% of the mandarins produced in the region, hence the primary purpose of the modern value chain is to sell mandarins to them (FEPEX, 2021). Traditional pathways are characterized by lower wholesaler prices at wholesaler and retailer. Main differences between both chains can be found in the modern value chain where wholesale dealers are replaced by distribution platform of the retailers. However, the introduction of alley crops would imply a significant change in the actual composition of agrifood value chains for citrus farmers, when considering additional products to be sold.

To overcome the environmental challenges of this monocropping system (MC), an intercropping system was proposed and implemented. Diversification (D) consists of mandarin intercropped with multiple cropping of vetch/barley (*Vicia sativa/Hordeum vulgare*) for feed in summer and fava bean (*Vicia faba*) for food in winter, during 2018, 2019 and 2020. Alley crops were grown in the alleys between the mandarin tree rows. More details about the experiment and diversifications can be found in Martínez-Mena et al. (2021), Martín-Gorriz et al. (2022) and Sánchez-Navarro et al. (2023).

Despite the short term of the field experiment, it shows promising environmental and social results for crop diversification practices. Table 1 collects the main ecosystem service indicator variation in crop diversifications regarding monocropping. Crop diversification practices reduce impacts on natural resources, as they improve soil retention, together with biodiversity enhancement through an increase in pollinators and vegetal species without affecting farm profitability and soil ecosystem services. This is also socially demanded because of its impact on human wellbeing, as its non-market value reveals. Such economic non-market value integrates the value of regulating (soil erosion reduction and biodiversity enhancement) and cultural (landscape and social heritage) ecosystem services, therefore revealing the multifunctionality of diversified farming systems. However, no significant differences have been found on the average performance of crop diversification for most of the other ecosystem services considered (Martínez-Mena et al., 2021; Martín-Górriz et al., 2022; Sánchez-Navarro et al., 2023), other than soil erosion and vegetal species diversity (Boix-Fayos et al., 2021). Instead, standard deviation of such indicators is reduced, therefore revealing a reduction for farm risk. Similarly, financial analysis results show that there are no significant differences of gross margins results between intercropping and monocropping, despite the significant increase in labour costs (Martín-Gorriz et al., 2022). It undermines, a priori, farmer intrinsic incentives to adopt crop diversification. Extrinsic incentives need to be integrated thereby with innovative business models for enhancing adoption rates of crop diversification among farmers, at least in the short term. It is expected therefore that in the long term this would ultimately materialise into significant better performance of intercropping experiments (Vanino et al., 2022).

The introduction of intercropping in mandarin orchards entails the production of different products, such as vetch, barley, fava bean, in the same plot, changing the typology of the agrifood value chain. Transition from a highly specialized to a diversified mandarin value chain under intercropping practices is highlighted, but continuous focusing on global and export-oriented markets for the main crop. Fava bean is a common tradeable product derived from alley crops given its local importance, as it is demanded in local markets during wintertime. Vetch and barley could be sold for feed also for local farmers, although this may not represent a significant demand. Instead, they could also be re-incorporated to the plot as soil cover or green manure, thereby to enhance soil health and biodiversity and help to improve environmental conditions and reduce input dependency. Figure 1 shows transitions from monocropping to intercropping systems implying the former the coexistence of traditional and modern value chain for mandarin and fava bean.

Incentive selection. Analytic hierarchy process

Crop diversification practices can supply more sustainable mandarins to national and international markets, but there is not a clear financial incentive for farmers in the short term. So, incentives for new business models need to be identified. To this end, a stakeholder consultation process was carried out to identify pathways to ensure the transition from monoculture to intercropping agriculture. Agrifood stakeholders selected, according to

Table 1. Ecosystem services indicators in mandarin monocropping (MC) and intercropping diversification (D) practices

Ecosystem service indicator	Units	MC Mean (± SD)	D Mean (± SD)	Δ	Source
Mandarin yield	kg/ha	26,111 (± 15,160)	14,738 (± 4,522)	-44% ns	Martín-Górriz et al. (2022)
Gross margin	€/ha	5,792 (± 5,094)	2,199 (± 1,373)	-62% ns	Martín-Górriz et al. (2022)
Non-market benefits	€/ha		1,148 (± 416)		Alcon et al. (2020)
Soil erosion	t/ha	50.5 (± 148.3)	11.0 (± 31.1)	-39.5*	Boix-Fayos et al. (2021)
Soil fertility–$N_{available}$	g/kg	1.3 (± 0.3)	1.2 (± 0.2)	-11% ns	Martínez-Mena et al. (2021)
Soil organic carbon	g/kg	9.8 (± 3.1)	8.2 (± 1.5)	-17% ns	Martínez-Mena et al. (2021)
CO_2 soil emission	mg/m^2 per hour	152 (± 114)	196 (± 109)	29% ns	Sánchez-Navarro et al. (2023)
Global warming	tCO_2eq/kg	0.4 (± 0.2)	0.4 (± 0.1)	-2% ns	Martín-Górriz et al. (2022)
Groundcover during crop cycle	% land	53.7 (± 16.8)	70.2 (± 31.6)	30% *	Canfora et al. (2022)

*Significant differences at 10% or higher. ns: non-significant differences.

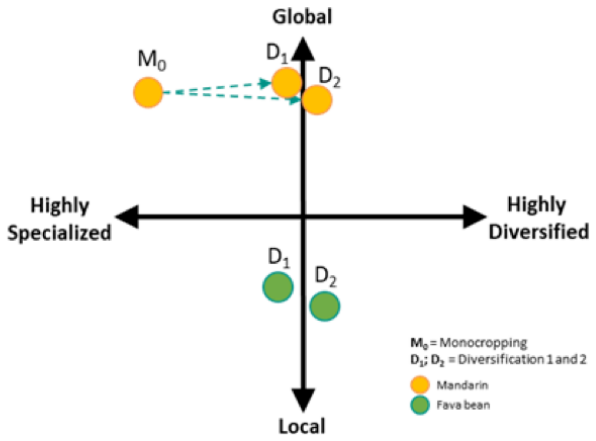

Figure 1. Pre-post diversification transition

their preferences, experience and role in the agrifood value chain, the most appropriate incentive for ensuring farmers to adopt crop diversification practices. Stakeholders involved in the agrifood value chain comprise farmers, cooperatives and producer associations, retailers, policy makers and researchers.

The analytic hierarchy process (AHP) method was used to evaluate such incentives and by considering a set of criteria. AHP is a well-known multi-attribute method, proposed by Saaty (1980), based on pair-wise comparisons of criteria and alternatives. The widely prevalence of the AHP method lies on its understandability in theory and the simplicity in application for evaluating and prioritizing different decisional alternatives. The implementation of this method comprises four main steps: (1) problem modelling, (2) alternative and criteria rating, (3) consistency analysis, and (4) prioritisation and synthesis. Problem modelling implies the definition of the decisional problem to be solved and the final goal, identifying possible alternatives, and defining the criteria. In this study, the goal is to identify the most suitable incentive for crop diversification practices to be adopted by farmers, which makes the incentives to represent the alternatives, being the criteria settled to the costs they might imply. Figure 2 summarises the criteria and alternatives employed. Alternative and criteria rating consists in the measure of the relative importance that decision-makers assigns to each of them. A nine-point dominance scale defined by Saaty (1980) was employed to make these pair-wise comparisons. As an intermediate step, a consistency analysis was performed, calculating the consistency ratio, and applying the method proposed by Harker (1987), which considers consistent those weights associated with matrices that exceed the 0.1 inconsistency threshold (Reed et al., 2014). Finally, the prioritization of alternatives and criteria was obtained and so the synthesis of results for decisional making was provided.

According to Piñeiro et al. (2020), environmental incentives "are instruments used by the public or private sectors to encourage farmers to protect or enhance ecosystem services beneficial to them and other". As such, despite the adoption of crop diversification practices may have a positive impact on the different linkages of the agrifood value chain, even society at a whole, the focus for adoption eco-incentives is on farmers. Incentives are understood in turn just as a tool to ensure the transition from current to sustainable agricultural practices. Incentives should be developed in a harmonised way and with the support of farmers. In such a context, incentives can be classified into three categories: (1) Regulatory incentives, which encompass general, and assumably mandatory rules, imposed by public or private agencies (e.g., certifications, environmental laws and standards); (2) Market- and non-market-based incentives, covering direct economic compensation through market signals and indirect technical, technology or fiscal support to engage farmers, respectively; (3) Cross-compliance incentives, conditioning additional outside rewards to the farmers' compliance with basic environmental standards. Considering this classification, specifically adapted for the adoption of sustainable agricultural practices (Piñeiro et al., 2020), three incentives were proposed, one related to each category of incentives:

(1) Diversified products label – Labelling product cropped with diversification practices (*Labelling*) [Regulatory incentive].

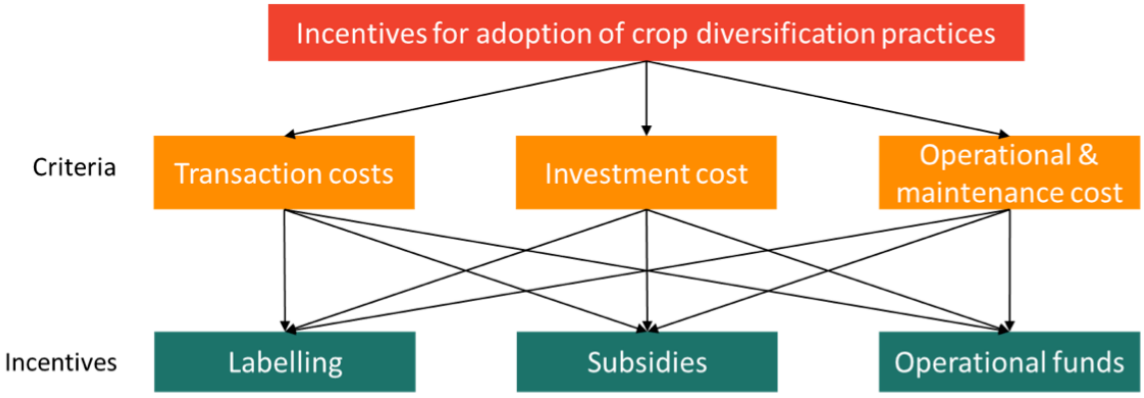

Figure 2. Problem modelling for incentive selection

(2) Diversified farming subsidy – Subsiding farmers that adopt diversification practices (*Subsidies*) [Market-based incentive].

(3) Diversified farming as environmental practice in operational programmes – Including diversification practices as legible environmental practices within operational programmes (*Operational funds*) [Cross-compliance incentive].

The creation of a new label for diversified farming products proposes to differentiate crops from diversification practices by a certified agency. Thus, markets would oversee recognizing the environmental added value of the products. Subsiding farmers that adopt diversification practices would imply direct payments to farmers related to the area where the intercropping practices are being adopted. The duration of the subsidy would be between 3 and 5 years, following the agri-environmental scheme framework. Farmers would be in charge of applying the subsidy to the public administration. Operational fund is a collective funding instrument of the CAP for fruits and vegetables producers' organizations. This instrument is considered as a financing instrument that provides producers organizations with an element through which they can propose initiatives to achieve specific objectives about sustainability. Operational programmes include different type of actions, among which environmental practices are compulsory. This cross-compliance incentive would imply including diversification as an environmental measure, so that intercropping practices would be included within the environmental measures required by operational programme. These funds would cover the additional costs of diversification, similar to the subsidy and would last between 3 and 5 years. The application process would be made by farmers through their producer organizations, and it would imply a co-financing of the practice cost between the farmer's association and the CAP funds.

Together with the proposed incentives, some relevant criteria were also proposed. Costs were settled as the core of such criteria, given the significance for making decisions about the incentives to be prioritized and their impact on the business model proposed afterwards. Three main criteria were identified, according to the following classification of costs: (1) transaction costs, (2) investment costs, and (3) operation and maintenance (O&M) costs. The transaction costs are those associated to the process of applying or processing the necessary formalities for the start-up of the business model. The investment costs comprehend those related with the start-up of the business model. The O&M costs are those costs arising from the maintenance of the business model.

Business model canvas

A business model is developed by a company to identify a plan for the way of capturing value for customers (Osterwalder & Pigneur, 2010). The concept of business model, despite in growing expansion and constantly improving, seeks to define the strategy followed to integrate and interconnect the key components and functions of a company within the organization and throughout its supply chain and stakeholder networks to generate value to its customers (Cirone et al., 2023). Widely employed from the private (Chesbrough, 2007) and also public sector (Fatima et al., 2022), business models can also be used by organization to redesign stakeholders' strategies (Massa et al., 2017), becoming more relevant for innovation initiatives and a key tool for sustainable technology adoption (Amoussohoui et al., 2022). It has also been extended for sustainable business models (Joyce & Paquin, 2016) and circular economy (Daou et al., 2020).

Business model canvas, proposed by Osterwalder & Pigneur (2010), is the most popular tool employed by companies and academia to show the value creation in a graphical, straightforward and comprehensive template. As an inside-out tool for business model innovation, business model canvas starts within the company and explores the potential changes to the current business models to promote value for costumers. According to the model canvas approach, a company is composed by nine interrelated core elements, grouped in four pillars, i.e., customer interface (segments, relationships and channels), product (value proposition), infrastructure management (activities, resources, and partners), and financial aspects (revenues and costs), being the value proposition the crucial element, followed by customer relationships and key partnerships (Dijkman et al., 2015). Innovation through current farm business model seeks to incorporate crop diversification practices, and the proposed incentives for enhancing their adoption, by exploring each of these nine elements. Hence, business model canvas is considered an appropriate tool for designing incentives for farmers to adapt crop diversification as placing sustainability at the core of its model innovation for value creation.

Data collection

Stakeholder consultation followed the selection process recommended by Landeta & Barrutia (2011). Personal interviews were conducted considering five agrifood stakeholders' groups (farmers, cooperatives and producer associations, retailers, policy makers and researchers) who were identified as relevant for their position in the agrifood value chain in the case study area. Interviews were carried out between October and December 2021.

The interviews were guided by a questionnaire (as detailed in Supplementary material where an English version of the questionnaire is included) which contained the aim of the survey, a brief explanation of the AHP methodology and the AHP exercise itself. To ensure that stakeholders' responses were free from any biases or anchoring effects, the interviews were conducted prior to any initiative developed in the area to promote intercropping practices.

A panel of the listed stakeholders were invited to participate in the survey, offering the possibility of nominating another representative if they were unable to participate. A total of 14 stakeholder representatives participated in the AHP survey. A breakdown of the stakeholder groups is presented in Table 2.

Table 2. Stakeholder distribution from the Analytic Hierarchy Process survey

Stakeholders group	n	%
Farmers	3	21
Cooperatives and producer associations heads	4	29
Retailers	2	14
Policy makers	3	21
Researchers	2	14
Total	14	100

Results

Incentive selection

Results obtained from AHP survey, collected in Table 3, show that, in average terms, operational funds, and then subsidies are the most valued incentives among agrifood stakeholders. In fact, farmers and cooperatives heads show a stronger valuation for operational funds in comparison with the other stakeholders' groups. While the use of subsidies is considered the most suitable incentive to promote crop diversification by policy makers and researchers, labelling dominates only for retailers. Indeed, this incentive is widely rejected by the other stakeholders' groups.

As such, there are some points to be highlighted. First, surveyed policy makers and retailers state that operational funds are more labour-intensive for farmers than what farmers actually claim. Nevertheless, farmers and cooperatives and producer associations heads interviewed assert that most of the administrative requirements of operational funds are developed by the association technicians, and so this is not a workload issue for farmers. Another point highlighted by policy makers, researchers and cooperative and producer associations is that farmers who do not belong to producer associations would be excluded from operational funds, which is not the case for subsidies.

Criteria weighting results also reveals significant differences between stakeholders' groups (Table 3). Stakeholders belonging to the agri-food value chain (farmers, cooperatives, and producer's associations heads) claim that investment costs would influence the most on the farmers' decision-making process. On the other hand, policy makers and researchers focus more on O&M costs. Instead, retailers consider transaction costs as the most relevant criteria, followed by investment costs criteria.

Common ideas arise from the discussion with stakeholders during the survey. First, there is a positive view about the inclusion of crop diversification practices as an environmental measure available for operational funds. The number of measures available is currently limited, and so crop diversification could be easily adopted by farmers in comparison with other environmental measures. Second, most of the stakeholders stated that, considering their previous experiences with innovative agricultural practices, training and promotion should be key aspects to encourage their adoption rate, irrespective of their public funding. Otherwise, diversification practices would be highly subsidy-dependent and would not be plenty integrated by farmers. Third, stakeholders agree that market would not be able to recognise the added value needed to cover the additional cost of intercropping practices. The lack of confidence in the economic viability of labelling diversified

Table 3. Incentives and criteria weighting by stakeholders' group

Stakeholders group	Incentives			Criteria		
	Label	Subsidies	Operational funds	Transaction cost	Investment cost	O&M cost
Farmers	0.14	0.16	0.70	0.32	0.38	0.29
Cooperatives and producer associations heads	0.16	0.31	0.53	0.16	0.57	0.27
Retailers	0.34	0.31	0.29	0.46	0.40	0.14
Policy makers	0.09	0.46	0.45	0.34	0.13	0.54
Researchers	0.22	0.34	0.26	0.12	0.39	0.49
Global	0.19	0.32	0.45	0.28	0.37	0.34

O&M: Operation & Maintenance

Table 4. Preferences for the incentives by stakeholders' group

Stakeholders group	Label	Subsidies	Operational funds
Farmers	0.07	0.32	0.58
Cooperatives and producer associations heads	0.16	0.32	0.52
Retailers	0.32	0.33	0.34
Policy makers	0.09	0.45	0.44
Researchers	0.37	0.34	0.28
Global	0.20	0.35	0.43

products is a general idea exposed by stakeholders. Some interviewees highlighted that labelling diversified farming products could only work for certain cases in local markets and for geographical indications. This is not the case of the Region de Murcia, where the agrifood sector is highly export-oriented, except in the case of a strong and well-known European label is developed.

The preferences for the incentives by stakeholders are summarised in Table 4. They are estimated as the average of individual preferences for the incentives weighted by their respective criteria preferences. This reveals that operational funds, followed by subsidies, would be the most preferred incentives to develop a business model based on intercropping in irrigated citrus crops. These results highlight the difficulty of creating a business model based on crop diversification where the market directly does not recognise the added value of these products. In contrast, payment for the environmental added value implicit in the intercropping practices is strongly preferred, especially if this is trough operational funds. This is also consistent with the preferences of agrifood stakeholders and the positive consumer willingness to pay on food expenditure for ecosystem services from intercropping practices.

Business model canvas

The preferred incentive identified by stakeholders in the AHP analysis considers crop diversification practices as an environmental measure to be included, and financed, within the operational programmes. Also, but at lesser extent, crop diversification business model based on direct farm subsidies is also seen as a feasible option for encouraging diversification practices. Implementing payments for intercropping practices in citrus crops, either through subsidies or through operational funds, implies quantifying the additional costs derived from the transition to a diversified system.

The proposed business model for diversified farming adoption based on operational funds would imply some relevant changes in the current monoculture mandarin's farm business model. These changes are described following the structure of the business model canvas, as shown in Figure 3, which allows a business to be structured in their fundamental elements (value proposition, key partners, key activities, customer relationship, customer segment, key resource, distribution channel, cost structure and revenue structure). These elements constitute at the same time two areas of the canvas: the value creation process (left area) and the customer relationship area (right area).

The value proposition element would be the same for mandarins as in the case of the conventional monocropping. However, some differences arising from intercropping practices: (1) a new marketable product, fava beans, is provided, and (2) there is also an improvement in environmental benefits and ecosystem services. These changes in the value proposition element would also imply changes in other elements of the value creation area, beyond mandarin production. Intercropping practices and alley crops rotation would become the key activities, as they underpin the value proposition and create environmental added value. Consequently, the key resource element of the business model is modified with respect to conventional monocropping. First, financing through operational funds is a key resource for being compensated for the environmental added value created. Second, the expertise and know-how needed for intercropping practices would impact on yields, as well as on the environmental benefits from these practices. Therefore, these additional key resources also require additional key partners related to the business value creation. Operational funds require the farmer to be associated in a producer organization, which oversees managing operational funds. Thus, producers' organizations and public administration would be the additional key partners needed for a business model based on operational funds, since they provide and manage financing resources and technical assistance. In the short term, the cost structure element would include the operational funds investment and O&M costs, together with the extra labour costs related to intercropping practices.

It should be noted that in the proposed business model based on operational funds, there would not be changes in the customer relationship area (right middle elements

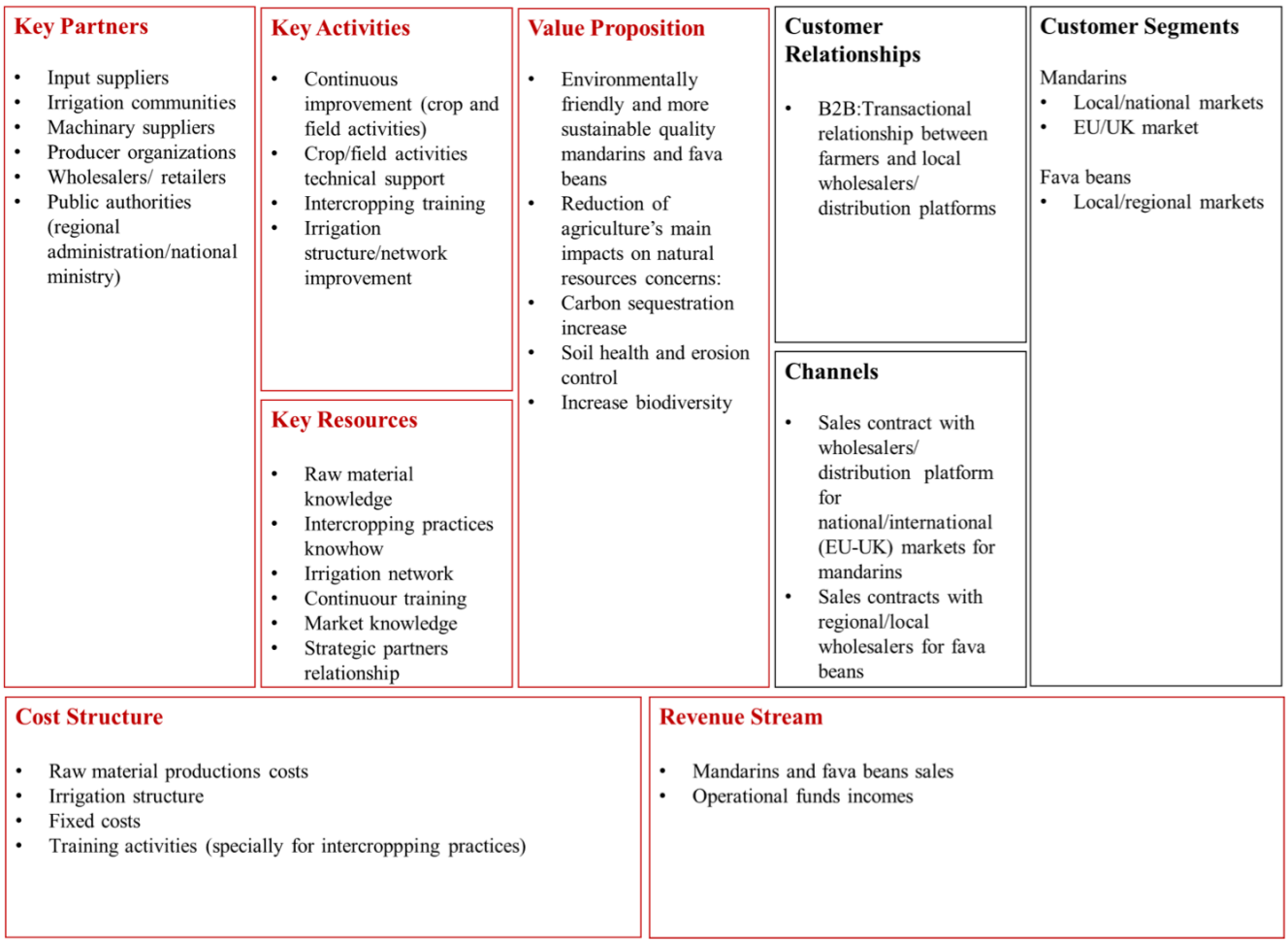

Figure 3. Business model canvas for mandaring diversification practices adoption

of the canvas, Fig. 3), since there are no changes in mandarins marketing. The only significant variation would be the incorporation of a second crop, fava beans, and their marketing. Traditional sales channels would play an important role in this business model, on top of the traditional one for mandarin monocropping.

This proposal of business model is contingent to the amount of money for the operational fund, given that the acceptance of the incentive could be compromised if low payments are proposed, acting as a bottleneck. Also, lack of knowledge and skills about intercropping practices might act as another bottleneck for adopting diversification practices. Therefore, promotion, dissemination, and training programmes on intercropping practices should also be considered. If this issue is not addressed, the inclusion of diversification practices in the environmental actions of operational funds would not be as successful as expected.

Alternatively, business model canvas based on subsidies would be similar to the one previously described for operational funds. Main changes would be at the funding stream, as financial resources would come directly from public administration to farmers, without the need of producer organizations. Therefore, public administration would become the key partner. This would also impact on the key resources area, changing the financing stream from operational funds to subsidies, as well as on transaction costs, which are expected to be higher than for operational funds. This is mainly due to the individual processing of applications, which would be more costly than collective processing, as is the case of operational funds. Nevertheless, there will not be any changes over customer relationship area, as it is the case for the business model based on operational funds.

Discussion

This study explores incentives to develop new business models based on crop diversification practices by farmers. Despite the environmental and social benefits, there is a lack of clear profitability of adopting intercropping practices in citrus crops for farmers. Thus, incentives are required to encourage the adoption of more sustainable and environmentally friendly agricultural practices, from production system to food consumption. Therefore, a redesigned farm business model offers farmers an incentive to engage intercropping practices, which may

also serve to overcome adoption barriers. According to the stakeholder's view, this would be preferably articulated through operational programmes.

The use of both business model canvas for developing sustainable agricultural businesses (Partalidou et al., 2018) and the AHP method (Muliana & Said, 2020) is not new in the literature. Nevertheless, this is the first time that both methodologies are applied together to develop a sustainable agricultural business model. The applied two-step procedure implies to initially identify the most feasible incentive by applying the AHP methodology with a stakeholder consultation and, secondly, analyse the key aspects of a business model for intercropping that must be considered to make a transition towards it.

Main stakeholders involved in the agrifood value chain have identified the incentives that ensures a successful transition to sustainable agriculture by intercropping practices. The inclusion of intercropping practices within the framework of operational programmes makes cross-compliance incentives as the preferred ones for enhance its adoption. This type of incentives integrates some advantages for farmers given its voluntary, certainty and economic nature (Piñeiro et al., 2020). Operational programmes offer farmers a wide spectrum of sustainable practices to be applied by farmers conditional to receive a payment in compensation for the additional cost they may suffer (Martin-Gorriz et al., 2022). So, intercropping is voluntary among the proposed practices, but the direct economic incentive that farmers would receive if adopt such practices is certainly known in advance. However, given such flexible structure, operational funds may lead some unplanned, or not, in line consequences for the intended agri-environmental strategy that promotes it (Ward et al., 2016). For example, operational funds may actually increase the adoption of intercropping practices, but also crowd out currently adopted sustainable practices, such as green manure, cover crops or residue mulching.

Despite the great efforts carried out in the last decades (FAO, 2016), most of the interviewed stakeholders showed a clear disfavour for the use of labelling for food differentiation. Distrust in such incentive is mainly due to the previously experienced problems with ecolabels. The creation of a new label would also imply creating a regulating council to ensure the well-functioning of the label issues, like certifying practices and guaranteeing premium price transitions across the value chain, from consumers to farmers. This last point is particularly relevant, as it is the economic incentive necessary to switch from conventional monoculture to diversified farming. Moreover, there is not any evidence supporting that labelling would imply an extra payment from the demand side. It could be possible that demand may not be as high as expected in the real market and that the obtained willingness to pay for diversified farming foodstuffs would be influenced by social desirability bias (Lopez-Becerra & Alcon, 2021) or, contrary, it could be overvalued by the halo effect (Caso et al., 2023). This label would be supposed to have strong synergies with the organic label products already implemented (Oberholtzer et al., 2005). Nevertheless, despite of the existence of local demand for organic food, Egea-Fernandez et al. (2014) pointed out that organic farmers in the study area encounter great difficulties for selling in short marketing circuits, allocating more than 95% of production for export. In other words, there is an imbalance between organic production – which accounts for 22.2% of the Region's cultivated land (CAERM, 2021) – and consumption – which at national level accounts for a share of 1.69% of the total food market. Thus, although a social demand and a willingness to pay more for diversified products is expressed (Alcon et al., 2020), the experience of "sustainable certifications" suggests taking the creation of a new label with caution. Accordingly, farmers may not see labelling as an agreeable incentive, which would imply that they would adopt diversified farming systems despite the indirect benefits obtained. However, alternatives such as including information to the consumers about the origin of the production system or the derived environmental benefits of the diversified systems could be explored, since this kind of information has been proved to be valuable by the consumers (Granado-Díaz et al., 2021).

Economic incentives, as proposed, may not be the only factors driving (or undermining) the adoption of crop diversification practices. The incentives evaluated only focus on the extrinsic motivation of farmers. However, behavioural factors, which comprehend dispositional, social and cognitive drivers may even be stronger drivers for their adoption, as they represent direct exponents of intrinsic motivation (Hansson et al., 2023) Therefore, research gaps arise from the present study, seeking to address the links between non-incentive drivers for the adoption of crop diversification practices and economic drivers. They could be disentangled in future research also considering the innate complexity of stakeholders' decision making, and their heterogeneity, regarding the adoption of new agricultural practices. Even, other different multicriteria methodologies could be implemented, such as the analytic network process (ANP), which allows to consider the interdependencies among agricultural practices, incentives, and non-incentive drivers for their adoption (Villanueva et al., 2015).

Business model canvas has served to integrate incentives for sustainable agricultural practices into a real business model, creating a planned structure on which farmers can develop a value-oriented activity with the support of main agrifood stakeholders. As such, a disruptive business model has been proposed, seeking to encompass all the spheres of the sustainability (Donner & de Vries, 2023) and the entire agrifood supply chain (Nosratabadi et al., 2020). This may become an actual example of how the triple bottom line perspective (Savitz, 2012) may be accounted and integrated into the agricultural sector.

The identified key points that need to be considered for the operational funds business model transition are highly relevant for policy makers. Initially, the new business model implies a redesign of the value chain where farmers would be the key agent, responsible of adopting the

intercropping practices. Thus, downstream mechanisms should be spotlighted, specially to the offered incentives for transitioning to intercropping. These incentives would be the main factor that determines the success of intercropping adoption. Due to the way in which operational funds work, the consensus among farmers, through producer organizations (farmers associations and cooperatives), and public administration needs to be ensured.

Public administration oversees the incorporation of intercropping as environmental practices within the operational program structure, establishing minimum requirements and quantifying the amount of payment. This payment should be quantified considering not only the possible over costs, but also the usual farmers heterogeneity in terms of willingness to accept (Villanueva et al., 2024) for specific intercropping adoption, which could be equal or higher than over costs. that is, even though farmers are they key agent in the adoption of intercropping practices, the public administration is a key partner that plays an important role in the initiation and development of the business model.

Producer organizations would be a key intermediary in charge of the training and technical support for farmers, which would be crucial for the long-term adoption of intercropping. This training should be both in agronomic aspects as well as in marketability of new products. By the agronomic side, know-how about the feasibility of alley crops and rotations would be a crucial aspect for enhancing main and alley crop yields and their environmental performance. By the marketability side, improving the knowledge about the trading alternatives and available markets for alley crops, namely, the redesign of agrifood value chains, is also a main task to improve the economic performance of intercropping farming.

The proposed business model relies on social demand of foodstuff produced in diversified farming systems, as its positive consumer willingness to pay shows (Alcon et al., 2020; Blasi et al., 2023). The total economic value of diversified agroecosystems is therefore higher than of conventional monoculture. The farmers willingness to accept for intercropping practices must be therefore equal o below the consumer willingness to pay, otherwise, the proposed business model would not be feasible from an economic point of view (Rossi et al., 2023).

Alternatively, and given that many farmers are not involved in producer organization, diversification practices for permanent crops are somehow considered in the last CAP reform (2023-2027) in order to achieve the European Green Deal objectives. Therefore, the new CAP environmental requirement includes incentives for voluntary environment-friendly farming practices allocating the 25% of the direct payment budget to eco-schemes. In the case study, the specific eco-scheme proposed for permanent crops related to the use of green covers in rows (sown or spontaneous) or inert covers (crush the remains of pruning and deposit them on the ground annually). Thus, for citrus crops in the Spanish case study, crop diversification practices would be included as an eco-scheme implying a compensation payment from 61 €/ha to 166 €/ha depending on the plot slope (MAPA, 2022).

Finally, despite the limited sample size used, the results here obtained seek to be applied and transferred to other different sustainable agricultural practices, crops, and regions. The main contribution of the research lies in the integration of stakeholder preferences when designing incentives for making innovative and sustainable farm business models. Independently of the instrument used, the generality of the nature of the proposed incentives – regulatory, market-based and cross-compliance incentives – (Piñeiro et al., 2020) makes them easy and scalable to be applied in other regions and crops. As such, the results highlight the easiness of applicability and implementation of cross-compliance incentives as they are embedded into a predefined structure, institution, or policy/programme. The incorporation of sustainable agricultural practices within the predefined structure that implies cross compliance incentives also implies a reduction of transaction, investment and O&M costs that is optimistically perceived by agrifood stakeholders. Hence, independently of the sustainable agricultural practice to be incentivised by developing innovative business models elsewhere, it will require predefined cross-compliance institutions ensuring that – transaction, investment and O&M – costs are minimized.

Conclusions

Business model innovation offers a framework to promote the adoption of crop diversification practices and spread sustainable agricultural practices aimed to achieve the environmental objectives of the European Green Deal. The study provides the most suitable incentive for crop diversification adoption and the related business model for farmers aiming to contribute to the achievement of health and sustainable food systems along the food value chain. The existing research about crop diversification and sustainable business models is extended by proposing a new agricultural business model based on the use of citrus intercropping practices. This business model was identified and defined by a two-step procedure, which combines incentive selection through an AHP exercise by using a stakeholder consultation and the development of a business model canvas based on such incentive. The consideration of intercropping practices as environmental practices within the operational programmes, and the relationships with key partners, as public administration and producer organizations, seem to be the key factors for their adoption.

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