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Can contract farming support sustainable intensification in agri-food value chains?

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ABSTRACT

Sustainable intensification aims to minimize the negative impacts of the current agricultural system while maintaining productivity and economic outputs. This study demonstrates that contract farming is a potential mechanism to support many, but not all, farmers in adopting sustainable intensification practices. A discrete choice experiment on a hypothetical value chain contract introducing three sustainable intensification practices, namely extended crop rotation, reducing agrochemicals and planting flower strips, was conducted with a sample of 314 north-Italian wheat farmers. The results show that permanently eliminating glyphosate from the plot under contract is strongly resisted by farmers, while farmers have less strong preferences between introducing legumes or oilseeds in rotation, and between temporary or permanent flower strips. Findings also indicate that farmers who are more educated, are not members of cooperatives and who generally prefer more flexible sales arrangements are unlikely to be triggered to adopt sustainable intensification practices through contract farming. Overall, this study indicates that while voluntary contract arrangements can be a potential tool to increase uptake of sustainable intensification practices, they will likely need to be complemented with more public policy intervention in order to bring sustainable intensification practices to scale.

1. Introduction

In the last two decades, agricultural intensification and specialization have persisted, supported by market incentives and public policy interventions, and despite the mounting evidence of their negative impacts on environment and climate (Kleijn et al., 2019; Rockström et al., 2017). Combined with a decline in soil health and increasing erosion, the threat to our food systems is growing (Davies, 2017). Among other factors, these impacts are due to reliance on monocultural systems and dependence on external inputs (Kleijn et al., 2019; Lanz et al., 2018), while economic profitability is often prioritized over social and ecological considerations (Struik and Kuyper, 2017; Lee et al., 2006). In European agricultural systems, increased agricultural intensification has also been observed in association with declining crop productivity and growing environmental costs (Antonini and Argilés-Bosch, 2017), and with higher economic vulnerability of farmers (de Roest et al., 2018).

Sustainable intensification (SI) has become one of the leading approaches to transform these highly specialised and input-dependent agricultural systems (Garnett et al., 2013; Petersen and Snapp, 2015; Pretty, 1997). SI generally refers to practices that maintain or increase yields, productivity and economic outputs, while minimising environmental impacts and use of land (Pretty, 1997; Pretty and Bharucha, 2014; Tittonell, 2014). It broadly includes approaches and practices such as precision and climate-smart agriculture, integrated crop-pest management, and crop diversification, with a focus on adapting the use of agrochemicals and (bio-)technology to specific agro-ecological conditions (Garnett et al., 2013; Tittonell, 2014; Uphoff, 2014). The adoption of these practices often asks for incremental changes in practices by farmers, and thus may have the potential for a wider up-take, potentially affecting the agricultural system as a whole, and

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agricultural value chains in particular (Duru et al., 2015; Pretty and Bharucha, 2014; Swinnen and Kuijpers, 2019).

Despite its potential, so far, the adoption of SI practices is relatively low, as only 9% of global agricultural land is estimated to operate under some form of SI (Pretty et al., 2018), and uptake is especially low in countries generally characterised by industrialised agricultural systems. Despite their benefits, implementing such practices often implies (initial) increased costs for farmers (Rosa-Schleich et al., 2019), who struggle to reduce agrochemical use (Bakker et al., 2021; Chèze et al., 2020; Mann, 2018), diversify their crop rotations (Jouan et al., 2020; Lemken et al., 2017), or improve on-farm biodiversity (Kirchweger et al., 2020; Mazé et al., 2021; Plaas et al., 2019). Additionally, a change in practices often requires the reorganisation of relations with downstream partners at value chain level, for example in the case of crop diversification and mixed cropping (Meynard et al., 2017), as well as the supply of suitable inputs from upstream, such as seeds and crop management systems (Magrini et al., 2016; Vanloqueren and Baret, 2009; Weituschat et al., 2022). Yet, while understanding the interplay between the adoption of SI practices and value chain (re-)organisation mechanisms is key, it is, as of yet, still under-researched (Ricome et al., 2016; Swinnen and Kuijpers, 2019).

Extant literature, in fact, mostly discusses forms of value chain organisation, including contract farming (CF), that have enabled farmers to adopt new practices aiming to improve product quality, or comply with food safety standards (e.g. Kumar et al., 2018; Mulwa et al., 2021; Wossen et al., 2017). Only few studies address sustainable practices (see Banterle and Stranieri, 2013; Mazhar et al., 2021; Ricome et al., 2016 for singular examples). Further, only Ricome et al. (2016) and Banterle and Stranieri (2013) have focussed on the European context from a value chain perspective, while the majority of studies assessing (potential) adoption of sustainable practices in Europe usually consider government-led agri-environmental schemes (AES) (e.g. Bougherara et al., 2021; Kuhfuss and Subervie, 2018; Santos et al., 2016). Value chain and commercial private sector initiatives, such as CF, have found only limited space in the literature on adoption of sustainable practices, against the evidence that private actors play a significant role, e.g. by creating incentives, setting standards or exchanging knowledge (Banterle and Stranieri, 2013; Cholez et al., 2020).

Against this background, this study aims to assess the potential of CF to support and incentivise the adoption of SI practices among farmers in Europe. Particularly, we draw on the case of a large-scale value chain-based initiative that has been implemented by a multi-national food manufacturer. More specifically, we have engaged with the Barilla Group and its recently launched sustainability-focussed Carta del Mulino initiative (CDM) (Barilla, 2021a). Through this programme, Barilla aims to reconfigure its value chain, including storage centres and millers, in order to incentivise farmers to adopt sustainable practices in line with an SI approach, focussing first on Europe (e.g. Italy, France and Germany). The design of a contract farming scheme has been key to Barilla's strategy (Barilla, 2018a, 2018b; Pancino et al., 2019). Through continuous interaction with this case and its actors, starting in 2013, we have been able to engage with wheat producers located in northern Italy, the area designated for initial pilot studies and the launch of the CDM initiative. Based on an extensive survey of 314 north-Italian farmers, the design of which was informed by intense previous engagement with the case through interviews, focus groups and company documents, we have analysed farmers' willingness to participate in a value chain-based contract farming scheme for SI. More specifically, this study pivots around three key questions: What is the potential of contract farming to incentivise the adoption of SI practices? Which practices can be effectively supported by contract farming? And which types of farmers are most likely to participate? To answer these questions, we implemented a hypothetical choice experiment to assess three SI practices (crop diversification, flower strips, and limiting glyphosate use) as contract attributes, and relate them to farmer characteristics and attitudes as determinants of contract acceptance and attribute preferences. Doing so, we are the first to demonstrate the potential of contract farming as a mechanism encouraging the adoption of sustainable intensification in the European context, as well as providing companies an indication for effective targeting for such contracts and policy makers for the limits of private sector initiatives. We have organised this paper as follows: We first give a brief overview of the concept of SI and then review relevant literature on the role of contract farming in the adoption of SI practices. Then, we present the context and methodology of this study, followed by the results of the choice experiment. Finally, we discuss the results and conclude.

2. The role of contract farming in the adoption of sustainable intensification practices

2.1. Mapping sustainable intensification practices

In this section, we will briefly discuss the concept of sustainable intensification (SI), as well as its related practices. SI has the overall aim to ensure food security for a growing population while minimising the negative environmental effects of industrial agriculture (Pretty, 1997; Rockström et al., 2017). It emphasizes the importance of adapting practices to local agroecological conditions when balancing production, productivity, and environmental costs and benefits (Pretty and Bharucha, 2014). However, due to this localised approach, many different practices have been discussed under the umbrella of SI (Tittonell, 2014; Wezel et al., 2015). This has led to confusion with regard to the actual meaning of the term and to what extent it actually differs from the status quo of industrialised agriculture (Petersen and Snapp, 2015). Some practices such as increasing the use of agrochemicals in previously low-input systems, which one might consider simply intensification, have also been described as SI (e.g. Mulwa et al., 2021; Struik and Kuyper, 2017). Its critics state that SI does not embody the paradigm shift necessary to mitigate and cope with the negative externalities of the current industrialised agricultural system (Levidow, 2015; Petersen and Snapp, 2015; Tittonell, 2014). However, while incremental, practices generally mentioned under this umbrella term, such as reduced and more precise use of agrochemicals, diversifying cropping systems, and improved seed varieties (Wezel et al., 2015), may still be a viable, or even necessary pathway towards more comprehensive and transformational approaches, such as agroecology (Garibaldi et al., 2019). Despite the breadth of approaches classified as SI, several common characteristics of SI practices have been defined (Pretty and Bharucha, 2014):

"(1) utilize crop varieties and livestock breeds with a high ratio of productivity to use of externally and internally derived inputs;

(2) avoid the unnecessary use of external inputs;

(3) harness agroecological processes such as nutrient cycling, biological nitrogen fixation, allelopathy, predation and parasitism;

(4) minimize use of technologies or practices that have adverse impacts on the environment and human health;

(5) make productive use of human capital in the form of knowledge and capacity to adapt and innovate and of social capital to resolve common landscape-scale or system-wide problems […]; and.

(6) minimize the impacts of system management on externalities such as GHG emissions, clean water, carbon sequestration, biodiversity, and dispersal of pests, pathogens and weeds" (Pretty and Bharucha, 2014, p. 1577).

Some of these practices are becoming increasingly relevant in the European context, with potential for broad uptake at scale. For example, *diversifying crop rotations*, particularly with legumes or oil crops, reduces pests and thus the use of pesticides (Pretty and Bharucha, 2014), increases biodiversity (Garibaldi et al., 2019) and, when introducing legumes, employs biological nitrogen fixation (Bedoussac et al., 2015; Lemken et al., 2017; Pretty and Bharucha, 2014). *Planting flower strips* increases on-farm biodiversity, reduces pests and creates habitats for pollinators (Gurr et al., 2016; Kirchweger et al., 2020). Finally, reducing use of agrochemicals, including glyphosate, can reduce their adverse effects on the environment and human health (Bakker et al., 2021; Chèze et al., 2020). Jointly, these practices thus reduce external inputs, make use of nitrogen fixation, reduce impacts on environment and human health, and improve biodiversity and reduce pests, all of which are SI principles (Pretty and Bharucha, 2014).

2.2. Contract farming and the adoption of SI practices

There is increasing evidence on the relationship between of forms of value chain participation and the adoption of agricultural practices (Swinnen and Kuijpers, 2019). Often contractual arrangements are needed to provide premium prices to farmers in order to incentivise the adoption of practices and the implementation of (quality) standards (Banterle and Stranieri, 2013). Nonetheless, studies suggest that there is no blueprint contract to encourage adoption (Meynard et al., 2017; Swinnen and Kuijpers, 2019), and designing adequate contracts and value chain configurations to support the adoption of sustainable practices can be a complex process (Pancino et al., 2019).

Empirically, several examples have started to illustrate the complex relationship, particularly between CF and farmers' adoption of new practices (e.g. Bonjean, 2019; Mazhar et al., 2021; Mulwa et al., 2021). However, these studies largely focus on cases in emerging economies. Studies on the European context are still rather scarce and are mostly centred on the French context. Ricome et al. (2016) find a connection between marketing contracts and adoption of more sustainable practices. They argue that the risk-reduction of marketing contracts might allow for more risk-taking when it comes to French grain farmers' adoption of low-input practices. Several studies analyse value chain organisation with regard to diversifying French cropping systems, such as Meynard et al. (2017) who analysed several case studies in France to show how diversifying cropping systems with minor crops requires a range of changes in the organisation of value chains. That analysis is complemented by Meynard et al. (2018) explaining how these required changes impede the uptake of such minor crops. Jouan et al. (2020) modelled how horizontal cooperation between crop and livestock farmers could diversify cropping systems by introducing legumes on French farms. Cholez et al. (2020) point to the importance of contract farming in the development and transfer of knowledge in legume production when building new value chains, using a case study in Britany, France. These studies, while limited to the French context, illustrate that a change in practices at farm level often requires changes in the organistion of the value chain. Beyond France, Banterle and Stranieri (2013) discuss how Italian farmers' adoption of integrated pest management practices for a private label also required a reconfiguration of contracts. Based on this literature, it is reasonable to suggest a relationship between value chain organisation and practice adoption, and there is still a lot of room to investigate the potential of contract farming to induce SI practice adoption, especially beyond the French context.

As studies on contracts for sustainable practices with value chain partners are still rare, we also draw from studies on public contracts, such as AES, to inform our study design. It is well established in this literature that contract attributes influence farmers' acceptance decisions (e.g. Bougherara et al., 2021; Christensen et al., 2011; Santos et al., 2016). Beyond the contract itself, previous research has shown that participation in AES is also related to farmer and farm characteristics (e.g. Kuhfuss and Subervie, 2018; Mack et al., 2020). For example, several studies have shown that farmers' environmental attitudes influence their willingness to partake in AES (Calvet et al., 2019; Defrancesco et al., 2018; Was et al., 2021), as well as general perceptions of or resistance to contracts (Allen and Colson, 2019). This general resistance to contracts was also shown for marketing contracts, though unrelated to sustainable practices, for Italian cereal farmers, where resistance to the use of written contracts being due to an aversion to restrictions and low trust in contracts generally (Solazzo et al., 2020). Further, more standard control variables have also been linked to the participation in AES, such as gender, age, education, experience, and land size (Calvet et al., 2019; Kuhfuss and Subervie, 2018; Mack et al., 2020).

3. Study context and methods

3.1. Research context

This study analyses Barilla's contract design for the Carta del Mulino initiative (CDM) aiming to make its soft wheat products more sustainable (Barilla, 2021a). CDM is in line with the concept of SI as it combines the aim to minimize environmental impact while maintaining or increasing economic value. This initiative followed several previous multi-stakeholder projects on value chain sustainability involving actors within and outside the company's value chains (Barilla, 2018b, 2020; Pancino et al., 2019). Initiated by the marketing department, CDM was developed with input from an NGO, two universities and value chain partners. Based on the CDM initiative and extensive stakeholder engagement through focus group discussions with farmers, elevators and millers, and in continued consultation with researchers and key managers in Barilla, three SI practices were eventually selected for further consideration in this study, namely crop diversification, flower strips, and limits on the agrochemical glyphosate. In essence, the CDM initiative, presents a contract farming arrangement to farmers, based on ten rules specifically designed to increase wheat quality, crop diversity and protection for pollinators, and reduce agrochemical use (Barilla, 2021a, 2021b). In order to signal this to consumers, products from the CDM initiative are traced throughout the value chain, third-party certified and labelled accordingly. Rolled out in 2017, more than 1400 farmers currently deliver under the CDM contract (Barilla, 2021b). Despite the participatory approach used by Barilla to design the CDM contracts, and the initial success during the roll-out, the company also experienced some internal and external pressure to further explore opportunities to enhance CDM contracts. The key aspects for further analysis have been the ability of CDM to impose stricter measures and to attract new farmers to deliver under the CDM rules. Specifically, questions remained whether crop diversification is preferred with legumes or oil seeds, the temporary or permanent nature of flower strips and extent of reduction of the chemical glyphosate, among others. As part of the stakeholder engagement, our research team has designed the discrete choice experiment to analyse the role of the above-mentioned issues. By targeting this case and related farmers, we ensure that the hypothetical contract design tested here is perceived as realistic. Further, Alcon et al. (2020) show that consumers are indeed willing to pay a premium price, for example, for products from more diversified systems, indicating that this is also a potentially attractive option for the companies involved.

3.2. Research design, sampling and data collection

The research design and sampling has been strongly informed by the roll-out process of the CDM contracts, and the sample was thus drawn from farmers operating in the areas where the initiative was already in place. Given the purpose of our study, we did not aim for a regionally representative sample, but instead specifically targeted farmers engaged in industrial value chains, in order to explore the potential of contract farming among this specific group of farmers.[1] Taking into account the sensitivity of issues discussed in the survey, including contract preferences and reservation prices, gaining access to farmers through a network known to them, was essential. We eventually sampled both from selected suppliers in the CDM value chain, as well as among

[1] The unavailability of farmers' contact data due to the Data Protection Act in force limits the possibility to use a more robust sampling design. Moreover, Italian farmers are quite unwilling to provide sensible business information and they generally agree to participate only if recommended by someone they trust. Therefore, we targeted farmers through their buyers and agronomic advisors.

comparable farmers in the same area, based on information provided by the company. This is due to the aim to reach both farmers currently targeted by CDM, as well as those in the same regions potentially targeted in the future. Farmers were located in the northern regions of Italy, namely Emilia-Romagna, Lombardy, Piedmont and Veneto (see Fig. 1). Data was collected between December 2019 and February 2021. Due to the COVID-19 pandemic affecting northern Italy at the time, data collection was prolonged, and adjustments had to be made to the data collection strategy along the way. While data collection started face-to-face, we eventually had to adjust to data collection by phone. Appendix 1 presents details of the adjustments to the strategies that were needed to cope with the challenges related to the pandemic. The final sample contains 314 complete observations. The survey itself contained five sections which collected data on farmer and farm characteristics, the farmer's value chain relationships, the discrete choice experiment, information on production and practices, and farmers' attitudes, respectively.

3.3. Discrete choice experiment

The questionnaire presented to farmers in the sample included a discrete choice experiment (DCE) to understand the potential of CF to incentivise the adoption of SI practices, analysing farmers' willingness to comply with specific restrictions. While initially developed by mathematicians in the 1960s (Luce and Tukey, 1964), DCEs have largely been used by economists to measure preferences and willingness to exchange attributes for a diverse range of products and services. Some examples of DCEs include, among others, health applications (Green and Gerard, 2009), job and food choices (Jaung et al., 2019; Miranda et al., 2012), and contract design (van den Broeck et al., 2017).

The DCE in this study started with a concise description of a hypothetical contract farming arrangement, framed as a contract with the farmers' current buyer. As mentioned in the previous section, the analysis focused on three strategic aspects of the CDM contract, and namely crop rotation, flower strips and glyphosate restrictions, which were carefully described to farmers in order to enable them to make an informed choice. Following standard procedure to calibrate the modelling approach, the level of the price premium was initially set based on stakeholder consultation, and then refined after the first set of surveys was collected (34 observations). Attributes of contracts and their levels are shown in Table 1.

The DCE investigated farmers' preferences by letting them choose between two contract schemes characterised by the four attributes with varying levels, plus an opt-out option, framed as the business-as-usual alternative. Levels of attributes change from one contract scheme to another following the Fedorov algorithm (Carlsson and Martinsson, 2003; Cook and Nachtsheim, 1980) that maximizes the D-efficiency of the design according to the covariance matrix of the conditional logit model. The resulting design identified 24 choice tasks organized in six blocks. Farmers were randomly assigned to one of the six blocks, each one containing four choice tasks. Fig. 2 shows an example of a choice set. Based on the presented choice set, respondents were asked to choose the preferred contract alternative or the opt-out option. This process was repeated for each choice task by each respondent, thus delivering (314 × 4) 1256 overall stated choices from 314 farmers.

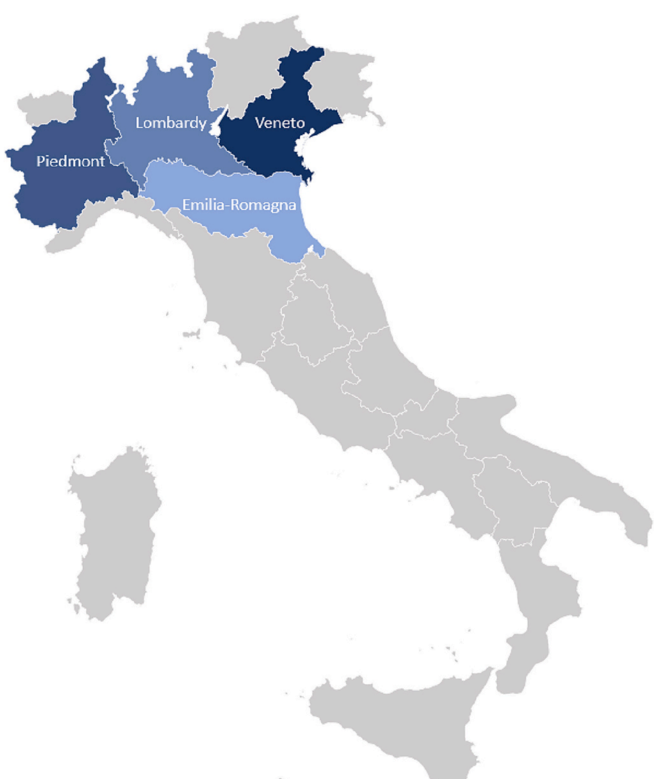


Fig. 1. Location of data collection.

3.4. Discrete choice model

Once collected, farmers choices were empirically examined by adopting the theoretical framework of the Random Utility Model (McFadden, 2001) and the Conditional Logit Model for estimating model parameters (Train, 2003). Analytically, by showing a set of 'A' contract alternatives to the i-th farmers, the farmer's utility associated with the alternative a can be represented as a linear function of all z attributes and levels characterizing contract a:

$$U^i{}_a = z_a{}^{'}\boldsymbol{\Omega} + e^i{}_a \quad (1)$$

where $\mathbf{z}_a$ is the vector of attributes characterizing the contract, $\boldsymbol{\Omega}$ is a vector of unknown parameters, and e_a^i represents the stochastic error component. The model assumes that the i-th farmer chooses the contract alternative a rather than b since it maximizes their 'expected utility': $U_a^i \geq U_b^i$, where a and b alternatives $\in A$ and $b \neq a$.

Farmers' choices are modelled in terms of probability: the probability that the i-th farmers prefers the contract a to b is due to the probability that the utility associated to the a alternative is higher (or equal) than the utility of the other proposed contract alternative: $p(U_a^i) = p\{U_a^i > \max(U_b^i, \ldots, U_A^i)\}$. In that way, the estimate of $\boldsymbol{\Omega}$ provides the influence of the different contract attributes on the probability that the contract is chosen, allowing a measure of farmers' preferences.

By considering preferences to be individual-specific, $\boldsymbol{\Omega}$ parameters vector can be assumed as distributed in the sample according to a distribution function defined by a location (μ) and a scale (σ) parameter:

$$U^i{}_a = z_a{}^{'}\boldsymbol{\Omega}^i + e^i{}_a \quad (2)$$

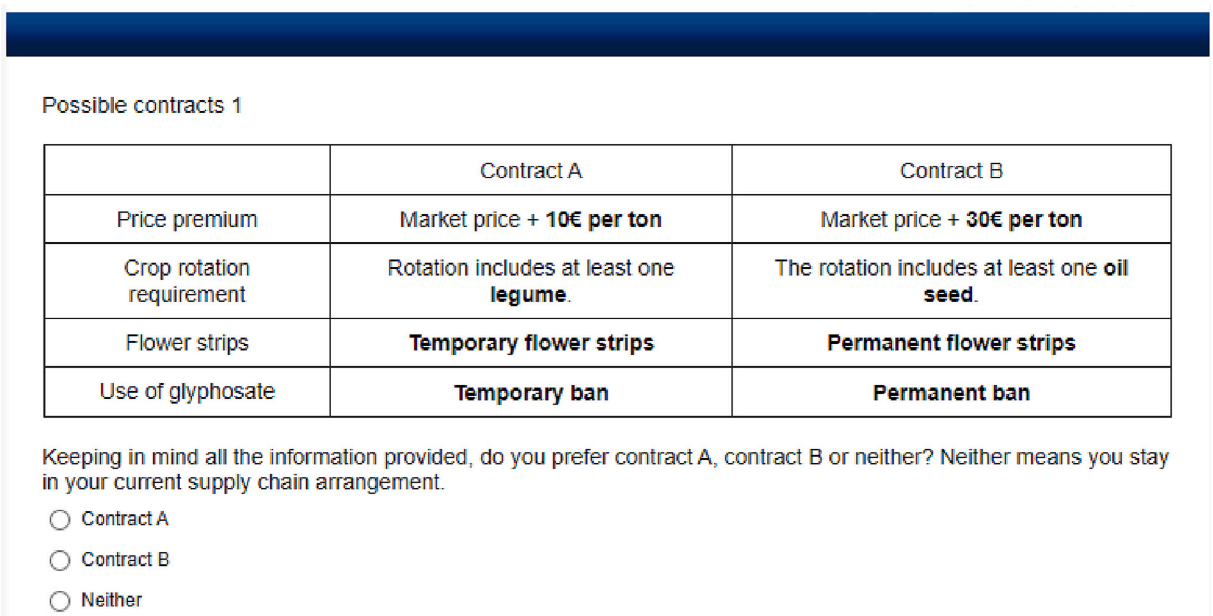
with $\boldsymbol{\Omega}^i = \boldsymbol{\Omega} + \boldsymbol{\nu}^i$. To allow correlation among the parameters, ν^i is assumed to be standard multivariate normally distributed $\boldsymbol{\nu}^i \sim N(0, \Sigma_{\boldsymbol{\Omega}})$. Individual model parameters $\boldsymbol{\Omega}^i$ were thus estimated using the maximum likelihood estimator assuming conditional logit random parameter specifications (Train, 2003), while the opt-out option was empirically modelled by introducing an alternative-specific constant (ASC) into the utility function for the opt-out alternative (Campbell and Erdem, 2019).

From the estimated parameters, for each farmer, the marginal value of the attribute in monetary terms (MVA) is calculated. It measures the trade-off between the presence of the s-th contract attribute and the base price. Analytically, it can be calculated taking the ratio parameter estimated for the non-monetary contract attributes to the price parameter multiplied by minus one, as follows:

$$\mathrm{MVA}_s{}^i = -\Omega_s{}^i / \Omega_{\mathrm{price}} \quad (3)$$

Table 1
Overview of contract attributes.

Attribute	Level A	Level B
Price premium	Market price + 10€ per ton	Market price + 30€ per ton
Crop rotation	At least one legume included in 5 year rotation.	At least one oil crop included in 5 year rotation.
Flower strips	Permanent flower strips of at least 3% of contracted soft wheat area located inside the farm.	Temporary flower strips of at least 3% of contracted soft wheat area located inside or next to the wheat field.
Ban on glyphosate	Temporary ban of glyphosate in the parcel under contract from 60 days prior to sowing until after harvest.	Permanent ban of glyphosate in the parcel under contract.


Possible contracts 1

	Contract A	Contract B
Price premium	Market price + **10€ per ton**	Market price + **30€ per ton**
Crop rotation requirement	Rotation includes at least one **legume**.	The rotation includes at least one **oil seed**.
Flower strips	**Temporary flower strips**	**Permanent flower strips**
Use of glyphosate	**Temporary ban**	**Permanent ban**

Keeping in mind all the information provided, do you prefer contract A, contract B or neither? Neither means you stay in your current supply chain arrangement.

- Contract A
- Contract B
- Neither

Fig. 2. Example of choice set presented to farmers in Qualtrics.

Similarly, the same procedure has been followed to calculate the marginal value of the opt-out alternative. While recognizing that several aspects may influence respondents choosing to opt out, such as the perceived complexity of the task, strategic or protest responses, we believe this analysis contributes to a better understanding of farmers willingness to prefer the status quo, rather than the sustainability-focussed CF scheme. With $MVA_s^i < 0$, it indicates the maximum amount of the base price per ton that the farmer is willing to give up in order to get that attribute in the contract, while with $MVA_s^i > 0$, it indicates the extra amount on the base price that farmers require to accept that attribute in the contract. Further insights can be gained via inspection of the empirical cumulative distribution function (eCDF) of the MVA_s associating each euro added to the base price with the share of farmers that are willing to accept that attribute in the contract.

3.5. *Analysis of farmers' preference heterogeneity*

In order to deepen the understanding of the heterogeneity of CF attribute preferences among farmers, a set of regressions was applied. This two-steps approach, using separate regression models to analyse preference heterogeneity using a random parameter specification, was suggested by Campbell (2007) and is often adopted in the literature (Czajkowski et al., 2017; Jiang and Chen, 2016; Yao et al., 2014). Campbell (2007) has shown how the use of the two-stage approach adds considerable explanatory power over standard methods that directly include individual-specific variables into the conditional logit. Meanwhile, Curtis et al. (2020) have highlighted the advantage of the two-stage approach being substantially less computationally demanding. The same authors mentioned that the two-stage approach allows for a better identification of drivers of heterogeneity in preferences.

In detail, following Curtis et al. (2020), a system of regression equations was set up, where the marginal values assigned to each farmer's MVA_s^i for each non-monetary contract attribute were analysed against farmer and farm characteristics using the seemingly unrelated estimator:

$$MVA_s{}^i = \boldsymbol{x}^{i'} \boldsymbol{\beta}_s + u_s{}^i \tag{4}$$

More specifically, based on the literature presented in Section 2.2, a range of farmer and farm characteristics were used to populate the $\boldsymbol{x}$ matrix: farmer's gender, age, experience working in agriculture (in years) to proxy a farmer's knowledge and skills, and the farmer's formal education, with the latter coded into three categories: No formal degree, at least a high school degree, and a university degree. The regressions also include among the covariates: whether the farmer was working on the farm full time (equivalent to a 5 day work week) to control for the time spent on the farming business, whether they were a member of a farmer cooperative or association since this influences the farmers' current value chain, whether they were already involved in CDM value chain and whether the farm held any certification (e.g. GlobalGAP, organic, or similar) to proxy the farmers' familiarity with the administrative burden of such a CF scheme. Moreover, three attitudinal scales on farmers' environmental attitudes, preferences for transaction conditions around the sale of wheat, and satisfaction with the current sales arrangement for wheat have been included. These attitudinal scales are each based on a set of statements and 5-point Likert scales asking to what extent the farmer agrees with each statement. Standardised means were used to combine the items into single indicators for each attitudinal scale.

For environmental attitudes, the set of questions is inspired by the idea that environmental action is affected by farmers' beliefs as to whether their own individual actions and production can have an impact on improving the environment, and whether environmental action is better done collectively (Cleveland et al., 2020; Despotović et al., 2021; Poteete and Ostrom, 2004). The attitudinal scale for transaction conditions measured the farmer's preferences for uncertainty and asymmetric information in sales transactions, focussing on price security and comparisons, transparent quality control, and plannability of sales activities (Cembalo et al., 2014; Pascucci et al., 2016). Lastly, the scale for satisfaction with the current buyer measures whether the sales prices are perceived as fair and at least cover costs, whether quality requirements from the current buyer are clear and whether the farmer believes this to be a long-term sales relationship. This variable was included in order to estimate the role of the current relationship with the buyer in the farmer's decision-making, since the DCE was framed as a contract with this current buyer, and the farmer's satisfaction with this relationship is likely to influence whether the farmer would like to intensify this arrangement. The individual items forming the indicators can be found in appendix 1.

Finally, a dummy variable was included in the model to control for any systematic differences on MVAs due the adjustment of the data collection strategy that obliged us to use phone interviews rather than face-to-face interviews. Descriptive statistics for all variables used can be found in Table 2 and Table 3. Where available, we also mention data from the Farm Accountancy Data Network (2020) representative for the same regions for comparison. Fig. 3 presents the proposed conceptual relationships between variables as indicated in this chapter.

4. Results

4.1. Results of the discrete choice model

This section presents the results of the discrete choice model. Estimates from the random parameter conditional logit analysis show that farmers strongly prefer a temporary restriction on glyphosate use over permanent ones. In fact, on average, to impose a permanent ban on glyphosate covering the entire rotation on the plot under contract would require a price premium of 33€/ton, with 19€/ton necessary to enrol just the most willing 25% of farmers. Further, temporary flower strips are preferred over permanent ones. This preference is less strong, however, if compared to the glyphosate ban. Only approximately 5€/ton would be needed, on average, to switch farmers from temporary to permanent flower strips. Finally, legume production in rotation is preferred over oil seed production. As can be seen in the empirical cumulative density function (see Fig. 5), less than 20% of farmers request any price premium at all to introduce legumes. Finally, the opt-out alternative is less preferred than entering the contract, meaning that overall farmers, on average, see value in contracting in order to implement SI practices for a price premium. Based on this analysis, over 60% of farmers in the sample see an added value in the presented contracts (Fig. 7). However, Fig. 7 also shows that of those farmers who demand a price premium, the majority requires one above 50€ per ton. Tables 4 and 5 show the estimates for this analysis. Fig. 4-7 show the empirical cumulative distribution functions for each contract attribute and the opt-out alternative.

Table 2
Descriptive statistics of continuous variables ($n = 314$).

Variable	Mean	Std. Dev.	Min	Max
Age (years)	51.24	12.97	19	84
Experience in agriculture (years)	28.78	13.43	1	75
Farm size, UAA (ha)[b]	77.89	286.67	2.5	3500
(*Official statistics*[a])	(*50.90*)	(*68.92*)		
Collective environmental attitudes	0	0.61	−1.75	1.55
Transaction preferences	0	0.73	−1.85	1.35
Satisfaction with current buyer	0	0.73	−1.57	1.46

[a] Source: Farm Accountancy Data Network, 2020.
[b] Mean and standard deviation of farm size are strongly affected by two outlier observations with large land holdings. Without these observations the mean drops to 55.65 ha with a standard deviation of 82.90 which is relatively close to the official statistics provided by FADN. The further analysis is not affected by these observations.

Table 3
Descriptive statistics of categorical variables ($n = 314$).

Variable	Categories		
Gender	Male	Female	
	95.54%	4.46%	
(*Official statistics*[a])	(*84.66%*)	(*15.34%*)	
Education	No degree	High school degree	University degree
	23.25%	70.06%	6.69%
	Yes	No	
Full time farmer	86.62%	13.38%	
Cooperative membership	71.97%	28.03%	
Presence of Certification[b]	36.94%	45.54%	
CDM farm	32.48%	67.52%	
Phone interview	35.99%	64.01%	

[a] Source: Farm Accountancy Data Network, 2020.
[b] average given to missing values.

4.2. Heterogeneity of farmers preferences

To examine the determinants of the marginal values of contract attributes and the opt-out option, we used seemingly unrelated regression estimates (Table 6). Results highlight similar statistically significant determinants for permanent glyphosate bans and introduction of oil seeds over legumes, with coefficients higher for glyphosate, indicating farmers have slightly stronger preferences regarding glyphosate use. All else equal, male farmers are more resistant to both stronger glyphosate restrictions and oil seed introduction in rotation instead of legumes. We find the same effect for full time farmers. Certification holders are less likely to oppose a permanent ban on glyphosate and less likely to prefer legumes. Farmers who believe to have effects on environmental outcomes and are willing to engage with others to improve the environment, and those more satisfied with their current sales arrangement are less resistant to permanent bans on glyphosate and oil seeds in rotation. Being interviewed by phone rather than face-to-face is also related to a higher resistance to a permanent ban on glyphosate as well as oil seeds in rotation. Finally, the only difference we see in determinants for these two regressions is with regard to whether farmers are currently participating in the CDM programme, which is not significantly related to preferences for glyphosate use but significantly reduces resistance to oil seeds in rotation.

For flower strips and the opt-out option, we again find similar determinants for both. Coefficients are higher for the opt-out alternative which are generally strongest across the results of all regressions. Here we find those with higher education more likely to oppose permanent flower strips and less likely to want to enter the contract at all, preferring the opt-out alternative. Farmers that are members in a cooperative or farmers association are less likely to oppose permanent flower strips. They also have a strong preference to enter one of the proposed contracts. This is also reflected in farmers' transaction preferences: those preferring more security in their sales arrangements for wheat are also more likely to want to enter the contracting arrangement, and are less likely to resist permanent flower strips. Similarly to the results observed for use of glyphosate and oilseeds in rotation, farmers' environmental attitudes are related to preferences for flower strips. Farmers' belief to be able to affect environmental outcomes and willingness to organise to achieve slightly reduces resistance to permanent flower strips. These attitudes also strongly relate to farmers' preference to enter the contract over the opt-out alternative. Currently participating in the CDM programme significantly reduces resistance to permanent flower strips, as well as, expectedly, significantly increasing farmers' preference to

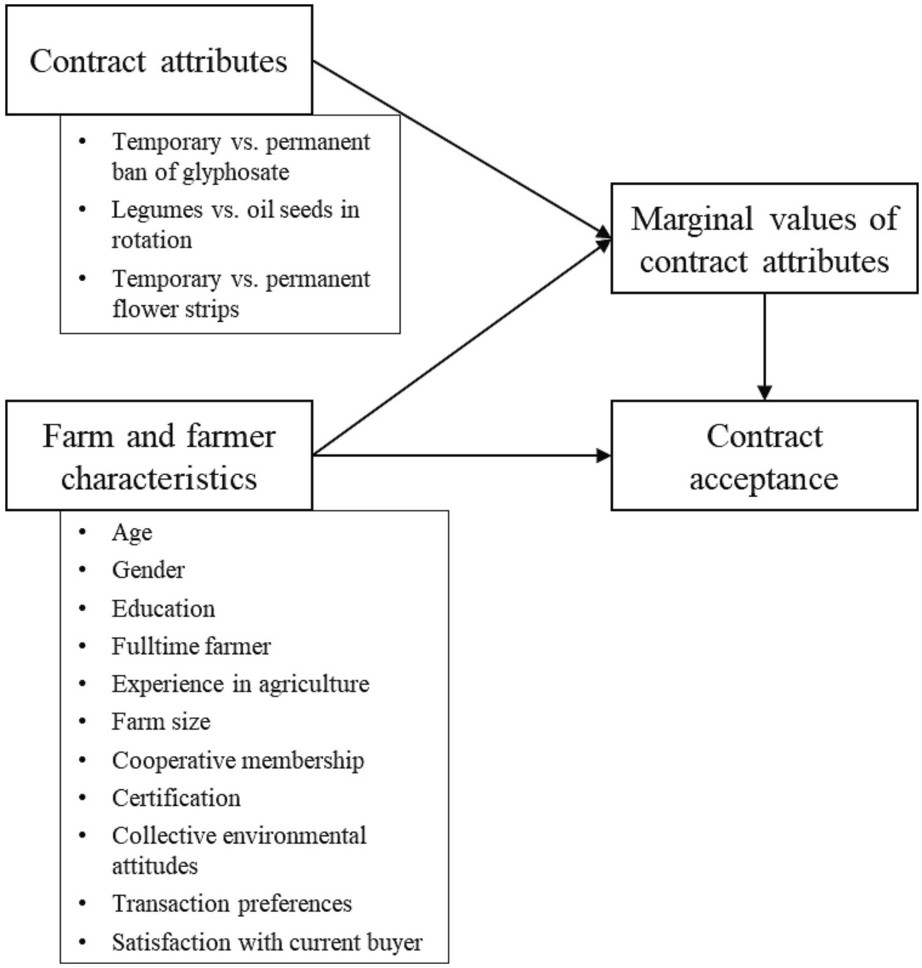


Fig. 3. Conceptual relationships between variables.

Table 4
Random parameter conditional logit estimates.

Attribute	Coef. Ω		std.err	*p*-value
Price Premium	0.053		0.009	<0.001
Use of Glyphosate (*Permanent*)	−1.741	[a]	0.236	<0.001
Flower strips (*Permanent*)	−0.276	[a]	0.155	0.075
Crop Rotation (*Oilseeds*)	−0.29	[a]	0.167	0.083
Opt-out (*business as usual*)	−2.951	[a]	0.708	<0.001
σ(Glyphosate)	1.870		0.257	<0.001
σ(Flower strip)	0.269		0.174	0.123
σ(Rotation)	0.323		0.209	0.123
σ(Opt-out)	7.999		1.041	<0.001

[a] : computed as mean value (μ) of the parameter distribution.

Table 5
Marginal value of the attribute (€/tons).

Attribute	Mean	std. err	95% conf interval		I quantile	III quantile
Use of Glyphosate (*Permanent*)	33.18	1.22	30.78	35.59	19.04	53.41
Flower strips (*Permanent*)	5.33	0.20	4.93	5.72	1.74	9.46
Crop Rotation (*Oilseeds*)	5.57	0.22	5.14	6.00	2.98	8.24
Opt-out	54.30	7.07	40.39	68.21	−94.07	176.44

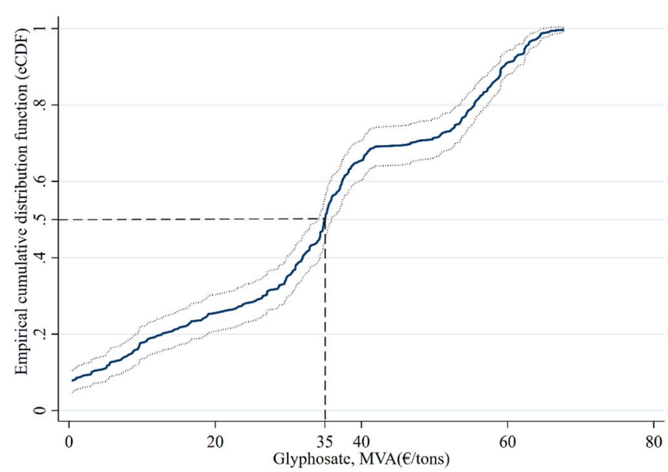


Fig. 4. Empirical cumulative distribution function of the marginal value of using glyphosate (95% confidence interval).

participate in the hypothetical contract over the opt-out option. Finally, being interviewed by phone instead of face-to-face decreases resistance to permanent flower strips, and increases farmers' preference for participation in the contract over the opt-out option.

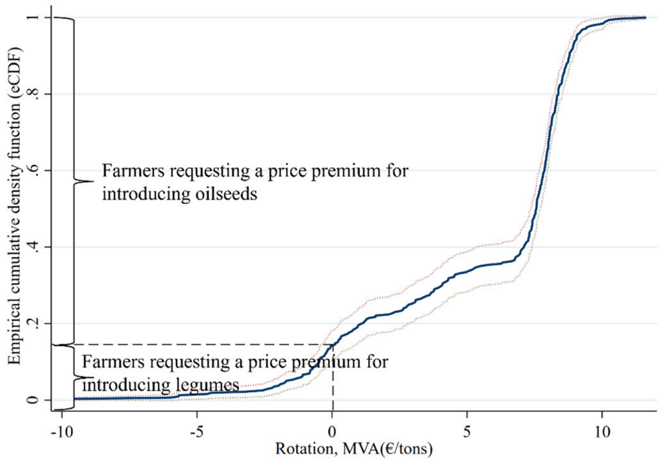


Fig. 5. Empirical cumulative distribution function of the marginal value of crop rotation (95% confidence interval).

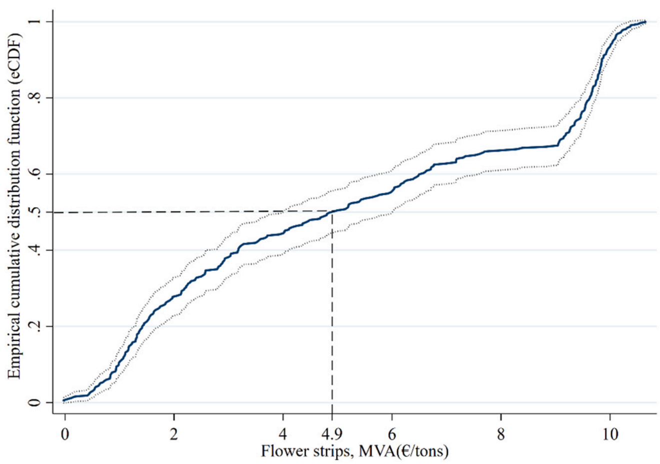


Fig. 6. Empirical cumulative distribution function of the marginal value of flower strips (95% confidence interval).

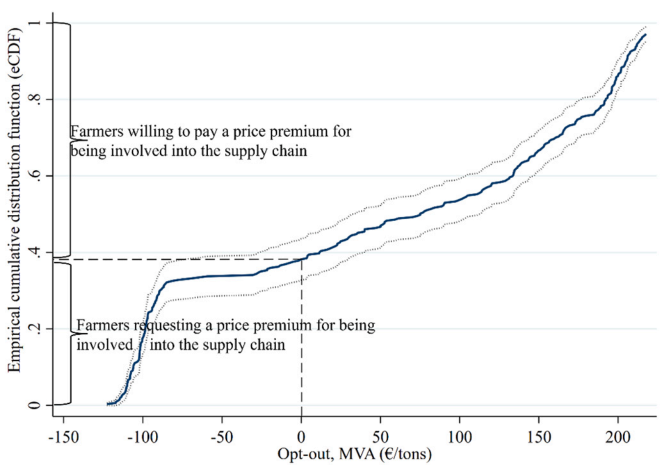


Fig. 7. Empirical cumulative distribution function of the marginal value of the opt-out option (95% confidence interval).

5. Discussion

Our research was designed pivoting around three key questions, to (1) analyse the potential of contract farming to incentivise the adoption of SI practices; (2) identify which practices can be effectively supported by contract farming; and (3) to identify the types of farmers most likely to participate in a sustainability-focussed contract farming scheme, such as the CDM initiative. Our results indicate that contract farming indeed has potential to support and incentivise the adoption of SI practices. However, the evidence gathered suggests that some practices seem to be challenging farmers' adoption more than others, while highlighting the relevance of designing contract farming arrangements taking into account farmers' characteristics. We start by discussing the former and then we move into a commentary on the latter, concluding the section by reconnecting our discussion to key contributions to the extant literature.

Looking at the practices tested in this study, glyphosate limitations seem to be the most difficult for farmers to accept. This indicates that glyphosate is a central element in the cropping system of farmers in this sample which they are rather unwilling to give up. This result is in line with other studies on the adoption of SI practices related to use of agrichemicals (Bakker et al., 2021; Chèze et al., 2020; Mann, 2018), and indicate where a key challenge in sustainability transitions may lay. There may also be an interaction between the adoption of flower strips, which may be a source of weeds, and the ban on glyphosate, as the adoption of the former may create a reluctance to accept the latter. While the literature on SI practices suggests an incremental approach to the adoption process, some of these practices for conventional farmers are more disruptive than others. Banning agrochemicals or severe limitations to their use, like in the case of the glyphosate in our study, is indeed perceived as a strong, perhaps unfeasible, constraint to some farmers' operations. Agrochemical management is likely to be a key aspect to consider in further articulation of a contract farming approach to SI practice adoption. Farmers' preference to include legumes in their rotation is encouraging, given the more extensive environmental benefits of legumes. According to some stakeholders' assessment, this may also be due to the regional circumstances of northern Italy, where agroecological conditions are fairly suitable for legumes and where there is cultural recognition of legume production. This may also be due to an increasing recognition of the overall economic benefits of legumes in rotations as indicated by, e.g., Cortignani and Dono, 2020 and Zander et al., 2016. Further, despite being low in recent decades, demand for legumes in food products in Europe is slowly growing under shifts to "healthier" and "more sustainable" diets (Lascialfari et al., 2019; Ferreira et al., 2021; Cusworth et al., 2021).

When it comes to farm and farmer characteristics, gender, education and being a fulltime farmer played a role in farmers preferences, which has also been found in previous studies (Calvet et al., 2019; Kuhfuss and Subervie, 2018; Mack et al., 2020). While more highly educated farmers have at times been found to be more open to participating in environmental schemes (e.g. Calvet et al., 2019), in this sample we find them to be more likely to resist contracting. Potentially, they may experience higher opportunity cost due to having more options at their disposal. Full-time farmers may be more resistant to stricter measures since their entire professional life is organised around their cropping system, thus making any changes to that system more profound. Certified farmers are possibly less resistant to stricter measures since they may already be used to adjusting to bigger changes in their cropping system, if they have already done so in the past to gain certification. Alternatively, in the case of organic, they may already go without agrochemicals entirely, and a complete removal of glyphosate from the given plot may thus not require any change at all.

Despite often theorised and found to impact adoption of innovative contracts and practices, the farmer's age and agricultural experience played no role in our model (e.g. Calvet et al., 2019; Mack et al., 2020; Murphy et al., 2011). Also, farm size had no effect on preferences for the contract or individual preferences (in contrast to e.g. Kuhfuss and

Table 6
Determinants of marginal value of the attribute in monetary terms (MVA), Seemingly unrelated regression estimates.

	Glyphosate (permanent)			Flower strips (permanent)			Rotation (oilseeds)			Opt-out (Business as usual)		
	Coef	Std.err	p-value	Coef	Std.err	p-value	Coef	std.err	p-value	Coef	Std.err	p-value
Age	0.111	0.155	0.476	0.016	0.026	0.536	0.027	0.027	0.315	−0.432	0.930	0.643
Gender (male)	**10.525**	5.817	0.07	1.251	0.994	0.208	**2.444**	1.023	0.017	−41.800	34.908	0.231
Education	−2.272	2.634	0.388	**1.125**	0.450	0.012	0.119	0.463	0.798	**−38.672**	15.806	0.014
Full time	**8.854**	3.564	0.013	0.578	0.609	0.342	**1.815**	0.627	0.004	−21.833	21.390	0.307
Cooperative membership	−0.139	2.788	0.96	**−1.189**	0.476	0.012	−0.584	0.490	0.234	**38.879**	16.730	0.020
Experience in agr.	−0.114	0.150	0.448	−0.005	0.026	0.85	−0.022	0.026	0.396	0.119	0.902	0.895
Farm size	0.003	0.004	0.464	0.001	0.001	0.229	0.001	0.001	0.206	−0.028	0.024	0.251
Presence of Certification	0.625	2.993	0.835	−0.787	0.511	0.124	−0.249	0.526	0.636	29.057	17.961	0.106
Collective environmental attitudes	**−4.057**	2.109	0.054	**−0.657**	0.360337	0.068	**−1.014**	0.371	0.006	**22.168**	12.659	0.080
Transaction preferences	1.390	1.778	0.434	**−0.557**	0.303647	0.066	−0.005	0.313	0.988	**23.068**	10.668	0.031
Satisfaction with current buyer	**−2.153**	1.122	0.056	−0.224	0.301255	0.457	**−0.483**	0.276	0.080	9.756	10.584	0.357
CDM farm	−2.929	2.920	0.316	**−1.120**	0.499	0.025	**−1.038**	0.513	0.043	**33.338**	17.522	0.057
Phone interview	**14.684**	2.901	0.001	**−2.484**	0.496	0.001	**1.445**	0.510	0.005	**87.588**	17.410	0.000
Cons.	10.200	9.326	0.274	**4.405**	1.593	0.006	1.089	1.640	0.507	**82.360**	55.968	0.141

R^2: 0.237(Glyphosate), 0.169(Flower strips), 0.245(Rotation), 0.17 (Opt-out) #obs 314
Note: Statistically significant coefficients ($p < 0.10$) are reported in bold.

Subervie, 2018; Mack et al., 2020; Murphy et al., 2011). We also confirm the role of environmental attitudes found by e.g. Defrancesco et al. (2018), Was et al. (2021) and Despotović et al. (2021). Effects we found for cooperative members and transaction preferences are in line with previous studies in which general attitudes towards contracts shaped farmers' preferences for specific contract offers (Allen and Colson, 2019; Solazzo et al., 2020). Finally, we found that satisfaction with the current buyer relationship makes farmers more likely to accept stricter contract conditions which echoes Calvet et al. (2019), who emphasise the importance of trust in the contracting institutions: trust seems more important the more profound the changes requested from the farmer. As one would expect, already participating in the CDM contract reduces resistance to some measures (permanent flower strips and oil seeds in rotation) and is related to being more willing to participate also in this hypothetical contract. Interestingly, it is not significantly related to farmers' preference regarding temporary or permanent glyphosate ban. This may be since farmers may have reservations on restricting glyphosate at all, rather than whether that restriction is temporary or permanent. This effect would only be reflected in farmers' general willingness to participate in the contract.

The similarity of determinants for glyphosate restrictions and crop rotations could be explained by the fact that both these practices are rather disruptive to farm management. Whether flower strips are temporary or permanent, their implementation could be considered less disruptive, and its determinants may therefore be more connected to whether the farmer is willing to engage in any kind of contracting that restricts choices in farm management. If one is opposed to those contracts in general, one may also be more sensitive to further restrictions, even if they are rather minor. The negative association between wanting to participate in the contract and preferring more flexibility in transactions is further echoed by the fact that, when asked why none of the contracts in the four choice tasks were selected, the most common answer from farmers was that they preferred to maintain more flexibility in their sales arrangement (59% of farmers). The individual practices were also mentioned as reasons to not want to enter the contract at all. Here reasons related to the rotation requirement were most common (42%), followed by glyphosate restrictions (34%) and flower strips (27%).[2] The premium being too low was only mentioned by 12% of farmers. These results support the interpretation that farmers that overall prefer more autonomy and flexibility are less inclined to engage in more coordinated value chain mechanisms, whether that is a cooperative or contract farming for SI.

Our results indicate that a price premium will indeed be necessary to induce farmers' acceptance of contract farming for SI. While Alcon et al. (2019, 2020) estimate that consumers are willing to pay more for products from more sustainable and diversified production, also in Italy, it remains to be seen whether the premium paid by consumers can fully compensate the price increase needed for farmers. This may even be exacerbated given that likely not the entire price increase paid by consumers will reach farmers. Any premium paid by consumers will likely also need to compensate increased coordination costs along the value chain, as well as being subject to effects of imbalance in market power and negotiations among value chain actors.

Yet, looking at our results, we can conclude that indeed a contract farming approach to facilitate adoption of SI practices is not necessarily an option for all farmers, and surely is highly dependent on the type of SI practice under consideration. Almost 40% of farmers in the sample require a likely prohibitive price premium and can thus be considered to be unwilling to engage in contracting for SI. These are mostly farmers that, all else equal, have more formal education, are not members of cooperatives and generally prefer more flexibility in their sales arrangements. This echoes results from Solazzo et al. (2020) who found that Italian wheat farmers in their sample prefer the autonomy granted by foregoing written contracts while at the same time still building on trust-based long-term relationships with their buyer. This seems to imply that a significant share of farmers is unlikely to be attracted by contracts that require written documentation, e.g., in order to provide certification of the practices used in crop production, which may limit the effect contract farming can have on practice adoption. It is still unclear, however, whether the trust in long-term buyers itself, rather than a contract, may be an avenue to reach these farmers and whether that will suffice to induce a change in practices, considering that some farmers may also be principally opposed to certain (agro-ecological) practices (Jaeck and Lifran, 2014). Thus, to maximise uptake of sustainable practices, heterogenous preferences for both contracts and practices need to be taken into account (Mack et al., 2020; de Salvo et al., 2018).

This indicates that there are limitations to what a voluntary private sector approach can achieve in terms of improving the uptake of more SI practices. Additionally, if the primary obstacle for farmers to adopt such contracts is maintaining flexibility, similar limitations may apply to voluntary contracting by the public sector through AES, as illustrated by e.g. by Espinosa-Goded et al. (2010) and Christensen et al. (2011), since these contracts may be perceived as equally restrictive. In order for farmers less willing to engage in SI through these voluntary approaches

[2] Other answers were that the contract was too risky (7%), the administrative burden too high (5%), preferring direct sales and/or on farm processing (4%), and preferring to sell under the organic label (4%). Multiple answers were possible and the question was only asked to farmers who rejected both contract options in all four choice tasks. 85 farmers answered this question.

to still implement these practices and improve the overall sustainability of the agri-food system, alternative approaches may thus be necessary, which we will discuss in the concluding section.

Due to the COVID-19 pandemic, we had to adjust the data collection strategy, and while we controlled for that in the analysis, in future research it would be preferable to avoid this. Still, if the experimental design had been too complex to be collected via phone, we would have likely seen a preference for the opt-out alternative for those interviewed by phone (Campbell and Erdem, 2019), but instead we observed that farmers interviewed by phone were less likely to opt out. Unfortunately, our experimental design was not set up to test for interactions between attributes, such as between flower strips as a source of weeds and the use of glyphosate. Further, while the case presented here is exemplary of farmers integrated in industrial value chains, the sample presented here did not aim to be regionally representative given that we targeted this specific group of farmers and needed to access them through channels known to them in order to discuss such business-sensitive issues. We therefore do not aim to generalise to farmers in the region. Also, there is most likely regional specificity. As is the case for finding suitable SI practices for each regional cropping system, farmers' preferences for practices and contract attributes are also likely to differ by region. It is thus advised that similar studies will be repeated for other locations. It would also be useful to engage in a direct comparative analysis to investigate whether and which farmers prefer to engage with public or value chain partners when it comes to contracting for more sustainable practices, or if contracts with either of these parties is considered equally restrictive. In addition, as Läpple and Rensburg (2011) suggest, the current degree of diffusion of a practice likely influences who adopts a practice and why. It is therefore advised to observe changes in farmers' preferences over time, depending on the continued uptake of SI practices (Dessart et al., 2019). Finally, a large majority of farmers in this sample were men. Further research may thus want to oversample for female farmers and farmers of other marginalised groups in order to assess the specific dynamics they may face in contracting for SI.

6. Conclusion

This study has highlighted that contract farming is a potential mechanism to support farmers in adopting SI practices. Many farmers in the sample see benefits in contracting for SI, and they are likely to accept legumes in their rotations and flower strips in their fields. Completely banning or strongly limiting glyphosate in their cropping system, on the other hand, will require more efforts and likely alternative weed management options. However, almost 40% of farmers in the sample are unlikely to be convinced to adopt SI practices through contract farming. All else equal, it is particularly farmers who are not members of co-operatives, are more educated and who generally prefer more flexibility in their sales arrangements that will resist this mechanism to promote practice adoption. If all farmers, and not only some, need to adjust their practices in order to reduce the environmental impacts of the agricultural sector as a whole, contract farming approaches may not be sufficient. Instead, policy interventions might be still needed to enhance participation, adoption and diffusion of SI practices. For instance, incentives such as linking subsidies to the adoption of SI practices, particularly through the CAP, may be a mechanism to enhance participation, and reach additional farmers. There is indeed potential to couple public interventions with private, supply chain based initiatives, like the one we have investigated in this study. Particularly if public policy mechanisms aim at supporting longer crop rotations, private sector initiatives may also benefit from synergies as farmers could reap benefits through both. However, it is unlikely that private initiatives would cover practices already subsidised through the CAP, and these may thus also function as substitutes. Alternatively, contracting may need to be more participatory to include mutual learning and knowledge exchange. This may overcome barriers other than financial incentives, such as personal preferences or biases farmers may have towards certain practices. Overall, it is likely that no single approach, policy or mechanism can reach all farmers, and that a combination of measures will be necessary to promote SI practices more broadly.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Sampling

Initially, in the time frame between December 2019 and February 2020, millers and storage centres in Barilla's value chain, who were willing to participate in the data collection, invited farmers to join sessions of up to 10 farmers. During these sessions farmers willing to participate self-administered the survey on tablets, supervised and supported by trained enumerators. They were discouraged to interact during this time. This initial approach levied responses for 75 farmers. When the COVID-19 pandemic initially reached Italy in the spring of 2020 and several government lockdowns restricted movements and gatherings, the data collection was halted. Due to risk of infection, the initial data collection strategy had to be abandoned. Instead, two different strategies were used between the end of September 2020 and end of February 2021. First, agricultural advisors active in the given value chain and willing to participate were trained as enumerators. The majority of enumerators then used their own network to target farmers participating in the CDM initiative and the Barilla value chain, while one enumerator used the advisory service's data base of clients to target comparable farmers in the same areas. In order to eliminate additional risk of infection, the enumerators targeted farmers in their network whom they were visiting anyway for other activities and then conducted face-to-face interviews. In this manner, 130 farmers were interviewed. Secondly, whenever farmers could not be visited in person, phone interviews were done in order to avoid a possible selection bias based on availability and willingness for an in-person visit. The hypothetical choice experiment in these phone interviews was visually supported by sending the contract options as pdf to the respondent's phone. By phone, we reached 114 farmers. The average response rate of this secondary, one-on-one approach was approximately 91.6%. We assume the achievement of such a response rate was due to the enumerators being known contacts to the farmers and thus increasing their willingness to participate. Five observations were incomplete and dropped from the analysis bringing the total from 319 to 314 farmers.

Appendix B. Attitudinal scales

Below the translated sets of items for the attitudinal scales used in the analysis. Answer options were: "I totally disagree", "I somewhat disagree", "I don't agree or disagree", "I somewhat agree", "I totally agree", or "I don't know".

Environmental and collective attitudes (6 items)
If I do something for the environment just as a single person, it will have no effect.*
Since other farmers already contribute to sustainable crop productions, my contribution is not relevant.*
The best way to solve environmental problems is to act collectively.
Forming an association with other farmers to contribute to environmental improvement is just a waste of time.*
For me, participating in collective actions related to the realization of a sustainable supply chain is important to help the environment.
My family and my friends would be proud of me if I contribute to the realization of a sustainable supply chain.
*reversed in code
Preferences for the sale of soft wheat (4 items)
It is important for my farm to fix a minimum reference price for soft wheat before sowing.
It is important that quality control systems for my soft wheat are clear and transparent
It is important for my farm to compare prices for soft wheat between different buyers before selling it.
For me it is a problem if I cannot plan the sale of my soft wheat in advance.
Satisfaction with usual wheat buyer in the last three years (4 items)
The agreement with my usual buyer gives me a fair price.
The agreement with my usual buyer has clear quality requirements.
The agreement with my usual buyer is a long term relationship.
The agreement with my usual buyer covers at least my cost.

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