DIVERFARMING

Crop diversification and low-input farming across Europe: from practitioners' engagement and ecosystems services to increased revenues and value chain organisation

NON-MARKET VALUATIONS

Deliverable D8.2

Version 1.0

Issue date: 30/07/2019

Authors: Francisco Alcón, Terhi Latvala, Emanuele Blasi, Cristina Marín-Miñano, Eleonora Sofia Rossi, José A. Zabala, María Dolores de Miguel, Heikki Lehtonen

This project has received funding from the *European Union's Horizon 2020 Research and Innovation Programme* under grant agreement No 728003

European Commission

Document summary	
Document title	NON-MARKET VALUATIONS
Authors	Francisco Alcon (UPCT), Terhi Latvala (Luke), Emanuele Blasi (UTu), Cristina Marín-Miñano (UPCT), Eleonora Sofia Rossi (UTu), José A. Zabala (UPCT), María Dolores de Miguel (UPCT), Heikki Lehtonen (Luke)
E-mail of principal author	francisco.alcon@upct.es
Lead beneficiary	Universidad Politécnica de Cartagena
Deliverable No.	D8.2
Work Package	WP8. Economic assessment at farms and value chains.
Dissemination type	Report
Dissemination level	Public
Deliverable due date	31/05/2019 (month 25)
Release date	30/07/2019 (month 27)
Copyright	© 2019 DIVERFARMING Project and Consortium

DIVERFARMING

List of Diverfarming participants

No	Name	ACRONYM	COUNTRY
1	Universidad Politécnica de Cartagena (Coordinator)	UPCT	Spain
2	Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria	CREA	Italy
3	Agencia Estatal Consejo Superior de Investigaciones Científicas	CSIC	Spain
4	Universita degli Studi della Tuscia	UTu	Italy
5	Asociación Regional de Empresas Agrícolas y Ganaderas de la Comunidad Autónoma de Murcia	ASAJ	Spain
6	Consorzio Casalasco del Pomodoro Società Agricola cooperativa	CCP	Italy
7	Arento Grupo Cooperativo Agroalimentario de Aragón	GA	Spain
8	Barilla G.E.R. Fratelli SPA	Bar	Italy
9	Disfrimur Logistica SL	DML	Spain
10	Universidad de Córdoba	UCO	Spain
11	Wageningen University	WU	Netherlands
12	Firma Nieuw Bromo van Tilburg	NBT	Netherlands
14	Industrias David S.L.U.	InDa	Spain
15	University of Portsmouth Higher Education Corporation	UPO	United Kingdom
16	Universität Trier	UT	Germany
17	Eidgenössische Technische Hochschule Zürich	ETH	Switzerland
18	Weingut Dr. Frey	WDF	Germany
19	University of Exeter	Exeter	United Kingdom
20	Pecsi Tudomanyegyetem - University of Pecs	UP	Hungary
21	AKA Kft	AKA	Hungary
22	Nedel-Market Kft	NMT	Hungary
23	Luonnonvarakeskus	Luke	Finland
24	Paavolan kotijuustola	PK	Finland
25	Polven juustola	PJ	Finland
26	Ekoboerderijdelingehof	Eko	Netherlands

Executive summary

The first Diverfarming objective is to develop and test different diversified cropping systems (rotations, multiple cropping and intercrops for food, feed and industrial products) under low-input practices to increase land productivity and crops quality, and reduce machinery, fertilizers, pesticides, energy and water demands. It means, in short, to reach a resilient and sustainable agriculture.

To make this goal effective in a long-term, a comparison between conventional and diversified cropping systems is needed, which requires a previous study of environmental and economic items within plots. In this framework, diversified cropping systems should be perceived as beneficial by most stakeholders within each agroecosystem. Thus, a cost-benefit analysis is demanded.

Concerning economical aspects, WP8.1 task consists of the development of a common integrated research methodology and protocol. This task includes as sub-task 8.1.2. the development of non-market valuations concerning crop diversification externalities.

In this context, this report, leaded by UPCT, provides the results of non-market valuations developed within Mediterranean South, Mediterranean North and Boreal pedoclimatic regions. Hence, Spanish (Region of Murcia), Italian (Padania Valley) and Finnish case studies within Diverfarming project are involved in the elaboration of non-market valuations, which will be a part of the integrated economic assessment.

The results suggest that consumers value several positive benefits of crop diversification. Estimated average willingness to pay in the case studies shows different perception between ecosystem services and countries. However, non-market value of crop diversification, with several implied consequences, was found to be significant even when compared to market value of agricultural production. The results as a whole suggest that various positive societal and environmental consequences of crop diversification such as domestic food production, food security, nutrient leaching, food culture or carbon sink are indeed very significant for consumers. Hence, marketing crop diversification should focus on larger and aggregate level societal and environmental benefits and not primarily on farm level implications.

Table of Contents

1. INTRODUCTION 1
2. SPANISH CASE STUDY 3
2.1. Case study description 3
2.1.1. Pedoclimatic region 3
2.1.2. Diversifications description 3
2.2. Methodology 4
2.2.1. Choice Experiment method 4
2.2.2. Econometric models 9
2.3. Results 11
2.3.1. Sample description 11
2.3.2. Preference modelling 12
2.3.3. Social demand factors 15
3. FINNISH CASE STUDY 16
3.1. Case study description 16
3.1.1. Pedoclimatic region and agriculture in the case study area 16
3.1.2. Diversification aspects of the Finnish case studies 16
3.1.3. Scenarios and survey design 18
3.2. Methodology 20
3.2.1. Contingent valuation 20
3.2.2. Econometric model 21
3.3. Results 21
3.3.1. Sample description 21
3.3.2. Consumer preferences for outcomes of Finnish agriculture 22
3.3.3. Willingness and unwillingness to pay 24
4. ITALIAN CASE STUDY 27
4.1. Case study description 27
4.1.1. Pedoclimatic region 27
4.1.2. Diversifications description 29
4.2. Methodology 30
4.2.1. Choice Experiment method 30
4.2.2. Econometric models 33
4.3. Results 35
4.3.1. Sample description 35
4.3.2. Preference modelling 36
4.3.3. Social demand factors 39

5. **DISCUSSION** **40**

6. **CONCLUSIONS** **45**

7. **REFERENCES** **46**

1. Introduction

The main objective of this report on non-market valuations is to estimate social perception about the value of Ecosystems Services (ES) provided by crop diversification, beyond the value of agricultural production. Both biodiversity and each group of ES (provisioning, regulating and cultural) will be valued. While provisioning services will be valued through market price-based methods according to the procedure stated in Deliverable D8.1 (Diverfarming 2019b), both regulating, cultural services and biodiversity will be valued through stated preferences methods: choice experiment (CE) and contingent valuation method (CVM).

The development of non-market valuation will contribute to the integrated economic assessment, which includes: (a) stakeholder analysis, (b) farm level economic analysis, (c) value chain economic and socioeconomic analysis, (d) available information on environmental impacts and field experimental data, and (e) non-market benefit-costs estimation. Non-market valuation was carried out only by Spanish (Region of Murcia), Italian and Finnish case studies within Diverfarming project (Figure 1.1). The results obtained here will allow a deeper comparison between crop diversification in different pedoclimatic regions (Mediterranean South, Mediterranean North and Boreal).

In this framework, ES approach was used to estimate non-market benefit-costs within Spanish, Italian and Finnish case studies. As ES derive from ecosystems functioning, the status of the agroecosystem will influence ES quality and quantity provisions. This approach can be assessed at Deliverable D8.1 (Diverfarming, 2019b). Since most ES provided by agroecosystems are not exchanged and priced in the market, a valuation through a hypothetical market seems appropriate to be developed. In fact, non-market goods can be highly valued by society. Indeed, these values can be higher than market goods (Shandu et al., 2008).

Diverfarming case studies are the starting point of this study. These case studies were defined by Diverfarming WP2 (Diverfarming, 2019a), and include all pedoclimatic areas within European Union. It allows an analysis of different crop diversifications through the variety of pedoclimatic conditions in Europe. Hence, the variability within the provision of ES in each type of agroecosystem is studied. Consequently, the value of different ES perceived by society within different countries will be also known.

Diverfarming project compares diversified and non-diversified cropping systems. In this context, stated preference methods were selected to estimate non-market values perceived by society, such as the value of the environmental benefits, landscape, traditional practices or biodiversity within the agroecosystem. This methodology can provide useful information for policy makers to manage these ecosystems. However, it should be considered that a large number of management alternatives for farmers exist due to the diversity within agricultural systems, not only in forms but also in scales. Diverfarming gazes at species diversification within fields, and also within crops, field and landscape diversification scales. Some study cases also consider temporally diversity, changing crop species (all or part of them) during the trial period.

In the following, the non-market valuation of three case studies (Spain, Italy and Finland) are described and estimated to be later discussed.

Figure 3.1. *Location of Finnish, Italian and Spanish case studies.*

2. Spanish case study

2.1. Case study description

2.1.1. Pedoclimatic region

All Spanish case studies are located in the Mediterranean South pedoclimatic region. More specifically, case studies CS1 and CS2 are placed within the Region of Murcia (Southeast of Spain) (Figure 1.1). This area is characterised by semiarid climate conditions with increasing water scarcity (mean annual precipitation of 231 mm). Hence, long draught periods are followed by torrential rainfalls, which causes problems as soil erosion or soil quality loss. 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).

As a consequence of the climate conditions described, agriculture within the Region of Murcia is based on a dual model, where irrigated crops (mainly citrus and vegetable crops) coexist with rainfed crops (i.e. almond or olive trees).

2.1.2. Diversifications description

Two case studies, rainfed almond crop (CS1) and irrigated mandarin crop (CS2), will be considered to develop non-market valuation within Mediterranean South pedoclimatic area.

2.1.2.1. Case study 1. Rainfed crops (almonds) in Spain

Almond crop area in the commercial plot farm covers a total of 2.63 ha, where Diverfarming experimentation area has an extension of 0.20 ha, with 54 almond trees. The current crop species is *Prunus dulcis*, whose final use is food. The current system consists of a conventional rainfed monoculture in a 7m x 7m pattern where the unique management practice is tillage. The blossom occurs in January-February, and almonds are harvested between July and August.

Main environmental problems in the case study are: low below and aboveground biodiversity, erosion (sheet, rills, gullies), low soil quality, low soil organic matter content, landscape homogeneity, high connectivity of water and sediment fluxes, low resilience and adaptability. These facts derive in a reduced potential of ecosystem services' potential related to soil and vegetation functioning.

In this context, the following cropping systems are being developed by Diverfarming project:

- Almond monocrop (MA).
- Diversification 1 (D1) of almond intercropped with *Capparis spinosa* (perennial) for food during 2018, 2019 and 2020.
- Diversification 2 (D2) almond intercropped with *Thymus hyemalis* (perennial) for essential oils and food during 2018, 2019 and 2020.

Regarding crop management, low input practices will be carried out, with reduced tillage. Further information about the case study can be found at Deliverable D2.2 (Diverfarming, 2019a).

2.1.2.2. Case study 2. Irrigated crops (citrus) in Spain

Mandarin crop total extension in the farm covers 206 ha, where Diverfarming experimentation area has an extension of 2.3 ha, with 1100 trees. The specific current species is *Citrus reticulate* var. Clemenvilla, whose final use is food. The current system consists of a conventional irrigated monoculture, in a 6m x 4m pattern, where management practices are intense tillage and mineral fertilizer, with intensive pesticides application. Blossom occurs in April, and mandarins are harvested between January and February.

At mandarin crop on case study CS2, the main problems to be found are: low below and aboveground biodiversity, erosion, low soil quality, low soil organic matter content, soil and water pollution, soil salinization and landscape simplification.

In this framework, the following cropping systems are being developed by Diverfarming project:

- Mandarin monocrop (MC).
- Diversification 1 (D1) of mandarin intercropped with multiple cropping of vetch/barley (*Vicia sativa/Hordeum vulgare*) for feed and fava bean (*Vicia faba*) for food, during 2018, 2019 and 2020.
- Diversification 2 (D2) mandarin intercropped with vetch/barley/oat (*Vicia sativa/Hordeum vulgare*) and fava bean (*Vicia faba*) during 2018; purslane (*Portulaca oleracea*) and cardoon (*Cynara cardunculus* var. cardunculus) during 2019; and cowpea (*Vignia unguiculata*) and rocket (*Eruca sativa*) during 2020.

Regarding crop management, low input practices will be carried out, with the addition of green manure, an integrated pest control, reduced tillage and regulated deficit irrigation. Further information about the case study can be found at Deliverable D2.2 (Diverfarming, 2019a).

2.2. Methodology

Methodology applies for both case studies and their monocrops and crop diversification systems.

2.2.1. Choice Experiment method

Choice Experiment (CE) was selected as an appropriate methodology to achieve Diverfarming's case studies CS1 and CS2 goals in non-market valuation. CE is a stated preference method based on Lancaster's multi-attribute utility theory (Lancaster, 1966) and the random utility theory (McFadden, 1974). According to them, the utility provided by a good or service can be decomposed into the sum of the utility provided by the attributes which compose it (Lancaster, 1966). Thus, an individual will choose an alternative according to maximize him/her utility level (McFadden, 1974). This method allows to analyse the provision of the attributes (and their levels) within a good and the relationships between these attributes (Bateman *et al*., 2002). In this case, CE allows a valuation of different ES within an agroecosystem, as well as the perceived added value which is provided by diversification practises.

Therefore, CE are based on the idea that a good can be valued through the values of its attributes. In this framework, a CE is implemented through four stages (Hoyos, 2010): (1) both the attributes and their levels are defined and stablished; (2) choice sets are selected; (3) the structure and assembly of the questionnaire are setted-up; and (4) data are collected. These stages are extended below.

2.2.1.1. Attributes and levels

Attributes for the CE development were selected through a literature review and expert interviews, considering the main environmental problems at the study cases. Furthermore, these attributes will be measured by different Divergarming WPs, thus initial qualitative levels could be transformed into numbers when data from different WPs is available. Selected attributes and their correspondent levels are shown at Table 2.1.

__Table 2.1.__ Description of attributes and levels used in the Choice Experiment exercise.

Attribute	Description	Code	Levels
Biodiversity	Nº of species identified within soil samples	BIOD	Low (*status quo*) Medium High
Soil erosion	Soil lost due to erosion	EROS	High (sq) Medium Low
CO_2 net balance	CO_{2eq} sequestered annually by the crop	CO2B	Low (sq) Medium High
Cultural heritage	Maintenance of traditional agricultural practices	CULT	Absence (sq) Presence
Landscape	Perception of agricultural landscape beauty	LAND	Monocrop (sq) Diversification
Cost	Monthly increase in foodstuff expenditure per family (fruit consumption)	COST	0 € (sq) 10 € 20 € 30 € 40 € 50 €

As it was mentioned previously, the attributes were selected due to their study within Diverfarming project as well as their presence on similar researches on environmental goods' non-market valuation. Regarding the use of the attributes on similar studies, biodiversity is a widely used attribute (Rodríguez-Ortega *et al*., 2016; Novikova *et al*., 2017; Dupras *et* al., 2018; Varela *et al*., 2018); landscape is also very common in the literature (Rodríguez-Ortega *et al*., 2016; Jourdain and Vivithkeyoonvong, 2017; Novikova *et al*., 2017; Dupras *et* al., 2018; Varela *et al*., 2018); but instead, soil erosion and carbon balance (Rodríguez-Entrena *et al*., 2012), as well as cultural heritage (Ragkos and Theodoritis, 2016) are less common within similar studies developed at agroecosystems. However, these indicators were considered to be relevant in this case as soil loss and carbon footprint are two significant agricultural problems, and also the loss of cultural heritage in places with farming traditions. As an example, mono-cropping and other intensification practices involve high risks of runoff and soil erosion (Boardman *et al*., 2003).

Attributes are referred to regulating and cultural ES, which do not participate directly in the market. Biodiversity, which is not an ES itself, is also considered due to its importance for the maintenance of a good status of an ecosystem (TEEB, 2010). On the other hand, provisioning services were excluded on this methodology because a market valuation will be also developed within Diverfarming project and double accounting should be avoided from the global agroecosystem valuation (Fisher *et al*., 2009).

With regard to the cost attribute, it was included in the choice experiment design to determine the increase in foodstuff expenditure per family derived from the willingness to consume products from diversified and low-input farming. The cost attribute levels were selected taking as a reference the monthly average expenditure in fruits, vegetables and cereals per family, valued in about 100€ (MAPA, 2018). Thus, five cost levels were defined: 10€, 20€, 30€, 40€, 50€, which imply considering an increase in foodstuff expenditure ranging from 10% to 50%.

2.2.1.2. Choice sets

The experimental design comprised the construction of the choice sets, which combined two diversification alternatives with the monocrop *status quo* (SQ) alternative. Twenty choice sets were blocked in four groups to create the choice experiment design. Different choice set blocks were distributed randomly through the respondents. To simplify CE and to ensure that respondents understood the exercise, attributes' levels were illustrated by images and clarifying comments were made when necessary. Figure 2.1 shows an example of a choice set.

Scenario 1.1	Diversification A	Diversification B	Monocrop (SQ)
Biodiversity	 High	 Low	 Low
Soil loss	 High	 Low	 High
CO_2 net balance	 High	 Medium	 Low
Cultural heritage	 Low	 High	 Low
Landscape	 Diversification	 Diversification	 Monocrop
Monthly overrun	**40 €**	**20 €**	**0 €**
Choose an option			

Figure 2.1. *Example of a choice set used in the CE.*

It is important to remark that the combination of attributes' levels for the generation of choice sets was developed following an S-efficient (pilot survey case) or a Bayesian efficient design (definitive survey) by means of Ngene 1.0.2 software package (Rose *et al*., 2010). In the case of the definitive survey, the Bayesian efficient design was the most suited in order to ensure efficient results, since the sample was great enough to its development.

2.2.1.3. Questionnaire design

The valuation scenario aimed to stablish a context for the respondents. The main message was:

"Intensive food production can provide environmental negative impacts. However, the current agricultural model can be improved through crop diversification and low input practices. Crop diversification allows an environmental risks reduction through an increase of biodiversity, erosion control, higher CO_2 balance, and also provides a more heterogeneous landscape and the conservation of traditional knowledge and practices. In this framework, Diverfarming project analyses low input diversified farming and aims to create better understanding of crop diversification as well as developing an optimized diversification practice to be adopted by farmers".

As complementary information of the CE, some information cards were showed at the respondents. These cards provided information about Diverfarming project (Figure 2.2.), about the impact of crop diversification and low input practises (Figure 2.3.) and about the attributes and levels of the CE.

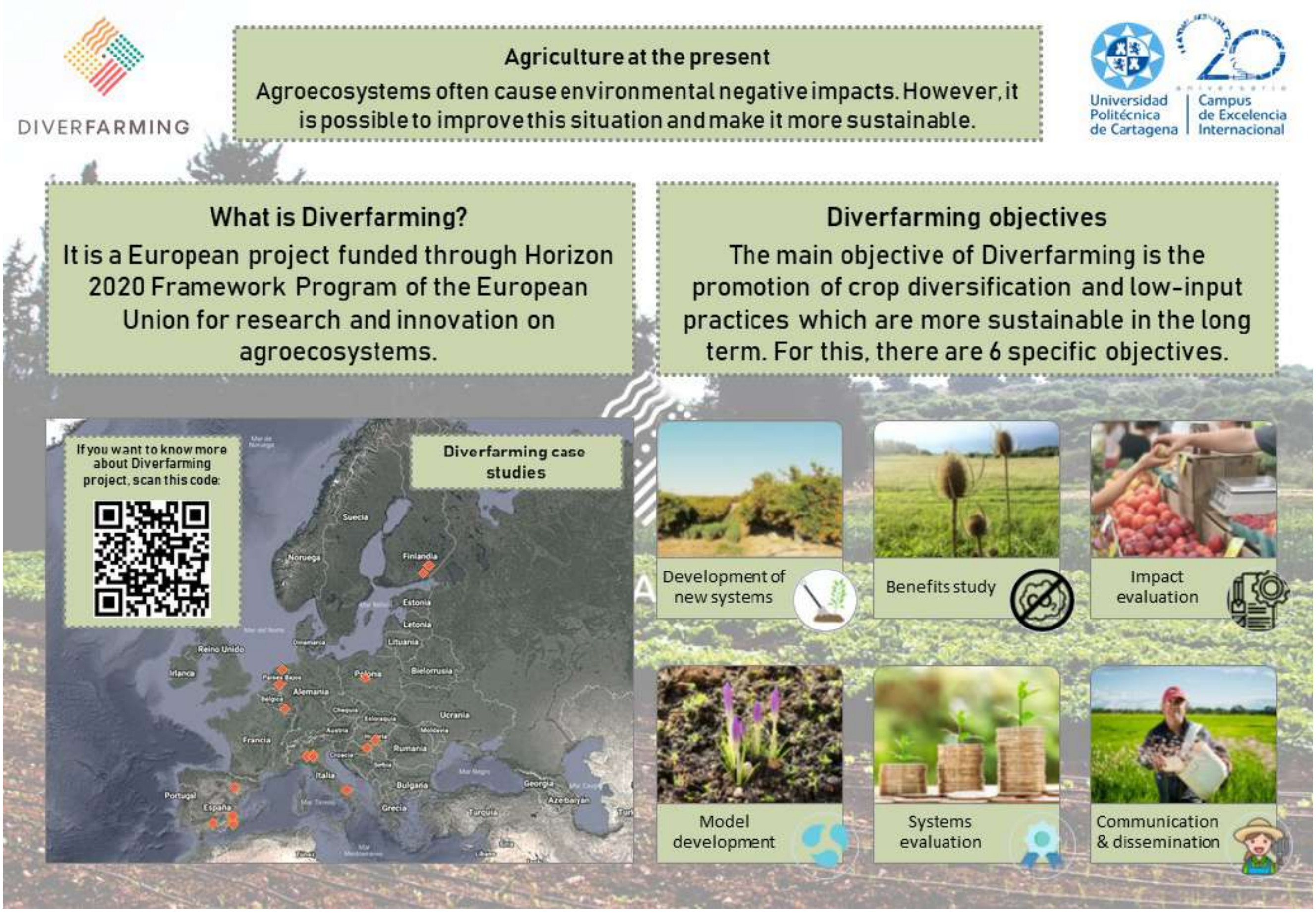

Figure 2.2. *Diverfarming informative card used in the CE.*

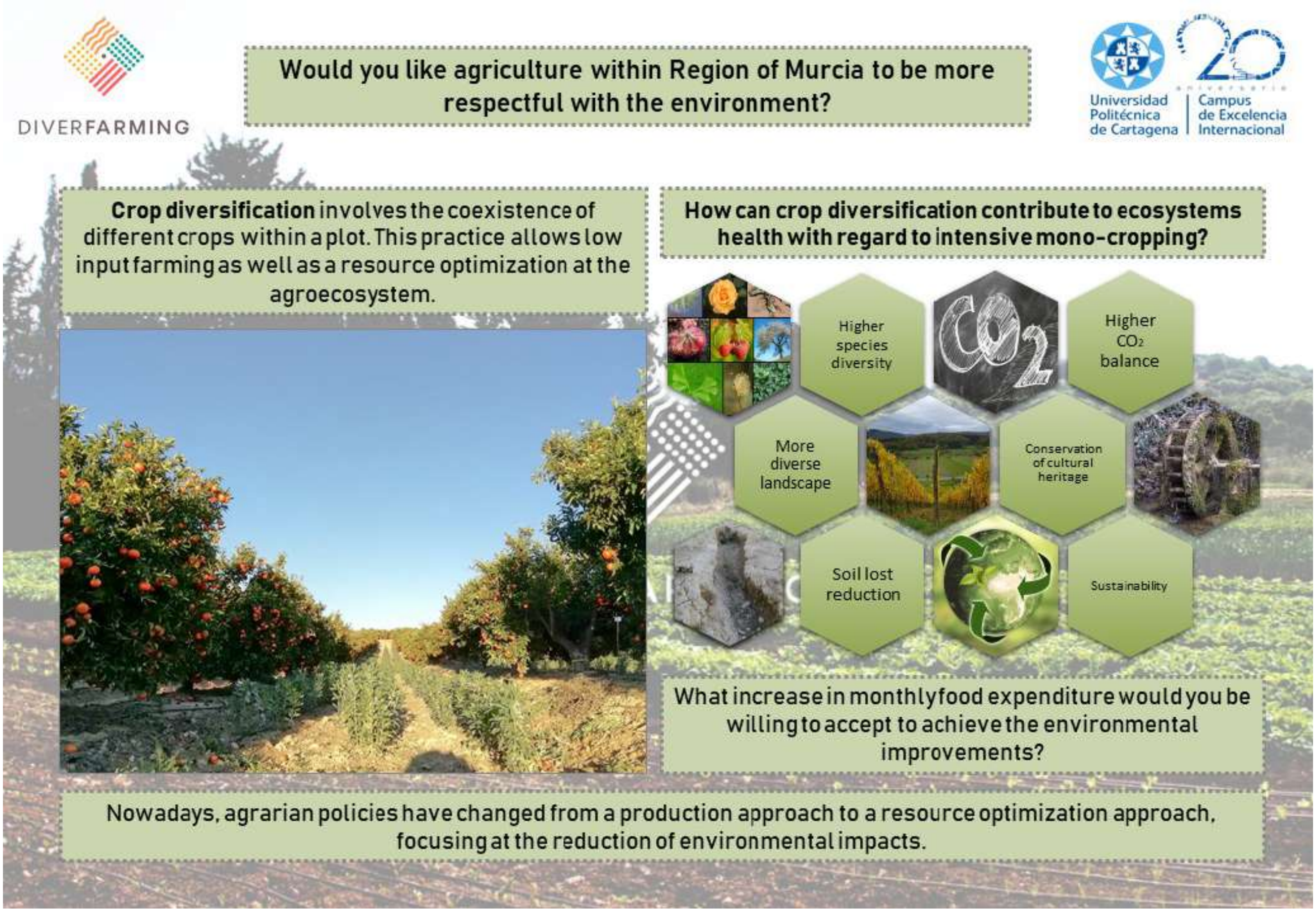

Figure 2.3. *Diversification impacts informative card used in the CE.*

The questionnaire followed the next structure:

- **Block 1**. Perception and attitudes regarding crop diversification and ecological commitment. This part of the survey included different questions about the respondent's previous knowledge about crop diversification, their benefits or what factors would influence on a higher diversified products consumption.

  On the other hand, the ecological commitment index was analysed through the valuation of a series of sentences about respondent's *Affective Ecological Commitment* (*AEC*), *Verbal Ecological Commitment* (*VEC*) and *Real Ecological Commitment* (*REC*). In this case, the respondent was asked to value his/her degree of agreement with each assertion in a point Likert scale of 1 (totally disagree) to 5 (totally agree).

- **Block 2**. Choice experiment. Each respondent was asked to complete a whole choice set block, with a total of five choice sets. Additionally, a sixth choice set, which consisted of a duplication of the first scenario, was added to analyse statistical consistency within the answers. As it was explained previously, each scenario had three alternatives. Two of them described crop diversification situations (which implied an extra cost for the consumption of diversified products), and other alternative was a mono-cropping system. In the case of a strong preference for mono-cropping systems (SQ), a follow up question was added to identify the reason of his/her choice. It enabled to identify and distinguish between real and protest answers (Barrio and Loureiro, 2013).

  Furthermore, an open-ended question was asked to value the highest monthly overrun of each respondent following the Contingent Valuation method. This question enabled a more direct comparison with Finnish case study, with a Contingent Valuation methodology approach.

- **Block 3**. Socioeconomic characteristics. This section included the main socioeconomic variables, such as respondent's age, gender, rent, place of residence, etc. Additionally, the individuals were asked about their level of implication with agroecosystems and rural landscapes, and about their monthly expenditure on fresh fruit and vegetables.

2.2.1.4. Sampling and data collection

After a first version of the survey was made, a pilot survey was filled by 15 respondents in October and November 2018. The results obtained were used to estimate prior attributes' coefficients within the choice model by using a conditional logit model. Subsequently, the optimized model was performed to create a final survey design to be implemented through the target population. The households within the Region of Murcia were selected as the target population because diversification benefits are mainly perceived at local scale. According to the National Statistics Institute of Spain, 593 000 households make up Murcia Region (with an average of 2.73 people per household).

By using a stratified by counties random sampling, a total of 396 surveys were carried out through face-to-face interviews between December 2018 and January 2019. The sample size, for a 95% confidence level, provided a sample error term below 5%. Table 2.2 shows the number of surveys planned and completed per county.

Table 2.2. *Number of surveys completed, distributed by counties.*

Counties within the Region of Murcia	Nº of households	Goal surveys	Filled surveys
Campo de Cartagena and Mar Menor	130,973	93	95
Guadalentín	85,058	61	67
Vega del Segura y Oriental	41,585	30	32
Área metropolitana de Murcia	22,793	160	160
Altiplano	21,909	16	16
Cuenca del Río Mula and Noroeste	34,681	25	26
Total Region of Murcia	**539,000**	**384**	**396**

Respondents were informed about the aim of the CE and the characteristics and levels of each indicator before starting the exercise. The implications of their participation were also notified and authorized through a consent form (Deliverable D11.2). After this, respondents were asked to choose one alternative for each choice set presented.

2.2.2. Econometric models

According to the random utility theory (McFadden, 1974), the utility (U_{ijt}) provided for an individual *i* by an alternative *j* in a choice set *t* can be decomposed into an observed (V_{ijt}) and an unobserved part (ε_{ijt}), additively considered:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} \quad (1)$$

Where V_{ijt} is the deterministic part of the utility, which is defined by the attribute levels and the individual sociodemographic characteristics. ε_{ijt} is a stochastic error term, identically and independently distributed. Assuming V_{ijt} as a weighted sum of the attribute levels and individual characteristics, U_{ijt} can be rewritten as:

$$U_{ijt} = \beta X_{ijt} + \varepsilon_{ijt} \quad (2)$$

Where X_{ijt} symbolizes the attribute levels and individual characteristics and β represents their associated marginal utility. The widest applied model to estimate the utility is the conditional logit model (CL). This model assumes the error term ε_{ijt} follows an extreme value type 1 distribution (Gumbell-distribution).

However, as the utility perceived by the respondent cannot be observed, his/her choices can be analysed as they can be observed. Thus, we can estimate the coefficients β which maximize the probability of observed choices. The probability of choosing an alternative j, ranging from 1 to J, in a choice set t (P_{ijt}) is estimated by the maximum likelihood method (Train, 2009):

$$P_{ijt} = \frac{e^{V_{ijt}}}{\sum_{p=1}^{J} e^{V_{ipt}}} \ \forall\, j \neq p \tag{3}$$

In this context, the utility from choosing an alternative derives from their individual characteristics and the provision of ES, which are indeed the indicators used to define the attribute alternatives (in this particular case, biodiversity, soil erosion, CO_2 balance, cultural heritage, landscape and additional cost). Therefore, the functional form of the utility (V_{ijt}) derived from individual i for alternative j in the choice set t can be defined within this study as:

$$V_{ijt} = \beta_0 SQ + \beta_1 BIOD_{jt} + \beta_2 EROS_{jt} + \beta_3 CO2B_{jt} + \beta_4 CULT_{jt} + \beta_5 LAND_{jt} + \beta_6 COST_{jt} + \varepsilon_{ijt} \tag{4}$$

Where β_0 is associated to the current situation (SQ), that is, mono-cropping, and β_k is the marginal utility obtained from each ES k provided by the agroecosystem, reflecting how utility level changes if the provision of ES increases. Specifically, β_1 refers to biodiversity (BIOD); β_2 and β_3 are related to regulating services (EROS and CO2B, respectively); β_4 and β_5 are related to cultural services (CULT and LAND, respectively); finally, β_6 is the coefficient for the assumed extra cost of buying food produced through crop diversification and low input practices.

Marginal rates of substitution allow us to go in depth into social preferences analysis after model coefficients estimation. When a cost attribute is included in the choice experiment, the marginal rate of substitution between the coefficient of non-cost attributes (β_k) and the cost attribute (β_6) shows the marginal willingness to pay (MWTP) for the non-cost attributes it refers. It is calculated as follows:

$$MWTP_k = -\left(\frac{\beta_k}{\beta_6}\right) \tag{5}$$

$MWTP_k$ represents, in monetary terms, how much respondents are willing to pay for each ES k provided by agroecosystem. It should be understood not only as a translation of the value of an ES, but also as a measurement of its contribution to individual wellbeing and, subsequently, of its relative importance within the overall contribution of agroecosystem to wellbeing.

Moreover, the results obtained from CL model allow to measure the mean willingness to pay ($\overline{WTP_k}$) for each ES k, which attempts to estimate the average ES value perceived by the respondents. Its importance lies in comparing the results from choice experiment and contingent valuation, since it allows to aggregate the value per each ES into an average willingness to pay per respondent:

$$\overline{WTP_k} = -\left(\frac{\beta_k * \overline{X}_k}{\beta_6}\right) \tag{6}$$

Where $\overline{X_k}$ represents the average level of each ES k presented in the choice experiment.

Due to the purpose of the present research, it is also interesting to measure compensating surplus (CS) (Bennet and Blamey, 2001), which translate into monetary terms the welfare changes of moving from current situation (SQ) to another different management scenario, that is, moving from mono-cropping to a diversification alternative. It is summarized as follows:

$$CS_{mg_i} = -\left(\frac{V_{sq_i} - V_{mg_i}}{\beta_6}\right) \tag{7}$$

Where V_{sq_i} represents the utility derived from the SQ and V_{D_i} measures the utility associated to a specific management scenario for an individual i. Negative values for the CS_{mg_i} imply society is willing to pay to support the aforementioned scenario.

Aggregating the individual value of CS_{mg_i} across all target population, the total economic value (TEV) provided by the agroecosystem can be calculated. TEV_{mg} measures, therefore, the overall contribution of a specific management scenario (mg) in the social welfare. Assuming again a linear utility function, TEV_{mg} is calculated as follows:

$$TEV_{mg} = \sum_i CS_{mg_i} = \sum_i -\left(\frac{V_{sq_i} - V_{mg_i}}{\beta_6}\right) \tag{8}$$

2.3. Results

2.3.1. Sample description

Table 2.3 shows respondents' characteristics regarding their sociodemographic information and their relation with agriculture. The final sample was composed by 396 respondents, whose average age was 44 years, similar to the regional average (48 years). However, the middle-age group (46-60 years) is overrepresented, while the oldest age group (> 60 years) is misrepresented. The sample is representative in terms of gender (54.04% women), although it is overrepresented in terms of household income and educational level, which are higher than the regional average in both cases.

Table 2.3. *Descriptive statistics.*

Variable		Sample	Region of Murcia
Sociodemographic information			
Age of people over 18 years old (years)		44.31	47.90[a]
	18-30 years (%)	20.96	18.65[a]
	31-45 years (%)	28.54	30.30[a]
	46-60 years (%)	39.90	26.72[a]
	> 60 years (%)	10.61	24.33[a]
Gender (% women)		54.04	49.93[a]
Household income (€/month)		2,317	2,325[b]
Educational level (%)	Lower education	1.52	3.5[c]
	Primary education	8.59	16.3[c]
	Secondary education	41.96	46.6[c]
	Higher education	48.23	33.5[c]
Relation with agriculture			
Does any member of your household work in agriculture? (% affirmative)		42.42	
How often do you visit an agroecosystem? (%)			
	Never	20.71	
	Sometimes	43.69	
	Usually	35.61	
If so, for what reason?			
	Recreation	74.52	
	Economic activity	20.38	
	Research/Education	5.10	

[a] INE (2018); [b] INE (2017); [c] INE (2019)

Regarding to respondents' relation with agriculture, a close relation was found through the sample. The 42.42% of the respondents had at least one family member (or him/herself) who worked in the agricultural sector. Moreover, the 79.3% of the respondents visit agroecosystems sometimes or usually, in contrast with the 20.7% who never visit them. The main reason to frequent agroecosystems is recreation (74.52%), followed by economic activities (20.38%) and research or educational reasons (5.10%).

2.3.2. Preference modelling

Before applying econometric models, the proportion of surveys which showed a constant preference for *status quo* (SQ) choice were analysed. In these cases, respondents did not agree with increasing their monthly fruit and vegetables' expenditure to obtain products derived from crop diversification and low-input farming. In this framework, a total of 40 respondents (10.10%) chose the SQ alternative at each choice-set, while 356 respondents (89.90%) would be willing to pay an extra amount of money for the consumption of food from crop diversification.

Focussing on the respondents whose preference was always SQ, it is essential to differentiate between 'real or legitimate' and 'non-true or protest' zeros. Thus, real zeros do participate in the CE exercise, but they do not recognize or value the benefits or goods of -in the present study- crop diversification, therefore they are not willing to pay extra for their products. On the other hand, protest zeros do not participate in the hypothetical market and they disapprove at least a part of the survey (e.g. payment vehicle). Consequently, protest zeros imply a protest behaviour which provides invalid answers. At the present work, protest zeros were defined as those who selected SQ at every choice set and one of the following arguments was also chosen: 'I think the additional cost should be paid by the Administration'; 'I think the additional cost should be paid by the farmer'. A total of 22 protest zeros were found within the whole sample. Hence, 374 individuals formed the sample used for the modelling.

The results obtained through the estimation of a CL model are presented at Table 2.4., where the coefficients associated with the different levels of attributes which make up the utility function are shown. All variables were found to be significant and the model was considered to be valid (Pseudo R^2 = 0.2675) according to the results of similar studies (Ragkos and Theodoritis, 2016; Aslam *et al.*, 2017, Niedermayr *et al.*, 2018).

These results point out the positive impact of the empowerment of ES at the utility function (positive marginal utility). In contrast, price attribute has a negative sign, which involves an expected disutility perceived by respondents. SQ attribute also showed a negative sign, thus it reduces the utility function and, as a consequence, there is a generalized desire of changing the current mono-cropping food demand.

Table 2.4. *Results derived from the conditional (fixed-effects) logit regression model.*

Choice (variable)	Coefficient	Standard error	p-value
SQ	-1.217	0.199	0.000
Biodiversity – Medium	0.256	0.102	0.012
Biodiversity – High	0.639	0.068	0.000
Erosion – Medium	0.413	0.097	0.000
Erosion – Low	0.686	0.076	0.000
CO_2 balance - Medium	0.226	0.091	0.013
CO_2 balance - High	0.630	0.076	0.000
Cultural Heritage	0.277	0.057	0.000
Diverse landscape	0.515	0.059	0.000
Price	-0.039	0.004	0.000

Number of observations = 396; LR chi^2 (10) = 1318.20; Prob > chi^2 = 0.0000; Pseudo R^2 = 0.2675.

2.3.2.1. Willingness to pay analysis

The Delta method (Hole, 2007) was applied to the conditional logit model to calculate the MWTP of each attribute and level. The MWTP of each ESs' status is shown in Table 2.5. The change from high erosion to low erosion is the most valuated, with a MWTP of 17.76 €/household/month. The existence of a high biodiversity and a high CO_2 balance within the agroecosystem are also very appreciated, with WTP of 16.52 and 16.30 €/household/month, respectively. The fourth ES in terms of implicit price is the diverse landscape, whose MWTP is 13.33 €/household/month. The conservation of the cultural heritage is the least valuated ES, with a MWTP of 7.16 €/household/month. Regarding the medium level of biodiversity, erosion and CO_2 balance, coefficients are lower than each ES higher level, which shows a clear coherence within the results.

Furthermore, medium erosion is the highest valued here (10.69 €/household/month), followed by medium biodiversity (6.62 €/household/month) and medium CO_2 balance (5.84 €/household/month).

Table 2.5. *Marginal willingness to Pay (€/household/month) analysis results.*

Attribute	MWTP (€/household/month)	Standard error	p-value	[95% Conf. Interval]
Biodiversity – Medium	6.62	2.799	0.018	1.13 – 12.11
Biodiversity – High	16.52	2.489	0.000	11.64 – 21.40
Erosion – Medium	10.69	2.986	0.000	4.84 – 16.55
Erosion – Low	17.76	2.984	0.000	11.91 – 23.61
CO_2 balance - Medium	5.84	2.503	0.020	0.93 – 10.74
CO_2 balance - High	16.30	2.663	0.000	11.08 – 21.52
Cultural Heritage	7.16	1.739	0.000	3.75 – 10.57
Diverse landscape	13.33	2.137	0.000	9.14 – 17.52
SQ	-31.49	3.337	0.000	-38.03 – -24.95

Together with the results of the MWTP, it is also interesting to measure the mean WTP ($\overline{WTP}$), mainly with the purpose of being able to compare the choice experiment results with the contingent valuation ones. In this context, the $\overline{WTP}$ analysis (Table 2.6.) show that, on average, respondents are willing to pay a total amount of 24.58 €/household/month in order to support diversified crops. This value is in line with the one obtained from the open-ended question in contingent valuation. In fact, respondents show an average WTP of 29.98 €/household/month (standard deviation = 19.34). The existence of small differences between the results of CE and the open question value show coherence. The results obtained in this case are in line to previous works in environmental non-market valuation (Boxal *et al*., 1996; Hanley *et al*., 1998b).

Table 2.6. *Mean willingness to Pay (€/household/month) analysis results.*

Attribute	Mean WTP (€/household/month)	Standard error	p-value	[95% Conf. Interval]
Biodiversity – Medium	0.74	0.311	0.018	0.13 – 1.35
Biodiversity – High	4.59	0.691	0.000	3.23 – 5.94
Erosion – Medium	1.95	0.543	0.000	0.88 – 3.01
Erosion – Low	4.92	0.827	0.000	3.30 – 6.54
CO_2 balance - Medium	1.13	0.485	0.020	0.18 – 2.08
CO_2 balance - High	4.54	0.741	0.000	3.08 – 5.99
Tradition	2.09	0.508	0.000	1.10 – 3.08
Diverse landscape	4.64	0.743	0.000	3.18 – 6.09
Total	24.58	3.433	0.000	17.85– 31.31

2.3.2.2. Management scenarios assessment

According to WTP results, different scenarios are valuated below:

- **Status quo (SQ).** This scenario is defined by SQ conditions. Thus, monocrop implies low biodiversity and CO_2 balance, high erosion rates, null traditional practices and a homogeneous landscape within the present study cases. SQ situation is associated with disutility, which is translated into monetary terms reflecting respondents are willing to pay in order to leave mono-cropping, that is, to support diversification.
- **Low input farming (LIF).** This scenario reproduces an intensive mono-cropping agroecosystem where low input farming is carried out. Hence, a low biodiversity is obtained (herbicides are not used, but pesticides and mono-cropping prevent biodiversity's increase), erosion reaches low rates, and CO_2 balance is improved until medium rates; landscape is homogeneous, and traditional practices are prevented due to the modernization linked to crop intensification. In this work, LIF scenario corresponds to CS2, in low-input farming plots, where geo-textile is used at mandarin mono-cropping.
- **Low-efficient crop diversification (LECD).** This alternative can represent the first step in crop diversification adoption or a system where meteorological conditions obstruct the optimal

development of soil-plant system. Here, biodiversity remains medium while species colonize the agroecosystem; erosion and CO_2 balance rates are medium due to root and plant systems are underdeveloped; traditional practices are applied and landscape is heterogeneous. In the present work, LECD scenario is associated to diversification within CS1 (almond intercropped with a perennial specie as *Thymus hyemalis* or *Capparis spinosa*).

- **High-efficient crop diversification (HECD).** This scenario could be understood as the environmentally best alternative due to the maximization of ES provision by the agroecosystem. Thus, high biodiversity and CO_2 balance are found, while erosion rates are low; tradition practices are carried out and landscape is heterogeneous due to crop diversification. In this work, HECD corresponds to a well-developed crop diversification, as mandarin intercropped with fava bean (*Vicia fava*) (CS2).

In order to compare the proposal management scenarios, CS and TEV are estimated (Table 2.7.). As their signs reveal, all estimated CS are negative, which means respondents are willing to pay to support them. Moreover, as management actions improve environmental and social benefits, from SQ to HECD scenario, both CS and TEV decrease, reflecting the social welfare gained from mono-cropping to a higher-efficient crop diversification. Specifically, SQ scenario is supported by an average of -31.49 €/household/month while LIF scenario involves a CS of -55.08 €/household/month for the consumption of fruit and vegetables produced through an intensive crop diversification system. LECD scenario reveals a CS of -75.13 €/household/month. Finally, HECD alternative shows the highest CS, -102.56 €/household/month, for the consumption of products derived from crop diversification, which is translated into 55.28 M€/month if considering the social welfare impact.

Table 2.7. *Compensating surplus (€/household/month) and TEV (M€/month) analysis results.*

Scenario	Management actions	Compensating surplus (€/household/month) Average [95% CI]	TEV (M€/month) Average [95% CI]
SQ	- Biodiversity – Low - Erosion – High - CO_2 balance – Low - Cultural heritage – Absence - Monoculture landscape	-31.49 [-38.03;-24.95]	-16.97 [-20.50;-13.45]
LIF	- Biodiversity – Low - Erosion – Low - CO_2 balance – Medium - Cultural heritage – Absence - Monoculture landscape	-55.08 [-62.65;-47.52]	-29.69 [-33.77;-25.61]
LECD	- Biodiversity – Medium - Erosion – Medium - CO_2 balance – Medium - Cultural heritage – Presence - Diverse landscape	-75.13 [-87.96;-62.29]	-40.49 [-47.41;-33.57.]
HECD	- Biodiversity – High - Erosion – Low - CO_2 balance – High - Cultural heritage – Presence - Diverse landscape	-102.56 [-118.60;-86.51]	-55.28 [-63.93;-46.63]

Therefore, adopting diversification practices at farm level would imply a social benefit at regional scale. In the Spanish case study, from LIF to HECD scenario, the social welfare gains from mono-cropping to a higher-efficient crop diversification range from 29.69 M€/month in the ICD scenario to 55.28 M€/month in the HECD scenario.

2.3.3. Social demand factors

Respondents' perception and attitudes regarding agricultural concerns were analysed through the calculation of the Ecological Commitment Indexes (ECIs). Affective commitment (ECI-A), Verbal commitment (ECI-V) and Real commitment (ECI-R) were established by means of the assessment of a set of related statements through a five-point Likert scale. Thus, respondents indirectly stated the different components of the ecological commitments. As it is shown in the Table 2.8, ECI-A is higher than ECI-V, and ECI-R is the lowest value.

Table 2.8. *Ecological commitment statistics.*

Ecological commitment indexes (ECI) – 1 to 5 scale	Sample
ECI- A (1 Minimum, 5 Maximum)	4.63
ECI - V (1 Minimum, 5 Maximum)	3.80
ECI - R (1 Minimum, 5 Maximum)	2.50

On the other hand, the participants were directly asked about their willingness to consume a higher proportion of products derived from diversified cropping systems than the currently consume. A 98.23% of the respondents agreed to increase this consumption. Respondents were asked for reasons which would motivate the previous answer. At this point of the survey, four reasons were given as options: (1) higher availability in supermarkets, (2) more competitive price, (3) higher quality of the products and (4) more information about food production. Respondents could choose one or more options. Thus, 49% of the respondents would consume more food from diversified cropping systems if it was easier to found within supermarkets; 55% would increase this consumption if the price was more competitive or more information about their production was given; a higher quality of the products was pointed out to be the most important factor (68%) in increasing the consumption of products derived from diversified cropping systems and low-input farming.

3. Finnish case study

3.1. Case study description

3.1.1. Pedoclimatic region and agriculture in the case study area

Pedoclimatic region for Finnish case studies is Boreal, which is the environmental zone covering the lowlands of Scandinavia. The case study CS12 and CS13 are located in southern Finland (Figure 1.1) where average length of the thermal growing season was 180–200 days during period 1981–2010. The effective temperature sum was 1300–1450 degree days in the whole range of southern Finland, and the average precipitation in the growing season was 350–400 mm, however with significant inter-annual variations (Pirinen *et al*., 2012). Annual precipitation (600-700 mm) is higher than evapotranspiration. The growing season usually starts in the last week of April and ends at the end of October (ibid). The main crops cultivated are barley, wheat, oats and turnip rape as spring crops and wheat, rye and oilseed rape (rather recently) as winter crops (OFS, 2019a). Spring cereals are harvested in August-September and winter cereals in August. Milk and beef production is based on temporary forage grasslands since silage maize is not feasible due to short growing season and low temperature sum, as well as due to risk of frost in spring.

The main environmental problems of agriculture in southern Finland, such nutrient leaching to watercourses and biodiversity loss, are related to cereals monocultures. Farmland birds and insect populations are decreasing because of decreasing number of grazing animals (Santangeli *et al*., 2019). Dairy and beef farms have been decreasing at a fast rate in southern and Finland while dairy and beef production are concentrating on other regions in Finland (OFS, 2019b). Grass forage crops, some of which have a large root biomass and which may increase soil carbon, inhibit soil erosion and nutrient leaching, have been decreasing in terms of cultivation area (OFS, 2019a). Rural development plans, however, have provided some incentives for maintaining grasslands as e.g. filter strips along the watercourses and as nature management fields and other biodiversity protection areas (Aakkula & Leppänen, 2014). Still cereal and even cereal species monocultures dominate in large parts of southern Finland which is the prime crop production region in the country, despite many alternative crops available for diversification of monocultures (Peltonen-Sainio *et al*., 2017). Areas under protein crops, oilseeds, potatoes, sugar beets and other crops is relatively small (OFS 2019b) due to limited domestic demand and excessive imports of protein feed for livestock (OFS 2018; food balance sheets), Typically arable farms have simple rotations (cultivation of 2-3 plant species) or monocultures (Peltonen-Sainio *et al*., 2017). Soil organic matter is gradually and slowly, but continuously decreasing. The change in management practices in last decades toward increasing cultivation of annual crops has contributed to soil C losses (Heikkinen *et al*., 2013).

3.1.2. Diversification aspects of the Finnish case studies

The main idea of case study number CS12 is to analyse a change from cereal monocultures to diversified crop rotations in southern Finland. The study site is Kotkanoja experimental field in Jokioinen, Finland (Figure 3.1). The long-term field experiment has already produced data on cereals monocultures, both in case of conventional tillage and no-till. Cereal cropping is diversified with winter crop and catch crop, with tillage or no-till (4 treatments). The hypothesis of case study CS12 is that improved crop yields, or reduced need for inputs, and lower losses in terms of nutrients will realise in diversified cropping systems.

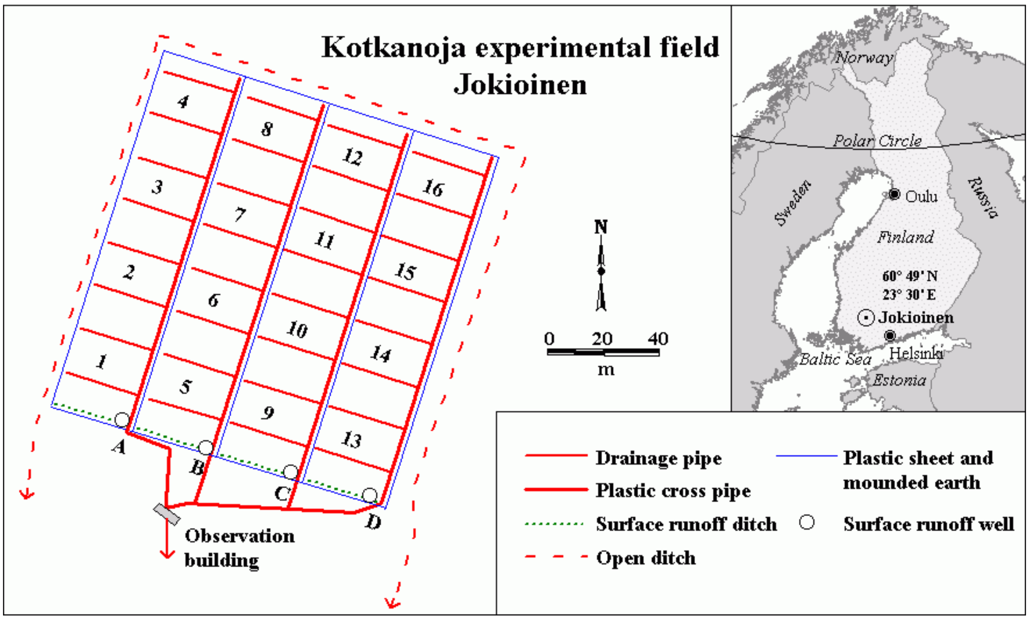

Figure 3.1. Field experiment arrangement and location of the Kotkanoja experimental field.

Diversified feed production is studied under three treatments:

- Cereal mono-cropping with no-till
- Diversification 1: Cereal, winter rapeseed, cereal, cereal
- Diversification 2: Cereal + catch crop

Mono-cropping has been studied as follows during the last 10 years:

Plough					Oats/barley/wheat
No-till					Oats/barley/wheat
Plough					Oats/barley/wheat
No-till					Oats/barley/wheat

From 2018, the diversifications are studied as follows:

Plough					Barley with ryegrass catch crop each year
No-till					Mouldboard plough in 2018, then no-till continued, barley each year
Plough					Barley-Winter rapeseed-Barley
No-till					Barley each year

Case study CS12 is also linked to small-scale cheese processing on farm which is dependent on milk supplies from few local dairy farms. The dairy farms use locally produced feed cereals and (domestically produced or imported) protein supplements in the feeding of dairy cattle.

Objective of case study CS13 are to quantify the long-term effects of organic farming - with more diversified crop rotations and lower nutrient intensity - on soil properties, runoff quality and crop yield as compared with conventional farming, and modified by proportion of legumes and grass in the crop rotations. There are two rotations for milk production in case study CS13 (Table 3.1).

Table 3.1. *Field experiment arrangement in case study 13.*

Year	Organic Cereal (A) 0,5 lu/ha manure + biological nitrogen fixation	Organic Milk (B) 0,9 lu/ha manure +biological nitrogen fixation	Conventional Cereal (C) Mineral fertilisers	Conventional Milk (D) 1,1 lu/ha manure + mineral fertilisers
1st year	Barley with undersown grass (timothy and clover)	Barley with undersown grass (timothy and clover)	Barley	Barley with undersown grass (timothy and meadow fescue)
2nd year	Grass ley (1 or 2 yields) Rye sown in the autumn	Grass ley (2 yields)	Barley Rye sown in the autumn	Grass ley (2 or 3 yields)
3rd year	Rye	Grass ley (2 yields)	Rye	Grass ley (2 yields)
4th year	Oats	Oats and vetch for fodder	Oats	Barley for fodder silage

Case study CS13 is linked to organic cheese production, dependent on few local dairy farms producing conventional and organic milk. The common hypothesis for both cases (CS12 and CS13) is that by diversifying cultivation (adding catch crops, oil crops and clover grass and leys in the rotation), monoculture can be broken and nutrient leaching, such as nitrogen and phosphorus, is supposed to decrease, soil structure to improved and soil organic matter to increase. In addition to crop diversification, broader effects of cheese making in the whole value chain will be taken into account by value chain analysis in next tasks.

In terms of non-market valuation, the interesting questions concern environmental effects of crop diversification as well as the value of local and traditional cheese production. Dairy milk products from raw milk are increasingly produced in relatively few and large specialized dairy processing factories. About 50% of cheese consumed in Finland is imported and the market share of domestically and locally produced cheese has gradually decreased since 2000 (OFS, 2018). The decrease in the number of dairy farms and dairy cows has been relatively fast in southern Finland compared to other regions (OFS, 2018; OFS, 2019a). Hence, the remaining crop farms have grown larger and land use has been shifted towards cereals instead of grasslands and leguminous crops (OFS, 2019b).

Overall, the aim of the non-market valuation of the diversification benefits in case studies CS12 and CS13 concern the environmental benefits and perceived societal benefits of crop diversification as well as the perceived societal benefits of local cheese production.

3.1.3. Scenarios and survey design

Three different scenarios were illustrated in the survey for respondents, a representative consumer panel of 600 respondents, at the national level. We first presented respondents the scenario1 with five different changes when cultivation is shifted from mono-cropping to more diversified cropping system. For respondents the current state and change of cropping system was presented with short texts and illustrated with symbols (see Table 3.2 and Table 3.3).

Scenario 2 illustrated seven changes occurring in the milk production, processing and Finnish society. Finally, in the survey, Scenario3 combined these two scenarios (5 + 7 attributes) presenting a total of 12 attributes.

Table 3.2. *Attributes and their changes in scenario 1.*

Attribute	Description of current status	Symbol	Description of change
Greenhouse gases (CO_2 balance)	The fields produce 70% of Finland's nitrous oxide emissions. Emissions arise especially outside the harvest season.		Winter time vegetation cover on fields decreases greenhouse gas emissions by 1/3.
Better growing conditions and robust crop yield	Great susceptibility to diseases and pests and sensitivity to exceptional weather conditions. Weakened soil growth condition.		Emergence of pests and diseases decreases and robustness of crop yields improves in extreme weather conditions. Soil structure and growth condition improves.
CO_2 balance	The accumulation of field carbon in the field has fallen slightly.		Field carbon accumulation and soil organic carbon content increase if reduced tillage and increased deep rooted crops are applied in crop rotation.
Runoff leakages	About half of the nutrient leaching to the water comes from the fields. In the current situation, about 9% of the arable land is cultivated with catch and cover crops.		Catch crop reduces field nitrogen leaching by 50%. Catch and cover crop areas can be tripled from current levels.
Landscape	Decreased amount of the wildlife organisms and species.		Cropping diversification increases the number of plant and animal species in fields and soils.
Cost	Monthly increase in foodstuff expenditures per household	€	

Table 3.3. Attributes and their changes in scenario 2.

Attribute	Description	Symbol	Change
Organic	The share of organic milk production is about 3%. Organic crop production covers 11% of the total arable area in Finland.		The share of organic milk and crops produced is increasing.
Low-input production	Fertilizers and feeds bought outside the farm are used in abundance. Cows are mainly high-yielding. Limited opportunities for crop rotation.		Cows feed is produced using less inputs purchased outside the farm, such as fertilizers, plant protection products and purchased feed. Cows are not necessarily high yielding.
Grazing cows in the landscape	Grazing cows are rarely seen.		Grazing cows are visible in the landscape.
Crop diversification (biodiversity)	In extensive fields, only a few crop species are cultivated or the same crop is grown on the same site year after year.		Arable landscape is more diverse and lively. Clovers and pea plants bring variation in plant biodiversity, and oilseed rape cultivation brings yellow colour to the landscape.
Regionality	Milk production has concentrated on the middle and northern part of the country. Milk processing is done only larger units.		Local cheese guarantees milk production to survive also in the southern part of the country. Small cheese factories are economically viable.
Rural jobs	In Finland, we have a few dozen small-scale cheese processing factories which usually are located in rural areas.		Cheese is made by domestic, small-scale cheese company. Cheese-making offers jobs in rural areas.
Tradition	Cheese and local products have strong meaning in the Finnish food culture.		Cheese making skills, knowhow and traditions are maintained in different parts of the country.
Cost	Monthly increase in foodstuff expenditures per household	€	

3.2. Methodology

3.2.1. Contingent valuation

We used a stated preference method, contingent valuation, to measure benefits of shifting from monoculture to diversified cropping systems in cheese production. This method allows us to attach non-market benefits of ES as public good and also to attach these benefits to a private good: cheese. These benefits are measured as consumer's maximum willingness to pay for the good in question. Two payment vehicles were used in the survey: extra cost of households' food expenditures (scenarios 1-3) and incremental cost of the current cheese price per kilogram in the last scenario (scenario 3).

Different instruments have been developed to mitigate hypothetical bias in contingent valuation and other stated preference methods. One way of reducing hypothetical bias is so called 'cheap talk', where participants are asked to consider about the phenomena of hypothetical bias prior to the valuation question. In our study, respondents were given a short explanation before valuation question '*Please evaluate as realistically as possible the maximum amount of incremental payment in your monthly food expenditures. It is important that you do not overestimate or underestimate it. Please consider carefully how this incremental cost will affect your monthly household's expenditures, so that you are totally sure that you are willing to pay the sum that is your choice in question*.

Section 3.1.2 illustrated three scenarios that were present in the survey. To avoid the so called 'order effect', scenario 1 was presented firstly to half of the respondents (n=300) and scenario 2 firstly to half of the respondents (n=300). Scenario 3 combined two previous scenarios with all 12 attributes. Thus there were two versions of the survey form, depending on which of the scenarios 1 and 2 were presented first.

Multiple bounded dichotomous choice (MBDC) format was used because it allows the respondent to express his/her ambivalence (Welsh & Poe, 1998). Respondents were given an identical set of bids and for each bid (e.g. "How surely you would pay maximum 10 cents per month if the described diversification were realized", "How surely you would pay 50 cents…", "How surely you would pay 1 euro…", …) they had five response categories to choose from 'Definitely I would pay', 'Possibly I would pay', 'Cannot say', 'Possibly I would not pay' and 'Definitely I would not pay'. This question type allows them to express ambivalence in their willingness to pay, in the case of each bid, separately.

3.2.2. Econometric model

Respondent's WTP can also be estimated non-parametrically, without assuming a utility function or distribution of an error term. In such cases, WTP is estimated using bid vector, and point estimations of WTP probabilities. According to economic theory, when offered bid (price or cost) increases, the proportion of observed no responses to each bid should increase, genuinely monotonic distribution functions. Sometimes this is not true due to randomness. In that case Turnbull distribution-free estimator can be applied (Turnbull, 1979; Haab and McConnell, 2002).

In the non-parametric estimation of a dichotomic WTP question, the relative proportion of "no" responses are calculated for each bid, a point estimator for the WTP function is made for the each bid $\boldsymbol{t_i}$ and the relative proportion of "no" responses $\boldsymbol{F_j}$ is calculated as follows

$$F_j = \frac{N_j}{T_j} \quad j = 0 \rightarrow J \tag{1}$$

where $\boldsymbol{N_j}$ is the proportion of "no" responses of the combined total $\boldsymbol{T_j}$ of all "yes" and "no" responses.

WTP is calculated from a monotonic WTP curve by dividing WTP in subranges $\{\boldsymbol{o} - \boldsymbol{t_{1,}}\, \boldsymbol{t_{1,}} - \boldsymbol{t_{2,}}, \dots, \boldsymbol{t_{M*}} - \boldsymbol{U}\}$. To calculate lower bound estimate (LB) of WTP, WTP_{LB}, (indicates that the accumulation of the probability mass is calculated only at the lower end bound of the subrange), F (0) = 0 (cumulative density function at the lower bound of WTP) and the upper bound for the WTP must be determined. By using these subranges, WTP can be calculated with the following formula:

$$E_{LB}\,(WTP) = \sum_{j=0}^{M^*} t_j \ * \ f_{j+1}^* \tag{2}$$

Where t_j is offered bid or extra cost and M^* number of bids.

3.3. Results

3.3.1. Sample description

Pilot research (n=100) was conducted in December 2018. The final questionnaire hold 600 responses collected in January 2019 through on-line questionnaire which is a representative sample (e.g. age, sex, income level) of the adult-aged (18 years old or older) Finnish population. Sample and population descriptive statistics are collected in Table 3.4. There was a control in the internet-based survey that the samples of respondents answering in the two different versions of the survey form (see section 3.2.1) were similar (in terms of age, sex, income, education) and not significantly different.

Table 3.4. *Descriptive statistics.*

Variable		Sample	Finland
Sociodemographic information			
Age of people over 18 years old			
	18-24 years (%)	10.8	9.9
	25-34 years (%)	16.0	15.8
	35-44 years (%)	15.1	15.7
	45-54 years (%)	16.9	15.3
	55-64	17.2	16.4
	65+	24.1	27.0
Gender (% women)		51.0	51.0
Household income (€/year before taxes)			
	<10 000 € (%)	5.8	
	10 001 - 20 000 € (%)	10.7	
	20 001 - 40 000 € (%)	23.5	
	40 001 - 60 000 € (%)	19.6	
	60 001 – 80 000 € (%)	13.9	
	80 0001 – 120 000 € (%)	7.9	
	< 120 001€ (%)	1.5	
Educational level (%)	Lower education (basic education)	10.2	27.9
	Upper secondary education	51.5	40.3
	Higher education	37.9	31.0
	Other	0.8	0.8
Relation with agriculture			
Do you live at the moment in rural environment? (%)			
	Yes	21.8	
Do you often spend time in rural environment? (%)			
	Yes	47.6	
Do you or your household own agricultural fields? (%)			
	Yes	11.7	
Do you have recreational home in rural environment? (%)			
	Yes	33.2	

3.3.2. Consumer preferences for outcomes of diversification in Finnish agriculture

Consumer opinions' significance of different aspects of Finnish agriculture including the effects that are implicated in diversified cropping systems were collected by using 5-point Likert-scale, from 1 (very small) to 5 (very high). The importance of diversification and other aspects of cheese making from consumers' viewpoint are shown in Table 3.5. Among highest ranked were domestic food production, followed by features arising from diversified cropping (decreasing nutrient leakages, preserving Finnish food culture, carbon sequestration and rural jobs). Low-input production was experienced difficult to estimate since 15 % or respondents answered "Cannot say".

***Table 3.5**. Importance of diversification and other aspects of cheese making from consumers' viewpoint.*

	Mean - Scale 1 - 5, (Standard deviation in parenthesis)	Cannot say (% of respondents)
1. Domestic food production and processing	4.41 (0.82)	1.8
2. Runoff leakages from agriculture will decrease	4.32 (0.88)	2.8
3. Finnish food culture is preserved (tradition, knowledge and processing skills)	4.25 (0.90)	1.9
4. The ability of fields to act as carbon sink and combat climate change is improving	4.18 (0.89)	5.0
5. The number of jobs in rural areas remains	4.13 (0.94)	2.7
6. Greenhouse gas emissions from agriculture are decreasing	4.12 (0.96)	3.3
7. Abundance of wildlife organisms in the field and soil	4.09 (0.87)	5.9
8. Diversity of arable crops	4.06 (0.85)	3.9
9. The growing conditions in the fields and robust crop yield under varying conditions improve	4.04 (0.86)	6.7
10. Organic production is becoming more common	3.87 (1.05)	4.0
11. The arable landscape is varied in vegetation	3.84 (0.93)	5.9
12. The variety of species of production animals	3.78 (0.96)	5.6
13. The grazing cows are visible in the landscape	3.72 (1.05)	3.1
14. Low-input production methods become more common (less inputs from outside the farm)	3.61 (0.97)	15.2
15. Evenness of regional distribution of agricultural production and processing	3.54 (0.99)	9.5

Case studies in different countries had different characteristics. To better compare results with case studies in Spain and Italy, Finnish data was reformatted to be able to define values for the same attributes: Biodiversity, runoff leakages (in Finnish case mainly referring to water quality, not erosion), tradition, CO_2 balance, cultural heritage (in Finnish case referring to food culture) and landscape. Overall results indicate that consumers' opinions are quite evenly distributed between different attributes (Table 3.6).

Table 3.6. *Importance and share of different attributes in Finnish case study for the division of total WTP value (Comparable attributes in other case studies marked as **bolded**).*

Attribute	Description	%
Domestic	Domestic food production and processing	10.3
Runoff leakages	**Runoff leakages from agriculture will decrease** (mainly nutrient leakages in Finland and water quality, not soil erosion)	**10.1**
Tradition	**Finnish food culture is preserved (tradition, knowledge and processing skills)**	**9.9**
CO2 balance	**(1) The ability of fields to act as carbon sink and combat climate change is improving** **(2) Greenhouse gas emissions from agriculture are decreasing**	**9.6**
Rural jobs	The number of jobs in rural areas remains	9.6
Biodiversity	**(1) Abundance of wildlife organisms in the field and soil** **(2) Diversity of arable crops** **(3) The variety of species of production animals**	**9.0**
Organic	Organic production is becoming more common	9.0
Adaptation	The growing conditions in the fields and robust crop yield under varying conditions improve	9.0
Landscape diversity	**(1) The arable landscape is varied in vegetation** **(2) The grazing cows are visible in the landscape**	**8.6**
Regionality	Evenness of regional distribution of agricultural production and processing	7.7
Low-input	Low-input production methods become more common (less inputs from outside the farm)	7.3
Total		100%

3.3.3. Willingness and unwillingness to pay

Results indicate that 21% (n=126) of consumers were not willing to pay any extra expenditure to support more diverse cropping systems. Many respondents indicated their zero-WTP saying that they cannot afford to pay more (n=58, 46% of No-responses). The statement 'Consumers or tax payers should not pay extra cost' was agreed by 31% of No-respondents. 30% of No-WTP respondents also stated that current cultivation practices are diversified enough.

For those who were willing to pay for diversified cropping systems (79%, n=474), we estimated the mean WTP for three scenarios. It seems that scenario1 was most highly valuated (increase in WTP 16 €/month/household). The broader value chain effects described in scenario 2 did not increase WTP much.

Third scenario (including both previous scenarios 1-2) had only a slight increase in WTP compared to scenario 2. We expected the third scenario to have higher value since it had all attributes included that were present in scenarios 1 and 2.

The range of WTP to the offered bids were estimated from responses ‘Definitely would pay’ and ‘Definitely would not pay’. These can be seen as lower and upper bound estimates for the WTP (Table 3.7).

Table 3.7. *Estimated mean WTP in three scenarios.*

	Scenario 1 (€/household/month) [95% CI]	Scenario 2 (€/household/month) [95% CI]	Scenario 3 (€/household/month) [95% CI]	Scenario 3 Yearly WTP per household in euros
Mean (Definitely Yes)	16 [13, 19]	15 [12, 18]	19 [15, 23]	228
Mean (Definitely No)	85 [75, 95]	121 [111, 131]	124 [104, 144]	1488

In Table 3.8 we calculated the share of different attributes according to the importance of the attributes for the respondents. Next we calculated results from the scenario including all the attributes (scenario 3) and divided total WTP according to the shares of different attributes. The monthly mean WTP was multiplied by 12 months, giving the average yearly WTP for the scenario3 totally 228€.

Table 3.8. *Estimated WTP of the households for the single attributes.*

Attribute	Description	%	Mean WTP (€/household/mo)	Mean WTP (€/household/y)
Domestic	Domestic food production and processing	10.32	1.96	23.54
Runoff leakages	**Runoff leakages from agriculture will decrease** (mainly nutrient leakages in Finland and water quality, not soil erosion)	**10.06**	**1.91**	**22.94**
Tradition	**Finnish food culture is preserved (tradition, knowledge and processing skills)**	**9.88**	**1.88**	**22.53**
CO2 balance	**(1) The ability of fields to act as carbon sink and combat climate change is improving (2) Greenhouse gas emissions from agriculture are decreasing**	**9.60**	**1.82**	**21.89**
Rural jobs	The number of jobs in rural areas remains	9.56	1.82	21.81
Biodiversity	**(1) Abundance of wildlife organisms in the field and soil (2) Diversity of arable crops (3) The variety of species of production animals**	**9.00**	**1.71**	**20.52**
Organic	Organic production is becoming more common	8.99	1.71	20.51
Adaptation	The growing conditions in the fields and robust crop yield under varying conditions improve	8.98	1.71	20.47
Landscape diversity	**(1) The arable landscape is varied in vegetation (2) The grazing cows are visible in the landscape**	**8.61**	**1,64**	**19.63**
Regionality	Evenness of regional distribution of agricultural production and processing	7.66	1.45	17.45
Low-input	Low-input production methods become more common (less inputs from outside the farm)	7.34	1.39	16.71
Total		100%	19.00	228.00

4. Italian case study

4.1. Case study description

4.1.1. Pedoclimatic region

Three of the four Italian case studies in Diverfarming are located in the Mediterranean North pedoclimatic region. More specifically, case studies CS5 and CS7 are placed within the Lombardia Region, Mantova and Cremona provinces respectively, and case study CS6 is located in Emilia Romagna region, Piacenza province (North of Italy). All Italian study areas are shown in Figure 4.1.

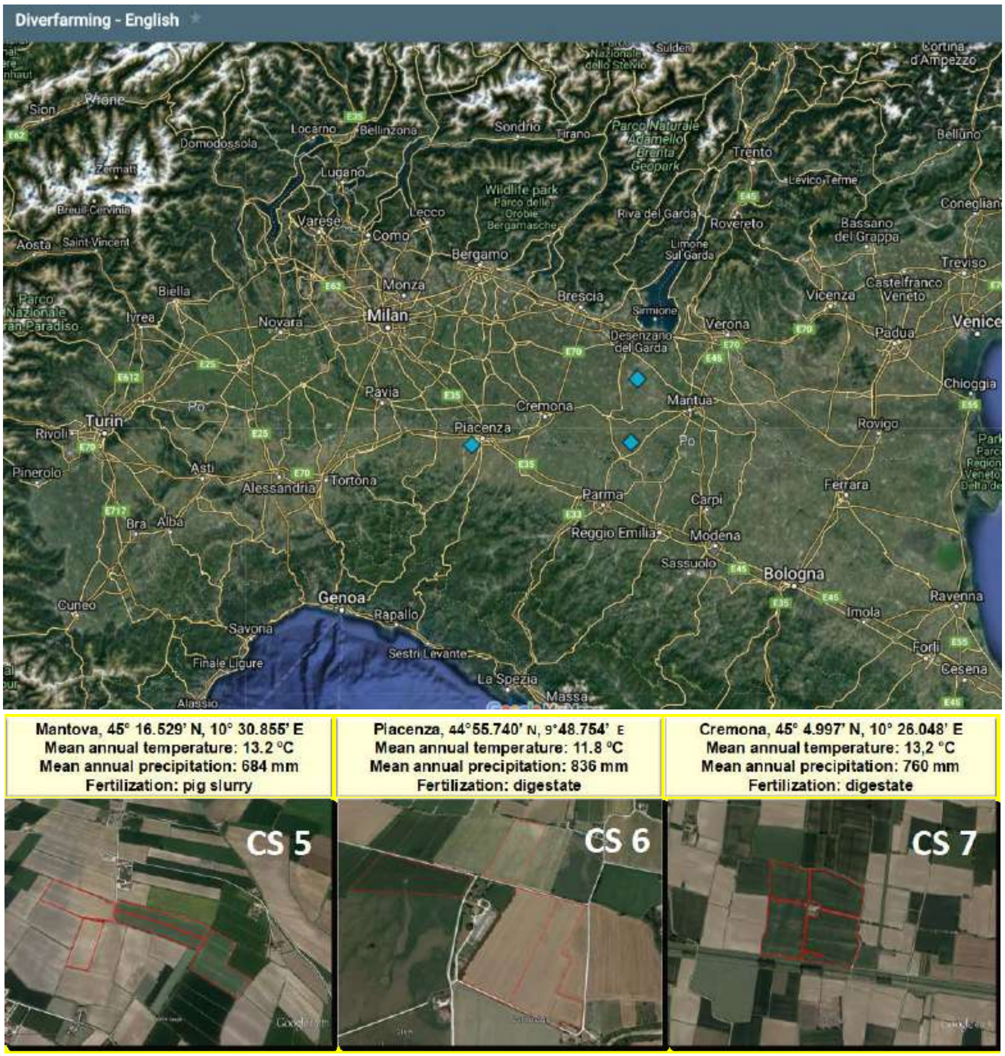

Figure 4.1*. Italian case study farms in Po Valley: Case study 5 Mantova, Case study 6 Piacenza, Case study 7 Cremona.*

The river Po basin is the largest productive agricultural area in Italy, representing about 70% of the total plan Italian surface. Indeed, agriculture systems are mainly based on an intensive production model addressed to respond at the agri-food industries, also diffuse in the same area, raw materials demand. Arable lands are managed by specialized farms where most common cropping systems present horticultural-industrial crops (i.e. tomato, corn, sunflower), rainfed crops (i.e. common wheat, durum wheat, barley) and fodder crops (i.e. alfalfa, silage maize, grass, sorghum). The Figures 4.2, 4.3 and 4.4 show the crops typology distribution on arable land during 2013-2017 period in the provinces where CS 5-6-7 are located.

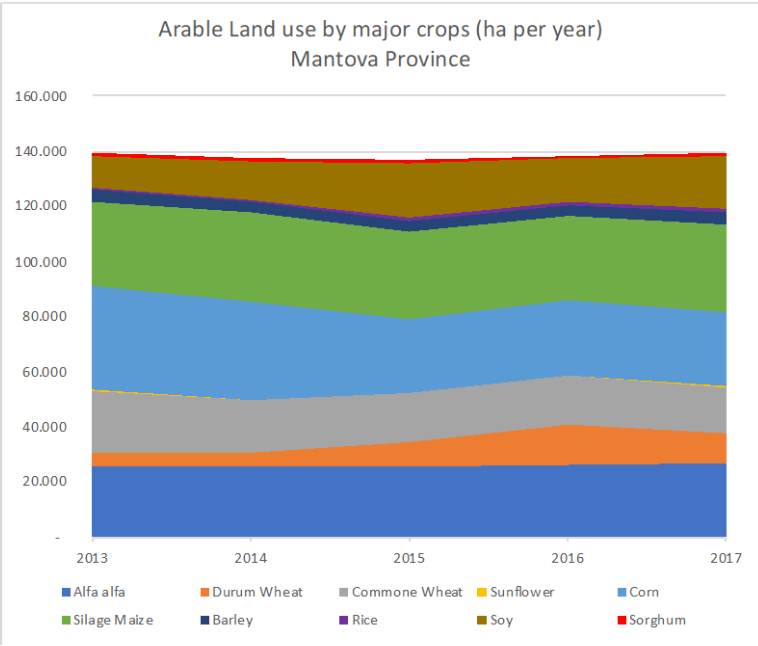

Figure 4.2. *Arable land use by major crops in Mantova Province (ha per year). Source: Authors elaboration on ISTAT 2018 agriculture and production dataset.*

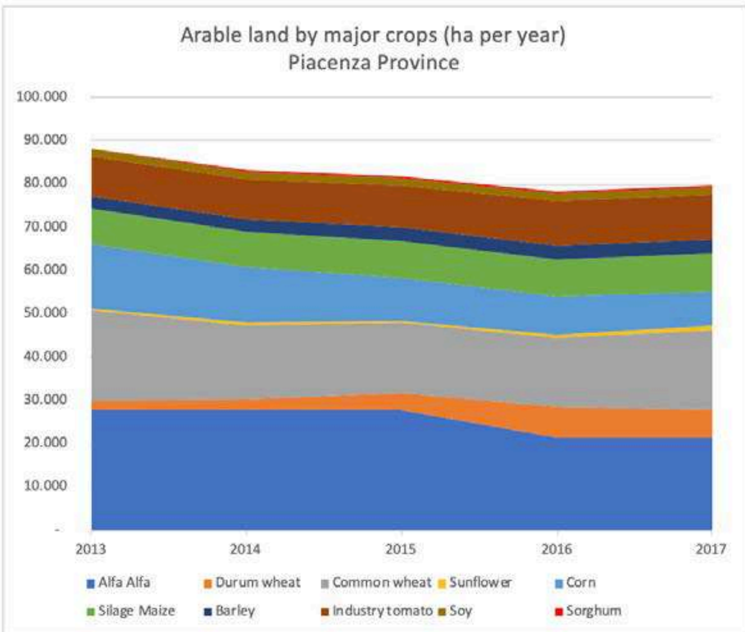

Figure 4.3. *Arable land use by major crops in Piacenza Province (ha per year). Source: Authors elaboration on ISTAT 2018 agriculture and production dataset.*

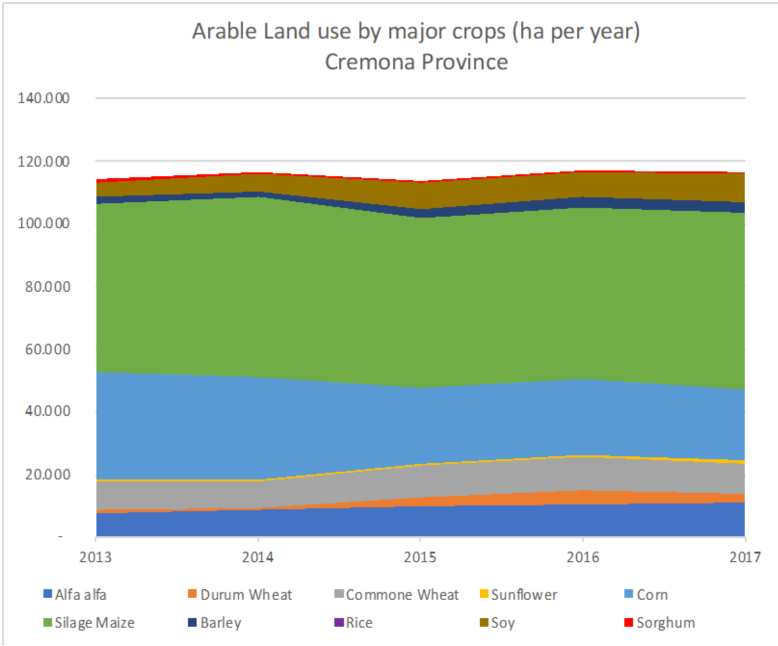

Figure 4.4*. Arable land use by major crops in Cremona Province (ha per year).*

Source: Authors elaboration on ISTAT 2018 agriculture and production dataset.

In all these areas environmental pressures are strictly connected to intensive agricultural productions models and other pressures generate by industrial sectors. The agricultural negative impacts in these areas are mainly recognized as: biodiversity loss (Bani *et al*., 2010), soil and water pollution by chemicals (Fava *et al.*, 2009), low soil organic matter rate content, nitrates losses in the environment (Cinnirella *et al*, 2005), high GHG emissions, soil compaction and landscape simplification (Perego *et al*., 2012).

Critical environmental aspects are also described by the Context Common Indicators used by Regions to define a Rural Development Program (RDP) 2014-2020 ex-ante evaluation. The strategies carried out by the Managements Authorities of Emilia Romagna and Piemonte RDPs, both propose several actions aimed to reduce GHG and ammonia emissions and to spread practices to favour more sustainable management of ecosystems and habitats in agricultural land. To mitigate these environmental impacts both RDPs define measures that provide per hectare payments aimed to: i) adopt more suitable crops rotations; ii) improve pesticides and fertilizer management; iii) mitigate environmental risks about fertilizers and pesticides management; iv) reduce biodiversity losses and ecosystems degradations.

4.1.2. Diversifications description

Three case studies, with intensive arable durum wheat and tomato production (CS5, CS6, CS7) will be considered to develop non-market valuation within Mediterranean North pedoclimatic area.

4.1.2.1. Case studies CS5, CS6, CS7: diversified annual crops

CS5 farms are located in Lombardia region, in Mantova province. It covers approximately 131 ha of arable land, 18.2 of them were dedicated to Diverfarming experiments. CS6 farm is located in Emilia Romagna, precisely in Piacenza province, and it accounts approximately 48 ha of arable land, 18 ha of them are dedicated to the experimentation area for Diverfarming project. CS7 is located in Cremona province, in Lombardia Region administrative territory. This farm manages 84.3 ha, of which 18.1 ha are dedicated to Diverfarming project experiment.

In all three farms, the current cropping system is mainly based on two-yearly crop rotation with the alternation of irrigated tomato (*Solanum lycopersicum*) and rainfed durum wheat (*Triticum durum*). Crops' harvest time are, respectively, on late spring and summer. The current management practices are characterized by an intensive production where the use of mineral fertilizer and pesticides is compliance with integrated pest management regional disciplinary.

The main environmental problems are linked to low soil organic matter, soil compaction and low aggregate stability, risk of water irrigation shortage, soil and water pollution, nitrate management, high greenhouse gas emission rate and landscape simplification. In this context the diversification strategy designed to solve these problems by researchers of Diverfarming project consists in:

- Tomato-Wheat (T-W): current situation
- Diversification 1 (D1): introduction of a leguminous crop in the rotation (pea for food)
- Diversification 2 (D2) introduction of tomato as second crop in the rotation after pea (multiple cropping)

Regarding low input management practices to be carried out, the use of organic fertilizer (CS5: pig slurry/two doses; CS6-7: digestate), reduced tillage, integrated irrigation, and pest and fertilizers control (use of decision support system in durum wheat cultivation) will be applied. Further information about the case studies can be found in Deliverable D2.2 (Diverfarming, 2019a).

4.2. Methodology

4.2.1. Choice Experiment method

Choice Experiment (CE) was selected as an appropriate methodology to achieve Diverfarming's case studies CS5, CS6 and CS7 expected positive environmental impact in non-market valuation. Following the methodological structure proposed for Spanish case studies analysis, CE stated preference method based on Lancaster's multi-attribute utility theory (Lancaster, 1966) and the random utility theory (McFadden, 1974). It was applied to the North-Mediterranean context.

4.2.1.1. Attributes and levels

The strategy of the Emilia Romagna and Lombardia regions, in line with RDPs priorities P4 and P5 for promoting sustainability and contrast to climate change, assumes a fundamental role as fundamental is the relationship between agriculture and production and protection of public goods such as biodiversity, agricultural landscapes, air, soil and water. In this context and also through the aid of a literature review, expert interviews and by Focus Group outcomes, the attributes for the CE development were selected considering the main environmental problems at the study cases, as mentioned above about pedoclimatic region (section 4.1.1). Furthermore, these attributes will be measured by different Diverfarming WPs, thus initial qualitative levels could be used when data from different WPs will be available. Selected attributes and their correspondent levels are shown at Table 4.1.

Table 4.1. *Description of attributes and levels used in the Choice Experiment exercise.*

Attribute	Description	Code	Levels
Biodiversity	Nº of insects species identified within experimental plot compare to the control one	BIOD	Low (sq) Medium High
CO_2 net balance	CO_2eq emission potentially avoided, monitored by specifics measures and predictive models	CO2B	Low (sq) Medium High
Water pollution risk	Presence of macro-nutrients in soil water	WTPO	High (sq) Medium Low
Agricultural landscape	Perception of agricultural landscape beauty	LAND	Monocrop (sq) Diversification
Food expenditure	Monthly increase in foodstuff expenditure per family (considering same quantity of consumption)	COST	0 € (sq) 3 € 8 € 15 € 22,5 € 30 €

The choice of the attributes biodiversity, carbon net balance and landscape, are motivated by connections to results expected from other WPs and to obtain comparable results between different Diverfarming pedoclimatic regions. The attribute of water pollution risk, highly relevant in the study area, is already used as attribute on several public goods' non-market evaluation analysis. Considering that water quality issue is broadly perceived by Padania Valley communities and citizens, this attribute was including in North-Mediterranean CE structure. This attribute is especially important when considering more than 50% of irrigated arable land is under salinization risk by 2050 (Jamil *et al*., 2011).

Regarding the cost attribute, it was included in the choice experiment design to determine the increase in foodstuff expenditure per family derived from the willingness to consume products from diversified and low-input farming. The cost attribute levels were selected taking as a reference the monthly average expenditure in tomatoes (canned, jar and bottle), pasta and biscuits, snacks and other pastries. The average expenditure was calculated for the two reference regions of the Italian case studies, using official data provided by Italian National Institute of Statistics about Lombardia and Emilia Romagna administrative region, classified as NUTS2 (ISTAT, 2017). Thus, five costs level were defined: 3 €, 8€, 15€, 22,5€, 30 €, that considering an increase of food stuff expenditure ranging from 10% to 100%.

4.2.1.2. Choice sets

The experimental design comprised the construction of the choice sets, which combined two diversification alternatives with the monocrop SQ alternative. The crop diversification alternative A is based on organic nutrient management and crop rotation with legumes and the Diversification Alternative B adds crop rotation with legumes and nutrient management an additional practice of diversification, namely sowing and maintaining a buffer strip on at least 3% of the arable land managed for annual crops.

To create the choice experiment design, 30 choice sets were blocked in five different groups. Different choice set blocks were distributed randomly through the respondents. To simplify CE and ensure that respondents understood the exercise, attributes' levels were illustrated by images and clarifying comments were made when necessary. Figure 4.5 shows an example of a choice set.

Scenario 1.1	Diversification A	Diversification B	Status quo
Biodiversity	High	High	Low
CO2 net balance	Medium	Low	Low
Water Pollution Risk	Low	Low	High
Agriculture Landscape	Diversification	Diversification	Monoculture
Cost	30 €	22,5 €	0 €
Choice			

Figure 4.5. *Example of a choice set used in the CE.*

It is important to remark that the combination of attributes' levels for the generation of choice sets was developed following a S-efficient by means of Ngene 1.0.2 software package (Rose *et al*., 2010).

4.2.1.3. Questionnaire design

The valuation scenario aimed to stablish a context for the respondents. After some tests, the main message told as introduction per each interview was defined as follow:

"In Europe, over the last 60 years an agricultural production system has been consolidated based on an intensive use of natural resources accompanied by a high use of chemical inputs. This agricultural system is continuing to generate negative impacts on the environment, in particular by reducing soil fertility, biodiversity, water quality and at the same time compromising the productive capacity of many farms and the profitability of farmers. The Diverfarming project aims to encourage the adoption of crop diversification systems capable of reducing the impact of European agriculture and at the same time producing environmental benefits for citizens. With Diverfarming, the environmental benefits arising from the adoption of diversification practices in farms located in different geographical contexts (pedoclimatic areas) in Europe will be analysed for four years".

The questionnaire followed the next structure:

- **Section 1**. Perception and attitudes with regard to crop diversification. This part of the survey included different questions about the respondent's previous knowledge about crop diversification, their benefits or what factors would influence on a higher diversified products consumption and what are the types of foodstuffs for which they would be willing to spend more. Additionally, the individuals were asked about their level of implication with agroecosystems and rural landscapes, and about their monthly expenditure on pasta and tomato sauce.
- **Section 2**. Choice experiment. Each respondent was asked to complete a block of the entire choice, with a total of six choice sets. Furthermore, the sixth-choice set, consisting of a duplication of the first scenario, was added to analyse the statistical coherence within the answers. Each respondent was again explained the benefits derived from a diversified cropping system and the different alternative diversification proposals, so each scenario had three alternatives. Two of them described crop diversification situations (which implied an extra cost for the consumption of diversified products), and other alternative was a mono-cropping system. In the case of a strong preference for mono-cropping systems (SQ), a follow up question was added to identify the reason of his/her choice. It enabled to identify and distinguish between real and protest answers (Barrio and Loureiro, 2013). Furthermore, an open-ended question was asked to value the highest monthly overrun of each

respondent following the Contingent Valuation method. This question enabled a more direct comparison with Finnish case study, with a Contingent Valuation methodology approach.

- **Section 3.** Perception and attitudes regarding to crop diversification and ecological commitment. On the other hand, the ecological commitment index was analysed through the valuation of a series of sentences about respondent's *Affective Ecological Commitment* (*AEC*), *Verbal Ecological Commitment* (*VEC*) and *Real Ecological Commitment* (*REC*). In this case, the respondent was asked to value his/her degree of agreement with each assertion in five-point Likert scale of 1 (totally disagree) to 5 (totally agree). In the end, interviewees were asked if they were still interested in more sustainable products and what could be the motivation that could push them to buy these foodstuffs; furthermore the general interest in environmental issues was tested with two questions. This section also included the main socioeconomic variables, such as respondent's age, gender, place of residence, etc.

4.2.1.4. Sampling and data collection

A pilot survey was filled by 15 respondents in March 2019. Later, using random stratified sampling, a total of 185 surveys were conducted through face-to-face interviews in May 2019. The interviews were carried out in three municipalities areas, Parma, Reggio nell'Emilia and Modena, in different times and days going to then cover the areas in the time frame of the whole day. According to the Italian National Statistics Institute (ISTAT) data, the cities selected in the Po valley to carry out the survey have a total of resident citizens equal to 552 904 at 01/01/2018. To estimate the numbers of households this number was divided by national average data of 2.40 people per families (Table 4.2.).

The selection of the interviewees was carried out through a random choice of one person every three passers-by. The sample size, for a 95% confidence level, provided a sample error term below 7%.

Respondents were informed about the aim of the CE through a consent form that had to signed (Deliverable D11.2) and the characteristics and levels of each indicator before starting the exercise. The implications of their participation were also notified and authorized through a verbal consent statement.

Table 4.2. *Number of surveys completed, distributed by cities.*

Cities within the Po valley	Nº of citizen	Nº of households	Goal surveys	Filled surveys
Parma	195,687	81,536	60	61
Reggio nell'Emilia	171,944	71,643	55	67
Modena	185,273	77,197	60	57
Total	**552,904**	**230,377**	**175**	**185**

4.2.2. Econometric models

According to the random utility theory (McFadden, 1974), the utility (U_{ijt}) provided for an individual *i* by an alternative *j* in a choice set *t* can be decomposed into an observed (V_{ijt}) and an unobserved part (ε_{ijt}), additively considered:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} \qquad (1)$$

Where V_{ijt} is the deterministic part of the utility, which is defined by the attribute levels and the individual sociodemographic characteristics. ε_{ijt} is a stochastic error term, identically and independently distributed. Assuming V_{ijt} as a weighted sum of the attribute levels and individual characteristics, U_{ijt} can be rewritten as:

$$U_{ijt} = \beta X_{ijt} + \varepsilon_{ijt} \qquad (2)$$

Where X_{ijt} symbolizes the attribute levels and individual characteristics and β represents their associated marginal utility. The widest applied model to estimate the utility is the conditional logit model (CL). This model assumes the error term ε_{ijt} follows an extreme value type 1 distribution (Gumbell-distribution).

However, as the utility perceived by the respondent cannot be observed, his/her choices can be analysed as they can be observed. Thus, we can estimate the coefficients β which maximize the probability of observed choices. The probability of choosing an alternative j, ranging from 1 to J, in a choice set t (P_{ijt}) is estimated by the maximum likelihood method (Train, 2009):

$$P_{ijt} = \frac{e^{V_{ijt}}}{\sum_{p=1}^{J} e^{V_{ipt}}} \; \forall \; j \neq p \tag{3}$$

In this context, the utility from choosing an alternative derives from their individual characteristics and the provision of ES, which are indeed the indicators used to define the attribute alternatives (in this particular case, biodiversity, soil erosion, CO_2 balance, cultural heritage, landscape and additional cost). Therefore, the functional form of the utility (V_{ijt}) derived from individual i for alternative j in the choice set t can be defined within this study as:

$$V_{ijt} = \beta_0 SQ + \beta_1 BIOD_{jt} + \; \beta_2 CO2B_{jt} + \beta_3 WTPO_{jt} + \beta_4 LAND_{jt} + \beta_5 COST_{jt} + \varepsilon_{ijt} \tag{4}$$

Where β_0 is associated to the current situation (SQ), that is, less diversified intensive cropping systems, and β_k is the marginal utility obtained from each ES k provided by the agroecosystem, reflecting how utility level changes if the provision of ES increases. Specifically, β_1 refers to biodiversity (BIOD); β_2 and β_3 are related to regulating services (CO2B and WTPO) CO_2 balance and water pollution risk respectively; and β_4 is related to a cultural service (LAND); finally, β_5 is the coefficient for the assumed extra cost of buying food produced by alternative crop diversification and low input agricultural systems.

Marginal rates of substitution allow us to go in depth into social preferences analysis after model coefficients estimation. When a cost attribute is included in the choice experiment, the marginal rate of substitution between the coefficient of non-cost attributes (β_k) and the cost attribute (β_5) shows the marginal willingness to pay (MWTP) for the non-cost attributes it refers. It is calculated as follows:

$$MWTP_k = -\left(\frac{\beta_k}{\beta_5}\right) \tag{5}$$

$MWTP_k$ represents, in monetary terms, how much respondents are willing to pay for each ES k provided by agroecosystem. It should be understood not only as a translation of the value of an ES, but also as a measurement of its contribution to individual wellbeing and, subsequently, of its relative importance within the overall contribution of agroecosystem to wellbeing.

Moreover, the results obtained from CL model allow to measure the mean willingness to pay ($\overline{WTP_k}$) for each ES k, which attempts to estimate the average ES value perceived by the respondents. Its importance lies in comparing the results from choice experiment and contingent valuation, since it allows to aggregate the value per each ES into an average willingness to pay per respondent:

$$\overline{WTP_k} = -\left(\frac{\beta_k * \overline{X}_k}{\beta_5}\right) \tag{6}$$

Where $\overline{X_k}$ represents the average level of each ES k presented in the choice experiment.

Due to the purpose of the present research, it is also interesting to measure compensating surplus (CS) (Bennet and Blamey, 2001), which translate into monetary terms the welfare changes of moving from current situation (SQ) to another different management scenario, that is, moving from mono-cropping to a diversification alternative. It is summarized as follows:

$$CS_{mg_i} = -\left(\frac{V_{sq_i} - V_{mg_i}}{\beta_5}\right) \tag{7}$$

Where V_{sq_i} represents the utility derived from the SQ and V_{D_i} measures the utility associated to a specific management scenario for an individual i. Negative values for the CS_{mg_i} imply society is willing to pay to support the aforementioned scenario.

Aggregating the individual value of CS_{mg_i} across all target population, the total economic value (TEV) provided by the agroecosystem can be calculated. TEV_{mg} measures, therefore, the overall contribution of a specific management scenario in the social welfare. Assuming again a linear utility function, TEV_{mg} is calculated as follows:

$$TEV_{mg} = \sum_i CS_{mg_i} = \sum_i -\left(\frac{V_{sq_i} - V_{mg_i}}{\beta_5}\right) \quad (8)$$

4.3. Results

4.3.1. Sample description

Table 4.3 shows respondents' characteristics regarding their sociodemographic information and their relations with agriculture and farming context. The final sample was composed by 185 respondents, whose average age was around 47 years, similar to the regional average (48 years). The sample was divided into 4 different age groups (18-30 years; 31-45 years; 46-60 years; >60 years), where the most numerous group (29.73%) is represented by older people (>60 years), while the least represented is the middle-age one (22.16). The sample is representative in terms of gender (50.81% women) but it shows a misalignment comparing to the composition of the family unit and lower education level if compared to the statistical data.

Table 4.3. *Descriptive statistics.*

Variable		Sample	Cities
Sociodemographic information			
Age of people over 18 years old (years)			
	18-30 years (%)	25,41	15.72 [a]
	31-45 years (%)	22,70	25.17[a]
	46-60 years (%)	22,16	27.00[a]
	> 60 years (%)	29,73	32.12[a]
Gender (% women)		50,81	51.18[a]
Educational level (%)	Lower education	4,86	18.47 [b]
	Primary education	16,22	25.46[b]
	Secondary education	49,19	32.38[b]
	Higher education	29,73	16.68[b]
Do you visit an agroecosystem frequently? (%)			
	Yes	41,62	
	No	58,38	
If so, for what reason?			
	Recreation	75,32	
	Economic activity	5,19	
	Research/Education	6,49	
	Other	12,99	

[a] ISTAT (2018); [b] > 6 years (%) ISTAT (2011).

It should be noted that over 80% of the sample (specifically 81.62%) was aware of crop diversification and specifically of crop rotation (i.e. diversification introduced in Italian case studies); this result was explained by several responders, who stated that crop rotation concepts were proposed as topics in primary school study education programs. To the 18.38% of the sample who did not know what "crop diversification" means, it was briefly explained by reading this sentence "*When two or more crops are grown at the same time or* *consecutively on a farm*". Regarding the typology of work activity, more than 50% (51.35%) of the sample is composed by freelancers or employees (of all levels), while students are 16.22%. As regards the unemployed category, those who are actively looking for work and housewives are also included, representing 7.57% of the sample. Only 16.22% of the sample is composed of families with children (0-12 years), with an average of 1.77 children each.

4.3.2. Preference modelling

Before being subjected to the choice set, respondents were asked if they were willing to pay more for products made by "more sustainable cropping systems". In 94.59% of cases the answer was positive. It should be noted, however, that the following question asked to indicate per which products were available to pay more, also have collected positive answers by the 5.41% that had previously declared unavailability to pay more for food products in general.

Additionally, participants were asked to choose between one or more food product typologies options among vegetables/fruits, pasta/bread, meat/eggs/fish, legumes, milk/milk products, in terms of which products they would spend the most. Most of the sample (83.78%) showed preference for vegetables/fruits, followed by meat/eggs/fish with 42.16%, milk/milk products with 39.46% and pasta/bread 24.32%, while only 1.89% chose legumes.

Before applying econometric models, the proportion of surveys which showed a constant preference for SQ choice, were analysed. In these cases, respondents did not agree with increasing their monthly food expenditure to obtain products derived from crop diversification and low-input farming. In the North-Med survey, a total of only six respondents (3.24%) chose the SQ alternative at each choice-set, while 179 respondents (96.76%) would be willing to pay an extra amount of money for the consumption of food from diversify cropping systems.

The results obtained through the estimation of a CL model are presented at Table 4.4., where the coefficients associated with the different levels of attributes which make up the utility function are shown. All variables were found to be significant, except for the CO_2 balance, however as whole the model was considered to be valid (Pseudo R^2 = 0.176) and comparable to other results carried out by similar studies (Ragkos and Theodoritis, 2016; Aslam *et al.*, 2017, Niedermayr *et al.*, 2018).

Taking into account these considerations, results point out the positive impact of ESs at the utility function (positive marginal utility). In contrast, price attribute has a negative sign, which involves an expected disutility perceived by respondents looking at SQ scenarios. SQ attribute also showed a negative sign, thus it reduces the utility function and, as a consequence, there is a generalized desire of changing the current mono-cropping food demand.

Table 4.4. *Results derived from the conditional (fixed-effects) logit regression model.*

Choice (variable)	Coefficient	Standard error	p-value
SQ	-1.017	0.186	0.000
Biodiversity – Medium	0.766	0.123	0.000
Biodiversity – High	0.889	0.132	0.000
CO_2 balance - Medium	0.233	0.126	0.065
CO_2 balance - High	0.111	0.144	0.441
Water pollution risk - Medium	0.633	0.129	0.000
Water pollution risk – Low	0.602	0.127	0.000
Diverse landscape	0.284	0.101	0.005
Price	-0.050	0.006	0.000

Number of observations = 185; LR chi^2 (10) = 419.13; Prob > chi^2 = 0.0000; Pseudo R^2 = 0.1786.

4.3.2.1. Willingness to Pay analysis

Delta method (Hole, 2007) was applied to the conditional logit model to calculate the Marginal Willingness to Pay (MWTP) of each attribute and level. The MWTP of each ESs' status is shown at Table 4.5. The change from medium biodiversity to high biodiversity is the most valuated, with a MWTP of 17.61

€/household/month. A lighter change to medium biodiversity rates is also well valuated (MWTP of 15.19 €/household/month). Water pollution risk is the second most valuated ES, with MWTP of 12.54 and 11.93 €/household/month for medium and low water pollution rates, respectively. CO_2 balance values are also positive, but not significant and not coherent with the other results, were an improving in environmental attribute is always connected with higher MWTP values. Finally, the existence of a more diverse landscape carries an implicit price of 5.62 €/household/month.

Table 4.5. *Marginal willingness to Pay (€/household/month) analysis results.*

Attribute	MWTP (€/household/month)	Standard error	p-value	[95% Conf. Interval]
Biodiversity – Medium	15.19	2.546	0.000	10.20 ; 20,18
Biodiversity – High	17.61	2.189	0.000	13,32 ; 21,90
CO_2 balance - Medium	4.62	2.368	0.051	-0,02 ; 9,26
CO_2 balance - High	2.20	2.718	0.418	-3,16 ; 7,53
Water pollution risk - Medium	12.54	2.545	0.000	7,55 ; 17,53
Water pollution risk – Low	11.93	2.489	0.000	7,05 ;16,81
Diverse landscape	5.62	1.915	0.003	1,87 ; 9,38
SQ	-20.16	4.534	0.000	-29,04 ; -11,27

Together with the results of the MWTP, it is also interesting to measure the mean WTP ($\overline{WTP}$), mainly with the purpose of being able to compare the choice experiment results with the contingent valuation ones. In this context, the $\overline{WTP}$ analysis (Table 4.6.) shows that, on average, respondents are willing to pay a total amount of 20.16 €/household/month in order to support diversified crops.

Table 4.6. *Mean willingness to Pay (€/household/month) analysis results.*

Attribute	Mean WTP (€/household/month)	Standard error	p-value	[95% Conf. Interval]
Biodiversity – Medium	3.38	0.566	0.000	2.27 ; 4.48
Biodiversity – High	3.91	0.486	0.000	2,96 ; 4,87
CO_2 balance - Medium	1.03	0.526	0.051	-0.00 ; 2.06
CO_2 balance - High	0.59	0.725	0.418	-0.83 ; 2.01
Water pollution - Medium	2.09	0.424	0.000	1.26 ; 2,92
Water pollution – Low	2.65	0.553	0.000	1.57 ; 3.74
Diverse landscape	1.69	0.575	0.003	0.56 ; 2.81
Total	12.68	4.534	0.000	8.88;16.48

4.3.2.2. Management scenarios assessment

According to WTP results, different arable cropping systems' scenarios are valuated below (Table 4.7):

- **Status quo (SQ).** This scenario shows the business as usual cropping system management in the cases study areas. Less diversification and high input intensive farming for Pianura Padana arable land management is carried out. These farming activities imply several problems in terms of environmental impacts. These are recognized as responsible for low biodiversity rate, low greenhouse gas emission balance, high water pollution risks, high landscape and cultural erosion. SQ is associated as a worst condition that affect negatively community wellbeing generating high social costs.
- **Integrated pest and nutrient management (IPNM).** This scenario reproduces an intensive and less diversified farming system where integrated pest management (IPM) and basic crop rotation is carried out. This system allows a rational use of chemical fertilizers and suggest two—yearly crop rotation but do not include legumes or nitrogen fixers crop in the crop planning. Hence level attributes expected are: low biodiversity rates, low GHG emissions balance mainly due to nitrogen mineral use, medium water pollution risks due to the use of less dangerous pest and disease molecules,

monoculture landscape and cultural erosion. In this work IPNM scenario corresponds to all control plot present in all CS.

- **Integrated pest and nutrient management - low input (IPNMLI).** This scenario reproduces an intensive and diversified agro-ecosystem characterized by: i) IPM rules adoption; ii) organic fertilization practices introduction; iii) four-yearly crops rotation where are introduced legumes (pea), and tomato as a second crop; iii) reduction of mineral fertilization quantities used per each crop. Hence the attribute level expected are: medium biodiversity rates, medium GHG balance mainly due to efficient management of nitrogen composed by mineral and organic mix nutrient sources, medium water pollution risks due to the use of less health and environment dangerous molecules, diversified landscape. In this work IPNMSI scenario corresponds to CS dedicate experimental sub-plots.
- **High-efficient biodiversity intensification (HEBI).** This scenario reproduces the IPNMLI scenario characteristic assuming a new cropping systems diversification where at least 3% of utilized agricultural area are dedicated to seeding and manage flower buffer strips. HEBI is a hypothetical scenario that will be directly tested in all CS experimental sub-plots dedicate to durum wheat cultivation in the last agrarian year of experimentation.

Table 4.7. *Consumer surplus (€/household/month) and TEV (M€/month) analysis results.*

Scenario	Management actions	Compensating surplus (€/household/month) Average [95% CI]	TEV (M€/month) Average [95% CI]
SQ	- Biodiversity – Low - CO_2 balance – Low - Water pollution risk – High - Monocrop landscape	-20.16 [-29.04;-11.27]	-4.64 [-6.69;-2.60]
IPNM	- Biodiversity – Low - CO_2 balance – Low - Water pollution risk – Medium - Monocrop landscape	-32.69 [-41.88;-23.51]	-7.53 [-9.65; -5.42]
IPNMLI	- Biodiversity – Medium - CO_2 balance – Medium - Water pollution risk – Medium - Diversification landscape	-58.13 [-69.02;-47.24]	-13.39 [-15.90;-10.88]
HEBI	- Biodiversity – High - CO_2 balance – High - Water pollution risk – Low - Diversification landscape	-59.95 [-69.52;-50.38]	-13.81 [-16.02;-11.61]

To evaluate and compare cropping systems' management scenarios the TEV and compensating surplus estimation values are reported in the Table 4.7. Moving from SQ to other diversification management options, compensating surplus shows a negative value. It confirms that the panel of citizens interviewed are willing to pay to support the transition to more diversified cropping system scenarios. This trend can be translated also in a social welfare impact which was estimated through the individual compensating surplus aggregation across all target population. In detail, SQ scenario is supported by an average of 20.16 €/household/month. Otherwise IPNM scenario implies a sensible increase of compensating surplus compared to IPNMLI scenario, whose compensating surplus value is 58.13 €/household/month. A considerable gain on compensating surplus' value is appreciable comparing the SQ value to diversified scenario IPNMLI, where a four years rotation and legumes introduction are included. In this case the CS value has tripled compared to the SQ and doubled compared to the IPNM scenarios. At the same time, HEBI scenario shows CS values very close to the IPNMLI scenario. These results seem to show how the perception of the value of a scenario is much more linked to the passage from non-diversified cropping systems to a medium diversified one, rather than from a medium to a high diversification. IPNMLI scenario show positive attributes levels compared to SQ and IPNM scenarios. The proposed scenarios for Po valley would involve the following implications on social well-being. A consumer surplus increase is derived from agricultural practices from monoculture, to a basic crop rotation (IPNM 4.7 M €/month), to a medium diversification level (IPNMLI scenario; 13.4.3 M€/month) and to the most environmental efficient diversification practices and positive attributes levels (HEBI scenario; 13.8 M€/month).

4.3.3. Social demand factors

Respondents' perception and attitudes regarding agricultural concerns were analysed through the calculation of the Ecological Commitment Indexes (ECIs). Affective commitment (ECI-A), Verbal commitment (ECI-V) and Real commitment (ECI-R) were established by means of the assessment of a set of related statements through a five-point Likert scale. Thus, respondents indirectly stated the different components of the ecological commitments. As it is shown in the Table 4.8, ECI-A is higher than ECI-V, and ECI-R is the lowest value.

Table 4.8. *Ecological commitment statistics.*

Ecological commitment indexes (ECI) – 1 to 5 scale	Sample
ECI- A (1 Minimum, 5 Maximum)	4.84
ECI - V (1 Minimum, 5 Maximum)	3.40
ECI - R (1 Minimum, 5 Maximum)	2.02

On the other hand, participants were asked about their willingness to consume products from more sustainable agricultural practices, and 100% of respondents expressed a positive opinion. Respondents were asked for reasons to motivate the previous answer. At this point in the survey, three options were provided as options: (1) higher competitive prices, (2) higher product quality and (3) more information on food production. Respondents could choose one or more options. Therefore, 55.14% of respondent would increase this consumption if products had a higher quality, while around 37% would consume product with further information on food production and 26.49% with competitive lower price. Only 1.6% of the sample believe that the current focus on climate change is not important, but over 99% believe that more investment is needed in terms of economic resources, communication and so on for more sustainable agriculture.

5. Discussion

5.1. Discussion based on case studies in Spain

Spanish results point out that 89.90% of people in the Region of Murcia would assume an extra amount in fruit and vegetables expenditure if they were produced through crop diversification and low input farming. Moreover, society within Region of Murcia have a close relationship with agroecosystems, as 79.3% visit these systems. This fact can positively affect the social support to a change in current cropping systems towards crop diversification and low input farming. These sustainable strategies would contribute to improve agroecosystems' ES provision, which is highly valued by society.

Erosion, landscape and CO_2 balance are the most valued factors among attributes set. As it is pointed out in similar studies, landscape is perceived as one of the most important attributes (Rodríguez-Ortega *et al*., 2016; Dupras *et al*., 2017). Social value of erosion rates reduction is similar to results obtained in mountain olive groves agroecosystems by Arriaza *et al*. (2008), which is relevant as this study was also developed in Southern Spain. The results provided by the present study prove that people in the Region of Murcia are aware of some of the main problems within agroecosystems, as soil loss. Furthermore, society is willing to take part in the process of changing the current agrarian model through increasing monthly food expenditure. Regarding this willingness to pay, a higher quality of the products was pointed out to be the most important factor (68%) in increasing the consumption of products derived from crop diversification and low-input farming, followed by a more competitive price (55%) and higher availability of these products in the supermarkets (49%).

Since the sample of the study was representative at the regional level, estimated total non-market value of cropping diversification at the whole Region of Murcia level can be calculated from 356 million € annually (55.08 €/household/month or 827.47 €/ha) when low-input farming were developed in the region, to 663 million € annually (102.56 €/household/month or 1,503.05 €/ha) in the most favourable scenario (high-efficient crop diversification). These quantities show an important demand for a sustainable agricultural model.

5.2. Discussion based on case studies in Finland

In the Finnish case study, 21% of respondents were not willing to pay anything for increased cropping diversity in their food expenditures. Almost half of them (46%) expressed a view that they cannot afford paying more for food. Moreover, 30% of those not willing to pay agreed with a view that consumers should not be the ones who pay for the diversified cropping system, and 31% agreed with a view that current cropping practices are diversified enough. However, 79% of respondents were willing to pay, even slightly, higher food bill for provision of food by diversified cropping systems. The survey results suggest that consumers value several positive implications of crop diversification. However, certain positive societal implications of cropping diversification seem to be valued higher, in terms of willingness to pay, than direct effects of diversification, e.g biodiversity, or landscape diversity. In particular, improved maintenance of domestic food production and processing, reduced nutrient runoffs from agriculture, maintained food culture and tradition, improved balance of CO_2 flows in agriculture, and the number of jobs in rural areas were valued higher than improved biodiversity due to increased species richness.

Other attributes of crop diversification valued by consumers were as follows. Organic production is relatively favoured if increased crop diversification with higher landscape diversity. However, evenness of regional distribution of agricultural production and processing within Finland, and low-input production methods and less purchased inputs at farms as a consequence of diversification were considered relatively least valuable. Many consumers answered "cannot say" if the low-input production methods are valuable. This is understandable since low-input production methods are related to farm level management consumers are most often not aware of.

The calculated non-market value of diversified cropping was 245 €/ha (1.996 million ha under agricultural crop production in Finland 2017; Luke, 2019a) per year in the case study of Finland. This can also be considered significant since average yielding cereals production (3.5 tons of crop yield per ha, 2000-2014 average price of barley approximately 150 €/ton) gives 525 €/ha market revenue for a crop farm. 245 €/ha per year compares also well with the annual total market revenue (1600 €/ha) at the level of whole agriculture in Finland, considering also livestock production (Luke, 2019b). Hence the value of diversified cropping can be as high as 47% compared to the annual market revenues at cereals, and 15% compared to the total market revenues in agriculture in Finland.

Since the sample of the study was representative at the national level, the calculated total non-market value of cropping diversification at the whole country level can be calculated as high as 489 million € annually (supposing 2,1 million households (79% of total amount of households); 228 € per year per household). This calculation is based on our conservative approach using the results based on the “Definitely would pay” responses and scenario including all attributes.

5.3. Discussion based on case studies in Italy

The results of the Italian sample showed that 94.59% of those interviewed in the Po Valley would be willing to pay more for food obtained by diversified and more sustainable cultivation systems. The 83.78% of respondents confirm that will be willing to pay more for vegetables/fruits coming from diversified cropping systems.

The 81.62% of the panel show a knowledge of crop rotation technical meaning and effects on fertility of arable lands soils. They also generally recognize that this practice is useful to reduce environmental pressures. This awareness is probably because 16.76% of respondents own personally a farm and 50.81% affirm that at least one relative is agricultural land owner. Considering the CAP reform phases, where environmental issues becoming a key matter to build a new social pact between society and farmers, these results can improve a more consciousness about the diversification practices role in the sustainable intensification of agricultural production.

Up to our knowledge, the implementation of these more sustainable agricultural practices would contribute to the improvement of ES provided by agro-ecosystems, which are highly demanded by society. This result is reinforced considering that 99% of the sample believes that a high level of attention to climate change is necessary as well as great investments in terms of economic resources, both for training and communication interventions relating to the dissemination of concepts and practices in favor of sustainable agriculture.

To obtain more economic resources aimed to improve these crop diversification’ process, a consumer awareness could be motivated. According to social perception, the demand for more sustainable products would be driven by: (1) an increase in the quality of the product itself, (2) clearer information about the food production process and (3) a more competitive price for "sustainable food".

Expanding the sample data to the universe represented by total numbers of families and by the hectares of arable land, a total non-market value of crop diversification scenario was estimated. Starting from the survey results it can be calculated a value between 56 M€/year (32.69 €/family/month or 150 €/ha), considering the IPNM scenario with low input and basic crop rotation agriculture, and 103 M€/year (59.95 €/family/month or 275 €/ha) in the HEBI scenario with more “efficient” diversification practices. These quantities show an important demand for a sustainable agricultural system and the value per hectare found in the IPNM scenario is in line with what is intended by surface measurements in the RDP for agro-climatic-environmental purposes.

5.4. Case studies comparison

The perceived value of different ES provided by agroecosystems was calculated for Finnish, Italian and Spanish case studies. These calculations were carried out through non-market valuation methods (contingent valuation and choice experiment). In all cases, data collection allowed a significant number of completed surveys for the analysis. In fact, socioeconomic parameters' analyses show samples to be representative of each corresponding target population.

Regarding population's relationship with rural areas, it is closer in Spain (Region of Murcia), where 79.30% of participants visits agroecosystems frequently (sometimes or usually); while this value is 47.60% in Finnish population and 41.62% in Italy. Thus, higher non-market values of crop diversification within Spanish case study could be explained due to the closer relation with agroecosystems (Bernúes *et al*., 2014). Furthermore, recreation seems to be the principal motivation to visit rural environments in all cases. In fact, this is the main reason for 74.52% of people within Region of Murcia, 75.32% of Italian sample, and a 33.20% of Finnish respondents had a recreational home in rural environments.

Estimated average willingness to pay in the case studies shows different perception between ES and countries. When $\overline{WTP}$ is analysed, some differences among attributes are found. Table 5.1 shows $\overline{WTP}$'s values for common attributes between all case studies. Therefore, WTP for high biodiversity rates are similar in Spanish and Italian cases; medium biodiversity rates are more valued in Italy, although. Consequently, biodiversity is valued in both cases, but society in the Spanish case study would appreciate more a baste improvement in biodiversity, while society within Italian counties value any positive change. Regarding CO_2 balance, medium rate is similar in Italy and Spain. High CO_2 balance values are not comparable due they are not significant at Italian case. On the other hand, diverse landscape is more valued by society within Spanish case than by Italian case study. Finally, total $\overline{WTP}$ is doubled in Spanish case study with respect to the Italian. This difference could be caused by the closer relationship with agroecosystems found in population within Region of Murcia (Bernúes *et al*., 2014). Improved CO_2 balances in agriculture were valued relatively high, more than biodiversity or landscape benefits of diversified cropping in the Finnish case studies where the highest WTP estimates were calculated for improved maintenance of domestic food production and processing, and reduced nutrient leaching from agriculture (not included in Table 5.1).

Table 5.1. *Mean willingness to Pay (€/household/month) analysis results.*

Attribute	Mean WTP (€/household/month)		
	Spain	Italy	Finland
Biodiversity – Medium	0.74**	3.376***	-
Biodiversity – High	4.59***	3.914***	1.71
CO_2 balance - Medium	1.13**	1.027*	-
CO_2 balance - High	4.54***	0.587	1.82
Diverse landscape	4.64***	1.687***	1.64
Total	24.58***	12.68***	19.00

Statistically significant at a level of *0.1, **0.05, and ***0.01

Regarding scenarios and TEV analysis, Table 5.2 shows the results obtained by the different case studies. In all cases, SQ situation has the lowest TEV, which increases according to scenario's improvement.

Table 5.2. *TEV (M€/month) analysis results in different scenarios (Spain 539,000 households; Finland 2.1 million households; Italy 230,377 households).*

Scenario	Brief description	TEV (M€/month) Average [95% CI]		
		Spain	Italy	Finland
SQ	High-input intensive mono-cropping.	-18.67 [-22.55;-14.79]	-4.64 [-6.69;-2.60]	0
LIF	Intensive mono-cropping agroecosystem where low input farming is carried out.	-32.66 [-37.15;-28.18]		
LECD	Crop diversification in a first step where efficient is low.	-44.55 [-52.16;-36.94]		
HECD	Well-developed crop diversification (high efficiency).	-60.82 [-70.33;-51.30]		
IPNM	Intensive farming where integrated pest management and basic crop rotation are carried out.		-7.53 [-9.65; -5.42]	
IPNMLI	Intensive crop diversification with organic fertilization, low-input farming and IPM rules adoption.		-13.39 [-15.90;-10.88]	
HEBI	High-efficient IPNMLI		-13.81 [-16.02;-11.61]	
DIVER	Diversified cropping system: CO_2 balance, adaptation, runoff leakages and biodiversity			-34.30 [-40.73;-27.87]
VALUECHAIN	Organic, low-input production including landscape, biodiversity and rural vitality effects			-32.15 [-38.58;-25.72]
DIVER + VALUECHAIN	Diversified cropping system with value chain effects			-40.73 [-49.30;-32.15]

Otherwise, these scenarios could be applied to croplands within the different cases. Furthermore, in the Region of Murcia (Spain), TEV was applied to the total cropped surface, including both rainfed and irrigated farmlands (as Diverfarming CS1 and CS2, respectively), and also herbaceous and tree orchard lands. In Po Valley, TEV was referred to the three case studies, excluding land use classified as pastures and orchards. TEV calculation in the Finnish case studies, based on nationally representative sample, accounted for the result that 79% of households are willing to pay for crop diversification. TEV calculation included all attributes and "Definitely would pay" answers to bids. While the annual food expenditure (13.5 billion euros) of Finnish households was 11.6% out of disposable income 2017 (Luke, 2019a), the calculated non-market value of diversification is approximately 3.6% of the annual level food expenditures. Table 5.3 shows the results of these calculations, with confidence intervals, in more detail.

__Table 5.3.__ TEV (€/ha/year) analysis results in different scenarios (441,103 ha of total cropped land in Region of Murcia; 1.996 million ha under crop cultivation in Finland; 374,393 ha of arable land in Padania Valley).

Scenario	Brief description	TEV (€/ha/year) Average [95% CI]		
		Spain	Italy	Finland
LIF	Intensive mono-cropping agroecosystem where low input farming is carried out.	-807.69 [-918.58;-696.80]		
LECD	Crop diversification in a first step where efficient is low.	-1,101.60 [-1,289.85;-913.36]		
HECD	Well-developed crop diversification (high efficiency).	-1,503.80 [-1,739.09; -1,268.52]		
IPNM	Intensive farming where integrated pest management and basic crop rotation are carried out.		-241.41 [-309.22;-173.59]	
IPNMLI	Intensive crop diversification with legumes and organic fertilization, low-input farming and IPM rules adoption.		-429.22 [-509.61;-348.84]	
HEBI	High-efficient IPNMLI		-442.67 [-513.34;-372.00]	
DIVER	Diversified cropping system: CO_2 balance, adaptation, runoff leakages and biodiversity			-206.16 [-244.81; -167.50]
VALUECHAIN	Organic, low-input production including landscape, biodiversity and rural vitality effects			-193.27 [-231,93; -154.62]
DIVER + VALUECHAIN	Diversified cropping system with value chain effects			-244.81 [-296.35; -193.27]

These results confirm that ES's value can be higher than market products for society (Sandhu *et al*., 2008), especially in low profitable crops, as rainfed almond crop (Diverfarming CS1). In other cases, as Finnish case study, ES's non-market value can reach up to a half of market value. Therefore, it is important to consider non-market values to develop a good economic analysis in any case.

6. Conclusions

The survey's results suggest that consumers value several positive benefits of crop diversification. The results as a whole suggest that various positive societal and environmental consequences of crop diversification such as domestic food production, food security, nutrient leaching, food culture or carbon sink are indeed very significant for consumers. Hence marketing crop diversification should focus on larger and aggregate level societal and environmental benefits and not primarily on farm level implications.

In the case studies analysed in Spain (Region of Murcia), society recognises environmental and social benefits derived from crop diversification. Landscape diversification and improving CO_2 balance are identified as the most relevant factors to be improved through crop diversification and low input farming practices. Also, the results carried out from the survey developed in Italy (Po Valley) identify positive implications related to diversified cropping systems implementation. In that case, society recognised biodiversity and water pollution risks reduction as the crop diversification ecosystems services most relevant.

In the case studies in Finland certain positive societal implications of cropping diversification seem to be valued higher, in terms of willingness to pay, than direct effects of diversification, e.g biodiversity, or landscape diversity. In particular, improved maintenance of domestic food production and processing, reduced nutrient runoffs from agriculture, maintained food culture and tradition, as well as improved balance of CO_2 flows in agriculture, and the number of jobs in rural areas were valued higher than improved biodiversity due to increase species richness. However, 21% of respondents were not willing to pay anything for increased cropping diversity in their food expenditures.

Finally, the present work compiles economic valuation of social preferences regarding crop diversification in Spain (Region of Murcia), Italy (Padania Valley) and Finland. The information provided by these results can be used to guide agricultural policies considering externalities. Thus, according to the results, policies focused on environmental and social values would be widely accepted by society.

7. References

Arriaza, M., Gómez-Limón, J. A., Kallas, Z., Nekhay, O. (2008). Demand for non-commodity outputs from mountain olive groves. Agricultural Economics Review, 9(1), 5-23.

Aslam, U., Termansen, M., Fleskens, L. (2017). Investigating farmers' preferences for alternative PES schemes for carbon sequestration in UK agroecosystems. Ecosystem services, 27, 103-112.

Bani L., Massimino D, Orioli V. Bottoni L., Massa R. (2010) Assessment of population trends of common breeding birds in Lombardia, Northern Italy, 1992–2007, Ethology Ecology & Evolution, Vol. 21, 2009 - Issue 1, 27-44

Barrio, M., Loureiro, M. (2013). The impact of protest responses in choice experiments: an application to a Biosphere Reserve Management Program. Forest Systems. 22(1), 94-105.

Bateman, I.J., Carson, R.T., Day, B., Hannemann, M., Hanley, N., Hett, T., Jones-LCE, M., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W., Sugden, R., Swanson, J. (2002). Economic Valuation with Stated Preference Techniques: A Manual. Edward Elgar, Northampton.

Bennett, J., Blamey, R. (2001). The Choice Modelling Approach to Environmental Valuation. Edward Elgar, Cheltenham.

Bernúes, A., Rodríguez-Ortega, T., Ripoll-Bosch, R., Alfnes, F. (2014). Socio-cultural and economic valuation of ecosystem services provided by Mediterranean mountain agroecosystems. PloS one, 9(7), e102479.

Boardman, J., Poesen, J., Evans, R. (2003). Socio-economic factors in soil erosion and conservation. Environmental Science & Policy 6, 1–6. doi:10.1016/S1462-9011(02)00120-X

Boxall, P. C., Adamowicz, W. L., Swait, J., Williams, M., Louviere, J. (1996). A comparison of stated preference methods for environmental valuation. Ecological economics, 18(3), 243-253.

Cinnirella S., Buttafuoco G., Pirronea N. (2005). Stochastic analysis to assess the spatial distribution of groundwater nitrate concentrations in the Po catchment (Italy), Environmental Pollution, Vol. 133, Issue 3, 569-580

Diverfarming consortium. (2019a). Description of diverfarming diversified cropping systems. Deliverable D2.2. Diverfarming project and Consortium. Available at www.diverfarming.eu.

Diverfarming consortium. (2019b). Development of a common integrated research methodology and protocol. Deliverable D8.1. Diverfarming project and Consortium. Available at www.diverfarming.eu.

Dupras, J., Laurent-Lucchetti, J., Revéret, J. P., DaSilva, L. (2018). Using contingent valuation and choice experiment to value the impacts of agri-environmental practices on landscapes aesthetics. Landscape Research, 43(5), 679-695.

Fava, L., Orrù, M.A., Scardala, S., Alonzo, E., Fardella, M., Strumia, C., Martinelli, A., Finocchiaro, S., Previtera, M., Franchi, A., Calà, P., Dovis, M., Bartoli, D., Sartori, G., Broglia, L., Funari, E. (2010). Pesticides and their metabolites in selected Italian groundwater and surface water used for drinking. Ann. Ist. Super Sanità 46, 309–316.

Fisher, B., Turner, R. K., Morling, P. (2009). Defining and classifying ecosystem services for decision making. Ecological economics, 68(3), 643-653.

Hanley, N., MacMillan, D., Wright, R. E., Bullock, C., Simpson, I., Parsisson, D., Crabtree, B. (1998a). Contingent valuation versus choice experiments: estimating the benefits of environmentally sensitive areas in Scotland. Journal of agricultural economics, 49(1), 1-15.

Hanley, N., Wright, R. E., Adamowicz, V. (1998b). Using choice experiments to value the environment. Environmental and resource economics, 11(3-4), 413-428.

Hansen, L. B., Termansen, M., Hasler, B. (2019). The Potential for Nitrogen Abatement Trading in Agriculture: A Hypothetical Market Experiment. Journal of Agricultural Economics.

Heikkinen, J., Ketoja, E., Nuutinen, V., Regina, K. (2013). Declining trend of carbon in Finnish cropland soils in 1974–2009. Global change biology. 19 (5), 1456-1469.

Hole, A.R. (2007). A comparison of approaches to estimating confidence intervals for willingness to pay measures. Health Economics. 16(8), 827-840. https://doi.org/10.1002/hec.1197

Hoyos, D. (2010). The state of art of environmental valuation with discrete choice experiments. Ecological Economics. 69(8), 1595-1603.

INE. (2017). Life Conditions Survey. INEBASE. National Institute of Statistics, Spain. http://www.ine.es (accessed 2 May 2019).

INE. (2018). Municipal Register. Population by municipality. INEBASE. National Institute of Statistics, Spain. http://www.ine.es (accessed 2 May 2019).

INE. (2019). Economically active population survey. INEBASE. National Institute of Statistics, Spain. http://www.ine.es (accessed 2 May 2019).

ISTAT. (2017) “Indagine sulle spese delle famiglie: microdati ad uso pubblico”, https://www.istat.it/it/archivio/180356

ISTAT. (2018) “Indagine sulla struttura e produzione delle aziende agricole - Stima delle superfici e produzioni delle coltivazioni agrarie, floricole e delle piante intere da vaso”, http://siqual.istat.it/SIQual/visualizza.do?id=8888893

Jamil, A., Riaz, S., Ashraf, M., Foolad, M.R. (2011). Gene expression profiling of plants under salt stress. Critical Reviews in Plant Sciences. 30, 435–458. doi:10.1080/07352689.2011.605739

Jourdain, D., Vivithkeyoonvong, S. (2017). Valuation of ecosystem services provided by irrigated rice agriculture in Thailand: a choice experiment considering attribute nonattendance. Agricultural Economics, 48(5), 655-667.

Lancaster, K.J. (1966). A new approach to consumer theory. Journal of Political Economy. 74(2), 132-157.

Luke (2019a). Agriculture and food sector in Finland 2019. Niemi, J. & Väre, M (eds.). Natural resources and bioeconomy studies. 37/2019 (Forthcoming)

Luke. (2019b). Economydoctor. Total Calculation of Agriculture (luke.fi/economydoctor). Data: Luke Profitability bookkeeping results. June 26, 2019

Ministerio de Agricultura, Pesca y Alimentación (MAPA) (2018). La alimentación mes a mes. Septiembre 2018. Recuperado de:

https://www.mapa.gob.es/es/alimentacion/temas/consumo-y-comercializacion-y-distribucion-alimentaria/informemesamesalimentacionseptiembre2018_tcm30-499637.pdf

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior, in: Zarembka, P., (Ed.), Frontiers in Econometrics. Academic Press, New York, pp. 105-142.

Niedermayr, A., Schaller, L., Mariel, P., Kieninger, P., Kantelhardt, J. (2018). Heterogeneous Preferences for Public Goods Provided by Agriculture in a Region of Intensive Agricultural Production: The Case of the Marchfeld. Sustainability, 10(6), 2061.

Novikova, A., Rocchi, L., Vitunskienė, V. (2017). Assessing the benefit of the agroecosystem services: Lithuanian preferences using a latent class approach. Land Use Policy, 68, 277-286.

OFS (2018). E-yearbook of food and natural resource statistics for 2017. Statistical facts on agriculture, forestry, fisheries and hunting in Finland. Official farm statistics of Finland. https://stat.luke.fi/sites/default/files/luke-luobio_20_2018.pdf

OFS (2019a). Utilised agricultural area. Official farm statistics of Finland. https://stat.luke.fi/en/utilised-agricultural-area

OFS (2019b). Milk production by area. Official farm statistics of Finland. https://stat.luke.fi/en/tilasto/152

Peltonen-Sainio, P., et al., (2017). Diversity of high-latitude agricultural landscapes and crop rotations: Increased, decreased or back and forth? Agricultural Systems 154, 25-33

Perego, A., et al., 2012. Nitrate leaching under maize cropping systems in Po Valley (Italy) (2012): Agriculture, Ecosystems & Environment 147, 57-65.

Perego A., Wu L., Gerosa G., Fincoc A., Chiazzese M., Amaduccia S. (2016) Field evaluation combined with modelling analysis to study fertilizer and tillage as factors affecting N2O emissions: A case study in the Po valley (Northern Italy).

Pirinen, P., Simola, H., Aalto, J., Kaukoranta, Juho-Pekka Karlsson, P., Ruuhela, R. (2012). Tilastoja Suomen ilmastosta 1981 - 2010 (Climatological statistics of Finland 1981–2010). Ilmatieteen laitoksen raportteja 2012:1.

Ragkos, A., & Theodoridis, A. (2016). Valuation of environmental and social functions of the multifunctional Cypriot agriculture. Land Use Policy, 54, 593-601.

Rodríguez-Entrena, M., Barreiro-Hurlé, J., Gómez-Limón, J. A., Espinosa-Goded, M., Castro-Rodríguez, J. (2012). Evaluating the demand for carbon sequestration in olive grove soils as a strategy toward mitigating climate change. Journal of environmental management, 112, 368-376.

Rodríguez-Ortega, T., Bernués, A., Alfnes, F. (2016). Psychographic profile affects willingness to pay for ecosystem services provided by Mediterranean high nature value farmland. Ecological Economics, 128, 232-245.

Rose, J. M., Collins, A. T., Bliemer, M. C. J., Hensher, D. A. (2010) Ngene. 1.0.2 ed. Statistical Software. Choice Metrics Pty Ltd.

Sandhu, H. S., Wratten, S. D., Cullen, R., Case, B. (2008). The future of farming: the value of ecosystem services in conventional and organic arable land. An experimental approach. Ecological Economics, 64, 835–848.

Santangeli A., Lehikoinen A., Lindholm T., Herzon I. (2019). Organic animal farms increase farmland bird abundance in the Boreal region. PLoS ONE 14(5): e0216009. https://doi.org/10.1371/journal.pone.0216009

TEEB Synthesis. (2010). Mainstreaming the Economics of Nature: A Synthesis of the Approach Conclusions and Recommendations of TEEB. Earthscan, London, Washington (2010).

Varela, E., Verheyen, K., Valdés, A., Soliño, M., Jacobsen, J. B., De Smedt, P., Decocq, G. (2018). Promoting biodiversity values of small forest patches in agricultural landscapes: Ecological drivers and social demand. Science of the total environment, 619, 1319-1329.