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Compatibility of Agricultural Management Practices and Types of Farming in the EU to enhance Climate Change Mitigation and Soil Health

Farmers review of Best Management Practices: drivers and barriers as seen by adopters and non-adopters

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Executive Summary

During the past decennia, **best management practices (BMPs)** have been developed in order to maintain or restore soil health which is essential to the sustainability and resilience of the farm. Adoption rates of these practices vary among different countries and even among different regions within a country. Adoption rates depend on the specific context of a region or a country, consisting of biophysical, economic, social but also regulatory and institutional conditions. Hence, the objective of this study was to investigate farmers' barriers towards adoption of BMPs across Europe.

To identify drivers and barriers for adopting BMPs, we applied a behavioral approach, based on the **theory of planned behavior**. This approach has been proven successful and offers a repeatable methodology which is very valuable for performing attitudinal research in an wide European context. According to this theory, the greater the intention to behave, the more likely one is to actually perform the behavior. The intention of a farmer to implement a certain BMP is determined by individual beliefs on a set of outcomes (expected effects) associated with the practice, on a set of referents who think the farmer should perform the behavior, and on a set of control factors that might facilitate or obstruct the behavior. All these beliefs influence a farmers' intention to adopt a certain BMP, and are acting as cognitive drivers or barriers which encourage or discourage the farmer to adopt a specific BMP.

This report describes the main drivers and barriers on BMPs perceived by the farmers in 24 Farm Type Zones (FTZ) spread over 8 European countries (Poland, The Netherlands, Spain, Italy, Belgium, France, Austria, Germany). These FTZs are regions within a country and are characterized by land use, farm specialization and by slope, soil texture and climate. The criteria to select FTZs for the study were 1) representation of a large agricultural area, 2) large economic value of the FTZ and/or 3) occurrence of soil degradation problems. The BMPs studied in each FTZ were determined based on expert judgment for their potential contribution to improve soil sustainability in that specific FTZ. About 20 different BMPs were studied across all countries.

To identify the outcomes, referents and control factors for each unique BMP in each of the 24 FTZs, 174 semi-structured interviews were first conducted, with an average of about 8 interviews per FTZ. Based on these lists of control factors, outcomes and referents, a large scale survey was constructed for each FTZ separately to reveal which of these outcomes, referents and control factors are perceived as hampering the adoption of a single BMP by the larger population of farmers. Each FTZ was addressed by a corresponding (tailor-made) questionnaire, reflecting the specific farming conditions of the FTZ. This large-scale survey reached out to several hundreds – in some cases up to 2,000 – farmers per FTZ. In total, about 10,000 farmers were reached. Answers were received from a total 2,520 farmers across all FTZs.

Some of the BMPs were only studied in one or a few FTZs (eg. direct drilling, row application of manure, permanent grazing). For these practices, the main drivers and barriers are summarized per FTZ in this report. Other BMPs were studied across multiple FTZs across countries, such as **non-inversion tillage (NIT)**, **cover crops** and **incorporation of straw**. High differences in adoption rate are seen for these BMPs across the FTZs. Adoption rate of NIT varies from 6% to 86% between these different FTZs. However, between FTZs within a country, this adoption rate seems to differ less. In Germany, Austria and Spain, most of the farmers apply NIT. In the Netherlands, Italy and France, moderate adoption rates are seen, whereas in Belgium and Poland, only a small part of the farmers indicate to apply NIT *on at least one field parcel* (i.e. our definition of adoption). In the Netherlands, adoption rate is remarkably lower on dairy farms than on arable farms. Adoption rates of sowing cover crops

varied from 0% to 100% among the different FTZs in which cover crops were included in the questionnaires. As for NIT, the country seems to be an important factor in explaining variation in adoption rate among different regions. In the Netherlands, Belgium, Austria and Germany, cover crops are implemented by most of the farmers on at least one parcel on their farm. In France, Poland and Spain, adoption rates are moderate or vary a lot among regions in the country. Only in Italy, adoption rate is very low and varies from 1% to 10% of the farmers adopting the practice.

To gain better insight into these differences in adoption rate for NIT, cover crops and incorporation of straw, a comparative analysis of main drivers and barriers across FTZs was established and described in this report.

For each of these practices, some widely recognized drivers and barriers could be identified, which means that they are recognized by farmers in different FTZs across different countries. Some examples might illustrate this.The beneficial effects of straw incorporation and cover crops on soil characteristics have been recognized by all regions. Farmers believe that straw incorporation is a good investment for soil quality in the long-term. The scientifically shown advantages of cover crops on preventing erosion and nitrogen leaching have been widely accepted across the FTZs. However, the beneficial effect of NIT on soil characteristics is less recognised and varies among regions and countries. Although research has proven that NIT is an excellent strategy to reduce soil erosion on-site, only farmers in some regions perceive this really as a benefit of this BMP. These regions are located in Belgium, Germany, Austria and France. Farmers do widely agree that NIT has a beneficial effect on cultivation costs and labour compared to conventional tillage. However, not having the appropriate machinery for NIT application is regarded to be an important barrier. With respect to cover crops, farmers expect an increase of total costs and an increase in labour efforts, labour peaks and modified work organisation. In the Netherlands, it was stressed that especially small farms will perceive this as a problem. Farmers do generally agree that NIT leads to more weeds which might increase the use of herbicides.

With respect to productivity, farmers are convinced that crop yields might improve when sowing cover crops while for NIT, survey results show that in several regions, farmers fear lower yields. However, beliefs with respect to the effect of NIT on crop yields are variable and depend on conditions of NIT. This illustrates that for a good understanding of the main drivers and barriers for adoption, taking into account the very specific context of the FTZ is very important. Soil texture, slope, legislation, the nature of the cultivated crops, etc. play a role in a farmers' decision making on whether or not to implement a specific practice. Farmers in almost all FTZs do believe that an additional dose of nitrogen is needed to digest the straw. This should not be a barrier, as believed by the Polish farmers. However, some farmers in Belgium and the Netherlands do believe that legislation does not allow to provide enough N for straw digestion. In Italy, NIT is perceived as less attractive on clay soils and in Belgium, NIT is considered to be less attractive for vegetable crops and crops with small seeds.

On dairy farms in Belgium and the Netherlands, maize is often preceded by Italian rye grass and farmers prefer to incorporate the grass instead of destroying it with chemicals. They think applying NIT is not compatible with incorporating grass. Moreover, in several regions, the legislation with respect to NIT is perceived as very restrictive. Farmers ask for more flexible norms based on the activities of the farms and the regions. Regulations should allow ploughing in some crops that are unsuitable for NIT, e.g. as horticultural crops or when weather conditions are not optimal, e.g. due to Mediterranean climate (dry long summers but high intensity rainfall events). Also for cover crops, some FTZ related barriers were identified. In Germany, the availability of fields that can be irrigated cost efficiently is a precondition for sowing cover crops because subsequently those fields can be used for maize

production without fear that cover crops have consumed too much of the soil water. In the Netherlands, the length of growing season is sometimes perceived as too short to sow a green manure.

Other less widely accepted barriers are more of a legislatory nature. In the Netherlands, two nitrogen standards exist for green manures: a low standard for legumes with nitrogen fixation and a higher standard for all others. The standards do not always allow a farmer to choose the green manure with the largest biomass, or the one that matches best with the soil fauna of his fields.

These findings are of substantial interest to research, extension services, local and national governmental institutions. These actors - in their efforts to improve the adoption of given practices - should be aware of widely recognised drivers/barriers but also of the context related drivers/barriers. Our results also show a very broad picture of barriers as has been suggested by previous work.

Besides obtaining insight into the general belief structure of the respondents in an FTZ, we investigated also differences between adopters and non-adopters . Some barriers and drivers are shared between both groups, whereas others are only a barrier to the group of non adopters, or are only perceived as a driver by the group of adopters. As an illustration, in Belgium, adopters of NIT seem to have better experience than non-adopters with positive effects on erosion. In Spain, some barriers are believed to be an outcome only for the non adopters since the management practices are not performed properly. It is a challenge to extension services to understand these differences in belief structure and reverse misconceptions that negatively influence a farmers' intention to adopt a specific behaviour. On the other hand, if some outcomes, referents and control factors are hampering both adopters *and* non adopters, there is likely a true need for solutions to overcome such barriers (e.g. further research, trainings, subsidies).

Our results show that adopters, compared to the non adopters, feel more stimulated by their social environment, which indicates the importance of social environment in increasing adoption. Specialized press and advisors are often consulted among all farmers. Also fellow farmers are a source of information and farmers believe their opinion is valuable. Therefore, it might be worthwhile to include adopters when training non adopters in how to deal with specific barriers, or when aiming to reverse misconceptions among non adopters.

1 Introduction

During the past decennia, **best management practices (BMPs)** have been developed in order to maintain or restore soil health which is essential to the sustainability and resilience of the farm. Nevertheless, compared to other regions in the world, the adoption of conservation practices by European farmers is lagging and varies among different countries and even among different regions within a country (Derpsch, 2005; Lahmar, 2010). Adoption rates are dependent on the specific context of a region or a country, consisting of biophysical, economic, social but also regulatory and institutional conditions (Stonehouse, 1995). With respect to European farmers, it has been suggested that they are generally not strongly affected by the consequence of soil degradation and therefore unlikely to adopt some conservation practices compared to other regions in the world (Vandeputte et al., 2010). However, adoption rates also fluctuate in time caused by e.g., some unforeseen problems after uptake of a new management practice or changes in economic conditions (Lahmar, 2010). In this respect, the fundamentally changing EU's common agricultural policy accompanied by an increased social pressure, might increase the adoption of conservation practices in Europe (Vandeputte et al., 2010). Nevertheless, to raise the uptake of conservation practices, we need a better understanding of country and region specific differences in adoption rates of BMPs. Therefore, it is necessary to investigate why farmers refrain from implementing practices that have proven to increase soil quality and sustainability. The overall aim of the CATCH-C project is to identify and improve on-farm compatibility of sustainable soil management practices for farm productivity, climate change (CC)-mitigation and soil quality. Hence, the objective of this study is to investigate farmers' barriers in adopting best management practices (BMPs) across Europe. Attitude and behavior towards new technologies, including soil conservation practices, have been extensively studied in agriculture. While some studies described the distribution of benefits and costs of adopting a management practice, other researchers studied correlations between the adoption of conservation practices and a number of potential independent variables such as age, land tenure, farm size, education level, etc. (Knowler, 2007). However, a meta- analysis to integrate these variables into significant correlations revealed no causal impact of variables such as farm size and land tenure on the adoption of conservation practices (Knowler et al., 2007). Farmers' attitudes towards specific conservation practices have also been investigated in a socio-psychological manner by using a behavioral approach, which refers to studies that employ actor-oriented quantitative methodologies for the investigation of decision making (Burton, 2004, Edwards-Jones, 2006, Wauters et al., 2013). This approach has been proven successful and offers a repeatable methodology which is very valuable for performing attitudinal research in an wide European context and allows us to identify the nature of the barriers in adopting BMPs. Therefore, this study applies a behavioral approach to identify differences in adoption rates and barriers and drivers for adoption of BMPs in a European context.

2 Theoretical framework

To identify drivers and barriers for adopting Best Management Practices (BMPs), we applied a behavioral approach, based on the **theory of planned behavior**, to identify the main barriers and drivers of farmers towards adoption of sustainable management practices. According to the theory of planned behavior, individual beliefs about a behavior or practice

are believed to determine intention and behavior (Ajzen, 1988; Ajzen, 1991). The greater the intention to behave, the more likely one is to actually perform the behavior. The intention of a farmer to implement a certain 'BMP' is determined by the degree to which implementing the BMP is evaluated positively or negatively by the farmer (attitude), the feeling of social pressure from others (called referents) to perform or not perform a certain BMP (subjective norm) and the subjective beliefs about the ease or difficulty of successfully performing the BMP (perceived behavioral control) (Figure 1). According to the theory of planned behavior, attitude is formed by the belief that the behavior will be associated with a set of outcomes (belief strength), weighted by an evaluation of these outcomes (outcome evaluation). The latter is the value given by the farmer to this outcome: e.g. how important it is to him/her to have good soil structure. Subjective norm is thought to be a function of how much we perceive others (called referents) think we should perform the behavior (normative belief), weighted by our motivation to comply with these referents. Finally, perceptions of behavioral control are determined by the belief that a set of control factors facilitate or obstruct the behavior (control beliefs), weighted by the expected impact that these factors would have if they were to be present (perceived power). Combining attitude, subjective norm and perceived behavioral control, results in a positive or negative intention to actually perform the behavior. All these underlying subjective beliefs influence a farmers' intention to adopt a certain BMP, and are acting as cognitive drivers or barriers which encourage or discourage the farmer to adopt a specific BMP.

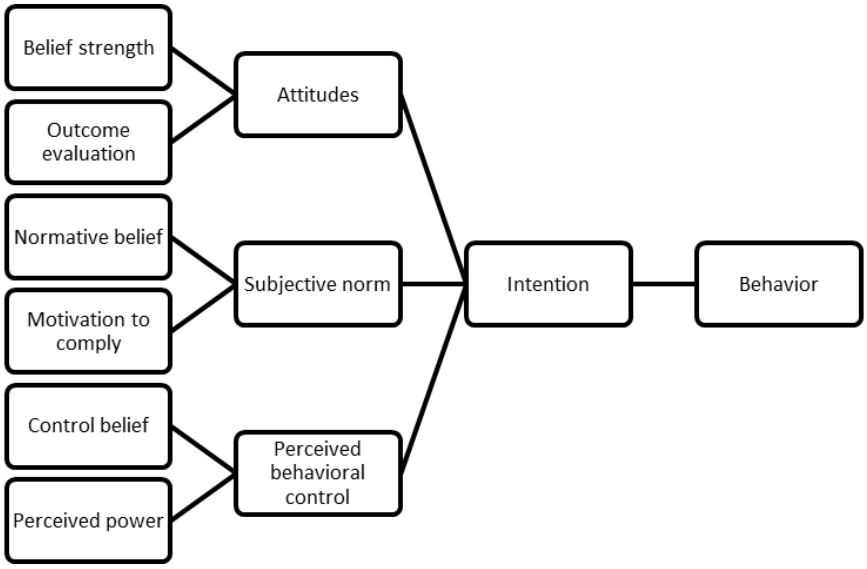


Figure 1: Theory of planned behavior, adapted from Ajzen, 1991

3 Research areas

In this report farmers' views on drivers and barriers to implement BMPs for eight European countries in 24 Farm Type Zones (FTZ) are presented. The FTZs are characterized by land use and farm specialization (EC 1985; Andersen et al., 2007) and by agri-environmental zones, defined by slope, soil texture (JRC soil map) and climate zone (Metzger et al., 2005). The agri-environmental zones as derived by Hijbeek et al., (2013) are shown in Figure 2. The criteria to select FTZs for the farm surveys were 1) representation of a large agricultural area, 2) large economic value of the FTZ and/or 3) occurrence of soil degradation problems. The FTZs selected are presented in Figure 3 and Figure 4. In most agri-environmental zones, one specific farm type was studied, in two agri-environmental zones two different farm types

were studied. The agri-environmental zones with numbers 18 and 19, located in the Netherlands, were combined, giving in total 24 combinations of farm type and agri-environmental zone. Some details of each FTZ can be found in Table 1. More details on the FTZs are given in Hijbeek, Wolf, & ittersum, (2013) and in the country reports on the farm survey.

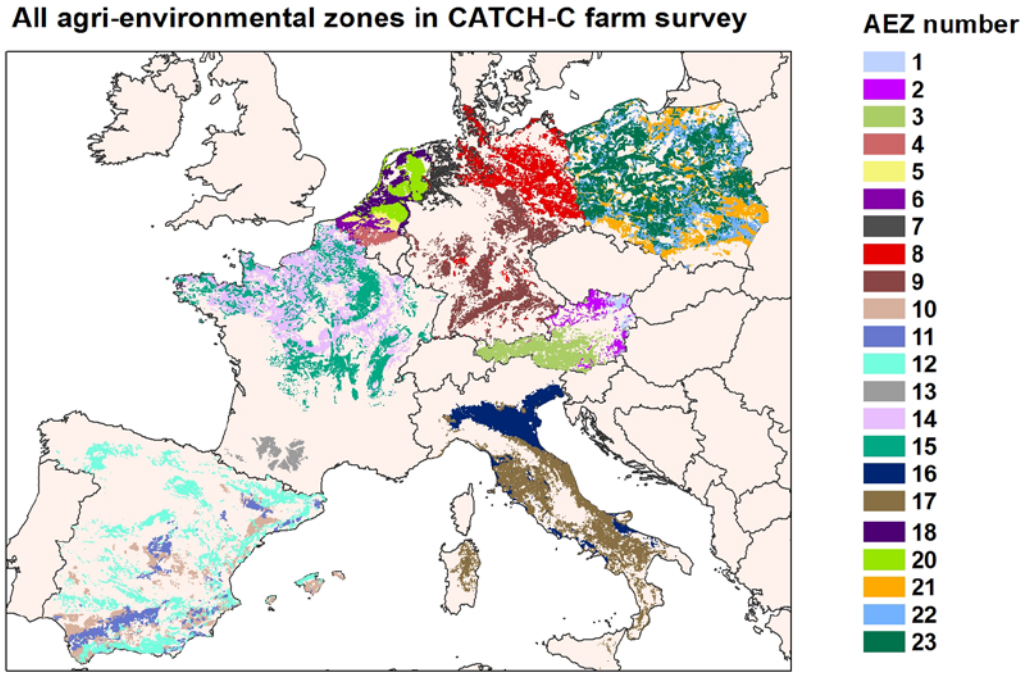


Figure 2: Overview of agri-environmental zones in which farm surveys were held.

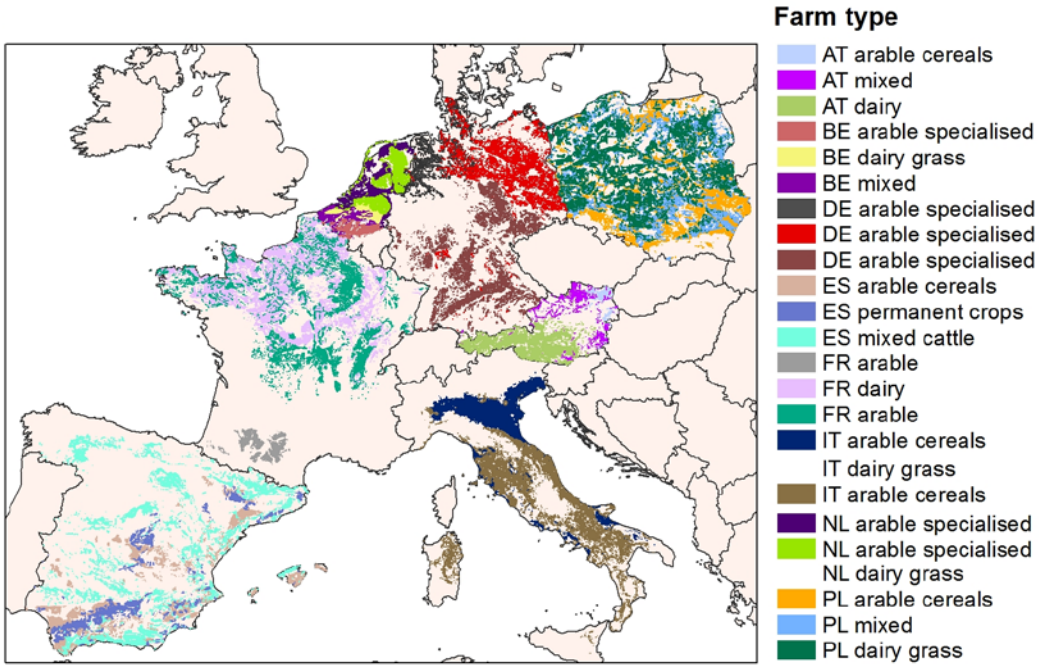


Figure 3: Overview of FTZs, in which farm surveys were held.

Table 1: Specialisation, land use and soil texture of each farm type zone (FTZ)

Country	FTZ ID	Farm specialization	Land use	Soil texture
Austria (AT)	1A	arable	cereals	medium soils
	2M	mixed	all land use types	medium soils
	3C	dairy cattle	all land use types	medium soils
Belgium (BE)	4A	arable	specialised crops	medium fine soils
	6C	dairy cattle	permanent grass	coarse soils
	5M	Mixed	all land use types	medium soils
Germany (DE)	7A	arable+mixed	specialised crops	coarse soils
	8A	arable+mixed	specialised crops	coarse soils
	9A	arable+mixed	specialised crops	medium fine soils
Spain (ES)	10A	Arable	cereals	fine soils
	11P	permanent crops	permanent crops	medium fine soils
	12C	beef and mixed cattle + sheeps and goats		medium soils
France (FR)	13A	arable	all land use types	fine soils
	14C	dairy cattle	all land use types	medium fine soils
	15A	arable	all land use types	medium soils

Italy (IT)	16A	arable	cereals	coarse to medium fine soils
	16C	dairy cattle	temporary grass	coarse to medium fine soils
	17A	arable	cereals	medium and medium fine soils
The Netherlands (NL)	18A	arable	specialised crops and cereals	medium and medium fine soils
	20A	arable	specialised crops	coarse soils
	20C	dairy cattle	permanent grass	coarse soils
Poland (PL)	21A	arable	cereals	medium fine soils
	22M	mixed	all land use types	coarse soils
	23C	dairy cattle	permanent grass	coarse soils

4 Best Management Practices

The BMPs studied in each FTZ (Table 2) were determined based on expert judgment for their potential contribution to improve soil sustainability in that specific FTZ.

Table 2: Number of FTZs in which each BMP was selected in the participating countries. The last column presents the overall number of FTZs in which the BMP was included in the study (DE: German, AT: Austria, PL: Poland, ES: Spain, FR: France, BE: Belgium, IT: Italy, NL: the Netherlands).

BMP	DE	AT	PL	ES	FR	BE	IT	NL	Total
Rotation									
Crop rotation	2			1		2	1	1	**7**
Legume crops		2				1	2		**5**
Land exchange						1			**1**
Cover crops	3	2	3	1	3	3	3	3	**21**
Early harvest of maize to enable cover crops								1	**1**
Permanent grazing/rotational grazing		1							**1**
Tillage									
Non inversion tillage/minimum tillage/light tillage	2	1	3	2	3	3	2	3	**19**
No tillage					3		2		**5**
Direct drilling				1					**1**
Controlled traffic farming	1			1				1	**3**
Reduced soil compaction	1								**1**
Nutrient management									
Soil analysis/nutrient management plan		3	2				1		**6**
Organic fertilizer		1					2		**3**
Application of farm yard manure						2			**2**
Application of compost						2		1	**3**
Use of digestate								2	**2**

Spring application of manure					1	**1**
Row application of manure in maize					1	**1**
Residue management						
Straw incorporation	3		1	3	2	**9**
Other						
Pastoral plan		1				**1**
Sprinkler and drip irrigation				2		**2**

5 Methodology

We applied a sequential mixed method, by combining qualitative and quantitative research techniques at different stages in time. In this study, the predominant quantitative data collection was preceded by a preparative qualitative step. After the major quantitative data collection, focus groups were applied as a last qualitative step.

First, semi-structured interviews were conducted to identify behavioral outcomes, normative referents and control factors for each unique BMP in each of the 24 FTZs (see section 3 and 4). The sample of 174 farmers for this qualitative data-collection stage was obtained through extension agents that were asked to select farmers contacts randomly (Table 3). The farmers were given a description of the BMP, which was followed by questions to elicit a list of behavioral outcomes, normative referents and control factors for each BMP. In order to attain a list of universally accessible outcomes, referents and control factors, the number an outcome, referent or control factor was mentioned, should be taken into account. Although a total of 174 semi-structured interviews were conducted during this study, the spread over 24 farm type zones across 8 European countries resulted in an average of about 8 interviews per farm type zone. Since this number of semi-structured interviews is rather low for each farm type zone, each outcome, referent and control factor was evaluated on its universal accessibility across a specific farm type, even if it was mentioned only once.

Table 3: number of semi structured interviews conducted in each of the participating countries

Country	N° of semi structured interviews
Germany (DE)	18
Poland (PL)	14
Austria (AT)	24
The Netherlands (NL)	20
Belgium (BE)	24
Spain (ES)	35
Italy (IT)	24
France (FR)	15

The second stage of the mixed method approach encompassed a large scale survey (on-line or paper questionnaire) based on the final lists of control factors, outcomes and referents of each BMP which resulted from the first qualitative stage. As these lists were constructed for each FTZ separately, each FTZ obtained an unique questionnaire, reflecting its specific farming conditions. The sampling for this step depended on the availability of a valid sampling frame, i.e., contact details of farmers, in each participating country. The availability of general databases of farmers' addresses allowed random sampling. However, due to privacy concerns, in some countries access to general databases was not possible. In these countries, researchers had to depend on farmers' associations, farmers' extension services or other contacts to distribute the questionnaire. In some countries, questionnaires were distributed online while other countries sent them by post (Table 4). These decisions were based on availability of time, the availability of email addresses and the expected response rate in the country.

The large scale survey (on-line or paper questionnaire) had two distinctive parts. The first part encompassed questions related to general farm characteristics and to soil management. For example, farmers were asked how they perceived soil quality on their farm and how they

perceived the evolution of soil quality. Furthermore, it was asked what dissemination channels were used most to gain knowledge on sustainable soil management. The second part concerned the accessible outcomes, referents and control factors. For each of these outcomes, referents and control factors, two questions were asked. For each outcome, its likelihood (belief strength) was checked: "What is the likelihood that compost improves soil fertility?" (scale from 1: very unlikely, until 5: very likely). In addition, for each outcome (improved soil fertility) the degree to which it was positively or negatively evaluated by the farmer was assessed (scale from -2: very bad , until +2:very good) (outcome evaluation). For each referent, the farmer was asked to which degree the referent was positive or negative towards a practice: "Literature is positive towards compost application?" (scale from -2: strongly disagree, until +2: strongly agree) (normative belief). Besides, the farmer was asked to which degree he values the judgment of the referent (scale from 1: extremely unimportant, until 5: extremely important) (motivation to comply). For each control factor, farmers were asked to which degree it makes BMP application attractive/difficult (scale from -2: unattractive/difficult to +2: attractive/easy) (control power). Additionally, it was asked to which degree that control factor is valid on the own farm (scale from 1: not true, until 5: true) (control belief). "Is the appropriate machinery available on your farm?

General data analysis of the questionnaire was based on descriptive statistics to reveal means, median and frequencies of the prevalence of the belief structure of the outcomes, referents and control factors. Attitude (*A*) was indirectly measured by combining the farmers' belief on the likelihood of occurrence (*b*) of an outcome *i* and by his evaluation of these outcomes (*e*) in the following manner:

$$\mathrm{A} = \sum_{i=0}^{n} b_i e_i$$

In which *n*= the total number of outcomes that were involved in the questionnaire. In a similar way, subjective norms (*SN*) and perceived behavioral control (*PCB*) were determined as follows (Ajzen, 1988, 1991):

$$\mathrm{SN} = \sum_{i=0}^{n} n_i m_i$$

$$\mathrm{PCB} = \sum_{i=0}^{n} p_i c_i$$

In which *n*= the farmers' opinion about what referent *i* wants him to do; *m*= the farmers' motivation to comply with referent *i*; *p*= the perceived ability of control factor i to facilitate a particular behavior; and *c*= the respondents' perception of whether control factor *i* is absent or present.

Barriers toward a particular behavior have been found to correlate significantly with the stated intention to perform the behavior (Garforth et al., 2006). Other studies stated differences in belief structure between adopters versus non adopters (Wauters et al., 2013). In this study, in order to identify differences in belief structure between adopters and non-adopters and between farmers with a positive versus negative intention, independent samples t-tests were performed. Adopters and non-adopters were identified by measuring behavior as a simple dummy variable, being 1 if the farmer applied the BMP on at least one parcel of his farm. Intention was measured using a latent-variable measurement scale consisting of three items. Each item took the form of a statement, to which the farmers indicated their degree of agreement on a scale from 1 to 5. Internal consistency of the scale was measured by Cronbach's alpha (cut-off value of 0.7). High intenders were defined as those with an

intention score higher than 3, and negative intenders were those with an intention score below 3.

As a final qualitative step, focus groups were conducted in each FTZ to elaborate on possible solutions towards the barriers on one or more BMPs, including non-inversion tillage. The target group for the focus groups included farmers, representatives of farmers' organizations and extension workers (farm advisors). In the first part, the project was introduced and the key findings on the questionnaire results were presented. Surprising findings and preliminary hypotheses resulting from the questionnaire were discussed afterwards. In the second part of the focus groups, possible solutions were discussed and ranked based on their likelihood to increase the adoption of the BMP and on the likelihood of success (how realistic are the solutions). Most important findings are included in the summarizing tables of the main barriers and drivers per BMP in a particular FTZ.

Table 4: Number of farmers reached and response rate of the questionnaires sent either online or by post in each of the participating countries. FTZ= farm type zone

Country	FTZ	Distribution of the questionnaires	Number of farmers reached	Response rate
Austria (AT)	1A (Austria -arable/cereals)	Due to a lack of human resources and of own general database of farmer addresses, private and federal advisors of the Austrian chamber of agriculture / FTZ were asked to support the distribution of the questionnaires. For an easier access to the questionnaires, better perception and participation of the farmers an own link (http://www.ages.at/ages/landwirtschaftliche-sachgebiete/boden/forschung/projekt-catch-c/) on the AGES website was prepared. The objective of the link was to give better information about the aims of the survey, updated results of the Catch-C project and its publications in farmer journals. The questionnaire was online for 3 months. Furthermore, the responsible project partners sent the link to farmers they were in contact with during our work in Catch-C and asked agricultural higher schools in Austria to forward the questionnaire to their students.		35 responses
	2M (Austria-mixed)			12 responses
	3C (Austria - dairy cattle)			6 responses
Belgium (BE)	4A (Belgium - arable/specialised crops)	The availability of general databases of farmers' addresses allowed random sampling. Questionnaires were sent by post	1600 (2*800: questionnaire was split up in 2 to reduce length of the questionnaire)	27%
	5C (Belgium - dairy cattle/permanent grass)		798	28%
	6M (Belgium - mixed)		1422 (2*711: questionnaire	24%

			was split up in 2 to reduce length of the questionnaire)	
Germany (DE)	7A (Germany - arable+mixed/specialised crops) 8A (Germany - arable+mixed/specialised crops) 9A (Germany - arable+mixed/specialised crops)	Questionnaires were distributed by post and emails with links to an online questionnaire were sent. The availability of farmers' addresses differed between regions. For 7A (Germany - arable+mixed/specialised crops) email addresses within Lower Saxony were available from the chamber of agriculture. In 9A (Germany - arable+mixed/specialised crops) email addresses from the federal agricultural institution of Thuringia were obtained. Their database was very limited though. In 8A (Germany - arable+mixed/specialised crops) it was impossible to get addresses from federal institutions. Thus, the outreach for all FTZs was expanded by using the database for training farms and sent the questionnaires by post. In addition, students at UGOE were asked to answer the questionnaire for their farms. This way, more farmers and a higher response rate could be reached. However, samples may be biased.	763 671 1371	20.84% 14.31% 13.49%
Spain (ES)	10A (Spain - arable/cereals) 11P (Spain - permanent crops) 12C (Spain - beef and mixed cattle)	Questionnaires (unnumbered) were distributed though different ways: - Training courses for farmers of diverse topics such as, organic farming, use of pesticides, conservation agriculture, integrated production or soil conservation - Technicians of Groups of Integrated Management in Agriculture - Distribution lists of emails provided by farmers' associations		109 questionnaires returned 158 questionnaires returned 107 questionnaires returned

		- To acquaintances, personally. These different ways enhanced the range of different farmers' profiles.		
France (FR)	13A (France - arable) 14C (France - dairy cattle) 15A (France - arable)	To facilitate comparisons between zones, the same questionnaire was used for the three FTZs. In each FTZ, farmers have been selected randomly out of two main sources, the national database for CAP subsidies (French ministry of agriculture, the database is public), and phone database. The farmers in each of the three zones have received a regular mail (1200 paper letters sent) in July 2013, announcing the beginning of the survey on internet, plus advertising on the French website dedicated to the project (http://catch-c.irstea.fr/). Because of low answer rate to this first phase of the survey, the survey was completed by phone calls, with a response rate around 5%, from mid-November to mid-December 2013	1200	5%
Italy (IT)	16A (Italy - arable/cereals)	Through advisors	A number of advisors were contacted who promised to contact 211 farmers.	124 filled questionnaires
	16C (Italy - dairy cattle/temporary grass)		the questionnaires were sent to various advisors	92 filled questionnaires
	17A (Italy - arable/cereals)		A number of advisors were contacted who promised to contact 165	98 filled questoinnaires

			farmers.	
the Netherlands (NL)	18A (The Netherlands - arable/specialised crops and cereals)	The availability of general databases of farmers' addresses allowed random sampling. Farmers were invited by post and received a personal log-in code to fill in an online questionnaire. Farmers who did not have internet access could request a paper copy of the questionnaire.	2700, 900 for each BMP as they were split into three groups	11.7%
	20A (The Netherlands - arable/specialised crops)		2000, 670 for each BMP as they were split into three groups	8.3%
	20C (The Netherlands - dairy cattle/permanent grass)		2000, 1000 for each BMP as they were split in two groups	8.9%
Poland (PL)	21A (Poland - arable/cereals)	As there were no databases of farmers' addresses available, 5 regional Extension Advisory Services located in the chosen FTZ were contacted. Each regional Extension Advisory Services received the list of participating districts and printed questionnaires. Advisors from Extension Services contacted farmers in their regions in order to fill in the forms.	150	62.5%
	22M (Poland - mixed) (Austria-mixed)		150	45.3%
	23C (Poland - dairy cattle/permanent grass)		150	93.3%

6 Results

6.1 Farmers' perceptions on soil quality

In the farm survey, a number of questions were asked on how farmers would assess the quality of their own soils. These questions were divided into: i) general soil quality; ii) change in soil fertility; iii) soil erosion; iv) soil compaction; v) shortage of soil organic matter and vi) soil diseases. Scale of questions was 1 to 5. 1 and 5 were considered to be extremes (very good or very bad) and 3 neither bad nor good.

6.1.1 Arable farmers on their soil quality

Arable farmers are quite satisfied with the general quality of their soil. Figure 4 shows a large majority of arable farmers scoring the quality of their soil 4 or 5 (on a scale of 5). When asked about the change of their soil fertility, farmers have more mixed opinions, with a bit less than half seeing a positive change on their lands in the last years (rating 4 or 5). When asked for specific soil degradation problems, around 15% of arable farmers indicate to have soil erosion problems (numbers 4 and 5 on a scale of 1 to 5) and slightly more than 15% of arable farmers indicate to have soil compaction problems (Figure 5). Farmers have a diverse set of opinions on the soil organic matter contents of their fields with equal amounts being satisfied as dissatisfied. Most farmers indicate to have no problems with soil diseases (Figure 6).

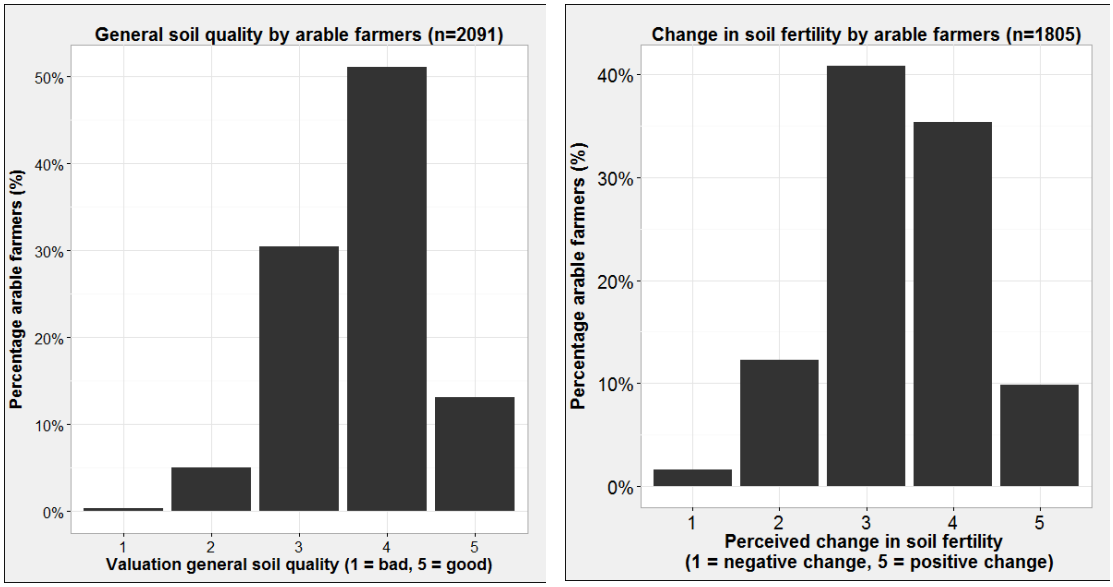


Figure 4: General soil quality and change in soil fertility perceived by arable farmers in the survey

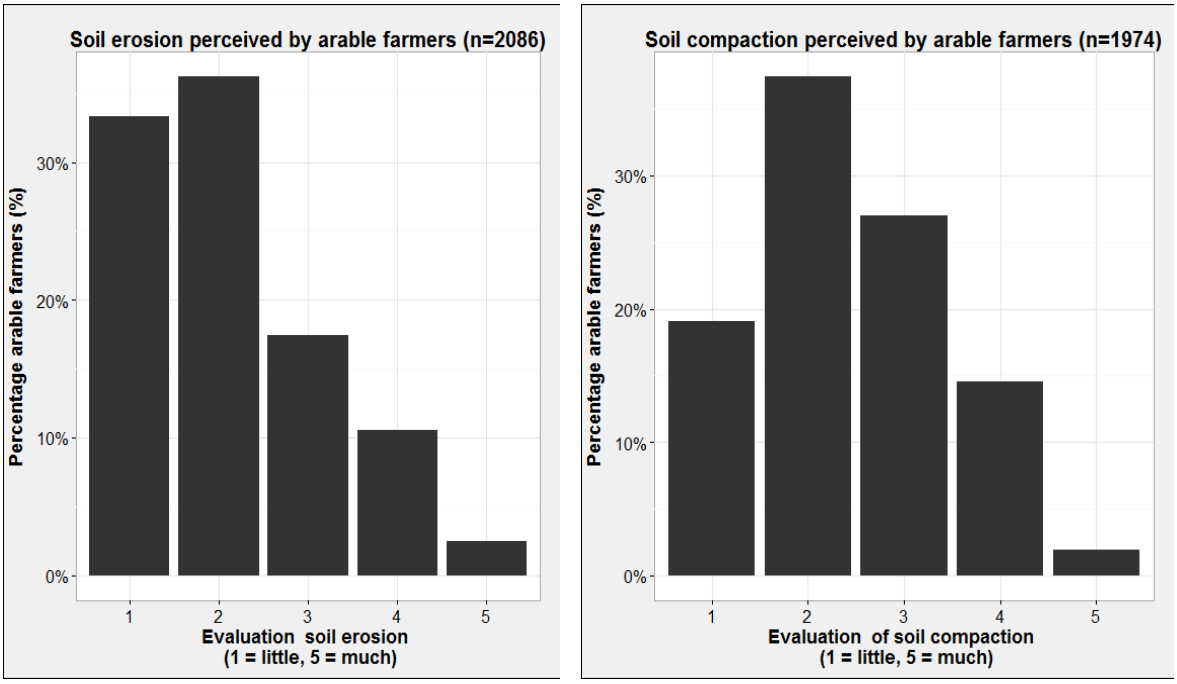


Figure 5: Soil erosion and soil compaction perceived by arable farmers

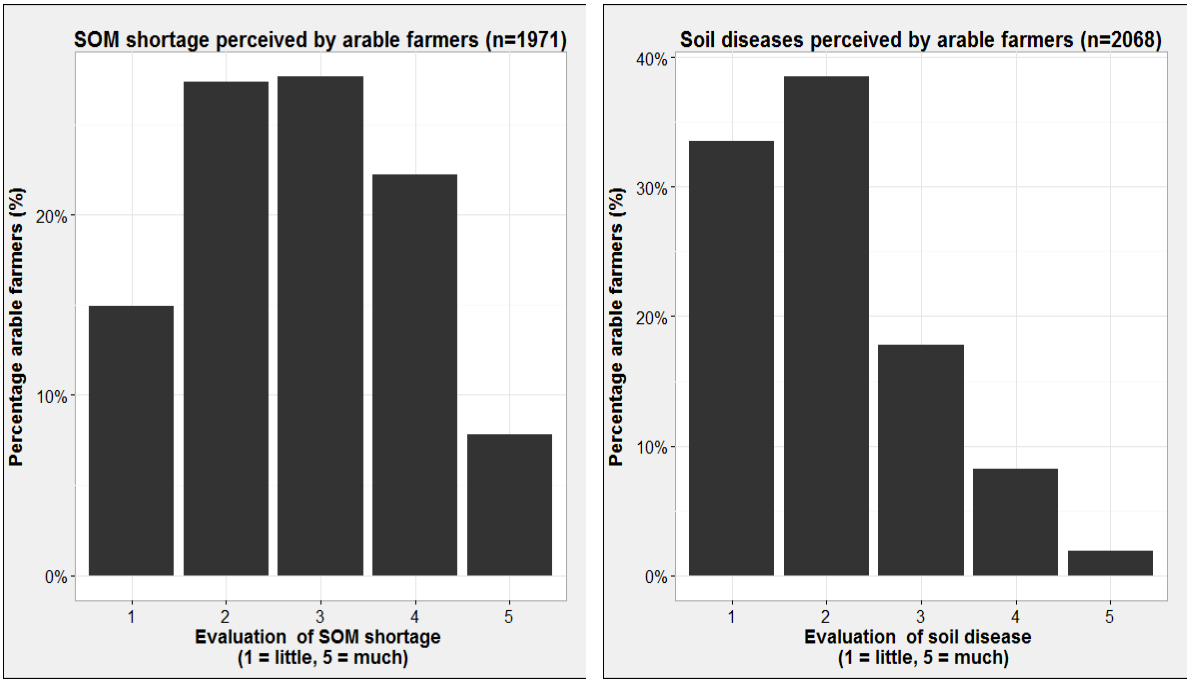


Figure 6: Shortage of SOM and soil diseases as perceived by arable farmers

6.1.2 Livestock farmers on their soil quality

Farmers who raise livestock or have a mix of livestock and crops seem to have a very positive view on the quality of their soils. When asked about the change in soil fertility a large percentage of livestock farmers gives a value 3, which means they either do not know or they do not see any change for good or bad. Slightly more livestock farmers see a negative trend compared to those who see a positive change in the fertility of their soils (Figure 7).

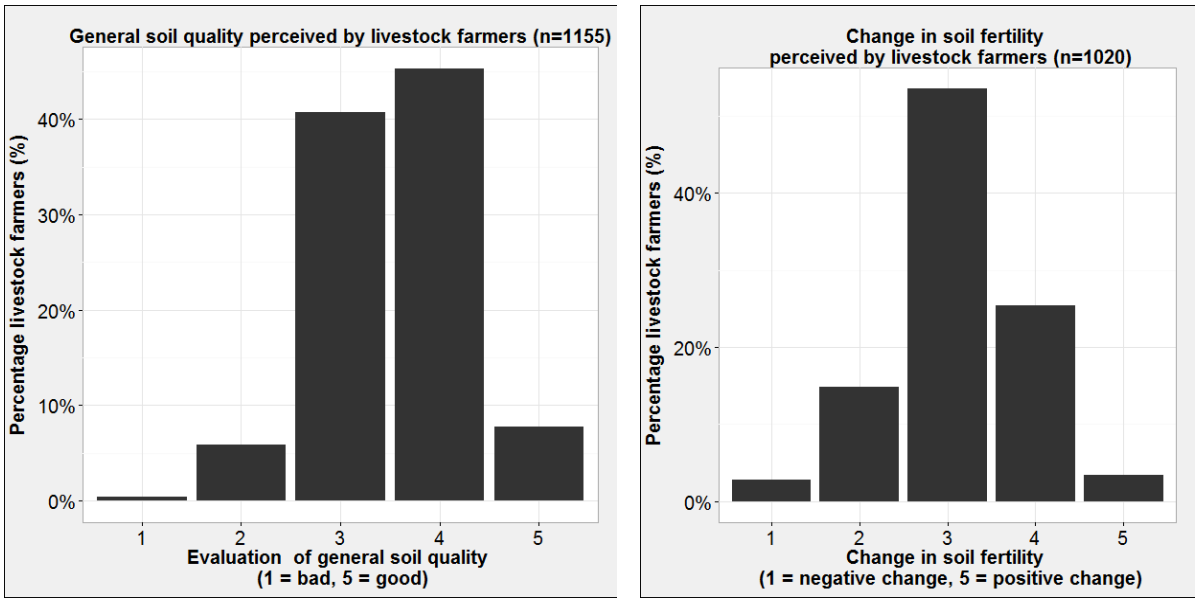


Figure 7: General soil quality and change in soil fertility as perceived by livestock farmers

Asked for more specific soil degradation problems, a bit less than 15% of livestock farmers indicated to have soil erosion problems (numbers 4 and 5 on a scale to 5) and slightly more than 15% of livestock farmers indicated to have soil compaction problems (Figure 8Figure 7)

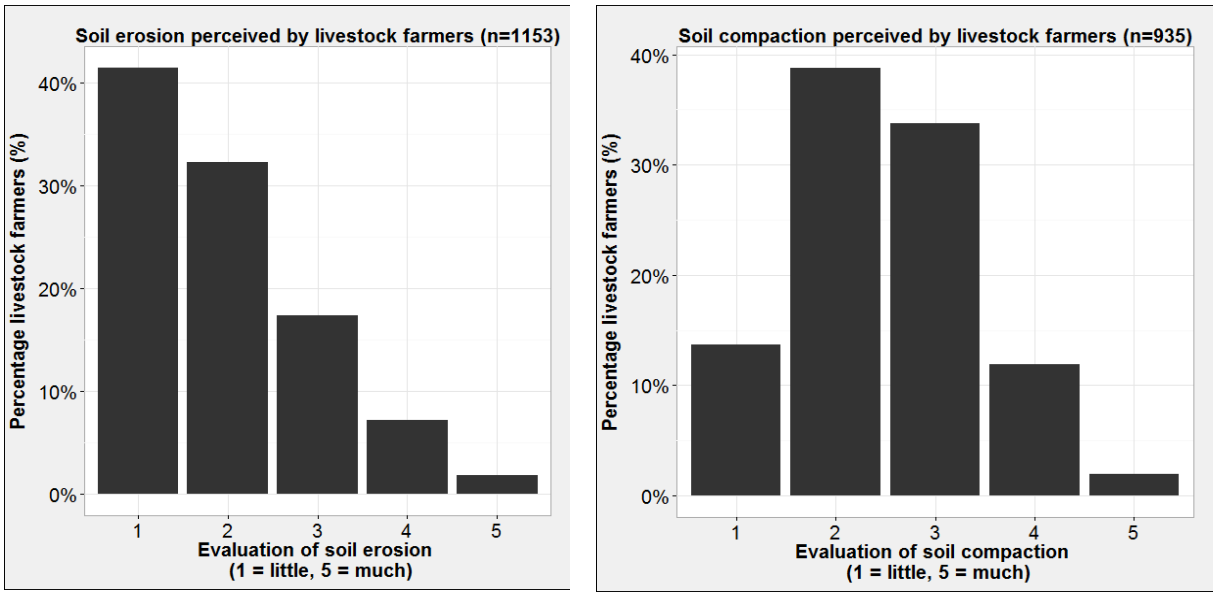


Figure 8: Soil erosion and soil compaction as perceived by livestock farmers

Farmers seem to vary widely in the valuation of their soil organic matter content with equal amounts being satisfied as dissatisfied. More or less 10% of livestock farmers indicated to have soil diseases, with the majority having none (Figure 9).

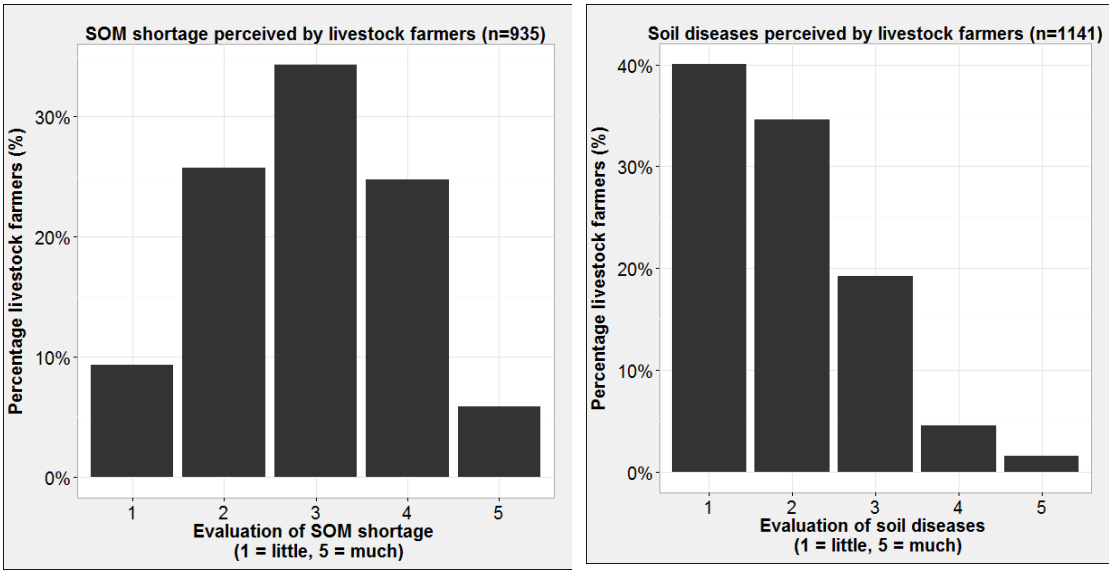


Figure 9: Shortage of SOM and soil diseases as perceived by livestock farmers

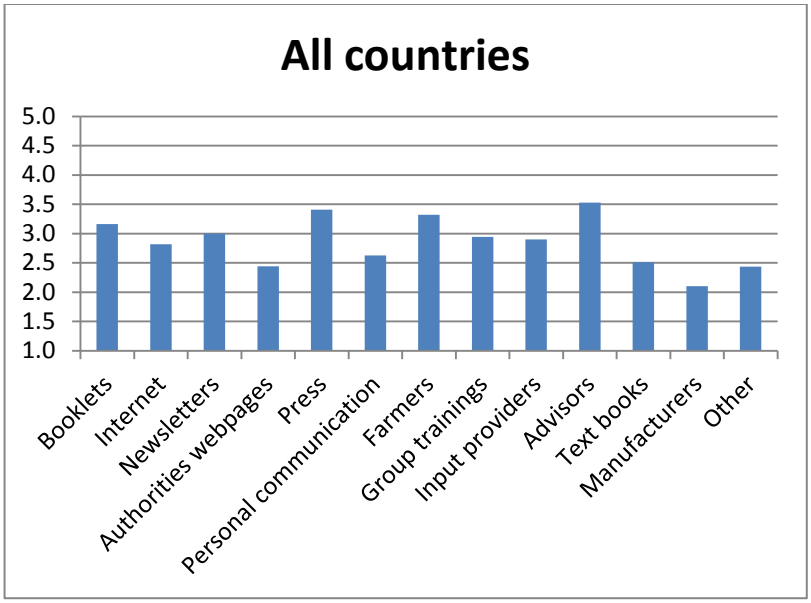
Overall both arable and livestock farmers seem to be quite positive when asked about the quality of their soils. A subset of farmers has severe problems though either with soil compaction, soil erosion, soil diseases or a shortage of soil organic matter. Combined, these might form a large part of the farmers' population.

6.2 Dissemination channels used by farmers

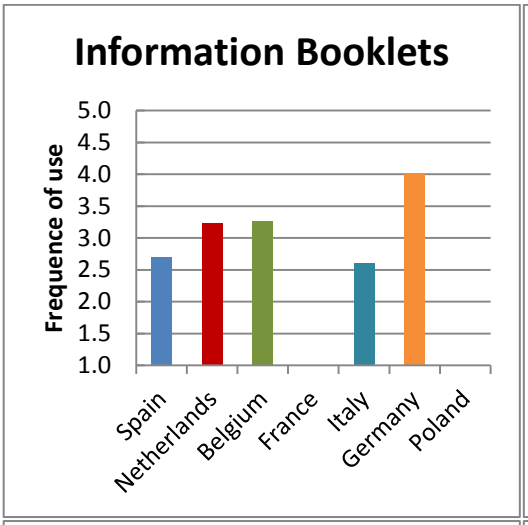
In order to target and address farmers by Catch-C dissemination activities a short question on information channels used by them during the past 12 months was included into the overall farm survey. Respondents were proposed a list of information channels and were asked to tick how frequently they used each channel to increase their knowledge on farming during the last 12 months, answers ranging from 1 – never to 5 – very often.

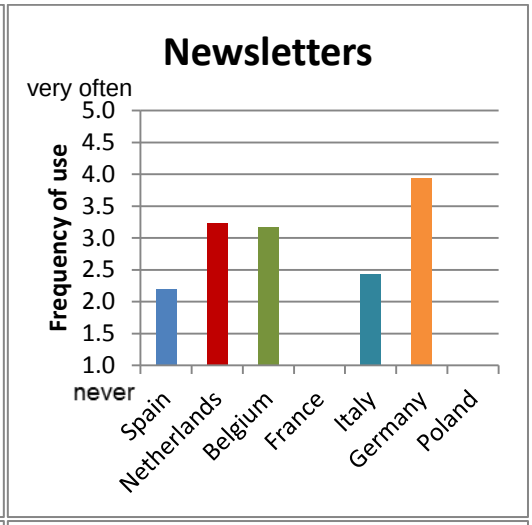
The following section presents a comparison first across countries and second across the FTZs within each country respectively.

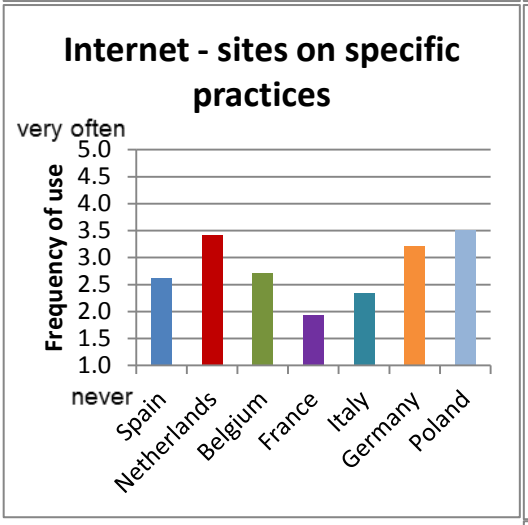
The replies of the farmers regarding the indicated information channels range between 2.3 and 3.5, averaged over all countries, on a scale of 1 to 5. Most frequently consulted sources (mean score >3) according to all respondents are agricultural advisors, specialized press, other farmers and information booklets.

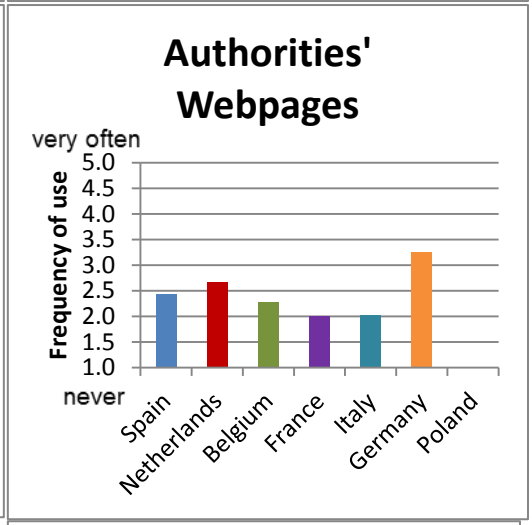


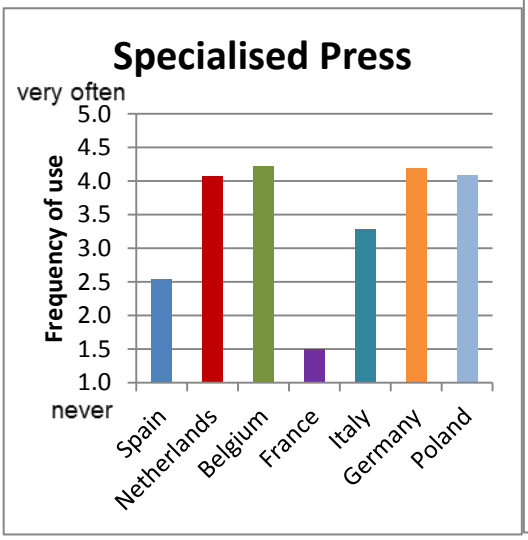
Information Booklets and Newsletters are utilized to high degree by German farmers (mean values = 4.0; 3.9), whereas these sources are of rather average relevance for other countries. Internet sites on specific practices are generally valuated in the middle range with highest mean points among Polish (3.5) and Dutch farmers (3.4) and lowest mean points among French respondents (1.9). In contrast, authorities' webpages are utilized less than other internet sites in nearly all countries. Only German users seem to regard this source as a more relevant one (3.2). Specialized press is on average the most consulted sources for agricultural information among all farmers. However within the category there are vast differences between countries. While Dutch, Belgian and German farmers regard this as the most important information channel and also in Italy and Poland high values were given, for French farmers this source is the least relevant category; they rely most on advisors. Personal contact with public authorities (administration) and research centers is valued above-average only for German farmers. On the contrary personal contact with fellow farmers is of superior importance for all countries with mean values between 3.3 and 3.8, except for France (2.5). Similarly in all countries, except Spain, respondents frequently use advisors as a source of information. In Poland the latter represents even the most important source of information (4.3). The use of agricultural textbooks is indicated at the lower range (<3), except in Germany (3.2). Group trainings are valued slightly higher. In Belgium, Germany and Poland even a frequent use is stated (3.1-3.7).

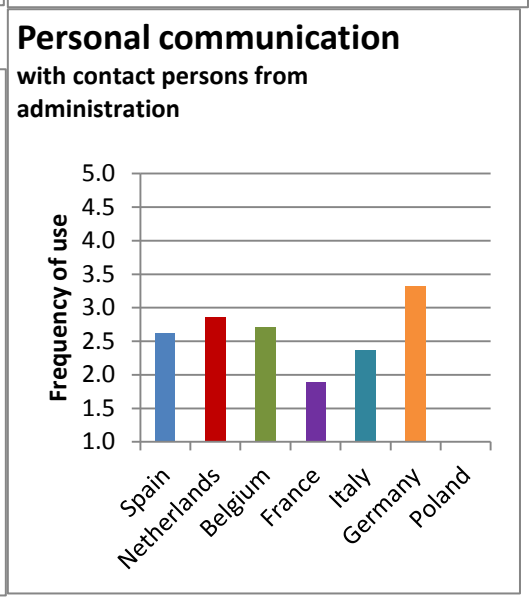

Information Booklets
Frequence of use
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
Spain
Netherlands
Belgium
France
Italy
Germany
Poland

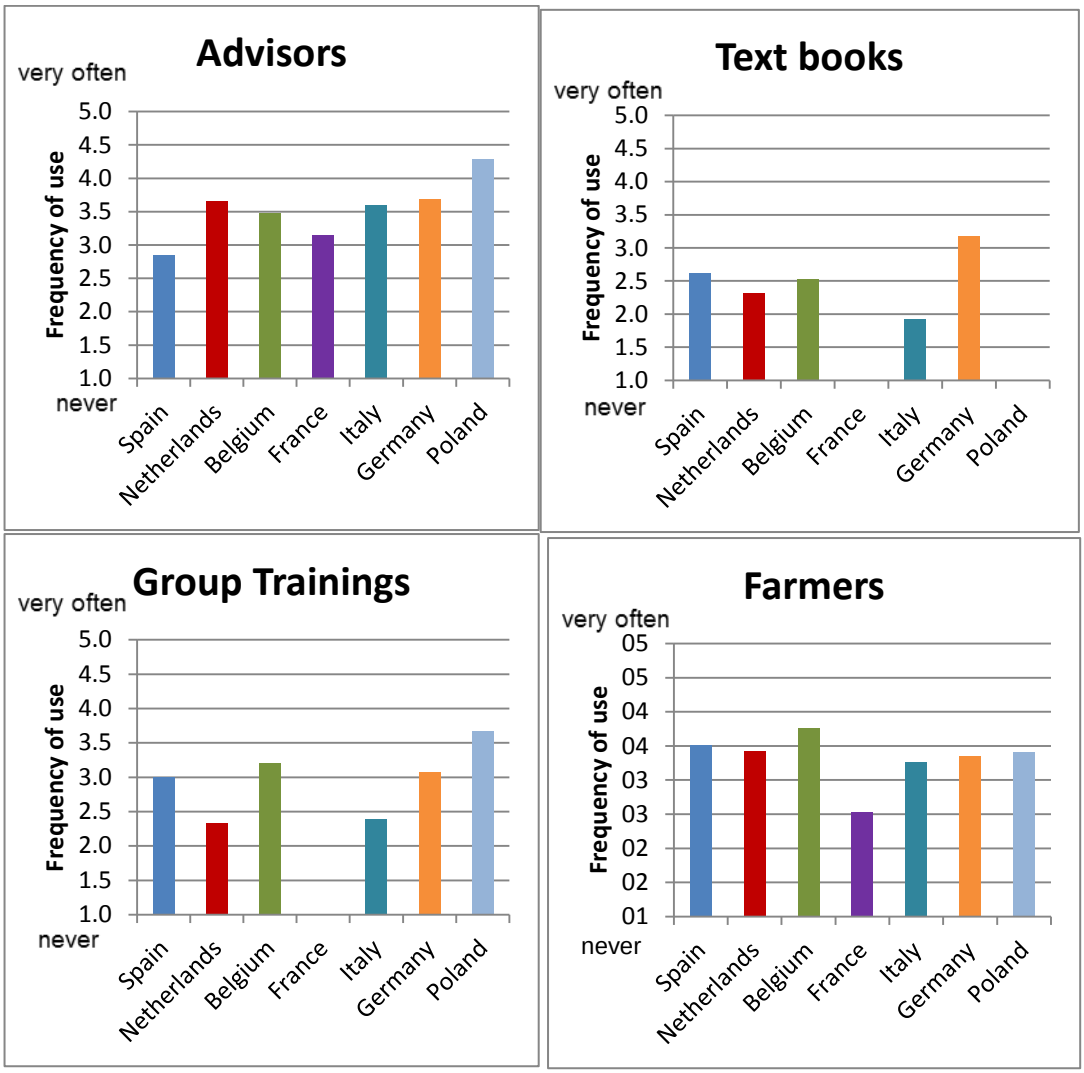

Newsletters
very often
Frequency of use
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
never
Spain
Netherlands
Belgium
France
Italy
Germany
Poland


Internet - sites on specific practices
very often
Frequency of use
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
never
Spain
Netherlands
Belgium
France
Italy
Germany
Poland

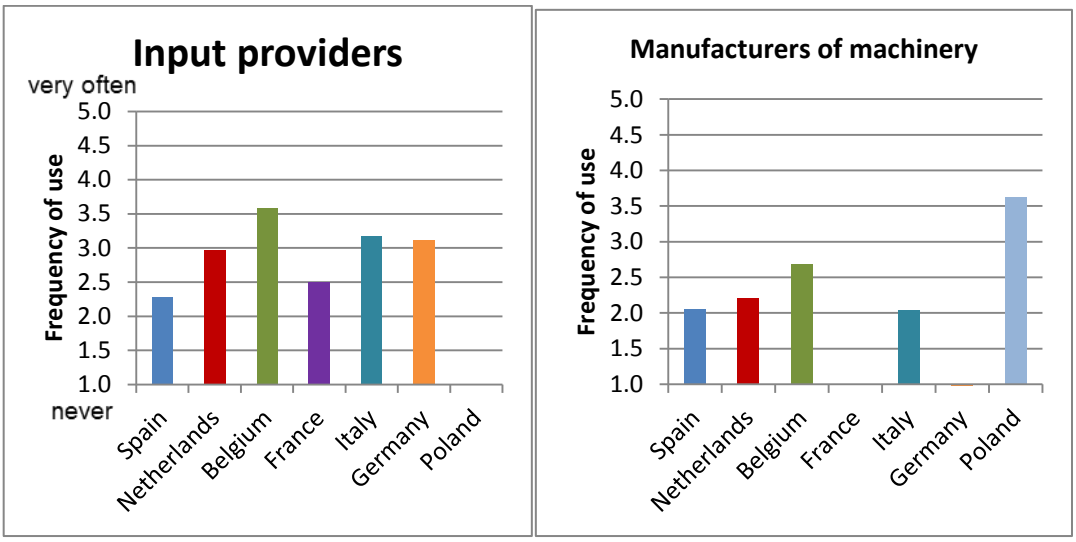

Authorities' Webpages
very often
Frequency of use
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
never
Spain
Netherlands
Belgium
France
Italy
Germany
Poland


Specialised Press
very often
Frequency of use
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
never
Spain
Netherlands
Belgium
France
Italy
Germany
Poland


Personal communication
with contact persons from administration
Frequency of use
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
Spain
Netherlands
Belgium
France
Italy
Germany
Poland

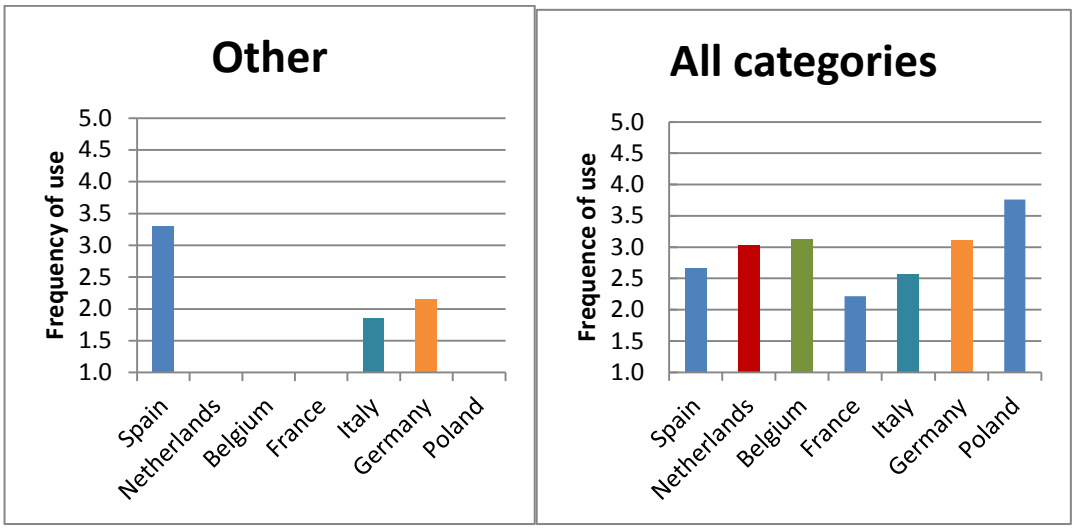


Information of different partners of the value chain is generally of lower importance. The most consulted source within these categories is the advertising by input providers which is of even above-average relevance for Belgium (3.6) and Italy (3.2). Information of manufacturers of agricultural machinery is utilized to a minor degree. Exceptions in this context are Polish farmers who indicate manufacturers as frequently used source of information (3.1).



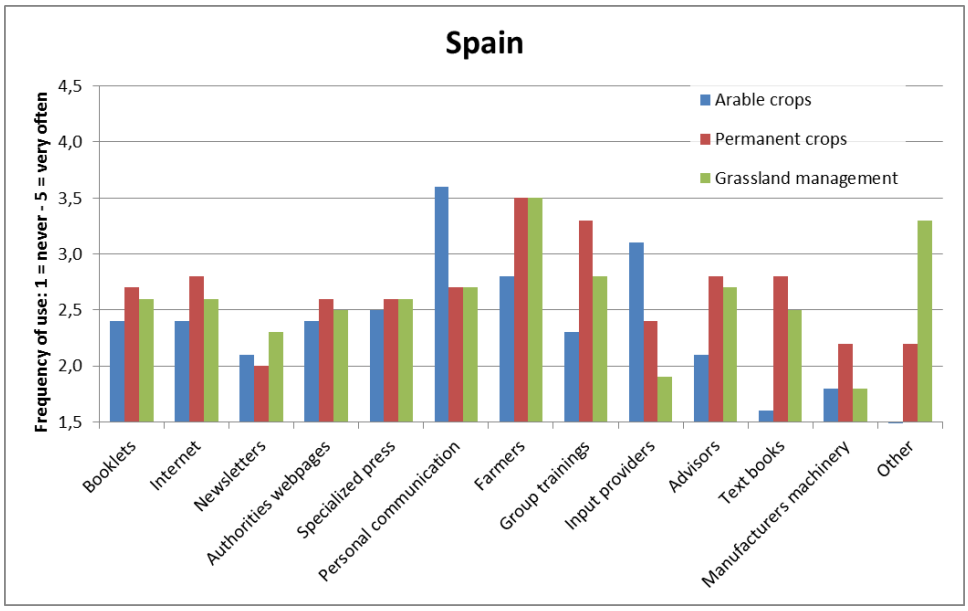
The average points given per countries exhibit a slight North-South divide. Replies of Polish and German farmers indicate on average a more frequent use of information channels in general, whereas the South-European respondents of France, Italy and Spain indicate in general lower frequencies of use. Possible reasons for these differences might be an actual lower use of the included choice of sources. In Spain for example “other sources” were indicated as most used information channel. However it has to be considered that only a small amount of farmers assigned a value to this category. Many countries excluded this category from the questionnaire which makes a clear statement on this issue difficult. Cultural differences or similar might also explain the difference in frequency of use of the investigated information channels.

In general, results show that web-based information channels are not (yet?) the most frequent used information channels, and that farmers rely a lot on print media like specialized press and information booklets. This can be interpreted in two ways: either the web-based media are currently not organized/presented in an appealing way (maybe especially authorities webpages, because they are so rarely used). Then we can propose to improve the appearance and information content of those information channels. OR the results can also be interpreted by saying that obviously farmer prefer print media and that advisory services and policy should focus on those media and spread information through this channel if they want to reach a high number of farmers. Maybe in the end it is a combination of both: on the short run print media can be used for widespread of information and on the long run web-based media should be improved and fully used to their potential. However, in general, no information channel currently is more important than the spoken word (exchange with fellow farmers and advisors). This indicates that policy should strengthen the advisory system and take care that there is an independent extension service available for all farmers.



Information channels comparison within countries

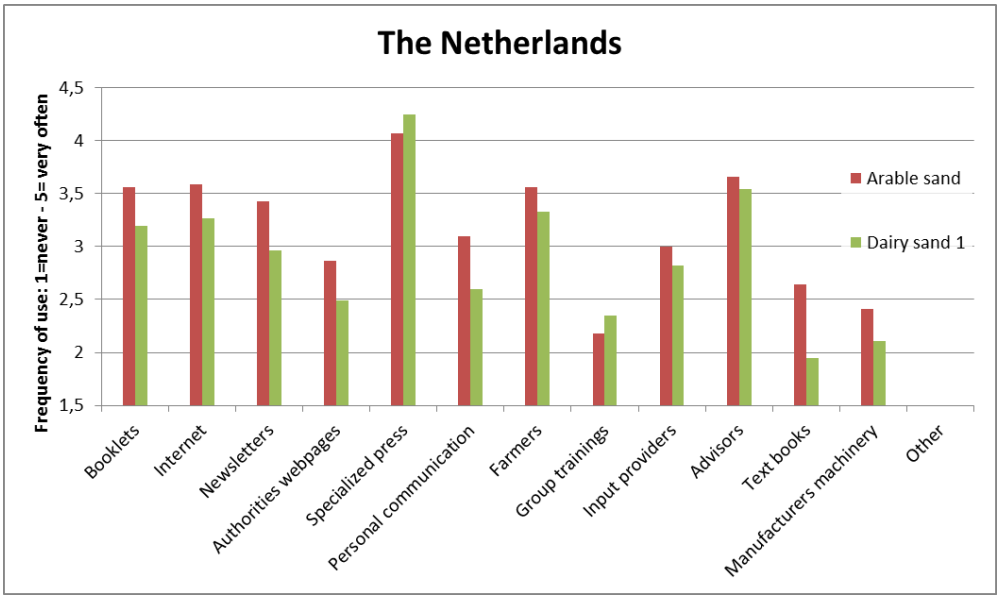
Besides the overall comparison between countries it is also interesting to look at the similarities and differences between the different FTZ within one country. The following section provides the results of the comparison for each country respectively.



In Spain for some information channels all farmers show the same information behavior: booklets, internet, newsletter, webpages, and specialized press. While for other information channels differences are noticeable. For example personal communications with people working at local authorities, administration etc., are used by arable farmers on a much higher frequency than by permanent crop farmers and by dairy farmers. The opposite is true for hints from fellow farmers, which are much more frequently used by the latter group of farmers. It seems as if permanent crop farmers and dairy farmers would exchange more with their colleagues whereas arable farmers exchange relatively more with personal contact persons at research centres, local authorities etc. Input providers are a source of information for arable farmers, followed by permanent crop farmers while dairy farmers rarely use this channel.

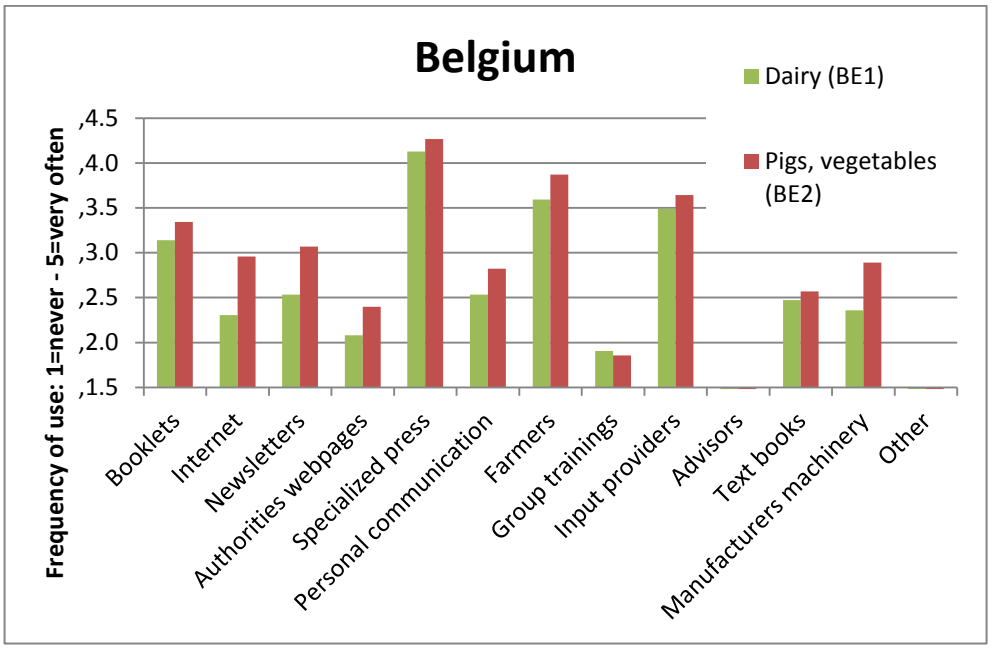
Advisors and text books are more often used by dairy farmers and permanent crop producers in contrast to arable farmers.

In general it is to state that arable farmers regularly use two information channels, namely personal communication with contact persons at research centers, authorities and the like and information from input providers. In contrast permanent crop producers mainly rely on exchange with fellow farmers, as do dairy farmers, and on information provided by group trainings – which are not so frequently used by dairy farmers. However the latter group also frequently used other sources of information, but this was not captured in the questionnaire.

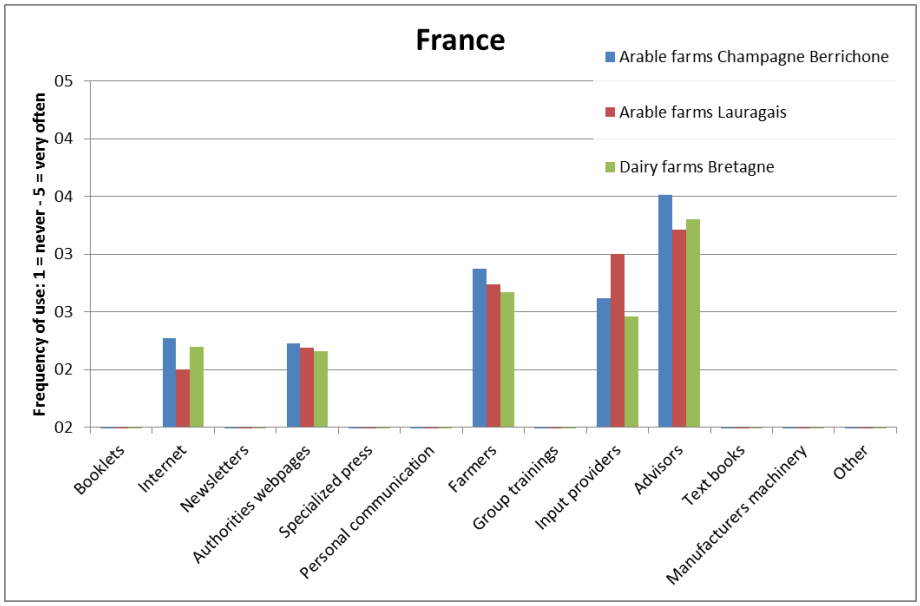


For the Netherlands results show that in general arable farmers more frequently use information channels, except specialized press and group trainings which are slightly more frequently used by dairy farmers. However in the Netherlands compared to other countries the differences in use of the different information channels between the different FTZ are very small, except for textbooks.

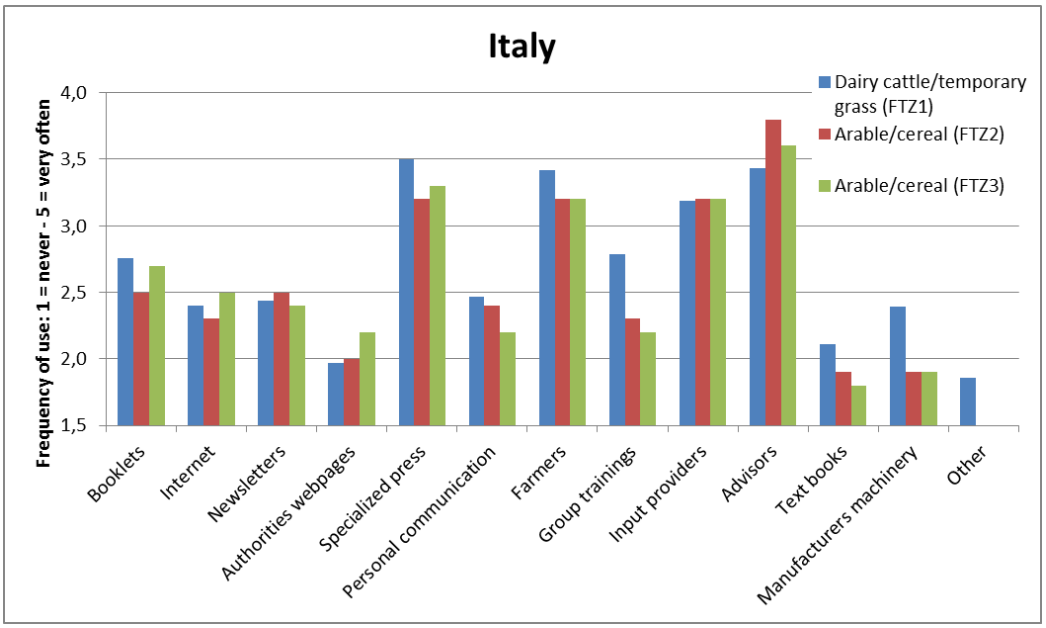
A reason for the homogenous information behavior might be that these information channels in the Netherlands provide their information on various topics which are of interest for both farmer groups.



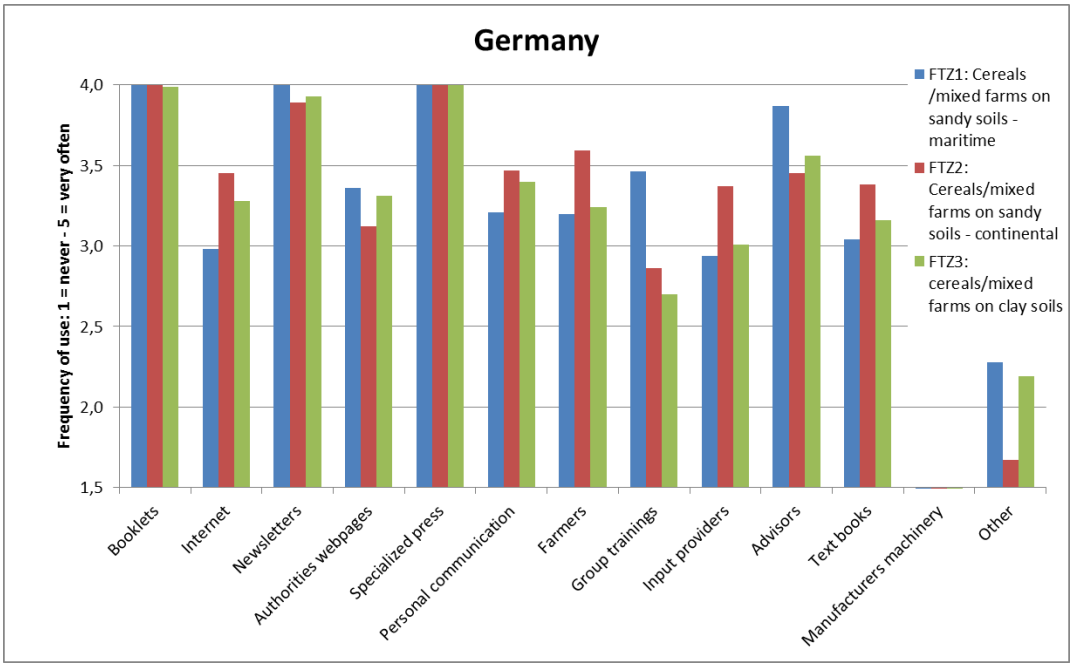
In Belgium as well as in the Netherlands farmers in the two compared FTZ do not show a very distinct information behavior. Generally it is noticeable that pig and vegetable farmers as well as arable farmers more frequently use information channels than dairy farmers but all groups show the same pattern of use between the different channels.



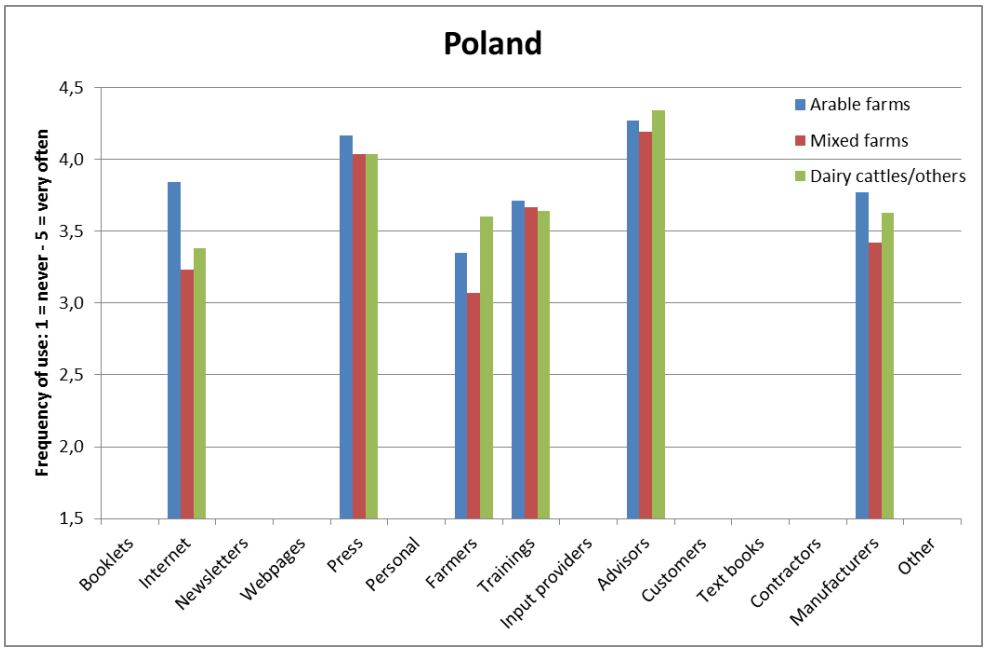
In France the analysis per FTZ does not reveal much difference between the FTZ. Only input providers are slightly more frequently used by arable farmers in Lauragais while advisors are more frequently used by arable farmers in Champagne Berrichone.



In Italy respondents claim to mainly use four information channels, namely specialized press, exchange with fellow farmers, Input providers and advisors. These four are used about equally frequently across the three FTZ. However, arable farmers slightly more often use advisors as source of information, in contrast dairy farmers more frequently participate in group trainings. Another difference is the use of information from the manufacturers of machinery: dairy farmers state to make use of this information channel more often than arable farmers (as well in FTZ2 and FTZ3), but all three groups anyways do not very frequently use this channel (values between 1.9 and 2.4).



In Germany results show a much higher frequency of all information channels compared to most other countries. The differences between the different FTZ are not very high. However group trainings are more frequently used in FTZ 1. In comparison farmers in FTZ 2 more frequently use information from Input providers and other farmers compared to the other FTZs.



In Poland use of information channels is very high compared to most other countries. Between the FTZ there is only a difference in use of Internet, which is used more frequently by arable farms and in use of exchange with other farmers which is more frequently used by dairy farms, followed by arable farms and least used by mixed farms.

Broadly generalized comparing all countries it gets obvious that arable farmers more frequently use input providers while dairy farmers tend to use the exchange with their colleagues more as a source of information. One reason for this pattern may be the assumption that generally for input providers the focus of agricultural information lies more on crop production and information about dairy farming is less represented. Another explanation could be that working routines of dairy farmers allow less time for exhaustive use of information channels (because they do not have a winter break for example). But it can also be the case that dairy farmers generally work closer together with their colleagues (e.g. collectively sell to the same dairy or the like) and thus simply just have more occasions for exchange with colleagues compared to pure arable farmers. Here further investigation is needed to shed light on the reasons for these differences (which might also be different in each country!).

6.3 Adoption rate of BMPs

Table 5 summarizes the adoption of the different BMPs across the FTZs. Adopters and non-adopters were identified by measuring behavior as a simple dummy variable, being 1 if the farmer applied the BMP on at least one parcel of his farm. Adoption is presented as the % of the respondents that indicated to apply the practice on at least one parcel of their farm. In the surveys, farmers were also asked on which percentage of the farm area, the practice was applied. However, these figures are not included in this report.

Table 5: Adoption rates of BMPs across 24 farm type zones (FTZs). N= number of farmers who completed the questionnaire.

FTZ	LAND USE	BMPs	N	Adoption rate
		GERMANY		
7A	arable and mixed farms on sandy soil	non-inversion tillage	72	66%
		cover crops	60	88%
		crop rotation	53	32%
8A	arable/cereal and mixed farms on sandy soils	cover crops	96	81%
		controlled traffic farming	86	8%
9A	arable/cereal and mixed farms on sandy soils	non-inversion tillage	95	86%
		reduced soil compaction (4)	93	72%
		cover crops (4)	80	66%
		crop rotation (4)	76	59%
		AUSTRIA		
1A	arable farms	soil analysis	35	60%
		non inversion tillage	28	86%
		legume crops	20	40%

		cover/catch crops, green manure >25%	15	93%
2M	mixed farms (arable farms)	soil analysis	11	91%
		organic fertilizer	11	73%
		Legume crops	7	14%
		cover/catch crops, green manure	6	100%
3C	dairy cattle/permanent grassland	soil analysis	6	33%
		permanent grazing and rotational grazing	6	17%
		POLAND		
21A	arable farms	reduced tillage	93	32%
		cover crops	93	54%
		straw incorporation	93	75%
22M	mixed farming	reduced tillage	68	22%
		cover crops	68	78%
		straw incorporation	68	50%
		nutrient management plan	62	37%
23C	dairy cattle	reduced tillage	140	6%
		cover crops	140	42%
		straw incorporation	140	23%
		nutrient management plan	136	24%
		SPAIN		
10A	Arable farms with cereals	crop rotation	96	75%
		direct drilling	94	30%
		controlled traffic farming	93	50%
11P	Permanent crop farms (olive and fruit trees,vineyards)	minimum tillage	151	68%

		cover crops	150	55%
12C	Mixed farms known as *Dehesa* (sheep, pigs and beef and permanent grass)	light tillage	101	68%
		pastoral plan	89	32%
	FRANCE			
15A	arable farms on Rendzina, Champagne Berichonne	cover crops	17	53%
		simplified cultivation technique	9	78%
		no tillage	14	43%
13A	arable farms on Cambisols	cover crops	5	0%
		simplified cultivation technique	19	42%
		no tillage	14	14%
14C	dairy farms on Cambisols and luvisols (long term grassland)	cover crops	17	82%
		simplified cultivation technique	25	44%
		no tillage	16	25%
	BELGIUM			
4A	arable/specialized crop farms	non inversion tillage	134	23%
		incorporation of straw	179	32%
		application of farmyard manure	152	67%
		application of compost	121	7%
		cover crops	196	87%
6C	dairy farms on sandy soils	non inversion tillage	186	13%
		rotation maize-grass	189	68%
		cover crops	198	92%
		fast sowing of the cover crop	198	79%
		rotation of maize with grass clover	181	20%
5M	mixed farms (vegetables/pigs)	application of farmyard manure	69	58%
		compost	62	0%

		land exchange	101	39%
		rotation of vegetables with cereals	41	67%
		non inversion tillage	117	26%
		cover crops	101	95%
		ITALY		
16C	dairy cattle/temporary grass	sprinkler and drip irrigation	92	47%
		green manure	91	1%
		rotation with grass meadows	92	46%
		rotation with legume meadows	92	51%
		crop residue incorporation	91	69%
		nutrient management plan	91	64%
16A	arable/cereal	sprinkler and drip irrigation	108	56%
		green manure	109	10%
		rotation with legume ley crop	108	19%
		crop residue incorporation	114	93%
		application of farmyard manure, compost and sewage sludge	106	32%
		non inversion tillage	112	42%
		no tillage	105	9%
17A	arable/cereal	green manure	92	10%
		crop residue incorporation	93	69%
		application of farmyard manure, compost and sewage sludge	90	28%
		non inversion tillage	94	41%
		no tillage/sod seeding	92	10%
		THE NETHERLANDS		
20C	dairy farms on sandy soils	non inversion tillage	101	23%
		rotation grass/maize	46	43%

		under sowing green manure within maize	49	14%
		early harvest maize to enable green manure	51	0%
		row application of manure	56	20%
18A	arable farms on clay soils	non inversion tillage	96	59%
		green manure	95	84%
		use of digestate	100	14%
		incorporation of straw	99	62%
		spring application of manure	101	62%
		controlled traffic	92	8%
20A	arable farms on sandy soils	non inversion tillage	71	52%
		green manure	132	83%
		use of digestate	68	16%
		incorporation of straw	55	71%
		use of compost	55	55%

6.4 Non inversion tillage (NIT)

The first section provides an overview of the results for the FTZs separately (6.4.1) after which an overall comparison is made (6.4.2).

6.4.1 Barriers and drivers per FTZ for NIT

Tables 7 to 23 provide an overview of the most important drivers and barriers for NIT per FTZ. In Table 6, an overview of the definition as formulated in the questionnaire in each country/ftz is given. This definition might be important in understanding differences in barriers and drivers between FTZs.

Table 6: Definition of NIT across FTZs (if FTZ is not specified, similar definition was used across FTZs within the country. FTZ: farm type zone.

Country	FTZ	Definition of BMP
Germany		a tillage system without ploughing. A farmer applies NIT if he does not turn the soil on a particular field plot for at least an entire year
Austria		Tillage without inversion, at a reduced depth (e.g. 5-15 cm), with specific equipment (e.g. grubber/cultivator) only or more than once a year. About 30% of soil cover after seeding (or the incorporation of organic matter >1120 kg/ha).
Poland		a tillage system in which the soil is not turned. Applying RT farmers use specific machines (grubber/cultivator) and do not use plough. In RT about 30% crop residues remaining on the field.
Spain	11P	From one to three plough passes per year without inverting soil profile and performed with a harrow, chisel, cultivator, or similar implement.
	12C	Surface tillage (5-10 cm) without soil inversion using a cultivator or a light harrow, every 5-7 years.
France		deep reduced tillage : use of chisel plow or field cultivator at more than 15 cm depth ;reduced tillage : use of chisel plow or field cultivator in between 5 and 15 cm depth; strip till : this type of tillage is performed with special equipment, to till up an 8 to 10 inch row, and at the same time incorporate fertilizers or chemicals, and just behind, seed.
Belgium		a tillage system in which the soil is not turned. Alternatively, it is called ploughless cultivation. A farmer applies NIT if he does not turn the soil on a particular field plot for a least an entire year while he sows at least one crop during that year. Only applying non-inversion tillage before sowing cover crops but ploughing before the main crop is not considered to be NIT.
Italy		Soil tillage at a reduced depth, using one or more machinery that do not invert the soil, compared to the traditional ploughing that is practiced in the area.
The Netherlands		The soil is not being ploughed for at least one year. Other cultivation methods may be used, such as superficial, mechanical soil loosening operations (disks, chisels, sweeps, etc.)

Table 7: main barriers and drivers for non-inversion tillage in 16A (Italy – arable/cereal) A= adopters, NA=non-adoptes, CT=conventional tillage

Barrier/driver	Suggested solution	Stakeholder	Likelihood of		Comments[1]
			Adoption	Success	
Main drivers					
Similar crop yield	Innovation needed to increase the crop yield under NIT	Advisors	-	-	A≠NA. Compared to non-adopters, adopters are significantly more convinced that NIT will guarantee crop yield similar to conventional tillage (higher behavioural belief strength). During focus group, farmers, advisors and public administration confirmed these outcomes as a motivation to adopt the BMP. According to them, sometimes crop yield can even increase under NIT compared to CT.
Lower cultivation costs			-	-	This is the most important driver among the outcomes.
Reduced working time			-	-	A≠NA
Improved timeliness of tillage			-	-	
Main barriers					
More weeds			-	-	Among the outcomes, this is the main barrier
Accentuated waterlogging	More efficient irrigation systems	Farmers	We did not have the time to discuss the likelihoods		
Clay soils	Adequate practices (green manure, residue return to soil, low-pressure tyres) to improve soil structure, to decrease surface soil crust and enter in the field even in the most adverse conditions	Farmers			A≠NA. Clay soils under NIT should be managed to avoid water shortage and at the same time avoid excessive soil water content that makes it difficult to pass on the field with machinery.
Heavy rainfall	Good management of ditches	Farmers			A≠NA

Table 8: main barriers and drivers for non-inversion tillage in 17A (Italy - arable/cereals) A= adopters, NA=non-adoptes

Barrier/driver	Suggested solution	Stakeholder	Comments[1]
Main drivers			
Reduced risk of waterlogging			In the focus group, farmers have indicated the opposite, i.e. that minimum tillage increases the water accumulation. This shows that some of the issues related to tillage can be site-specific.
Lower cultivation costs			Among the outcomes, this is the most important driver.
Diesel fuel is expensive			Among the factors, this is the most important driver. The focus group confirmed that the price of diesel fuel greatly influences the adoption. In addition, the participants in the group have stated that if the price would decrease, farmers who adopt regularly the practice would not go back to conventional tillage, given the numerous advantages of NIT.
Reduced working time			A≠NA
Main barriers			
Reduced crop yield			Among the outcomes, this is the most important barrier. The participants in the focus group have indicated that NIT increases or decreases crop yield (compared to conventional tillage) depending on rotation, crop type, soil compaction, rainfall and soil texture.
More weeds			
Reduced soil water retention	Doing minimum tillage in the right moment, not after heavy rainfall, to prevent surface erosion and soil compaction	Farmers	
Clay soils	Doing minimum tillage in the right moment, with appropriate soil conditions	Farmers, contractor	The focus group indicated that the minimum tillage can be favoured or disadvantaged by the texture, depending on the location: in Tuscany it is difficult to apply the BMP, while in the Marche Region it is feasible. The questionnaires indicate that non-adopters are significantly more convinced of the negative influence compared to adopters (significantly different control power and perceived behavioural control).
No machineries in the farm			Among the control factors, this is the most important barrier.

Table 9: main barriers and drivers for non-inversion tillage in 4A (Belgium - arable/specialised crops)

Barrier/driver	Comments
Main drivers	
Less labor	
Less fuel	
Less erosion	
Freezing of remaining potatoes	
Increased water holding capacity	
Sowing cover crops in august	
Main barriers	
More weeds	
Increased use of herbicides	
Higher risk of transfer of crop diseases	
Lower yields	In general, but mainly when weather conditions are bad
Less sure of good seedbed preparation	
No appropriate machinery	
Good results with ploughing	
Adjustment of rotation scheme	
No experience	

Table 10: Main barriers and drivers for non-inversion tillage in 6C (Belgium – dairy cattle/permanent grass)

Barrier/driver	Comments
Main drivers	
Lower fuel costs	
Lower tillage costs	
Less labour needed	
Main barriers	
No experience	
Not enough technical knowledge	
No appropriate machinery	
Maize preceded by Italian rye grass	
More weeds	Both adopters and non adopters

More soil compaction	Not perceived as a barrier by the adopters
Lower yields	Not perceived as a barrier by the adopters
Higher sensitivity of maize to fungi related diseases	
Not stimulated by extension services	
Not stimulated by other farmers	
Not stimulated by the contractor	
No positive results on experimental fields	not perceived as a barrier by the adopters and persons with positive intention
More herbicides needed	

Table 11: main barriers and drivers for non-inversion tillage in 5M (Belgium - mixed)

Barrier/driver	Comments
Main drivers	
Less fuel	Both adopters and non adopters
Decrease of total costs	Only believed by the adopters
Time saving	Both adopters and non adopters
Less erosion	Both adopters and non adopters although to a lesser extent for the group of non adopters
Better soil structure, more humus	Only believed by the adopters
Permits earlier sowing in spring	Both adopters and non adopters
Experimental results	Only for the adopters
Main barriers	
Intensive cultivation of vegetables	Both are confronted with this control factor. Especially perceived as a barrier for the non adopters
After harvest, crop residues often remain	Both are confronted with this control factor. Especially perceived as a barrier for the non adopters
Lagging crop residues hamper soil tillage activities	Both adopters and non adopters
No appropriate machinery	Barrier to non adopters
Less airy soil	Both adopters and non adopters
More weeds	Only non adopters
Faster germination of weeds	Both adopters and non adopters
Higher risk on tracks	Both adopters and non adopters
Higher risk on soil compaction	Only the non adopters
After harvest, soil damage occurs	Both are confronted with this control factor. Especially perceived as a barrier for the non adopters
Esthetically less beautiful fields	Only the non adopters
Extension services	Both adopters and non adopters do not feel stimulated
Not often applied in my surroundings	Especially perceived as a barrier for the non adopters
Lower crop yields	Only the non adopters

Table 12: main barriers and drivers for minimum tillage in 11P (Spain - permanent crops)

Barriers	Suggested solution	Stakeholder	Likelihood of		Comments
			Adoption	Success	
FINANCIAL					
Lack of subsidies and economical support	Training.	Farmers	High	High	
	Dissemination and training.	Policy makers	Medium	Medium	
	Subsidies, training and dissemination.	What farmers want from policy makers	Low	High	
NATURAL					
It enhances diseases	Information.	Farmers	High	High	
	Training.	Policy makers	High	High	
	Training.	What farmers want from policy makers	High	High	
It increases soil loss	Information.	Farmers	High	High	
	Training and subsidies.	Policy makers	Medium	High	
	Training and economical support.	What farmers want from policy makers	Medium	High	
It increases runoff	Field demonstrations and training	Farmers	High	High	
	Training and subsidies.	Policy makers	Medium	High	
	Training and subsidies.	What farmers want from policy makers	Medium	High	
Farm characteristics (steep slopes, many stones, clayey soils, etc.)	Information about techniques to minimize these limitations.	Farmers	Medium	High	
	Training, financial compensations and regulatory standards of soil quality.	Policy makers	Medium	High	Farms with steeps slopes are more susceptible to erosion and this practice is difficult to carry out. For the proper management of these factors maybe another practice such as no tillage.
	Subsidies.	What farmers want from policy makers	Medium	High	
PHYSICAL					
Top roots are damaged	No tillage or partial minimum tillage.	Farmers	High	High	
	Subsidies and dissemination of the benefits.	Policy makers	Medium	High	
	Subsidies to mitigate the damages.	What farmers want from policy makers	Low	High	
Operations in the farm are more difficult	Prepare the soil surface before the harvest.	Farmers	High	High	
	Normatives for promoting soil conservation.	Policy makers	Medium	High	
	Subsidies.	What farmers want from policy makers	Medium	High	

There is no adecquated machinery	Training.	Farmers	Medium	High	Farmers can associated to reduce costs.
	Training and dissemination.	Policy makers	Medium	High	
	Subsidies.	What farmers want from policy makers	Low	Medium	
Not compatible with cover crops	Design of a planning and a strategy for combining both practices.	Farmers	High	High	Vegetation cover has benefits but it certainly is not compatible on the same temporal space with minimum tillage. Both can be combined in the same agricultural year and in the case of clay soils, it breaks cracks formed in summer.
	Normatives for soil conservation.	Policy makers	Medium	High	
	Training and subsidies.	What farmers want from policy makers	Medium	High	
Changing weather conditions	To adapt the technique based on the precipitation.	Farmers	Medium	High	Weather conditions affect to all agricultural managements. The lack of rainfall in autumn impairs sprouting of vegetation cover, and a spring drought, causes competition with the crop, and then it should be removed as soon as possible.
	Subsidies for unfavourable conditions.	Policy makers	Medium	High	
	Training and subsidies.	What farmers want from policy makers	Medium	High	
SOCIAL					
Salespeople	Contrast the information they provide with technicians, researchers and universities.	Farmers	High	High	It is need an impartial service which assess farmers.
	To encourage the training.	Policy makers	High	High	
	To promote the association of farmers.	What farmers want from policy makers	High	High	
Local traditions	To try the benefits in the farms.	Farmers	Medium	High	Technicians should encourage it.
	Promote this practice.	Policy makers	Medium	High	
	Subsidies and normatives to implement it.	What farmers want from policy makers	Low	High	

Table 13: main barriers and drivers for light tillage in 12C (Spain - beef and mixed cattle)

Barriers	Suggested solution	Stakeholder	Likelihood of		Comments
			Adoption	Success	
NATURAL					
Is not helpful for controlling schrubs and weeds	Training to value the benefits of this tillage to the whole farm.	Farmers	Medium	Medium	Its efficeincy controlling weeds is lower compared to deep plow but it presents several advantages.
	Training.	Policymakers	Medium	Medium	
	Training and research about its effects.	What farmers want from policymakers	Medium	Medium	
Increases soil compaction and	To do it properly.	Farmers	Medium	Medium	

the develop of a plow sole	To encourage this practice by law.	Policymakers	Medium	Medium	
	Finantial support for training.	What farmers want from policymakers	Medium	Medium	
There are more gullies and soil loss	To do it properly.	Farmers	Medium	Medium	
	To encourage this practice by a soil conservation law.	Policymakers	Medium	Medium	
	Finantial support for training.	What farmers want from policymakers	Medium	Medium	
Water retention capacity is reduced	Training and visit other farms with good yields and doing light tillage.	Farmers	Medium	Medium	Based on soil characteristics, farmers should decide about the convenience of how to implementate light tillage.
	To encourage this practice by law.	Policymakers	Medium	Medium	
	Finantial support for training.	What farmers want from policymakers	Medium	Medium	
More runoff	To do it properly.	Farmers	Medium	Medium	
	To encourage this practice by a soil conservation law.	Policymakers	Medium	High	
	Finantial support for training.	What farmers want from policymakers	Medium	Medium	
Contamination increases because more herbicides are required	Training.	Farmers	Medium	Medium	
	Norms and legislation.	Policymakers	High	High	
	Flexible norms based on the productive activities of the farms and regions.	What farmers want from policymakers	Medium	High	
FINANCIAL					
There are no subsidies for preserving soil conservation	To create farmers associations that promote soil conservation techniques.	Farmers	Medium	High	
	Training and finacial support.	Policymakers	Medium	High	
	Training and finacial support.	What farmers want from policymakers	Medium	High	
HUMAN					
Organic farming is not compatible	Training in organic farming.	Farmers	Medium	High	Mechanical control of weeds is compatible with organic farming.
	Flexible legislation according to particular conditions of each farm.	Policymakers	Medium	High	
	Information and research.	What farmers want from policymakers	Medium	High	

NATURAL					
Farm characteristics (stones, steep slopes, etc.)	To avoid overgrazing and dedicate marginal zones to permanent pasture. Financial support for unfavourable conditions of farms. Training and finacial support.	Farmers Policymakers What farmers want from policymakers	Medium Medium Medium	Medium Medium Medium	The marginal zones are the ones that need more protection and therefore good management practices should be implemented in these areas.
PHYSICAL					
It is difficult to reduce costs if tillage is necessary	Look for assessment. Norms and support. Subsidies and information.	Farmers Policymakers What farmers want from policymakers	Medium Medium Medium	Medium Medium Medium	It is important to choose the right moment of the year to do it.
SOCIAL					
The legislation of these farms is very restrictive	Follow the legislation. Flexible norms adapted to each farm. Flexible norms adapted to each farm.	Farmers Policymakers What farmers want from policymakers	High Medium Medium	High High High	Legislation should facilitate the management of the farm. The compliance of the legislation should be checked periodically.

Table 14: main barriers and drivers for reduced tillage in 21A (Poland - arable/cereals)

Barrier/driver	Suggested solution	Stakeholder	Comments
Main drivers		Farmers	
Lower fuel use		Farmers	
Lower labor input		Farmers	
Lower financial costs		Farmers	
Less agricultural practices		Farmers	
Stimulation by extension services		Farmers	
Main barriers			
No appropriate machinery	Finance investments programs	Farmers	
Increase of crop protection		Farmers	
More weeds		Farmers	Both adopters and non adopters
Not enough technical knowledge	More training on farms, publication in agricultural magazines	Farmers	

Lower yields		Farmers	Not perceived as a barrier by the adopters
No experience	More training on farms	Farmers	
Not stimulated by other farmers		Farmers	Not perceived as a barrier by the adopters and persons with positive intention
No positive results on experimental fields	Field trips, more training on farms	Farmers	Not perceived as a barrier by the adopters and persons with positive intention

Table 15: main barriers and drivers for reduced tillage in 22M (Poland - mixed)

Barrier/driver	Suggested solution	Stakeholder	Comments
Main drivers		Advisors	
Lower fuel use		Advisors	
Lower labor input		Advisors	
Lower financial costs		Advisors	
Less agricultural practices		Advisors	
Stimulation by extension services		Advisors	
Main barriers			
No appropriate machinery	Finance investments programs	Advisors	
Increase of crop protection		Advisors	
More weeds		Advisors	Both adopters and non adopters
Not enough technical knowledge	More training on farms, publication in agricultural magazines	Advisors	
Lower yields		Advisors	Not perceived as a barrier by the adopters
No experience	More training on farms	Advisors	
Not stimulated by other farmers		Advisors	Not perceived as a barrier by the adopters and persons with positive intention
No positive results on experimental fields	Field trips, More training on farms	Advisors	Not perceived as a barrier by the adopters and persons with positive intention
Barrier/driver	Suggested solution	Stakeholder	Comments
Main drivers			
Lower fuel use			
Less labor needed			

Lower financial costs			
Less agricultural practices			
Stimulation by extension services			
Main barriers			
No appropriate machinery	Finance investments programs	Farmers	
Increase of crop protection			
More weeds			Both adopters and non adopters
Not enough technical knowledge	More training on farms, publication in agricultural magazines	Farmers	
Lower yields			Both adopters and non adopters
No experience	More training on farms	Farmers	Not perceived as a barrier by the adopters
Not stimulated by other farmers			Not perceived as a barrier by the adopters
No positive results on experimental fields	Field trips, more training on farms	Farmers	

Table 16: main barriers and drivers for reduced tillage in 23C (Poland - dairy cattle/permanent grass)

Barrier/driver	Suggested solution	Stakeholder	Comments
Main drivers			
Lower fuel use			
Less labor needed			
Lower financial costs			
Less agricultural practices			
Stimulation by extension services			
Main barriers			
No appropriate machinery	Finance investments programs	Farmers	
Increase of crop protection			
More weeds			Both adopters and non adopters
Not enough technical knowledge	More training on farms, publication in agricultural magazines	Farmers	
Lower yields			Both adopters and non adopters
No experience	More training on farms	Farmers	Not perceived as a barrier by the adopters
Not stimulated by other farmers			Not perceived as a barrier by the adopters
No positive results on experimental fields	Field trips, more training on farms	Farmers	

Table 17: main barriers and drivers for simplified cultivation techniques in 15A (France - arable).

Barrier/driver		Comments
Main drivers	**Promoting paths**	
Economic (prod costs)		
decreases fuel cost	Taxes on fuel, incentives for biocarburants development	
decrease fertilisation cost		Driver but not very important, mostly in lin k with new crop successions
work load and organisation		
decreases work load		Only minor driver
environnement (on-farm)		
improves soil biological activity	Local experiments on soil properties with SCT demonstrating biological activity changes	The main driver quoted
decreases deep layers compaction	More precise knowledge needed	Minor driver
improves top layers porosity	Demonstrations in local experiments	Second driver quoted
improves soil structure stability	Knowledge based at France level	
increase organic matter content	Local experiments on soil properties with SCT demonstrating OM content in each soil layer	Third driver quoted
environnement (off-farm)		
decreases erosion		
Control factors		
Soils lack OM		Champagne Berrichonne has traditionnaly low OM contents in soil
Main barriers	**Suggested solution**	
increase herbicide cost	Local experiments to increase knowledge base and management skills	The linked barrier “increase weeds” is quoted as neutral; but because of the large variety of opinions, this barriers might be linked with knowledge and management capacity
increase pests	Local training courses to increase knowledge base and management skills	SCT are considered neutral regarding pests (there is a variety of opinions on this point) but quoted as important for adoption
Not stimulated by other farmers		
Not stimulated by	Political choices	There is a competition in champagne Berrichonne for which BMPs to promote and they have

extension services		chosen to promote the increase of crop succession variety

Table 18: main barriers and drivers for simplified cultivation techniques in 13A (France - arable).

Barrier/driver		Comments
Main drivers	**Promoting paths**	
Economic (prod costs)		
decreases fuel cost	Taxes on fuel, incentives for biocarburants development	
decrease fertilisation cost		Driver but not very important, mostly in link with new crop successions
Decreases mechanisation cost		Minor driver and wide variety in responses
work load and organisation		
decreases work load		Only minor driver
environnement (on-farm)		
improves soil biological activity	Local experiments on soil properties with SCT demonstrating biological activity changes	
decreases deep layers compaction	More precise knowledge needed	
improves top layers porosity	Demonstrations in local experiments	
improves soil structure stability	Knowledge based at France level	Main driver quoted
increase organic matter content	Local experiments on soil properties with SCT demonstrating OM content in each soil layer	
environnement (off-farm)		
decreases erosion		
Decreases run-off		
Control factors		
Soils lack OM		
Soils are compacted		Consistent with the main driver quoted
Good quality soils		
Main barriers	**Suggested solution**	
increase herbicide cost	Local experiments to increase knowledge base and management skills	
Needs a modification of material		Non adopters stress the need of material modification, while adopters emphasise on decrease of material cost

Modifies work organisation		The time periods during which no till is applicable are very narrow some years
Increases weeds		
increase pests	Local training courses to increase knowledge base and management skills	
Not stimulated by other farmers		
Not stimulated by extension services		
Control factors		
Lack appropriate material		Highlighted by non-adopters
Managing weeds is difficult on the farm	Training sessions to improve capability and knowledge	
Lack of knowledge about the technique		

Table 19: main barriers and drivers for simplified cultivation techniques in 14C (France - dairy cattle)

Barrier/driver		Comments
Main drivers	**Promoting paths**	
Economic (prod costs)		
decrease fertilisation cost		Driver but not very important
environnement (on-farm)		
improves soil biological activity	Local experiments on soil properties with SCT demonstrating biological activity changes	
decreases soils born diseases	More precise knowledge needed	
improves soil structure stability	Knowledge based at France level	
increase organic matter content	Local experiments on soil properties with SCT demonstrating OM content in each soil layer	
Control factors		
Managing weeds isn't difficult on the farm		
Main barriers	**Suggested solution**	
increase herbicide cost	Local experiments to increase knowledge base and management skills	
Needs a modification of material		Barriers for non adopters
Increases weeds		
increase pests	Local training courses to increase knowledge base and management skills	

Not stimulated by other farmers		
Not stimulated by extension services		

Table 20: main barriers and drivers for non inversion tillage in 1A (Austria -arable/cereals)

Barrier/driver	Suggested solution
Efficient way of farming	-
Saved energy	-
Reduced operational costs	-
Reduced erosion	-
Conservation of soil life	-
Improved soil structure	-
Increased soil moisture on the surface	-
Avoidance of an plowsole	-
Elimination of pressure damages by lanes	-
Crumbly seedbed	-
Society "LOP - Landwirtschaft ohne Pflug"	-
Literature	-
Higher weed pressure	Improving of agricultural advice Advice, information sessions with practical demonstrations such as soil, water protection advice, environmental advice
Higher disease pressure	Improving of agricultural advice Advice, information sessions with practical demonstrations such as soil, water protection advice, environmental advice
Growth of the previous crop in the following crop	Advice, information sessions with practical demonstrations such as soil, water protection advice, environmental advice

Table 21: main barriers and drivers for non-inversion tillage in 7A (Germany - arable+mixed/specialised crops)

Barrier/driver	**Comments**
Increased work effectiveness	Both, adopters and non-adopters and persons with positive and negative intention
Prevention of erosion	Both, adopters and non-adopters and persons with positive and negative intention
Support of soil life	Both, adopters and non-adopters and persons with positive and negative intention
Better storage of soil moisture	Both, adopters and non-adopters and persons with positive and negative intention
Better soil structure	Both, adopters and non-adopters and persons with positive and negative intention
Lower use of fuel	Both, adopters and non-adopters and persons with positive and negative intention
Prevention of layers of unrotten straw	Both, adopters and non-adopters and persons with positive and negative intention
Application of manure in upper 10 cm of the soil	Both, adopters and non-adopters and persons with positive and negative intention
More easy employment of unskilled labor	Both, adopters and non-adopters and persons with positive and negative intention
More vital, strong plants	Both, adopters and non-adopters and persons with positive and negative intention
Diversified work	Both, adopters and non-adopters and persons with positive and negative intention
More use of contractor service	Not perceived as driver by adopters and non-adopters and persons with positive and negative intention
Extension	Not perceived as driver by adopters and non-adopters and persons with positive and negative intention
Other farmers	Not perceived as driver by non-adopters and persons with negative intention
Barriers	
Difficulties with *elymus repens* (quackgrass)	Both, adopters and non-adopters and persons with positive and negative intention
Slow warming up of soil in spring	Both, adopters and non-adopters and persons with positive and negative intention
Higher use of herbicides	Both, adopters and non-adopters and persons with positive and negative intention
Bad conditions for crop emergence	Both, adopters and non-adopters and persons with positive and negative intention
No prevention measures against the corn borer	Both, adopters and non-adopters and persons with positive and negative intention
Worse exterior quality of potatoes	Both, adopters and non-adopters and persons with positive and negative intention
Non-durable machines	Both, adopters and non-adopters and persons with positive and negative intention
Volunteer crops	Not perceived as driver by adopters and non-adopters and persons with positive and negative intention
Lower maize yields	Both, adopters and non-adopters and persons with positive and negative intention
Tearing up stones from bottom to soil surface	Both, adopters and non-adopters and persons with positive and negative intention
Not being able to do mulch seeding with the available machines*	Both, adopters and non-adopters and persons with positive and negative intention
Uneven fields	Both, adopters and non-adopters and persons with positive and negative intention
Unavailability of cheap capital to easily buy new machines*	Both, adopters and non-adopters and persons with positive and negative intention
Having a farm size that does not allow to just buy a machine when wanted to*	Adopters and non-adopters and persons with negative intention

Not many neighbors successfully apply non-inversion tillage*	Both, adopters and non-adopters and persons with positive and negative intention
High set up times	Both, adopters and non-adopters and persons with positive and negative intention
No possibility to easily borrow machines*	Both, adopters and non-adopters and persons with positive and negative intention
High cover crops	Both, adopters and non-adopters and persons with positive and negative intention
Non-affordable glyphosate*	Both, adopters and non-adopters and persons with positive and negative intention
Not having a disc harrow*	Both, adopters and non-adopters and persons with positive and negative intention
Non-availability of a cultivator with needed features on the market	Both, adopters and non-adopters and persons with positive and negative intention
Not having a big tractor*	Both, adopters and non-adopters and persons with positive and negative intention
Regular application of dung	Non-adopters and persons withnegative intention
Having a seeder that gets blocked more easily when applying NIT	Both, adopters and non-adopters and persons with positive and negative intention
Not saving costs with NIT*	Non-adopters and persons with negative intention
Dry conditions when soil needs to be worked	Not perceived as barrier by adopters and persons with positive intention
A complex plant production system	Not perceived as barrier by adopters and non-adopters and persons with positive and negative intention
Having wet soils that require ploughing	Not perceived as barrier by adopters and non-adopters and persons with positive and negative intention

Table 22: main barriers and drivers for non inversion tillage in 9A (Germany - arable+mixed/specialised crops)

Barrier/driver	**Comments**
Drivers	
High work efficiency	Adopters and non-adopters and persons with positive and negative intention
Prevention of plough pans	Adopters and non-adopters and persons with positive and negative intention
Fuel savings	Adopters and non-adopters and persons with positive and negative intention
Nutrients in upper soil layer	Adopters and non-adopters and persons with positive and negative intention
Farmers' journals	Adopters and non-adopters and persons with positive and negative intention
	Not perceived as driver by adopters and non-adopters and persons with positive and negative intention
Barriers	
More diseases	Adopters and non-adopters and persons with positive and negative intention
Root and stem diseases	Adopters and non-adopters and persons with positive and negative intention
Bad conditions for crop emergence	Adopters and non-adopters and persons with positive and negative intention
Bad soil tilth	Adopters and non-adopters and persons with positive and negative intention
Uneven fields	Adopters and non-adopters and persons with positive and negative intention
Wet soils	Both, adopters and non-adopters and persons with positive and negative intention

Table 23: main barriers and drivers for non inversion tillage in 20C (The Netherlands - dairy cattle/permanent grass)

Barrier/driver	Suggested solution	Stakeholder	Likelihood of success		Comments
Main drivers			Adoption	Success	
Better for soil fauna					More valued by adopters + positive intention than by non-adopters + negative intention
Increased organic matter in the top soil					More valued by adopters than by non-adopters
Saves time compared to ploughing					More valued by adopters + positive intention than by non-adopters + negative intention
NIT cheaper than ploughing					More valued by adopters + positive intention than by non-adopters + negative intention
Research is positive on NIT					More valued by adopters + positive intention than by non-adopters + negative intention
Main barriers					
Increased weed pressure	In time: top soil will be depleted of weed seeds				More valued by negative intention than by positive intention
Increased pesticide use	- Develop technique to incorporate winter hardy green manures without pesticide use	Research	slow	High	More valued by non-adopters + negative intention than by adopters + positive intention
Increased risks on diseases	Grass/maize rotation	farmer	high	High	Equally valued by all groups
More impermeable soil layers	Use deep cultivation, to 40 cm	farmer	High	High	More valued by non-adopters + negative intention than by adopters + positive intention
Lower yields	Not confirmed	-			More valued by non-adopters + negative intention than by adopters + positive intention
No financial benefits	- Less time or fuel use are financial benefits - Mitigated by deep cultivation				More valued by non-adopters + negative intention than by adopters + positive intention
Must plough to incorporate winter hardy green manure	Early cultivation, (march), combined with spraying	Farmer/contractor	Low	Unknown	Less of a barrier to farmers with a positive intention
Unsolvable weed problem	enough pesticides available	farmer	?	Unknown	Less of a barrier to adopters and farmers with positive intention than to non-adopters and farmers with a negative intention

6.4.2 Comparison among FTZ for NIT

The tables below (Table 24; Table 25) present an overview of the main drivers and barriers per FTZ for applying NIT. Based on the results of the questionnaire, an outcome, referent, or control factor is perceived as an important driver or barrier, if the majority of the sample in each FTZ perceived this particular outcome, referent or control factor as a driver or barrier. If medians for both questions (eg. belief strength and outcome evaluation questions for an outcome) with respect to a particular outcome, referent or control factor are lower or higher than 3 (depending on how the questions were formulated), this outcome, referent or control was defined as an important barrier/driver. Area marked dark green refers to a main driver both important to adopters and non adopters in a specific FTZ, whereas light green refers to a driver only perceived important by the group of adopters. Area marked red refers to a barrier both important to adopters and non adopters in a specific FTZ, whereas pink refers to barriers only important for the group of non adopters. These results in Tables 24 and 25 are only based on the results from the questionnaires. Additional drivers and barriers came up during the focus groups for some regions but these are not included in these tables! So for detailed and more information on NIT in a single FTZ, we refer to the summarizing tables (6.4.1) or to the individual country reports.

Adoption and behaviour towards non inversion tillage was studied in 19 European FTZs across all countries participating in Catch-C. Adoption rate of non inversion tillage varies from 6% to 86% among these different FTZs. There is a high variability in adoption rate among FTZs, however within countries, this adoption rate seems to differ less. In Germany (9A, 7A), Austria (1A) and Spain (11P, 12C), most of the farmers apply non inversion tillage (from 66% in 7A to 86% in 9A). In the Netherlands (52-59%), Italy (41-42%) and France (42-78%), moderate adoption rates are seen, whereas in Belgium (13-26%) and Poland (6-32%), only a small part of the farmers indicate to apply non inversion tillage on at least one field parcel. Agricultural specialisation seems not to explain differences in adoption rates at the European level. However, within countries, some differences were seen. In the Netherlands, adoption rate is remarkably lower on dairy farms (20C) with respect to arable farms (18, 20A). In Italy (16A), farmers stated during the focus groups that adoption rates depend on farm size, with a lower adoption rate in smaller farms, which are managed by older and more traditional farmers or by part time farmers. Also in Poland (22M), farm size seems to matter. The utilized agricultural area (UAA) of farms were reduced tillage is implemented is much higher than the average size according to the central statistical office (10.2ha), and 50% of the adopters cultivate even on more than 50ha. Polish advisors emphasized that small farms cannot afford to purchase modern machinery. Mixed farms have lower revenues compared to dairy and arable farms and therefore, they invest less in equipment.

Farmers widely agree on the beneficial effects of non inversion tillage on cultivation costs and labour compared to conventional tillage, which might contribute to a more efficient way of farming. In Italy (17A and 16A), farmers believe this improves the possibility to till at a proper timing. The beneficial effect of this practice on soil characteristics is less recognised and varies among regions and countries. In two regions (16A, 5C), not any soil related benefit was perceived as important driver to shun the plough. In several other regions, some advantages were only perceived as drivers by the adopters. Although research has proven that NIT is an excellent tool to reduce soil erosion on-site, only farmers in some regions perceive this really as a benefit of this BMP. These regions are located in Belgium, Germany, Austria and France. In Belgium, only the adopters perceive this as a driver. In some regions, farmers are convinced that organic matter content in the soil top layer increases (which might be beneficial for soil life). Farmers in other regions are convinced that water holding capacity might be improved. However, concerning these soil related benefits we might conclude, there

is no general acceptance across FTZs, which might indicate that i) there is still an important job left for extension services to increase awareness of soil related benefits of NIT or ii) the difference in soil related benefits depends heavily on soil type and climate.

In general farmers do not believe crop yields will increase. On the contrary, survey results show that in several regions (5C, 4A, 16A, 17A, 7A), farmers fear lower yields. Mainly non adopters feel less secure about crop yield under non inversion tillage. During a focus group in Italy (17A), farmers stated that crop yields under NIT might be affected by crop rotation, machinery and knowledge. These farmers believe NIT works well if it is carried out before sowing winter cereals (wheat and barley), while it is not successful before spring crops. Vegetable farmers in Belgium (5M), believe cultivation of vegetables is not compatible with non inversion tillage. Besides crops, weather conditions are recognised as an important factor concerning the success of NIT. Italian farmers stated that in some areas, yield increases under NIT only if rainfall is scarce, because with abundant rain there are erosion problems. In other areas, wheat yield increases with NIT only in conditions of high rainfall. Also in Belgium (4A), both adopters and non adopters believe that when NIT is applied under bad weather conditions, yield of the following crop will be lower compared to ploughing. During focus groups in Italy, farmers mentioned NIT is an opportunistic practice to be rotated with conventional tillage. In other words, it does not need to be adopted always and everywhere; it should be used only when it can give benefits.

Although beliefs with respect to productivity are variable and depend on conditions of NIT, farmers do generally agree that NIT leads to more weeds which might increase the use of herbicides. In most of the regions, both adopters and non adopters perceive this as a barrier. In Germany, the use of glyphosate is under debate, and farmers are concerned about future restrictions in use of glyphosate. However, they see its availability as crucial for non-inversion tillage. Besides more weeds, farmers in half of the FTZs believe NIT increases the risk on transfer of diseases. In Germany, during the focus groups, farmers believed an “adapted crop rotation” with 8 or more crops enables to solve weed and disease problems. Not having the appropriate machinery for NIT application is regarded to be another important barrier for NIT implementation. In Poland, some farmers believe the purchase of the appropriate equipment is only affordable by large farms. Farmers emphasize the need to develop finance investments programs in the farms.

Besides these barriers that are independent of the regional context, some barriers were more related to the regional characteristics or land use and agricultural specialisation. In Italy (16A and 17A) clay soils under NIT should be managed to avoid water shortage and at the same time avoid excessive soil water content that makes it difficult to pass on the field with machinery. Adequate practices (green manure, residue return to soil, low-pressure tyres) should be combined with NIT to improve soil structure, to decrease surface soil crust and enter in the field even in the most adverse conditions. In Belgium (4A), NIT is considered to be less attractive for vegetable crops and crops with small seeds. On the dairy farms in Belgium and the Netherlands (5C, 20C), maize is often preceded by Italian rye grass and farmers prefer to incorporate grass instead of destroying with chemicals. They think applying NIT is not compatible with incorporating grass. They believe the winter hardy grass green manure needs to be ploughed into the soil. Using herbicides to kill the green manure is an alternative, however this would negatively contribute to environmental evaluation of the production method which is unwanted.

Non adopters in several regions indicate a lack of knowledge as a hindrance for applying NIT. During focus groups (16A), farmers emphasized the value of non adopters visiting the adopters. Farmers adopting the practice display the effectiveness of NIT to other farmers. These experiences are very important because farmers tend to trust other farmers, and because the result can be easily seen on the field. As an illustration, in Belgium (4A),

adopters seem to have better experience with positive effects of NIT on erosion than non-adopters. Extension services could help to inform non adopters and to distribute advice on good practices applied by adopters that prevent the negative aspects such as lower yields. In Spain, some barriers are believed to be an outcome since the management practices are not performed properly. In 12C, non adopters believe that soil compaction is increased and a plough sole will be developed. Besides extension services, trainings and visits to adopters, also results from experimental fields might be a manner to tackle misconceptions among non adopters. Only in the Netherlands, results from experimental fields were mentioned as a driver towards adoption. In the Netherlands, arable farmers are positively stimulated by their social environment, in contrast to dairy farmers. The latter group feels only positively stimulated by research.

During focus groups in several regions, subsidies were mentioned as an interesting manner to increase adoption. In France, as non adopters stress the lack and cost of specific material, an easy way to foster non inversion tillage adoption is to include them in the list of techniques (under CAP pillar II) that can improve agricultural competitiveness, in other terms enable subsidising specific material in regional development plans. In Germany, they also stressed to provide subsidies during the conversion because in the first years farmers have to learn a lot and have yield reductions due to mistakes and also the positive effect of NIT in the soil only shows after some years of consequent NIT. However, in Belgium, where non inversion tillage can be subsidized with AES (CAP pillar II), subsidies only make NIT attractive to a limited extent. Other barriers, than financial ones seem to be more important.

Moreover, in several regions, the legislation is perceived by farmers as very restrictive. Farmers ask for more flexible norms based on the activities of the farms and the regions. Regulations should allow ploughing in some crops that are unsuitable for NIT, e.g. as horticultural crops or when weather conditions are not optimal, eg. due to Mediterranean climate (dry long summers but high intensity rainfall events). Using non inversion tillage or ploughing is not a fundamental decision and farmers in general do not rigidly apply one or the other exclusively. Moreover, time is required to achieve a sufficient entrepreneurial and managerial capacity for NIT.

Table 24: Main drivers (based on medians) for non inversion tillage perceived by farmers in different FTZs. Dark green: main driver for adopter and non adopter, light green: main driver for adopter; pink: main barrier for non adopter; red: main barrier for adopter and non adopter; yellow, main driver for adopters and main barrier for non adopter

Country	PL	BE	GE	GE	PL	BE	NL	NL	IT	IT	FR	FR	FR	ES	NL	BE	PL	ES
FTZ	22M	5M	7A	9A	21A	4A	18A	20A	16A	17A	15A	13A	14C	12C	20C	6C	23C	11P
Adoption rate	22%	26%	66%	86%	32%	23%	59%	52%	42%	41%	78%	42%	44%	68%	23%	13%	6%	68%
Soil and environment																		
Less erosion																		
Promotes freezing of remaining potatoes																		
Prevention of plough pans																		
Crumbly seedbed																		
Nutrients in upper soil layer																		
Humus in top layer of soil																		
Increase of organic matter content in soil																		
Enhances maintaining soil quality																		
Improved soil structure																		
Increases moisture holding capacity of the soil																		
Support of soil life																		
Cultivation technique																		
Allows faster sowing																		
I sow cover crop in august																		
Efficient way of farming																		
Less labour intensive																		
Financial																		

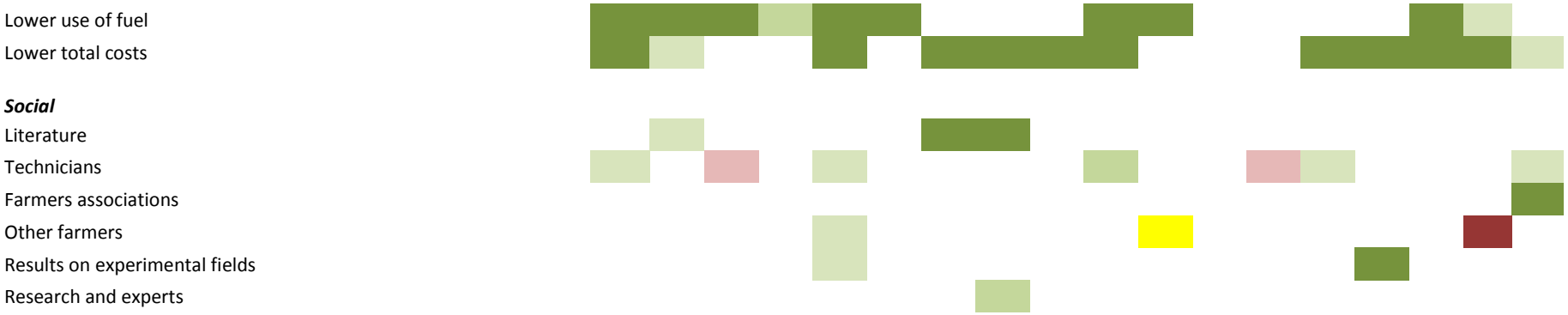
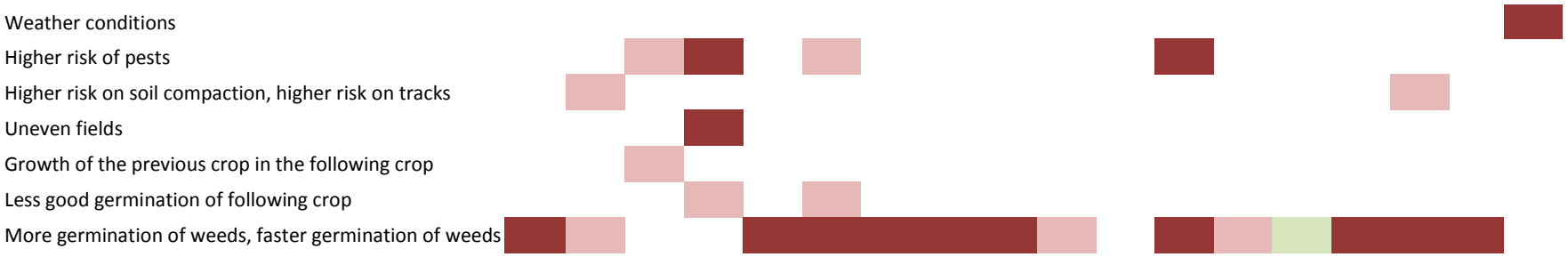
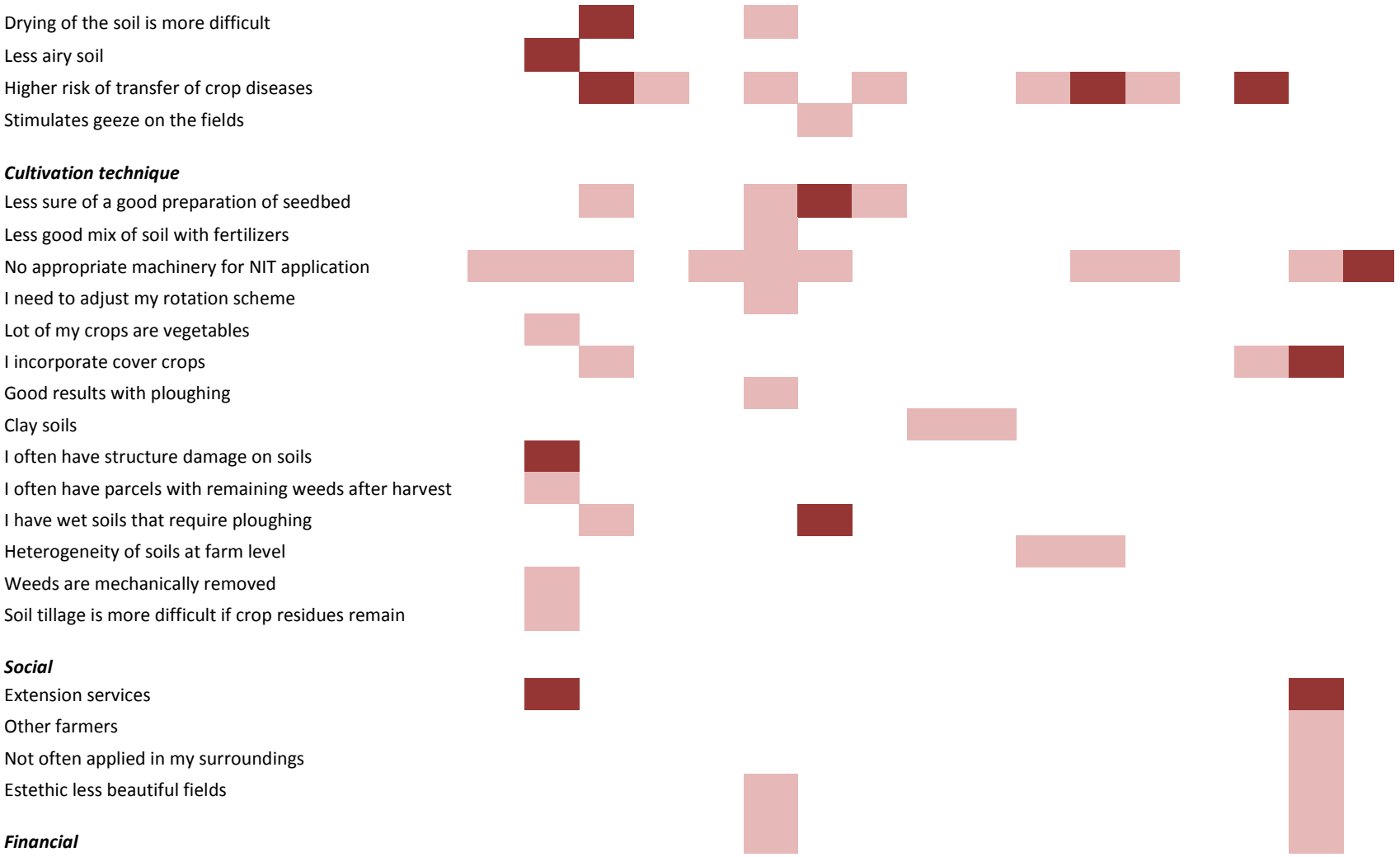


Table 25: Main barriers (based on medians) for non inversion tillage perceived by farmers in different FTZs. Dark green: main driver for adopter and non adopter, light green: main driver for adopter; pink: main barrier for non adopter; red: main barrier for adopter and non adopter

Country	PL	BE	GE	GE	PL	BE	NL	NL	IT	IT	FR	FR	FR	ES	NL	BE	PL	ES
FTZ	22M	6M	7A	9A	21A	4A	18A	20A	16A	17A	15A	13A	14C	12C	20C	6C	23C	11P
Adoption rate	22%	26%	66%	86%	32%	23%	59%	52%	42%	41%	78%	42%	44%	68%	23%	13%	6%	68%




Drying of the soil is more difficult
Less airy soil
Higher risk of transfer of crop diseases
Stimulates geeze on the fields
Cultivation technique
Less sure of a good preparation of seedbed
Less good mix of soil with fertilizers
No appropriate machinery for NIT application
I need to adjust my rotation scheme
Lot of my crops are vegetables
I incorporate cover crops
Good results with ploughing
Clay soils
I often have structure damage on soils
I often have parcels with remaining weeds after harvest
I have wet soils that require ploughing
Heterogeneity of soils at farm level
Weeds are mechanically removed
Soil tillage is more difficult if crop residues remain
Social
Extension services
Other farmers
Not often applied in my surroundings
Estethic less beautiful fields
Financial


Increased use of herbicids
Lower yields in general, less secure of good yields
No subsidies available
No experience with NIT, not enough knowledge on the technique

6.5 Cover crops

The first section provides an overview of the results for the FTZs separately (6.5.1) after which an overall comparison is made (6.5.2).

6.5.1 Barriers and drivers per FTZ for cover crops

Table 27 to Table 48 provide an overview of the most important drivers and barriers of sowing cover crops/green manure per FTZ. In Table 26, an overview of the definition as formulated in the questionnaire in each country/ftz is given. This definition might be important in understanding differences in barriers and drivers between FTZs.

Table 26: Definition of cover crops across FTZs (if FTZ is not specified, similar definition was used across FTZs within the country). FTZ: farm type zone.

Country	FTZ	BMPs	Definition of BMP
Germany		cover crops	The coverage of the soil **during the whole year** with either the main crop or a cover crop. Cover/catch crops are harvested or incorporated into the soil. Double cropping (two different crops grown on the same area in one growing season) is here included.
Austria		cover/catch crops, green manure >25%	The growing of different species of crops in a crop rotation with >25% coverage with cover/catch crops. Double cropping (two different crops grown on the same area in one growing season) is here included. Cover/catch crops are harvested.The growing of different species of crops in a crop rotation with >25% coverage with green manure crops. Green manure crops are incorporated into the soil.
Poland		cover crops	The growing of different species of crops sowing after the harvest of the main crop and incorporated into the soil in the spring.
Spain	11P	cover crops	Spontaneous or sown vegetation strips along the inter tree rows **for** controlling soil erosion purposes.
France		cover crops	Soil is covered by specific crops from at least November to March
Belgium		cover crops	The coverage of the soil **during the whole year** with either the main crop or a cover crop. Cover/catch crops are harvested or incorporated into the soil. Double cropping (two different crops grown on the same area in one growing season) is here included.
Italy		green manure	a specific crop sowing, which is not harvested, but entirely incorporated in the soil, or left on the ground if sod seeding is adopted. The crop residues incorporation is not classifiable as green manure.sowing and growing a crop, which is not harvested but completely buried (or left on the soil in case of no-tillage). Incorporation of crop residue in the soil is not classified as green manuring.
The Netherlands		green manure	The cultivation of a crop as an alternative for fallow land. The crop is not harvested.

Table 27: barriers and drivers for cover crops in 4A (Belgium - arable/specialised crops)

Barrier/driver	Comments
Main drivers	
Increased soil quality (C, structure, health)	More carbon and a better soil structured are valued as more important by farmers with positive intention
Lower soil erosion risk	
Better for environment (nitrate leaching)	Adopters and farmers with positive intention value this as more important than the non-adopters
Easier farming (less weeds, soils can be earliers tilled in spring)	
Main barriers	
Short time between harvest and 1st of September	If they sow before the first of September they can get subsidy
Having to sow cover crops before September 1 to get a subsidy	Mainly a barrier for non-adopters
Too much administration involved for getting a subsidy	Mainly a barrier for non-adopters
No appropriate machinery for sowing/incorporation	Mainly a barrier for non-adopters and farmers with negative intention
Increased costs	Mainly a barrier for non-adopters
Bad weather conditions in autumn	Mainly a barrier for non-adopters
Harvest late in autumn	Mainly barrier for farmers with negative intention
Additional fertilizer needed	Mainly a barrier for non-adopters
Additional labour for sowing/incorporation	Mainly a barrier for non-adopters

Table 28: main barriers and drivers for cover crops in 6C (Belgium – dairy cattle/permanent grass)

Barrier/driver	Comments
Main drivers	
Less nitrate leaching	
Improved soil fertility and soil humus	
Less soil erosion/compaction	
Improved root formation of the following crop	
Higher yield of following crop	
Additional roughage for the herd	
Subsidy	Cover crop before 15th of October.

Derogation	Obligation to sow cover crop before 30th of November (and take a cut of it)
Main barriers	
More labor/labor peaks	
High cost of seed for cover crop	Compensated by the subsidy?
Labor peaks	
Less flexibility for sowing maize	For derogation. grassland should be mowed after the first of april. rye should not be harvested before the 15th of march.
Rigid soil in spring after grassland as cover crop	
Bad weather in autumn	

Table 29: main barriers and drivers for cover crops in 5M (Belgium - mixed)

Barrier/driver	Comments (very small group of non adopters; widely adopted technique)
Main drivers	
Less erosion and improved soil structure	Both adopters and non adopters
Lower N residue in autumn, less nitrate leaching	Both adopters and non adopters
More soil humus	Both adopters and non adopters
Subsidy	Is not perceived as very stimulant by both adopters and non adopters although most adopters do get the subsidy
Agricultural press, other farmers, research, extension, government	Non adopters feel less stimulated by these referents
Main barriers	
More labor	Both adopters and non adopters
Crops are harvested late in autumn (after 15th of October)	Both adopters and non adopters
Bad weather conditions in autumn	Both adopters and non adopters
Increased costs	Both adopters and non adopters

Table 30: main barriers and drivers for cover crops in 7A (Germany - arable+mixed/specialised crops)

Barrier/driver	**Comments**
Drivers	
Yield increase of succeeding crop	
Enriches soil with humus	
Prevention of soil erosion	Is evaluated much more positive by adopters compared to non-adopters

Food and shelter for the wildlife	
Earlier slurry application without immediate incorporation	
Cover crops cover the soil so that it does not dry out	Is stronger believed by non-adopters but evaluated more positively by adopters
Avoidance of nitrogen and potash leaking	
Plots that can be irrigated cost-efficiently	
Water management	
Improved water storage capacity of the soil	Adopters do not believe this to be an outcome of cover cropping
Advisors	
Paying off of cover crops through higher yields in succeeding crops	The hypotheses that this is a driver was rejected, but is also not a barrier
Successors	Respondents were only asked if these persons approve of cover cropping. If they ticked no, this does not automatically mean that they are barriers. But the hypotheses, that these are drivers is rejected.
Fellow farmers	
Beekeepers	
Barriers	
Lack of machine endowment for stubble cultivating and seeding of cover crops	
High precipitation in autumn	Perceived as a problem on similar level by adopters and non-adopters
Impossibility to start already during harvest with stubble treatment*	
High cover crops‘ seeds prices	
No efficient contractor available in the region	
Does not fit into the workflow	Adopters strongly reject this statement in contrast to non-adopters
A lot of unevenly spread straw on the fields after thrashing	
Growing maize after sugar beets	
Higher costs	
Labor peaks during springtime seeding	
Higher work effort	The hypotheses that this is a barrier was neglected, but it is also not a driver. Values fluctuate strongly

Table 31: main barriers and drivers for cover crops in 8A (Germany - arable+mixed/specialised crops)

Barrier/ Driver	Comments
Drivers	
Reduced nutrient leaching	Both, adopters and non-adopters and persons with positive and negative intention
Prevention of erosion	Both, adopters and non-adopters and persons with positive and negative intention

Positive influence on humus content	Both, adopters and non-adopters and persons with positive and negative intention
Better soil tilth/ crumb structure	Both, adopters and non-adopters and persons with positive and negative intention
More nutrients for the succeeding crop	Both, adopters and non-adopters and persons with positive and negative intention
Better workability of soil	Both, adopters and non-adopters and persons with positive and negative intention
Facilitation of bees	Both, adopters and non-adopters and persons with positive and negative intention
Training/ studies	Both, adopters and non-adopters and persons with positive and negative intention
Cover crops in line with crop rotation*	For statistical analyses the question was phrased negatively: *Cover crops that are not in line with my crop rotation*. Thus the factor can be regarded as a driver here.
Additional fodder for cattle and biogas plants	Both, adopters and non-adopters and persons with positive and negative intention
Predecessor/ successor	Adopters and persons with positive intention
Beekeepers	Both, adopters and non-adopters and persons with positive and negative intention
Barriers	
No irrigation plots for maize cultivation*	Both, adopters and non-adopters and persons with positive and negative intention
Limitation of workforce	Both, adopters and non-adopters and persons with positive and negative intention
Growing cover crops results in labor peaks on my farm	Both, adopters and non-adopters and persons with positive and negative intention
Producing seeds for cover crops oneself*	Both, adopters and non-adopters and persons with positive and negative intention
It is not profitable to grow lupines and peas	Both, adopters and non-adopters and persons with positive and negative intention
Often extreme wet conditions/ drought in autumn	Both, adopters and non-adopters and persons with positive and negative intention
Financial situation is not relaxed*	Both, adopters and non-adopters and persons with positive and negative intention
Not many summer crops in crop rotation*	Both, adopters and non-adopters and persons with positive and negative intention
Relatively late harvest	Both, adopters and non-adopters and persons with positive and negative intention
No technical solutions for mulch drilling*	Both, adopters and non-adopters and persons with positive and negative intention
Not being motivated to prevent fallow fields in winter*	Both, adopters and non-adopters and persons with positive and negative intention
Prices for cover crops' seeds are currently high	Both, adopters and non-adopters and persons with positive and negative intention
Not possible to combine cover crops with direct drilling*	Both, adopters and non-adopters and persons with positive and negative intention
No use of cover crops as fodder or in a biogas plant possible*	Both, adopters and non-adopters and persons with positive and negative intention
Many cover crops have an early seeding time	Both, adopters and non-adopters and persons with positive and negative intention
Not necessary to add organic matter to my fields*	Both, adopters and non-adopters and persons with positive and negative intention
Higher workload	Non-adopters and persons with negative intention
Previous bad experience with cover crops	Not perceived as barrier by adopters and persons with positive intention
No plots where it is possible to grow maize early in the year	Not perceived as barrier

Table 32: main barriers and drivers for cover crops in 9A (Germany - arable+mixed/specialised crops)

Barrier/driver	Comments
Drivers	
More active soil life	Both, adopters and non-adopters and persons with positive and negative intention
Prevention of erosion	Both, adopters and non-adopters and persons with positive and negative intention
Looser and better aerated soil	Both, adopters and non-adopters and persons with positive and negative intention
Humus enrichment	Both, adopters and non-adopters and persons with positive and negative intention
Better trafficability in autumn	Both, adopters and non-adopters and persons with positive and negative intention
Suppression of weed emergence	Both, adopters and non-adopters and persons with positive and negative intention
Less nutrient leaching	Both, adopters and non-adopters and persons with positive and negative intention
Food and shelter for wildlife	Both, adopters and non-adopters and persons with positive and negative intention
Faster warming of soil in spring	Both, adopters and non-adopters and persons with positive and negative intention
	Not perceived as driver by both, adopters and non-adopters and persons with positive and negative intention
Barriers	
Difficult to incorporate cover crops in spring*	Both, adopters and non-adopters and persons with positive and negative intention
More fuel use	Both, adopters and non-adopters and persons with positive and negative intention
Higher work effort	Both, adopters and non-adopters and persons with positive and negative intention
No winter furrow	Both, adopters and non-adopters and persons with positive and negative intention
Lack of possibility to try new practices on small plots*	Both, adopters and non-adopters and persons with positive and negative intention
I grow rape	Both, adopters and non-adopters and persons with positive and negative intention
	Not perceived as barrier by adopters and non-adopters and persons with negative intention
	Not perceived as barrier by adopters, persons with positive intention and persons with negative intention

Table 33: main barriers and drivers for cover crops in 15A (France - arable)

Barrier/driver	Comments
Main drivers	
Crop management	
Decreases weeds	When well managed, appropriate catch-crop can lower the weed pressure on the crop successions

Environment (on-farm)	
improves soil biological activity	The main driver highlighted by the survey
improves top layers porosity	This is linked to more soil ploughing for seeding
improves soil structure stability	Linked to greater organic matter content in the topsoil
increase organic matter content	When ploughed, the crop residues are incoprorated
Control factors	
Soils lack OM	Champagne Berrichonne has traditionnaly low OM contents in soil
Main barriers	
Increases pest pressure	On wet soils, catch-crop favor slugs and several other pests which seem to be difficult to manage
Not stimulated by other farmers	
Not stimulated by extension services	

Table 34: main barriers and drivers for cover crops in 14C (France - dairy cattle)

Barrier/driver	Comments
Main drivers	
Economics	
Increases yield over the rotation	Not reported as a driver because catch-crops are mandatory
Environment (on-farm)	
improves soil biological activity	The main driver highlighted by the survey
increase organic matter content	When ploughed, the crop residues are incoprorated
Main barriers	
Economics	
Increases seed cost	Not reported as a barrier because catch-crops are mandatory but considered as a drawback
Increases fuel cost	idem
Referents	
Not stimulated by other farmers	
Not stimulated by extension services	

Table 35: main barriers and drivers for green manure in 16C (Italy – dairy cattle/temporary grass)

Barrier/driver	Comments[1]

Main drivers	
Improved soil structure	
Less nitrogen losses from soil	
Less weeds	
Increase of SOM	
Less inorganic fertiliser used	
Main barriers	
Lower self-production of forage	These two barriers (lower self-production of forages and cost increase, with attitudes of -4.2 and -7.2) are overriding the importance of the drivers, so that only one respondent out of 92 is actually cultivating green manure.
Cost increase	
Other farmers	Other farmers are the referents with the lowest normative belief (1.88); they have a subjective norm of -3.60.
Feed advisor	Feed advisors have the lowest subjective norm (-4.03).
Availability of livestock manure	The availability of livestock manure has a perceived behavioural control of -2.8, and therefore acts as a barrier to the adoption of green manure. The lack of SOM and a bad soil structure have a low perceived behavioural control (0.8 and 0.6, respectively), and therefore do not act as drivers for adopting green manure as a means to improve soil fertility.

Table 36: main barriers and drivers for green manure in 16A (Italy - arable/cereals)

Barrier/driver	Comments [1]
Main drivers	
Higher soil organic matter	Farmers give to this outcome the main importance.
Higher soil nitrogen content	This result is counter-intuitive: adopters are significantly less convinced that green manure increases the N soil content.
Higher crop yield	However, the non-adopters do not apply GM anyhow.
Improved soil structure	
Main barriers	
No incentives for green manure	
Additional costs for green manure	Both adopters and non-adopters believe that additional costs hinder the cultivation of green manure. Additional costs are represented by the production factors (seed) and the mechanical operations (tillage) used during GM cultivation.
Other farmers	Main referent barrier for both adopters and non-adopters.

Table 37: main barriers and drivers for green manure in 17A (Italy - arable/cereals)

Barrier/driver	Comments[1]
Main drivers	
Higher soil organic matter	Among the outcomes, the increase of soil organic matter and the improvement of soil structure are the main drivers.
Improved soil structure	
Increased protein content in following crop	A≠NA. Adopters are more interested in increased protein content compared to non-adopters (significantly higher outcome evaluation).
Reduced use of mineral fertilisers	Even if the outcome evaluation is significantly higher for adopters, the attitude is not.
Main barriers	
Higher cultivation costs	Among the outcomes, this is the most important barrier. Cultivation costs are represented by the production factors (seed) and the mechanical operations (tillage) used during GM cultivation.
Other farmers	Among the referents, other farmers and family members are those with the lowest subjective norms.
Family members	

Table 38: main barriers and drivers for green manure in 18A (The Netherlands - arable/specialised crops and cereals)

Barriers	Suggested solution	Stakeholder	Likelihood of		Comments
			adoption	Success	
More labour	Good time organisation end of summer. More access to machinery	Farmers and contractors of machinery	Moderate	Moderate	
More nematodes	Deepening of farmers' knowledge of different types of green manures	Farmers and seed suppliers	Moderate	High	
Nitrogen standard	Create more diverse nitrogen standards for different types of green manures	Government	high	100%	

Table 39: main barriers and drivers for green manure in 20A (The Netherlands - arable/specialised crops)

Barriers	Suggested solution	Stakeholder	Likelihood of		Comments
			adoption	Success	
Growing season	More emphasis on benefits of green manure, even late in season.	Farmers, advisors, farmers 'organisations, government	small	small	
Nitrogen standard	Allow slurry after 1st of September when green manure is grown	Government	small	high	

Table 40: main barriers and drivers for cover crops in 1A (Austria -arable/cereals)

Barrier/driver	Suggested solution
Reduced erosion	
Soil is rooted and loosened	
Enhanced soil life	
Fixation of nitrogen	
Increased humus content	
Improved water storage over the winter	
Food for the insects	
Enriches the soil with nutrients	
Agricultural school	
Literature	
Advisors of "Bioforschung Austria"	
Available technical equipment	
Same seeding technology for different crops	

Use of an cultivator	
Contiguous agricultural area	
Sufficient precipitation	
Cheap seeds	
Support by ÖPUL	
Combination with mulch or non-inversion tillage	
Higher costs	Technical training on advantages regarding cost savings in fertilization Compensation by ÖPUL Funded by ÖPUL
Higher use of fuel	Technical training on advantages regarding cost savings in fertilization Funded by ÖPUL
Reduction of the income	Technical training on advantages regarding costs/benefits Funded by ÖPUL
Time consuming	Technical training on advantages regarding costs/benefits Funded by ÖPUL
Not possible to use the field for cash crops	Compensation by ÖPUL
Higher application of plant protection	In general, further advice and training and practical demonstrations (by trials) for ground-water protection are available; they are performed by "Maschinring"; unfortunatly the quality of the green manure is not evaluated
Higher weed pressure	-
High risk of failure	-
Loss of water that is not longer available for the main crop	Technical training on ecologically advantages (e.g. higher SOM, improved water storage capacity) Only in very few exceptional cases
Difficult incorporation of crop residues	Improving of the agricultural advice Use of green manure in biogas plants

Table 41: main barriers and drivers for cover crops in 2M (Austria-mixed)

Barrier/driver	Suggested solution

Good soil structure	
Reduced soil erosion	-
Increase of the humus content	-
Stimulated soil life (especially the earthworms)	-
Loosening the soil	-
Nutrient storage till the main crop	-
Reduced soil-borne diseases	-
Early tillage	-
Early harvestable crops (e.g. barley)	-
Good adapted variaties	-
Support by funding program ÖPUL	-
Crop experts	-
Private agricultural advisors	-
General weed management (e.g. weed control) is more demanding	-
Slower warming and drying of the fields in spring	Alternative: Strip Till
Overwintering of fungal diseases	-
Problem with seed placement	-
Caused costs	Technical training on advantages regarding cost savings in fertilization
No technical equipment	-

Table 42: main barriers and drivers for cover crops in 21A (Poland - arable/cereals)

Barrier/driver	Suggested solution	Stakeholder	Comments
Main drivers		Farmers	
Lower fertilization costs		Farmers	
Prevent erosion		Farmers	
Better soil structure		Farmers	
Increase organic matter in the soil		Farmers	
Higher yields		Farmers	
Stimulation by extension services		Farmers	
Main barriers			
No experience	More training on farms	Farmers	Not perceived as a barrier by the non adopters
Not enough technical knowledge	More training on farms, publication in agricultural magazines	Farmers	Not perceived as a barrier by the non adopters
Not stimulated by other farmers		Farmers	
No positive results on experimental fields		Farmers	Not perceived as a barrier by the adopters and persons with positive intention

Table 43: main barriers and drivers for cover crops in 22M (Poland – mixed)

Barrier/driver	Suggested solution	Stakeholder	Comments
Main drivers		Advisors	
Lower fertilization costs		Adviosrs	
Prevent erosion		Adviosrs	
Better soil structure		Adviosrs	
Increase organic matter in the soil		Adviosrs	
Higher cereal yields		Adviosrs	
Stimulation by extension services		Adviosrs	
Main barriers			
No experience	More training on farms	Adviosrs	Not perceived as a barrier by the non adopters
Not enough technical knowledge	More training on farms, publication in agricultural magazines	Adviosrs	Not perceived as a barrier by the non adopters
Not stimulated by other farmers		Adviosrs	

No positive results on experimental fields		Adviosrs	Not perceived as a barrier by the adopters and persons with positive intention

Table 44: main barriers and drivers for cover crops in 23C (Poland - dairy cattle/permanent grass)

Barrier/driver	Suggested solution	Stakeholder
Main drivers		
Lower fertilization costs		Farmers
Prevention erosion		Farmers
Increase of organic matter in the soil		Farmers
Better soil structure		Farmers
Higher nitrogen content in the soil		Farmers
Main barriers		
No experience	More training on farms	Farmers
Not enough technical knowledge	More training on farms, publication in agricultural magazines	Farmers

Table 45: main barriers and drivers for cover crops in 11P (Spain - permanent crops)

Barries	Suggested solution	Stakeholder	Likelihood of		Comments
			Adoption	Success	
FINANCIAL					
The cost of maintenance	Training.	Farmers	Medium	High	A more specific training is necessary for solving the problems

	Training and dissemination.	Policy makers	Medium	High	of managing cover crops.
	Subsidies.	What farmers want from policy makers	Low	Medium	
	Consider the benefits of this management practice.	Farmers	Medium	Medium	
Lack of subsidies	Subsidies and norms.	Policy makers	Medium	High	
	Financial support.	What farmers want from policy makers	Low	High	
HUMAN					
Technical limitations	To look for advice.	Farmers	Medium	High	
	Training and farmers associations.	Policy makers	Medium	High	
	Financial support.	What farmers want from policy makers	Low	Medium	
More research in cover crops	To Follow right guidelines for a proper management of the cover crops.	Farmers	Medium	High	
	To promote and incentivate research to improve the management of the vegetation, reduce the use of herbicides, look for varieties…	Policy makers	Medium	Medium	
	Financial support.	What farmers want from policy makers	Medium	High	
Risk of fire	A right management of the cover crop.	Farmers	Medium	High	
	Control measurements.	Policy makers	Low	Medium	
	This possibility may be included in the CAP.	What farmers want from policy makers	Medium	High	
NATURAL					
Enhances pests and diseases	To be informed and try to implement biological control of pests.	Farmers	Low	Medium	Cover crops improve the biodiversity of the farms and therefore new insects. The selection of pesticides should consider this fact.
	To promote training.	Policy makers	High	High	
	To maintain and promote the assessment by technicians and experts.	What farmers want from policy makers	High	High	
Farm characteristics (steep slopes,clayey soils, etc.)	Combine the use of cover crops with some tillage operations, use the cover crops for control erosion pursposes, etc.	Farmers	Medium	High	Cover crops can be very useful for controlling soil erosion in farms with steep slopes.
	To maintain the 'non-productive' investment in farms.	Policy makers	Medium	High	

Bare soils for a long time	Financial support.	What farmers want from policy makers	Medium	High	Because of that, spontaneous cover crops are difficult to be established.
	To sow the cover crop.	Farmers	Medium	High	
	Financial support.	Policy makers	Medium	High	
	Financial support.	What farmers want from policy makers	Medium	High	
PHYSICAL					
Harvesting is more complicated	Training.	Farmers	High	High	Cover crops can make the harvest easier in some crops. However, rainfall is a limitant for harvesting but when having cover crops, harvest can be done the next day after the rain.
	To promote the use of cover crops by law.	Policy makers	High	High	
	Financial support.	What farmers want from policy makers	Medium	High	
	To be informed and visit other farms already with cover crops.	Farmers	High	Medium	
Increase contamination	More training and regulation for farmers for teching them the right use of herbicides and pesticides.	Policy makers	High	High	
	Farmers associations and dissemination by technicians.	What farmers want from policy makers	Medium	High	
SOCIAL					
Traditions of the region	To try cover crops in small areas of the farm and evaluate how it works.	Farmers	Medium	High	The dissemination of the benefits of cover crops is essential.
	To motivate farmers.	Policy makers	Medium	High	
	Financial support.	What farmers want from policy makers	Low	High	

6.5.2 Comparison among FTZ for cover crops

The tables below (Table 46; Table 47) present an overview of the main drivers and barriers per FTZ for applying cover crops. Area marked dark green refers to a driver both to adopters and non adopters in a specific FTZ, whereas light green refers to a driver only perceived by the group of adopters. Area marked red refers to a barrier both to adopters and non adopters in a specific FTZ, whereas pink refers to barriers only for the group of non adopters. These results are only based on the results from the questionnaires. Additional drivers and barriers came up during the focus groups for some regions but these are not included in these tables! So for detailed and more information on cover crops in a single FTZ, we refer to the summarizing tables (6.5.1) or to the individual country reports. Based on the results of the questionnaire, an outcome, referent, or control factor is perceived as a driver, if the majority of the sample in each ftz perceived this particular outcome, referent or control factor as a driver. If medians for both questions (eg. belief strength and outcome evaluation questions for an outcome) with respect to a particular outcome, referent or control factor are lower or higher than 3 (depending on how the questions were formulated), this outcome, referent or control was defined as a barrier/driver.

The growing of cover crops was questioned across 20 European regions across all countries participating in Catch-C. Adoption rates of sowing cover crops varied from 0% to 100% among the different FTZs in which cover crops were incorporated in the questionnaires. The country seems to be an important factor in explaining variation in adoption rate among different regions. In the Netherlands, Belgium, Austria and Germany, cover crops are implemented by most of the farmers (from 66% in 9A to 100% in 2M) on at least one parcel on their farm. In France, Poland and Spain, adoption rates are moderate or vary a lot among regions in the country. Only in Italy, adoption rate is very low and varies from 1% to 10% of the farmers. There are no striking differences among farming types. In regions where dairy farms dominate the landscape, adoption rate varies from 1% (Italy) to 92% (Belgium). Among regions where arable crops are dominating, adoption rate also varies much (from 10% in Italy to 88% in Germany).

The scientifically shown advantages of cover crops on preventing erosion and nitrogen leaching have been widely accepted across the FTZs. In general, farmers across Europe, also in regions with low adoption rates, are convinced that cover crops are beneficial for their soils. The increase of organic matter content in the soil, improved soil structure and decreased soil compaction are widely accepted as positive outcomes, but also other advantages are mentioned, such as increased soil fauna and improved water retention. Non adopters are also usually convinced of these positive outcomes, but less so than the adopters. In several regions in Belgium, Germany and the Netherlands, farmers believe cover crops might improve soil workability. In many FTZ, farmers believe that nitrogen mineralisation increases. In Italy and Poland, they associate this with lower use of inorganic fertilisers and in lower fertilisation costs which is in all Polish regions perceived as an important driver to sow cover crops.

In some countries, farmers are convinced that crop yields might improve when sowing cover crops. However, in Belgium and France, this is limited to the dairy farms. In some regions in Poland, Germany, also arable farmers are convinced of higher yields of the following crop. In Italy, they believe the protein content of the main crop might increase but they do not have cultivation contracts that remunerate higher protein yields. This explains why the higher protein content is not perceived as a driver by the non adopters.

In general, farmer's social environment stimulates farmers to sow cover crops, except for France. Farmers in Belgium, the Netherlands, Italy and Poland feel stimulated by extension services, not only because extension services are positive towards sowing cover crops, but also because farmers seem to add much value to the opinion of the extension services. An

exception are the Italian dairy farmers who feel discouraged by the feed advisors to sow cover crops. In the Netherlands, farmers perceive the positive opinion of literature and study clubs as important drivers.

Some other advantages were identified but were not shared among all regions and countries. They are mainly of a social and legislative nature. In several countries (Belgium, Poland, Austria and the Netherlands), farmers can get a subsidy for sowing cover crops, which is perceived as an important driver. However, sometimes some preconditions have to be fulfilled in order to get the subsidy, which might reduce the attractiveness of the subsidy. This is the case in Flanders. Some arable farmers, depending on the location, have to sow the cover crop before the first of September. Farmers believe that the time period between harvest of the main crop and this 1st September is short, which is considered as an important barrier among the non adopters. Dairy farmers have to sow cover crops before the 15th of October to get the subsidy, so the maize has to be harvested before this date. Most farmers have indicated that it is no problem to harvest before this date. Besides these subsidies, sowing cover crops might be mandatory or a precondition, e.g., when applying for derogation. 35% of the dairy farmers in Flanders have indicated that cover crops are still attractive on parcels on which no derogation applies, while 22% does not find this attractive on these parcels. In the Netherlands, cover crops are mandatory after harvest of maize and in France, as the whole of Brittany is nitrate vulnerable zone, catch-crops are mandatory. It seems that all FTZs with high adoption rates, do perceive some incentives (subsidies, mandatory) by government. In Spain and Italy, the absence of subsidies is perceived as a barrier.

The importance of subsidies might be explained by taking a closer look at the barriers. Two of these barriers are often recognised by the farmers. One of these barriers is the increase of total costs. During focus groups in Italy, the participants suggested to consider incentives for green manure, and to investigate and disseminate low-cost techniques to cultivate green manure. However, in Germany and Poland, increased costs were not perceived as a barrier, which might be explained by the existence of a subsidy in these countries. Moreover, in Poland, farmers are convinced that fertilization costs are reduced. Another widespread disadvantage of cover crops in Belgium, the Netherlands, France and Spain, is an expected increase in labour efforts, labour peaks and modified work organisation. In the Netherlands, during a focus group, it was stressed that especially small farms will perceive this as a problem. Larger farms have more machinery and can chose one employee to sow green manure on all land in a few days. However, both larger and smaller farms do need a good organisation to sow green manures at the end of the summer.

Besides these more widely accepted barriers, some barriers were more dependent on agricultural specialisation and the crop types cultivated. As an example, on dairy farms in Italy (16C (Italy - dairy cattle/temporary grass)) green manure occupies the soil during winter, when a forage crop could be cultivated. In Germany the availability of fields that can be irrigated cost efficiently is a precondition for sowing cover crops because subsequently those fields can be used for maize production without fearing that cover crops have consumed too much of the soil water content. In the Netherlands, the length of growing season is sometimes perceived as too short to sow a green manure. Some farmers always grow a green manure, no matter what the date of harvest is, whereas others only grow it after an early harvest or when it is an obligation (after maize).

Other less widely accepted barriers are more of a legislatory nature. In the Netherlands, two nitrogen standards exist for green manures: a low standard for legumes with nitrogen fixation and a higher standard for all others. The standards do not always allow a farmer to make the choice for a green manure with the largest biomass and compatible with the soil fauna of his fields. Government could offer a more diverse range of standards.

Some barriers are only perceived as important by the non adopters and might be important in explaining differences between adopters and non adopters. However, differences between adopters and non adopters are highly variable among FTZs. In France, non adopters fear an increase in pests and weeds more than adopters do. So they believe this will increase the cost for herbicides. In the Netherlands, during the focus groups, it was mentioned that the influence of green manure on nematodes is a point of consideration when choosing type of green manure, but if the type of green manure is chosen carefully, one can even exterminate nematodes. Can French farmers learn from the Dutch farmers in this specific case ?

In some cases, the farming context between adopters and non adopters is different, which makes sowing cover crops more difficult or less attractive to the non adopters. Lack of machinery might be hampering farmers from sowing cover crops in some regions in Belgium and Germany. In Germany (9A (Germany - arable+mixed/specialised crops)), non adopters seem to grow more rapes compared to the adopters. They indicate there is a lack of good cover crop varieties that are not crucifers because of the high amount of rapes in crop rotation. Growing legumes could be a solution. In other cases, non adopters do not have a different farm situation but they perceive things as more problematic. In several regions in Belgium, the Netherlands and Germany, non adopters do seem to have more problems with bad weather conditions in autumn. This might presumably be a problem for crops that are harvested late in autumn. In Belgium, dairy farmers need to harvest the maize and sow cover crops before 15th of October to get subsidies. However, non adopters seem to find this more difficult. Does this mean that the subsidy stimulates the adopters to harvest their maize earlier or formulated differently, if the subsidy would no longer be given, would adopters harvest the maize more often after October 15th? Or with respect to the non adopters, would they start sowing cover crop if the subsidy was also given when cover crop is sown after the 15th of October? Perhaps the reason why non adopters want to harvest their maize after October 15th should be investigated as we suspect that this reason is more important for farmers than subsidies. In the Netherlands, farmers indicate it is difficult to apply liquid manure in time between harvest and sowing green manure. However, this does not make sowing green manure unattractive to the adopters, while non adopters indicate this prevents them from sowing green manure. Similarly, adopters also indicate weather conditions are sometimes hampering sowing cover crops in time, but this does not prevent them from sowing cover crops in contrast to the group of non adopters.

Table 46: Main drivers (based on medians) for cover crops perceived by farmers in different FTZs. Dark green: main driver for adopter and non adopter, light green: main driver for adopter; pink: main barrier for non adopter; red: main barrier for adopter and non adopter; yellow: main barrier for non adopter, driver for adopter

Country	BE	BE	BE	NL	NL	FR	FR	FR	IT	IT	IT	GE	GE	GE	SP	PL	PL	PL
FTZ	4A	6C	5M	18A	20A	15A	13A	14C	16C	16A	17A	7A	8A	9A	11P	21A	22M	23C
Adoption rate	87%	92%	95%	84%	83%	53%	0%	82%	1%	10%	10%	88%	81%	66%	55%	54%	78%	42%
Soil and environment																		
More organic matter																		
More airy soil																		
Improved water retention in winter and no drying out in summer																		
Increase soil fauna																		
More nitrogen mineralisation																		
Better soil structure, reduces compaction																		
Support long term soil fertility, soil health																		
Uptake of soil nitrogen, lower N residue in autumn																		
Food for insects, food and shelter for wildlife, facilitation of bees																		
Less nitrogen leaching																		
Less wind and soil erosion																		
Cultivation technique																		
Soil can be tilled earlier in spring																		
Less storage space for slurry needed																		
I'd like to plough down my straw																		
I have plots to grow maize early in the year																		
not always possible to apply liquid manure in time																		
Relaxing of crop rotation																		
Less inorganic fertiliser used																		

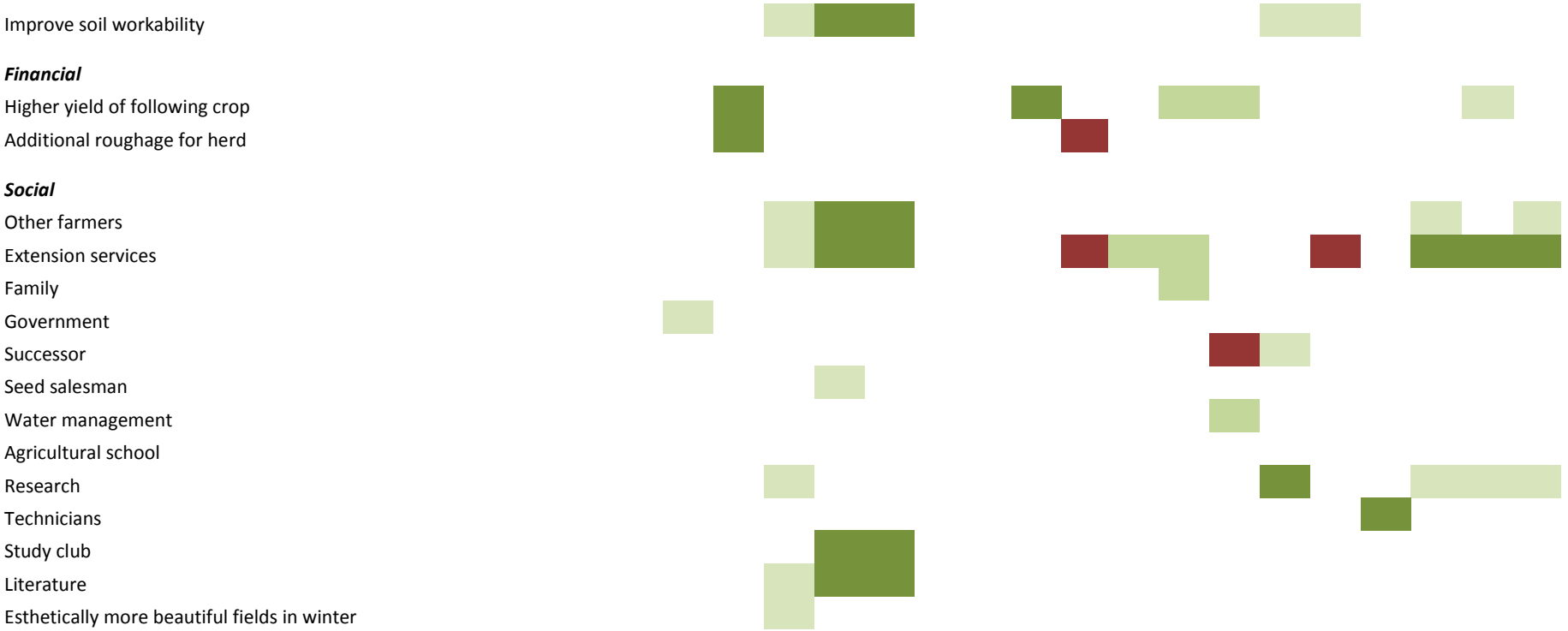
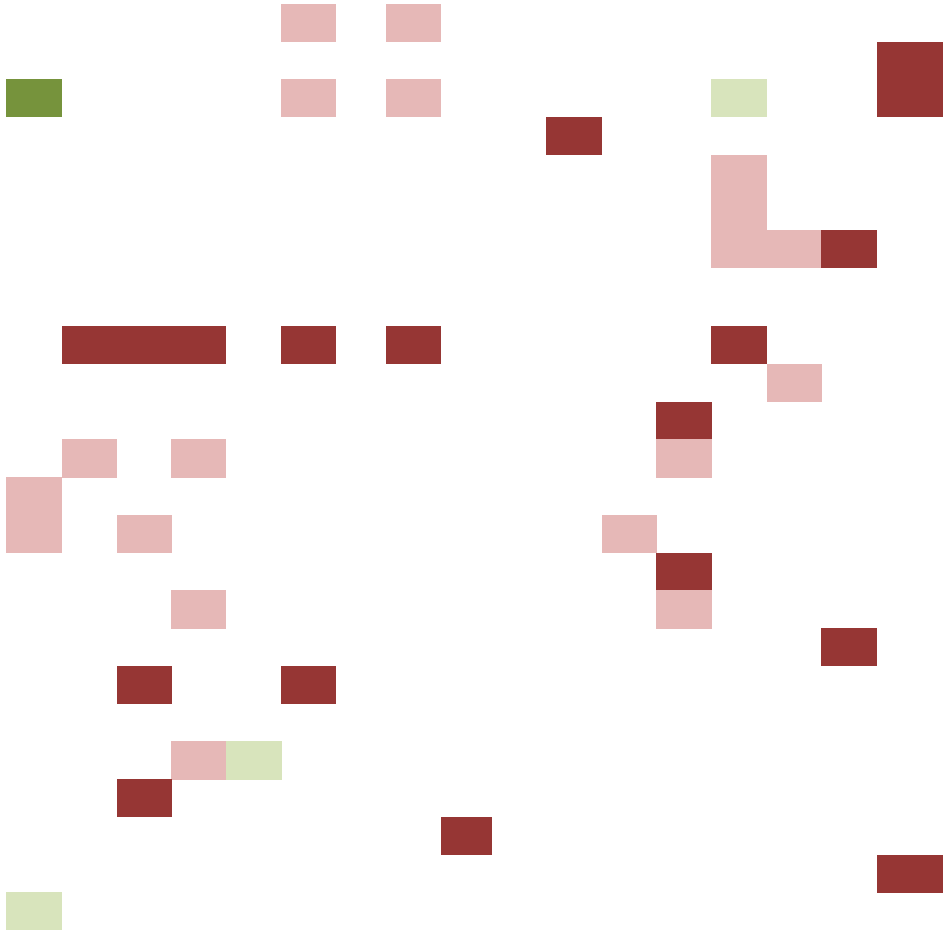


Table 47: Main barriers (based on medians) for cover crops perceived by farmers in different FTZs. Dark green: main driver for adopter and non adopter, light green: main driver for adopter; pink: main barrier for non adopter; red: main barrier for adopter and non adopter

Country	BE	BE	BE	NL	NL	FR	FR	FR	IT	IT	IT	GE	GE	GE	SP	AT	At	PL	PL	PL
FTZ	4A	6C	5M	18A	20A	15A	13A	14C	16C	16A	17A	7A	8A	9A	11P	1A	2M	21A	22M	23C
Adoption rate	87%	92%	95%	84%	83%	53%	0%	82%	1%	10%	10%	88%	81%	66%	55%	93%	100%	54%	78%	42%
Soil and environment																				



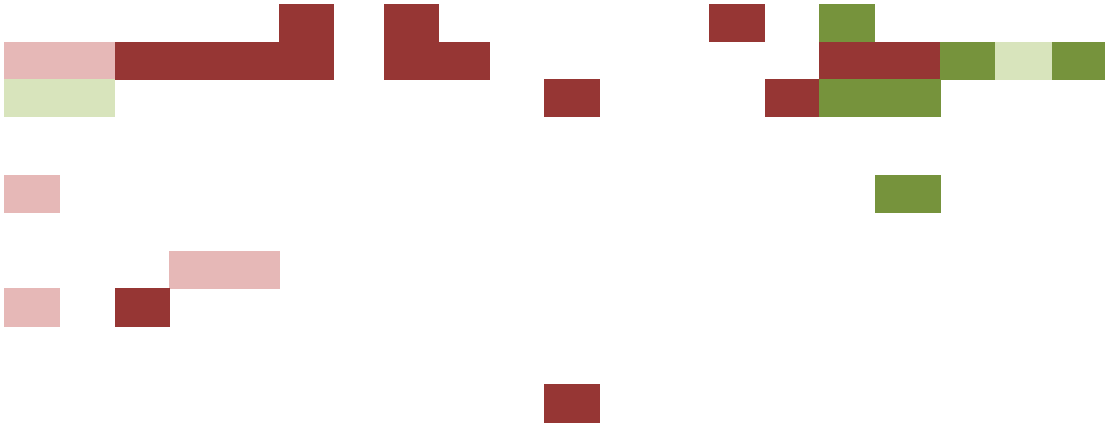
Increase pests
Overwintering of fungal diseases
Weeds
Clay soils
Emergence of cover crop in main crop
No winter furrow
Competition of water with the main crop, not enough precipitation

Cultivation technique

Additional labour, labour peaks, modifies work organisation
Bare soils for a long time
Adding organic matter is necessary
Weather conditions in autumn
Additional fertilization is needed for white mustard
No appropriate machinery for sowing, and incorporation of cover crops
I do not have irrigation plots for maize cultivation
I mainly grow winter wheat
No combination possible with mulch or non inversion tillage
Graminoid cover crops need to be destroyed in spring
Large rainfall variability
Sometimes, growing season is too short for a good crop
Soil is longer wet in spring after graminoid cover crops
Availability of livestock manure
Problems with seed placement
I fertilize as much as is allowed on my parcels

Financial

High prices for seeds



More use of fuel
Increase costs
No incentives (subsidies)

Legislatory

Short time period between harvest and obligatory timing for sowing
The nitrogen standard not flexible enough
With green manure, nitrogen quotum increases
Lots of administration to get subsidy

Social

Cultivation contracts do not remunerate high protein content

6.6 Incorporation of straw/crop residues

The first section provides an overview of the results for the FTZs separately (6.6.1) after which an overall comparison is made (6.6.2).

6.6.1 Barriers and drivers per FTZ for incorporation of straw

Table 49 to Table 54 provide an overview of the most important drivers and barriers for straw incorporation per FTZ. In Table 48, an overview of the definition as formulated in the questionnaire in each country/ftz is given. This definition might be important in understanding differences in barriers and drivers between FTZs.

Table 48: Definition of straw incorporation across FTZs (if FTZ is not specified, similar definition was used across FTZs within the country). FTZ: farm type zone.

Country	FTZ	BMP	Definition of BMP
Belgium	4A	incorporation of straw	The incorporation of cereal straw instead of exporting it from the field (excluding grain maize)
Italy	16C	crop residue incorporation	Crop residue is the straw of winter cereals or the stalks of maize/sunflower. This is different than the stubble, which is normally left on the soil. For simplicity, we will speak about 'crop residue incorporation' also in the case of no-tillage, when residues are left on the soil surface.
	16A, 17A	crop residue incorporation	Crop residues are the straw of autumn-winter cereals or the stalks of corn / sunflower. In the following questions, to simplify, the BMP is called 'residues incorporation' even in the case of sod seeding, in which the residues are left on the soil surface.
The Netherlands		incorporation of straw	After harvest the straw is shredded and incorporated

Table 49: main barriers and drivers for crop residue incorporation in 16C (Italy - dairy cattle/temporary grass)

Barrier/driver	Suggested solution	Comments[1]
Main drivers		
Increase of soil organic matter		
Improvement of soil structure		
Yield increase		
Reduction of weeds and fungi in the following crop		During the focus group it was pointed out that, together with crop residues, also weed seeds might be incorporated in the soil. According to these farmers, therefore, this would be a barrier (named "Increase of weeds in the following crop").
Availability of adequate machinery		Farmers have adequate machinery and think that this favours incorporation.
Main barriers		
Increase of straw requirements at the farm scale	No solution identified in the focus group.	If the straw produced in the field is incorporated in the soil (and therefore cannot be used as litter), the straw for the litter in the stable needs to be bought outside the farm. No solutions were discussed in the focus groups because the farmers attending the group did not sell the residues and therefore did not have this problem. In other areas farmers sell the residues and therefore increase the straw requirements, but this did not occur to the farmers attending our group.
Access to market of winter cereal straw	No solution identified in the focus group.	Ambiguous formulation: in our intention it was referring to the possibility to **sell** straw, but it could have been interpreted as the possibility to **buy** straw. It is possible that this is not a barrier everywhere; it could even act as a driver. We did not discuss solutions to this barrier because the farmers attending the focus group do not sell the residues, and therefore this was not a barrier for them.

Table 50: main barriers and drivers for crop residue incorporation in 16A (Italy - arable/cereals)

Barrier/driver	Suggested solution	Stakeholder	Likelihood of		Comments[1]
			Adoption	Success	
Main drivers					
Higher soil organic matter	-	-	-	-	A≠NA

Improved soil structure	-	-	-	-	
Reduced use of mineral fertilisers	-	-	-	-	This result is mainly due to a high desirability of the outcome, rather than to an elevated expected probability that fertiliser use can actually be reduced (behavioural belief strength is only 3.12).
Advisors of companies selling production factors	-	-	-	-	
Crop residues burn is forbidden	-	-	-	-	The prohibition is recognised by both adopters and non-adopters (not significantly different control strength), but only adopters believe that the presence of the legislation is an incentive to adopt the BMP (significantly higher control power).
Increased protein content in wheat grain	-	-	-	-	
Main barriers					
Increased risk of fungal diseases	Independent advisory service (details in the text above)	Farmers: follow advisor's suggestions	Different opinions in the group: likely for somebody, moderately likely for others	It is likely only if the farmers will see an economic advantage, and an environmental advantage (particularly for younger farmers)	There is a possible influence of residue incorporation on diseases, but this is of secondary importance compared to the decomposition problem. Farmers tend to believe that continuous wheat with straw incorporation increases the presence of fungal diseases.
Adverse environmental conditions that hinder residues degradation		Advisors: disseminate the advantages of crop residue incorporation			Farmers complain that there are conditions (in particular clay soils and high summer temperatures) that slow down (or even stop) the decomposition of crop residues after incorporation in the soil. They know that inorganic nitrogen would alleviate the problem.
Increased nitrogen fertiliser use		Researchers: study alternatives to fertilisers for favouring residue decomposition in the soil			Note that the reduction of **mineral** fertilisers is a driver, while the increase of **nitrogen** fertilisers is a barrier. The two outcomes have a rather similar behavioural belief strength (they have a similar probability to occur). However, during the focus group the use of inorganic N did not appear to be a barrier to residue incorporation.
Residues selling at a high price		Policy makers: - provide subsidies for using inorganic N; - favour the market of			Farmers do not think that they can sell residues at a high price (control strength is 2.37). However, they recognise that if they could sell at a high price it would be rather difficult to incorporate the residues in the soil

		organic fertilisers derived from livestock manure.			(control power of 2.16). The resulting perceived behavioural control is negative. The focus groups has shown that there are areas were residues are traditionally sold (even if soil organic matter is low), and areas where they are more frequently incorporated. In other words, a straw market exists, but is different from region to region.

Table 51: main barriers and drivers for crop residue incorporation in 17A (Italy - arable/cereals)

Barrier/driver	Suggested solution	Stakeholder	Comments[1]
Main drivers			
Higher soil organic matter			
Increased soil fertility			Among the outcomes, this is the most important.
Improved soil structure			
Legislation forbids crop residues burning			We conclude that legislation, knowledge of advantages of CR, and adequate machinery are drivers of this BMP. In all the cases A≠NA, with a difference of perceived behavioural control, between adopters and non-adopters, respectively equal to 3.91, 4.03, 4.03, 4.54.
Incorporation is important			
I have adequate machineries			
Main barriers			
More weeds, pests and diseases	Use rotations. Carry out on-farm trials.	Farmers	A≠NA. According to some farmers, crop residues (either left on the surface of the soil, or incorporated) increase wheat diseases compared to removing them. Not all farmers agree. Burning is seen as a solution.
	Rotate active ingredients of pesticides and herbicides. Disseminate information about crop rotations and BMPs.	Advisors	
	Promote integrated pest management and rotations	Officers / Policy makers	

	Find new solutions with lower impact. Select more resistant plants Study the effects of residue management on crop diseases	Researchers	
Increased nitrogen fertiliser use	Understand how residues decompose in the soil. Increase his/her knowledge. Understand that residues are important. Use rotations. Continue residue incorporation for many years.	Farmers	
	Inform farmers about biological aspects of residue decomposition. Stimulate farmers to carry out soil analyses	Advisors	
	Protect local productions. Guarantee sufficient income for rotated crops. Subsidise crop residue incorporation	Officers / Policy makers	
	Disseminate results. Find a solution to increase residue decomposition (besides adding N). Increase fertiliser response.	Researchers	
Following crop sowing hindered by residues	Carry out on-farm trials. Learn how to use sowing machines that work well in the presence of residues. Be available to spend.	Farmers	
	Provide site-specific advice. Show how to operate to farmers who do not know	Advisors	Advisors need to work closely with the farmers. Advisory service should be independent (either public or private). Advices should be paid.
	Fund field trials useful to farmers. Fund no-tillage	Officers / Policy makers	Field trials need to be local, close to farmers, using techniques that farmers can apply. This is a key to convince farmers.
	Develop seeders that are more efficient. Understand which tillage techniques	Researchers	Researchers are invited to visit farmers, talk to them, and do experiments in real farms, together with farmers. Researchers should not provide information only from their point of view; otherwise, the farmers will not listen.

	are more adequate to decompose crop residues. Make experiments to show the advantages of leaving residues on soil surface. Evaluate the difference between residues incorporated and residues on soil surface		
Loss of income if residues are not sold			NA>A. During the focus group, however, the possibility of selling straw was not considered a real barrier.

Table 52: main barriers and drivers for straw incorporation in 18A (The Netherlands - arable/specialised crops and cereals)

Barriers	Suggested solution	Stakeholder	Likelihood of		Comments
			adoption	Success	
Compatibility green manure	Gain access to appropriate machinery. Learn from other farmers	Farmer	Moderate	high	
Nitrogen application within Dutch manure law	Be creative when making farm plan to have some nitrogen left for decomposition of straw.	Farmer	Moderate	High	
Straw price	*No real suggestion given*				

Table 53: main barriers and drivers for straw incorporation in 20A (The Netherlands - arable/specialised crops)

Barriers	Suggested solution	Stakeholder	Likelihood of		Comments
			adoption	Success	
Compatibility green manure & Nitrogen application within Dutch manure law	Allow more nitrogen application on land when growing green manures and incorporating straw	Government	Low	Moderate	

Table 54: main barriers and drivers in 4A (Belgium - arable/specialised crops)

Barrier/driver	Comments
Main drivers	
Improved soil quality (humus, structure, fertility, long-term improvement)	
Main barriers	
Good price for straw	
Additional fuel needed	
Use of farmyard manure	Non-adopters make more use of farmyard manure
Legislation does not allow to provide enough N for digestion	
Makes cover crop sowing more difficult	Barrier mainly for non-adopters and farmers with negative intention
Increased costs for chopping straw	Barrier mainly for non-adopters and farmers with a negative intention; this could be related to the fact that they are less able to harvest and chop straw in one operation

6.6.2 Comparison among FTZ for incorporation of straw

Table 55: Main drivers (based on medians) perceived by farmers in different FTZ. Dark green: main driver for adopter and non adopter, light green: main driver for adopter; pink: main barrier for non adopter; yellow: main barrier for non adopter, main driver for adopter

Country	BE	NL	NL	PL	PL	PL	IT	IT	IT
FTZ	4A	18A	20A	21A	22M	23C	16C	16A	17A
Adoption rate	32%	62%	71%	75%	50%	23%	69%	93%	69%
Soil and environment									
More organic matter to the soil									
Increase of soil fertility									
Source of potassium and trace elements									
Increase of soil fauna									
Reduced water losses									
Prevention of erosion									
Improved soil structure									
Cultivation technique									
It is easier to incorporate straw than to remove it									
It improves soil cultivation									
No need for heavy machinery, adequate machinery available									
Nutrients stay in the field									
Social									
Other arable farmers									
Extension services recommend it									
Results on experimental fields									
Study club is positive									
Magazines are positive									
Legislation									
Hard to maintain humus content of soil									
Crop residues burn is forbidden									
Straw is not calculated as source of N and P in legislation									
Financial									
increase crop yield									
Reduced use of mineral fertilizers									

Table 56: Main barriers (based on medians) for straw incorporation across ftzs. Dark green: main driver for adopter and non adopter, light green: main driver for adopter; dark red: main barrier for adopter and non adopter, pink: main barrier for non adopter

Country	BE	NL	NL	PL	PL	PL	IT	IT	IT
FTZ	4A	18A	20A	21A	22M	23C	16C	16A	17A
Adoption rate	32%	62%	71%	75%	50%	23%	69%	93%	69%
Soil and environment									
Increase in fungal diseases									
Culitivation technique									
Crop residues hinder sowing of the following crop									
Alternatives to apply organic matter									
Decomposition of straw needs extra N									
Financial									
Additional fuel is needed									
Large market for straw, straw requirement at farm scale									
Good prices for straw									
Crop residues are given for free									
Increased cost for chopping straw									
Legislation									
Not allowed to give enough nitrogen to digest straw									

The tables above (Table 55 and 56) present an overview of the main drivers and barriers per FTZ for incorporation of crop residues. Area marked dark green refers to a driver both to adopters and non adopters in a specific FTZ, whereas light green refers to a driver only perceived by the group of adopters. Area marked red refers to a barrier both to adopters and non adopters in a specific FTZ, whereas pink refers to barriers only for the group of non adopters. These results are only based on the results from the questionnaires. Additional drivers and barriers came up during the focus groups for some regions but these are not included in these tables! So for detailed and more information on straw incorporation in a single FTZ, we refer to the summarizing tables or to the individual country reports. Based on the results of the questionnaire, an outcome, referent, or control factor is perceived as a driver, if the majority of the sample in each ftz perceived this particular outcome, referent or control factor as a driver. If medians for both questions (eg. belief strength and outcome evaluation questions for an outcome) with respect to a particular outcome, referent or control factor are lower or higher than 3 (depending on how the questions were formulated), this outcome, referent or control was defined as a barrier/driver.

The beneficial effects of straw incorporation on soil quality have been recognized by all regions. Farmers believe that straw incorporation is a good investment for soil quality in the long-term, which they consider important. More specifically, they believe a.o. it increases humus content of the soil, improves soil fertility and soil structure. Also non adopters mainly agree that straw incorporation is beneficial for their soils. In general, farmer's social environment is positive towards incorporation of straw. Only in one region in Poland, non adopters do not agree that extension and experimental results are positive towards straw incorporation. Whether they really take into account the opinion of the referents, is not only depending on the opinion of the referents, but also on the farmer's motivation to comply with these opinions. In most of the regions, farmers do seem to take into account the opinion of other arable farmers, extension services and experimental results. As a consequence, it is important that benefits are demonstrated to farmers, but also that extension services are convinced and that adopters are involved if one wants to increase the adoption rate in a given area.

Besides these mainly common drivers, some drivers were stated less frequently. These drivers might be related to specifics of the region. In Belgium and Italy, additional drivers were more related to legislation. In Belgium, some farmers believe that it is hard to maintain humus content of the soil due to legislation, which makes straw incorporation an attractive practice. In contrast to exogenous organic matter, the advantage is that humus content can be increased regardless of the N and P content of the straw. In Italy, the prohibition of residue burning promotes the incorporation of straw. But only those who incorporate the residues believe that the presence of the legislation is an incentive to adopt the BMP. Only on the dairy farms in Italy, some farmers are convinced that crop residue incorporation might increase yields.

Besides these drivers, several barriers were perceived by farmers. Two of these barriers are generally recognised by the farmers across almost all FTZs. One of these barriers is an increase in fungal diseases. However, except for one region in the Netherlands, this is mainly believed to be a barrier by the non adopters only. Farmers in almost all FTZs also do belief that an additional dose of nitrogen is needed to digest the straw. Having to add additional N should not necessarily be a barrier, as seen in all Polish FTZs. In Belgium, the fact that straw digestion consumes soil mineral N is perceived as a driver, probably because it helps them to reduce the nitrate residue in their soils in autumn. However, some farmers in Belgium and the Netherlands do believe that legislation does not allow to provide enough N for straw digestion. In southern Italy, next to the use of inorganic N, advisors suggest deep incorporation (25-30 cm) to favour decomposition of the straw. In the Netherlands, farmers indicate that when making a farm plan, a farmer needs to choose his crops wisely, so he will be able to apply little nitrogen to his straw. It is advised to be creative when making a farm plan to have some nitrogen left for decomposition of straw.

Another generally perceived barrier is the large market for the straw. In Belgium and a part of the Netherlands, farmers indicate to get good prices for the straw. In Italy, straw market differences exist with respect to this barrier. In the north (province of Alessandria) in an area specialised in cereal production, cereal straw is traditionally sold and exported to remote areas with intensive livestock production. This appears to be more a problem of culture and tradition than a situation with high straw selling prices. For the farmers in dairy regions (Poland and Italy), straw is used as litter on the farm. Incorporating straw while they have to buy straw on the market to use as litter is perceived as an important barrier. However, in Italy, some of them note that the straw-derived farmyard manure produced using farmer's straw is incorporated in the soil. Therefore, part of straw organic content returns to the soil on these farms with housing systems that use straw as litter. So, although they do not adopt the

practice, they will still achieve the benefits indirectly of straw incorporation. Besides the additional income farmers might receive for straw, some farmers believe additional fuel is needed for straw chopping, which might increase cost for straw incorporation. In some regions in Italy, farmers are less convinced that they can sell crop residues, but believe chopping is an additional cost. This, together with environmental conditions that slow down residue decomposition in the soil, makes them more favourable to give the residue for free than to incorporate it in the soil.

No appropriate machinery does not seem to be a problem, although in Belgium, non adopters seem to be less able to harvest cereals and chop straw in one operation, which might explain they perceive higher chopping costs as a barrier in contrast to the adopters. Also in the regions in Italy, where straw is traditionally sold, harvesting machinery do not have straw chopper tools as much as in other areas. In some regions, farmers indicate that other ways to apply organic matter might prevent them from incorporating straw. In Belgium, this is more specified by the use of farmyard manure, which is more used by the non adopters.

In Poland and Italy, participants of the focus groups emphasize the importance of knowledge transfer and dissemination. There seem to be more need for advisors who are independent from companies selling production factors. Farmers need clearer and conclusive information about e.g. the conditions favouring straw degradation in soil and the effects of crop residue incorporation on weeds, pests and fungi. In some region, there might even be the need to change farmer's culture and tradition towards this BMP. Gaining insight in the main barriers perceived in every region, might help extension services to establish their role optimally.

With respect to research institutions, studying alternatives to fertilisers to favour residue decomposition in the soil (with cost analysis) and trying to understand control factors that slow down degradation might be worthwhile.

6.7 Rotation

6.7.1 Crop rotation

Table 58 to 64 present the main drivers and barriers for the adoption of a wider crop rotation, as was asked in 7 FTZs. In Table 57, an overview of the definition as formulated in the questionnaire in each country/ftz is given. This definition might be important in understanding differences in barriers and drivers between FTZs.

Table 57: Definition and specification of crop rotation across FTZs (if FTZ is not specified, similar definition was used across FTZs within the country. FTZ: farm type zone.

Country	FTZ	BMP	Definition of BMP
Germany		crop rotation	Wide crop rotation as presented to the farmers: a crop rotation is considered a wide crop rotation if you have at least 4 cultures in your rotation.
Spain	10A	crop rotation	An annual crop in rotation with another crop the following year or fallow
Belgium	6C	rotation maize-grass	Rotating maize with temporary grassland on a regular basis to avoid monoculture of maize. Grassland as intermediary cover crop between two successive cultivations of maize is not included. Temporary grassland should be retained for at least one entire year.
	5M	rotation of vegetables with cereals	Growing cereals (e.g., triticale, wheat, barley) in the crop rotation (*note: silage maize and grain maize are not considered to be cereals*)
Italy	16C	rotation with grass meadows	The rotation of crops with a grass meadow involves the variation, from one production cycle to the next one, of the cultivated species in a given field. The new crop that is inserted (grass meadow) is cultivated for more than one year. The grass meadow is mostly composed of forage crops of the Poaceae family (with no or few species of the Leguminoseae family).

The Netherlands	20C	rotation grass/maize	As an alternative to continuous cropping of maize, maize is cropped after grass.

Table 58: Main barriers and drivers for maize/grassland rotation in 5C (Belgium - dairy cattle/permanent grass).

Barrier/driver	Comments
Main drivers	
Increased soil fertility. soil activity/biology	
Less weeds	
Increased maize yield	During 1 to 2 years after grassland
Main barriers	
Parcels are not close to the farm	Results in increased costs for labor and fuel (so also a financial barrier)
Soil texture just more appropriate for cultivation of grass	
Often too high nitrate residue in autumn when grassland is followed by maize	

Table 59: Main barriers and drivers for crop rotation of vegetables with cereals in 6M (Belgium - mixed).

Barrier/driver	Comments
Main drivers	
More soil humus	Both adopters and non adopters
Less damage to soil structure, prevents erosion	Both adopters and non adopters
Less heavy soils	Both adopters and non adopters
Easier sowing of the cover crop	Both adopters and non adopters
Higher yields of following crops	Both adopters and non adopters
Main barriers	
Not used as ingredient in pig feed	Both adopters and non adopters
Limited surface area on my farm	Both adopters and non adopters although a greater barrier for non adopters
Do not fit in current rotation scheme, mainly vegetables on the farm	Only non adopters
Additional fertilization is needed compared to maize	Both adopters and non adopters

Bad weather conditions when cereals need to be sown	Both adopters and non adopters
Easy access for pigeons	Both adopters and non adopters
Lower yields for cereals, lower prices for cereals compared to maize	Both adopters and non adopters agree on the low prices of cereals, non adopters are more convinced of the lower yields when sowing cereals
Higher risk on failure with cereals	Only non adopters
Economically less interesting crop	Only non adopters

Table 60: Main barriers and drivers for crop rotation in 9A (Germany - arable+mixed/specialised crops).

Driver/ barrier	**Comments**
Driver	
Organic farm	Both, adopters and non-adopters and persons with positive and persons with negative intention
Higher yields	Both, adopters and non-adopters and persons with positive and persons with negative intention
Maintenance of humus content	Both, adopters and non-adopters and persons with positive and persons with negative intention
Mutual facilitation of crops within the crop rotation	Both, adopters and non-adopters and persons with positive and persons with negative intention
Breaking of labor peaks	Both, adopters and non-adopters and persons with positive and persons with negative intention
Food and shelter for wildlife	Both, adopters and non-adopters and persons with positive and persons with negative intention
Prevention of nutrient deficiency	Both, adopters and non-adopters and persons with positive and persons with negative intention
Other farmers	Not perceived as driver by both, adopters and non-adopters and persons with positive and persons with negative intention
Extension	Not perceived as driver by adopters and non-adopters and persons with negative intention
Predecessor/ successor	Not perceived as driver by adopters and non-adopters and persons with negative intention
Barrier	
Remote fields	Both, adopters and non-adopters and persons with positive and persons with negative intention

Lack of different market and utilization opportunities for a lot of different crops*	Both, adopters and non-adopters and persons with positive and persons with negative intention
Not necessary to grow legumes*	Both, adopters and non-adopters and persons with positive and persons with negative intention
Crops with lower yields	Both, adopters and non-adopters and persons with positive and persons with negative intention
No direct marketing*	Both, adopters and non-adopters and persons with positive and persons with negative intention
Higher work effort	Both, adopters and non-adopters and persons with positive and persons with negative intention
No legumes*	Both, adopters and non-adopters and persons with positive and persons with negative intention
No possibility to use machines better in a wider crop rotation*	Both, adopters and non-adopters and persons with positive and persons with negative intention
No possibility to use machines better in a changed crop rotation*	Both, adopters and non-adopters and persons with positive and persons with negative intention
I have not solved a certain weed problem with crop rotation*	Both, adopters and non-adopters and persons with positive and persons with negative intention
Lack of sufficient storage capacity for different crops*	Both, adopters and non-adopters and persons with positive and persons with negative intention
Not having the know-how of growing many different crops*	Non-adopters and persons with negative intention
Crops with high demands on herbicide resistance	Non-adopters and persons with negative intention

Table 61: Main drivers and barriers for crop rotation in 7A (Germany - arable+mixed/specialised crops).

Barrier/driver	Comments
Drivers	
Increase soil fertility	Non-adopters are neutral towards this belief
Support soil health	Much stronger believed by adopters compared to non-adopters
Avoid certain problematic weeds	Stronger believed by adopters but evaluated on the same level
Secure the yield stability of each crop	Stronger believed by adopters but evaluated on the same level
Prevent the escalation of pests and diseases	Stronger believed by adopters but evaluated on the same level
Yield increase	Same belief strength but more positive evaluated by non-adopters
Increase soil humus content	Non-adopters are neutral towards this belief

Contribute to a beautiful landscape	
Support bees	
Break labor peaks	Is stronger believed by adopters but evaluated more positively by non-adopters
Well running workflow	
Acceptance of my biogas plant increases	
High cereal prices	A driver in this FTZ because it is not a cereal region and cereals are actually enriching the crop rotation which consist of mainly maize
Other farmers	Respondents were only asked if these persons approve of cover cropping. If they ticked no, his does not automatically mean that they are barriers. But the hypotheses, that these are drivers is rejected
Agricultural advisory	
Barriers	
If the crops that are possible to grow vary widely in respect to their gross margin	
High land rents	
Considerable higher costs*	
Low income	
No other biomass plants beside maize	This barrier is perceived as higher difficulty by adopters compared to non-adopters
Biogas plant	
Specialized farm	Is not perceived as a barrier by adopters
On former grassland	
If one needs a lot of straw	
Lack of market and utilization opportunities for the different crops	

Table 62: Main barriers and drivers for rotation grass/maize in 20C (The Netherlands - dairy cattle/permanent grass)

Barrier/driver	Suggested solution	Stakeholder	Likelihood of success		Comments
Main drivers			**Adoption**	**Success**	
The rotation of grass-maize favours yields of both crops					
The rotation of grass-maize improves the quality of the fodder					
Regular resowing of grass improves the sod					
With the rotation of grass-maize you have less soil diseases					
With a rotation of grass-maize I can establish the sod in August					
Main barriers					
Harvesting maize when fields are very wet causes physical damage to the soil					At the 10% level more valued by adopters than by non-adopters
Costs of ploughing and the establishment of the sod are high					Highly but equally valued by adopters and farmers with positive intention as by non-adopters and farmers with negative intention. But, evaluation shows that the subject is not that important to farmers
The rotation of grass-maize decreases soil organic matter content					
When practicing rotation of grass-maize pesticide use increases					
Yields are lower when resowing the sod					
The protein content is low in the first year of resowing the sod					
Standard application of N for grass too low to establish the sod					Highly but equally valued by adopters and non-adopters but evaluation is higher valued by adopters than non-adopters.

Table 63: Main barriers and drivers for rotation with grass in 16C (Italy - dairy cattle/temporary grass).

Barrier/driver	Comments[1]
Main drivers	
Improve soil structure	
Less herbicide used	
Less insecticide used	
Improve the ration of dairy cows	
Better distribution of labour peaks in the farm	

Main barriers	
High amount of irrigation water needed for the grass meadow	The attitude for the three barriers is, in absolute terms, much lower than the attitude for the drivers: the two barriers have attitudes of -2.69, -2.22 and -2.07, while the drivers have attitudes ranging from 4.33 to 5.89.
Cost for meadow cultivation	
High selling price for maize	

Table 64: Main drivers and barriers for crop rotation in 10A (Spain - arable/cereals).

Barriers	Suggested solution	Stakeholder	Likelihood of		Comments
			Adoption	Success	
FINANCIAL					
Fallow do not have any profit	Crop rotations with crops adapted to the local conditions of the farms.	Farmers	Medium	Medium	Fallow was a common practice in the mid s.XX in order to recharge the soil. Now is not very common because good yields are obtained without the need of fallow because of the fertilizations.
	Policies enhancing crop rotations with crops adapted to local conditions.	Policy makers	Medium	High	
	Subsidies in case of external risks such as, frozens, heavy rains, …	What farmers want from policy makers	Medium	High	
Benefits and profitability are reduced	Make good decissions choosing the crops based on climate conditions and soil characteristics.	Farmers	High	High	Farmers training is essential for making good decissions. Research and extension services are very important as well.
	Rational policies for crop rotations adapted to markets and the region.	Policy makers	High	High	
	Flexible subsidies which improve the free development of the sector.	What farmers want from policy makers	High	High	
It is difficult to sell the product when there is surplus	More information and sown the right crops demanded by the markets based on soils, weather conditions, etc.	Farmers	Medium	Medium	Crop systems are very homogeneous and productive but sometimes, this is a problem because there is a surplus.

	Maintain constant subsidy to ensure a minimum benefit to farmers despite of the markets fluctuations.	Policy makers	Medium	High	
	Flexible normatives to adapt the crop to the market.	What farmers want from policy makers	Medium	High	
The CAP establish which management practices farmers have to do	Follow the CAP.	Farmers	High	High	CAP is an important input in the farmers economy and sometime it should be more flexible.
	Adapt the CAP to the different regions.	Policy makers	Medium	High	
	Consider the particular conditions of the different reagions of each country.	What farmers want from policy makers	Medium	High	
HUMAN					
There is not enough knowledge about crop rotation implementation. Farmers need training	Training and visiting other farms to know farmers already implementing crop rotations, the technique and its benefits.	Farmers	Medium	Medium	Crop rotation maintain soil fertility and that means benefits for farmers. It is based on traditional knowledge or market regulations, being essentioal the combination of both factors and adding thecnical knowledge adapted to the local conditions.
	To make easier the farmers training. To enchance the technical assesssment and associations.	Policy makers	Medium	High	
	Accessibility to technical expertise and specific training, such as crop management, regarding crop rotations.	What farmers want from policy makers	Medium	High	
Assessment on markets and profitable crops are needed	Grouping in farmers associations to be well assessed.	Farmers	Medium	High	Farmers should know markets situation for choosing the most profitable crops regarding theiir farms.
	Dissemination of information and transparency. To promote farmers association by law.	Policy makers	Medium	High	
	Facilities to create associations for farmers assessment.	What farmers want from policy makers	Medium	High	
NATURAL					
Pests, diseases and weeds are worse controlled	Training and information about the ideal rotations in each farm.	Farmers	Medium	High	Crop rotations is a diverse and versatile system. Therefore pests,

	To know the advantages and disadvantages of crop rotations. Flexible norms in funtion of the regions.	Policy makers	Medium	High	diseases and weeds are better controlled as they are not adapted to the same crop.
	Accessibility to training and subsidies adapted to the characteristics of each farm.	What farmers want from policy makers	Medium	High	
Weather conditions are very variable	Training and technical advice for the most appropriate time to perform the work in order to minimize damage to crops.	Farmers	High	High	Las condiciones climáticas juegan un papel importante en el calendario de labores del Farmers, pues el manejo del cultivo depende de ellas. Esta es una limitación tanto para los cultivos de invierno como de verano, con independecia si se realiza rotación de cultivos en la finca.
	To facilitate the access to training and flexible regulation.	Policy makers	Medium	High	
	Subsidies which ensure an economical input every year, specially if in the case of total or partial loss of the crop.	What farmers want from policy makers	Medium	High	
PHYSICAL					
Farmers do not have the proper machinery	To use the services of some companies devoted to small farms or groups of samll farmers.	Farmers	High	High	Small farms do not have the proper machinery for crop rotation, as these are very expensive for the volume of the holding; therefore, farmers do not amortize the investment.
	To facilitate or promote by law the association of farmers to buy the machinery.	Policy makers	Medium	Medium	
	Subsidies for investments.	What farmers want from policy makers	Medium	Medium	
SOCIAL					
Traditionally fallow is not well seen	Training and assessment.	Farmers	Medium	High	
	Training, assessment, and dissemination of the information at the fiel level.	Policy makers	Medium	High	
	Enchance farmers training and farmers associations.	What farmers want from policy makers	Medium	High	

6.7.2 Land exchange

Table 65 provides an overview of the most important drivers and barriers of land exchange in 6M (Belgium – mixed). Land exchange was defined as the temporary exchange of arable fields with colleagues to make it possible to have more different crop types in the crop rotation.

Table 65: Main drivers and barriers for land exchange in 6M (Belgium - mixed).

Barrier/driver	Comments
Main drivers	
More possibilities for crop rotation	Both adopters and non adopters
Dairy farmers	Only adopters
Less diseases	Non adopters are less convinced
Higher yields	Non adopters are less convinced
Additional source of revenues	Both adopters and non adopters
Decreases soil depletion	Both adopters and non adopters
Increased balance of soil nutritients	Non adopters are less convinced
Main barriers	
I do lots of effort to maintain soil quallity	Both adopters and non adopters and is only perceived as a barrier by non adopters
not often applied in this region	Both adopters and non adopters
Received land is further away	Both adopters and non adopters
Lots of farmers grow the same crops as I do	Both adopters and non adopters
I have a good rotation scheme	Both adopters and non adopters and is perceived as a bigger barrier by non adopters
Less good structure of my soil	Both adopters and non adopters, non adopters are more convinced
Higher transport costs	Both adopters and non adopters
For certain crops, I have to pay for land of other farmers	Bigger barrier for non-adopters
Increase of specific weeds	Only non adopters
Other farmers will not take as good care of my soil as I do	Only non adopters
Unsure how other farmers will deal with/fertilize my land	Only non adopters
Unsure on land quality I get in return	Only non adopters

6.7.3 Legume crops

Table 67 to Table 71 provide an overview of the most important drivers and barriers on the rotation with legume crops per FTZ. In Table 66, an overview of the definition of legume crops as formulated in the questionnaire in each country/ftz is given. This definition might be important in understanding differences in barriers and drivers between FTZs.

Table 66: Definition of legume crops across FTZs (if FTZ is not specified, similar definition was used across FTZs within the country). FTZ: farm type zone.

Country	FTZ	BMP	Definition of BMP
Austria		legume crops	The growing of different species of crops in a crop rotation with >25% coverage with legume crops.
Belgium		rotation of maize with grass clover	Rotation of maize with grass clover (for mowing, not grazing). Grass clover should be maintained for at least one year
Italy	16C	rotation with legume meadows	Rotation with legume crops involves the variation of the cultivated species in a field by inserting legume meadows (e.g. alfalfa), which remains in place for more than one year.
	16A	rotation with legume ley crop	rotation with legume ley crop is a technique that involves the change, from a production cycle to another, of the species cultivated in the same plot with the inclusion of legumes as ley (e.g. alfalfa) that remain in cultivation for more than a year.

Table 67: Main drivers and barriers for rotation with legume crops in 16C (Italy - dairy cattle/temporary grass).

Barrier/driver	Comments[1]
Main drivers	
Increase soil fertility	
Increase crop yield	
Less weeds	
Reduction of insects Reduction of fertilisers in the following crop	
High forage production	

Diversity of forage	
Increase of milk production	
Improved soil structure	
Reduce the cost of the protein for the ration, compared to buying it	
Main barriers	We did not identify barriers for ROTL.

Table 68: Main barriers and drivers for rotation with legume crops in 16A (Italy - arable/cereals).

Barrier/driver	Comments[1]
Main drivers	
Increased soil nitrogen availability	
Increased soil fertility	This is the most important driver among the outcomes (attitude of 7.50).
Higher crop yield	
Reduced cultivation costs	A≠NA
Advisors of professional organisations	A≠NA. The subjective norm for all referents is close to zero. The highest subjective norm is for the advisors of professional organisations (farmers' unions).
Main barriers	
Machineries are expensive	This is the most important barrier among control factors, in contrast with the outcome 'Reduced cultivation costs'.
Lack of skills to cultivate alfalfa	Adopters think they have significantly less lack of skills (i.e. they are more skilled) compared to non-adopters (control strength of 1.41 for adopters and 2.24 for non-adopters). However, the perceived behavioural control is not significantly different between the two groups.

Table 69: Main barriers and drivers for legume crops in 5C (Belgium - dairy cattle/permanent grass).

Barrier/driver	Comments
Main drivers	
More crude protein in silage compared to grassland/N fixation	

Less use of mineral fertilizers	Having to use less mineral fertilizers is important but they are not really convinced yet that grass-clover leads to lowered needs for N-fertilization. Better knowledge dissemination is needed.
Not enough land for roughage for my herd	Having not enough roughage is regarded to be a barrier for non-adopters and a driver for adopters
Main barriers	
Grassland is intensively cultivated on my farm	Barrier for non-adopters but not for adopters.
Positive N balance on the farm	Barrier is more important for non-adopters
Not enough land for roughage for my herd	Having not enough roughage is regarded to be a barrier for non-adopters and a driver for adopters
Higher sensitivity of clover towards some herbicides/higher costs for crop protection	
Disappearance of clover	

Table 70: Main barriers and drivers for legume crops in 2M (Austria-mixed).

Barrier/driver	Suggested solution
Increased nitrogen content	-
Support the soil fertility	-
Good previous crop value for winter cereals	-
Increased humus content	-
Uncomplicated in cultivation	-
Contribution to the local protein supply	-
Requires no mineral fertiliser	-
Grain production technology can be used	-
Decreased production costs	-
Less labour intensive	-
Increased risk of erosion	Depends on the crop rotation – better agricultural advice
Problems with pests	Increase of the mechanical soil tillage

Lack of maturity in some years	-
High weather dependency	-
Low self compatibility	Use of suitable varieties – improving of the agricultural advice
Increased complexity of the crop rotation and the farm management	Improving of agricultural advice and training
No effective pesticides	-
No professional plant breeding	-
Late stage of maturity	-
High local precipitation	-
Cultivation of rape instead	-
Fertilisation with slurry	Ground-based application of liquid manure (reduction of NH3 emissions)
Strong fluctuations in yield	Higher share of grain legumes are probably only possible about ecological compensation areas in "Greening", i.e. direct intervention via CAP; on farms with cattle husbandry corn silage can be substitute by clover / grass-clover, but there are already incentives available, such as in the system "Immergrün" in the ecological program ÖPUL 2015-2020 (better erosion protection, less use of N fertilizer, ...)
Poor contribution margin	Technical training on advantages regarding costs/benefits Improving of the agricultural advice and training (saving of ressources, maintaining of the soil fertility)
Reduced yields over the years	Technical training on advantages regarding costs/benefits
Not competitive	Technical training on advantages regarding costs/benefits Improving of the agricultural advice and training (saving of ressources, maintaining of the soil fertility)
Expensive seeds	Technical training on advantages regarding costs/benefits
No market demand	-
Higher opportunity costs	Technical training on advantages regarding costs/benefits
High yield uncertainty	-
Low market price	Improving of the agricultural advice and training (saving of ressources, maintaining of the soil fertility)

Low price for pork meat	-

Table 71: Main barriers and drivers for legume crops in 1A (Austria -arable/cereals).

Barrier/driver	Suggested solution
Positive previous crops	-
Better soil structure	-
Fixation of nitrogen	-
Cultivation of soil is easier	-
Good deep loosening of the soil	-
Uniform and comprehensive growth of the following crop	-
Feeding of legumes to cattles	-
Wide crop rotation	-
Funding or financial compensation	-
Agricultural experiments	-
Literature	-
Information about GM free feeding	-
High demand in the population	-
Higher pesticide applications	Increase of the mechanical soil tillage
No stabile variants	-
Bad seed quality	Use of suitable varieties – improving of the agricultural advice
Expensive seeds	Technical training on advantages regarding costs/benefits
Bad marketing	-
Difficult crop management	-

Strong yield fluctuations	Higher share of grain legumes are probably only possible about ecological compensation areas in “Greening”, i.e. direct intervention via CAP; on farms with cattle husbandry corn silage can be substitute by clover / grass-clover, but there are already incentives available, such as in the system "Immergrün" in the ecological program ÖPUL 2015-2020 (better erosion protection, less use of N fertilizer, ...)

6.7.4 Permanent grazing/rotational grazing

Table 72 provides an overview of the most important drivers and barriers on permanent grazing in 3C (Austria – dairy cattle). This BMP was defined as ‘continuous feeding on standing vegetation by livestock/Rotational feeding (i.e. changing the grazed parcels) on standing vegetation by livestock’.

Table 72: Main barriers and drivers for permanent grazing in 3C (Austria - dairy cattle).

Barrier/driver
Saved time and money
Increased contribution margin
Reduced concentrated fodder
Improved animal health
Less stress for the herd
Improved fodder quality
Improved metabolic cycle of the cows
Increased humus content
Reduced mineral fertilisation
Closed and sustainable circle is possible
Requires a regularly overseeding
Enough adjacent pasture around the barn
Literature

Advisors of the Chamber of Agriculture
Trampling damages in the sward with wet weather
Animals are too far away and the animal viewing is insufficient
Additional combat of cow parasites
Steep slopes
Number of animals on the pasture do not fit with the precipitation or weather conditions
Animals have to bridge long distances
Leads to erosion
Fertiliser irregularly distributed on the field surface
Planning safety regarding the upcoming CAP (Common Agricultural Policy) misses
Lack of know-how
Parents

6.8 Tillage

6.8.1 No tillage

Table 73 to 77 provide an overview of the most important drivers and barriers on no tillage per FTZ. In the FTZs in Italy, it was defined as ‘sod seeding (or no tillage or direct drilling) is a cultivation system based on the absence of any type of soil mechanical tillage. It is run with specific drills that are able to sow directly on untilled soil, possibly occupied by the residues of previous crop on the soil surface.’ In France, no tillage was defined as ‘no-till planters use a coulter, located at the front of the planting unit; once the coulter has broken through the residue and crust, the disk opener slices the soil, and the planter drops the seed into the furrow; then a press wheel closes the furrow.’

Table 73: Main barriers and drivers for no tillage in 15A (France - arable).

Barrier/driver		Comments
Main drivers	**Promoting paths**	
environnement (on-farm)		
improves soil biological activity	Local experiments on soil properties with NT demonstrating biological activity changes	Second driver quoted
improves top layers porosity	Demonstrations in local experiments	
improves soil structure stability	Knowledge based at France level	Third driver quoted
increase organic matter content	Local experiments on soil properties with NT demonstrating OM content in each soil layer	Main driver quoted
Control factors		
Soils lack OM		Champagne Berrichonne has traditionnaly low OM contents in soil
Main barriers	**Suggested solution**	
Economics (profit)		
Increases herbicide cost		Important barrier
machinery		
Needs a modification of material	Subsidies for buying material	
work load and organisation		
modifies work organisation	Training sessions	
Increases weeds	Local experiments to increase knowledge base and management skills	Linked with increase of herbicides costs
Needs modifying the crops succession	NT can be combined with the changes in crop succession already promoted at the regional level	
Increases pests	Local training courses to increase knowledge base and management skills	
Not stimulated by other farmers		
Not stimulated by extension services	Political choices	There is a competition in champagne Berrichonne for which BMPs to promote and they have chosen to promote the increase of crop succession variety
Control factors		

Lack of appropriate material		

Table 74: Main barriers and drivers for no tillage in 13A (France - arable).

Barrier/driver		Comments
Main drivers	**Promoting paths**	
environnement (on-farm)		
improves soil biological activity	Local experiments on soil properties with NT demonstrating biological activity changes	Second driver quoted
Immproves soil structure stability	Demonstrations in local experiments	
increase organic matter content	Local experiments on soil properties with NT demonstrating OM content in each soil layer	Main driver quoted
Control factors		
Soils lack OM		
Soils are heterogenous		
Non eroded soils		
Good soil quality		Adopters have a better soil quality than non adopters
Main barriers	**Suggested solution**	
Economics (profit)		
Increases herbicide cost	Local experiments to test adaptation paths towards better weeds management	Important barrier
machinery		
Needs a modification of material	Subsidies for buying material	
Increases weeds	Local experiments to increase knowledge base and management skills	Linked with increase of herbicides costs
Increases pests	Local training courses to increase knowledge base and management skills	
Not stimulated by other farmers		
Not stimulated by extension services		Depends on the area
Control factors		
Lack of appropriate material	Subsidies for buying material	

Table 75: Main barriers and drivers for no tillage in 14C (France - dairy cattle).

Barrier/driver		Comments
Main drivers	**Promoting paths**	

environnement (on-farm)		
improves soil biological activity	Local experiments on soil properties with NT demonstrating biological activity changes	Second driver quoted
Improves top layer porosity		Important because of crusting phenomenon
Immproves soil structure stability	Demonstrations in local experiments	Important because late cropping of corn in wet condition damage soil structure
increase organic matter content	Local experiments on soil properties with NT demonstrating OM content in each soil layer	Main driver quoted
Main barriers	**Suggested solution**	
Economics (profit)		
Increases herbicide cost		Important barrier
Increases weeds	Local experiments to increase knowledge base and management skills	Linked with increase of herbicides costs
Increases pests	Local training courses to increase knowledge base and management skills	
Not stimulated by other farmers		
Not stimulated by extension services		
Control factors		
Lack of appropriate material	Subsidies for buying material	
Managing weeds is difficult in the farm		

Table 76: Main drivers and barriers for no tillage in 16A (Italy - arable/cereals).

Barrier/driver	Comments[1]
Main drivers	
Increased soil organic matter	
Lower cultivation costs	Among the outcomes, this is the main driver (attitude 7.06).
Improved timeliness of tillage	
Information from technical journals	Among the referents, this is the main driver (highest subjective norm).
Main barriers	
Lower crop yield	A≠NA
More weeds	Among the outcomes, this is the main barrier.

Nice-looking field	A≠NA
Expensive machineries	A≠NA . Non-adopters are more convinced, compared to adopters, that with expensive machineries it is harder to apply the BMP. Both groups recognise this factor as a barrier.

Table 77: Main barriers and drivers for no tillage in 17A (Italy - arable/cereals) (Germany - arable+mixed/specialised crops).

Barrier/driver	Comments[1]
Main drivers	
Higher crop yield	A≠NA. Farmers are not convinced at all that yield will be higher in NT compared to CT (behavioural belief strength of 1.73).
Improved soil structure	This is an important driver, but its behavioural belief strength (2.96) is substantially lower compared to other drivers lower cultivation costs and reduced working time. Adopters are significantly more convinced of the occurrence of this outcome compared to non-adopters.
Lower cultivation costs	This is the main financial driver to adoption.
Reduced working time	This is the main physical driver to adoption.
Main barriers	
Lower crop yield	Among the outcomes, these are the most important barriers.
More weeds	Farmers are more convinced that yield will be lower in NIT compared to CT (behavioural belief strength of 4.09).
Increased wheat diseases	
Lack of adequate machineries	Among control factors, this is the most important barrier.
Information from technical journals	
Family members	A≠NA. Among the referents, this is the most important barrier.
Other farmers	The second most important barrier among referents.

6.8.2 Direct drilling

Table 78Table 78 provides an overview of the most important drivers and barriers for direct drilling in 10A (Spain – arable/cereals). Direct drilling was defined as sowing with minimum disturbance of the soil surface. Crop residues, which vary in quality, quantity and characteristics depending on the rotation and operation, remain on the soil surface.

Table 78: Main drivers and barriers for direct drilling in 10A (Spain - arable/cereals).

Barriers	Suggested solution	Stakeholder	Likelihood of	Comments

			Adoption	Success	
FINANCIAL					
Lack of subsidies	To get informed about the advantages and disadvantages for thaking the best decission.	Farmers	High	High	Direct drilling is not very well know and not widely implemented among farmers. Is it important to know its benefits for a decission making-
	Regional normatives.	Policy makers	Medium	Medium	
	Subsidies and technical assessment.	What farmers want from policy makers	Medium	High	
HUMAN					
Information and training is demanded	Training and assessment from technicians with exppecience in this practice.	Farmers	Low	Medium	Research in direct seeding is very important; past experiences of other countriescan be taken as reference. Training and assessment are also necessary to adapt the technique to the local conditions
	Training and dissemination of technical knowledge.	Policy makers	Low	Medium	
	Subsidies for buying machinery.	What farmers want from policy makers	Low	Medium	
NATURAL					
More pests and diseases	Training and assessment by technicians.	Farmers	Medium	Medium	
	To facilitate the training and farmers association.	Policy makers	Medium	High	
	Organization of training and support partnerships to address setbacks.	What farmers want from policy makers	Medium	High	
Higher soil compaction	Training and assessment by technicians.	Farmers	Medium	High	
	To facilitate the training and norms.	Policy makers	Medium	High	
	Training and subsidies.	What farmers want from policy makers	Medium	High	
My farm has a high clay content	Training and assessment by technicians.	Farmers	Medium	Medium	This technique has many benefits but for clayey soil, soil consolidation is significant.
	To facilitate the training and promote reaseach.	Policy makers	Medium	Medium	
	Research in direct drilling and its	What farmers want from policy makers	Medium	Medium	

	implememtation in different crop rotations.				
PHYSICAL					
Some operations in the farm are more complicated	Formarse y asociarse con otros Farmers de siembra directa.	Farmers	Medium	Medium	Direct drilling requires specific equipment and skilled labor.
	Favorecer a la información de los Farmers y a la asociación de los mismos.	Policy makers	Medium	Medium	
	Subvenciones para afrontar las dificultades de la finca.	What farmers want from policy makers	Medium	Medium	
More herbicides are required	Informarse d e mejor tratamiento	Farmers	Medium	Medium	
	Una norma que controle la utilización de pesticidas	Policy makers	Medium	High	
	Ayudas económicas	What farmers want from policy makers	Low	High	
Strong invesment in machinery	Associations of farmers and services companies.	Farmers	Medium	Medium	The machinery used for direct drilling is not suitable for all types of soils and weather conditions, which are the major constraints for sowing. The adaptation of machinery and farmers association would favor the adoption of this practice on farms.
	To facilitate the adquisition of machinery through economical support.	Policy makers	Medium	Medium	
	Subsidies.	What farmers want from policy makers	Medium	Medium	
The available machinery do not work well	Do not implement direct drilling if the soil is not appropriate to use these heavy machines.	Farmers	Medium	High	Direct drilling machinery is large and heavy.
	Encourage research to adapt the equipment to the characteristics of the soil.	Policy makers	Medium	High	
	To establish regulations to encourage research and development of machinery adapted to the needs and characteristics of the soil.	What farmers want from policy makers	Medium	High	
This practice is not well established	To inform, and visit farms with	Farmers	High	High	The technique is not well adapted

	similar characteristics.				in clayey soils.
	Supporting research and the training of farmers.	Policy makers	High	High	
	Research to adapt the equipment to different soils.	What farmers want from policy makers	High	High	
More herbicides are required	Direct drilling in only one crop of the rotation.	Farmers	Medium	High	Farmers need technical assistance for ensuring the success of the practice regardless of the interests of the herbicides manufactures.
	To promote crop rotation based on the farm characteristics.	Policy makers	Medium	Medium	
	Training and dissemination of the information.	What farmers want from policy makers	Low	Medium	
SOCIAL					
People think that the farm is abandoned	To inform, and visit farms with similar characteristics.	Farmers	Medium	Medium	Direct drilling leave crop residues on soil surface which once they are degraded provide some nutrients to the following crop.
	Supporting research and the training of farmers.	Policy makers	Medium	Medium	
	Research about residues incorporation to soil profile.	What farmers want from policy makers	Medium	Medium	

6.8.3 Controlled traffic farming

Table 80 to 82 provide an overview of the most important drivers and barriers for controlled traffic farming per FTZ. In Table 79, an overview of the definition as formulated in the questionnaire in each country is given. This definition might be important in understanding differences in barriers and drivers between FTZs.

Table 79: Definition of controlled traffic farming across countries.

Country	Definition of BMP
Germany	CTF uses the very same machine tracks every year. By Using DGPS and machines with the same working widths the fields are separated in parts with and without traffic
Spain	Keep the same paths and tracks throughout the year to perform the different agricultural machinery operations.
The Netherlands	All crop handling is always carried out on the same lanes, except ploughing and harvesting. This means every year all machinery is driving on the same lane with the aid of precision GPS.

Table 80: Main drivers and barriers for controlled traffic farming in 8A (Germany - arable+mixed/specialised crops).

Drivers/ Barriers	Comment
Drivers	
Better root growth	Both, adopters and non-adopters and persons with positive and negative intention
Support of soil life	Both, adopters and non-adopters and persons with positive and negative intention
Looser soil between machine tracks	Both, adopters and non-adopters and persons with positive and negative intention
Higher yields	Both, adopters and non-adopters and persons with positive and negative intention
Prevention of subsoil compaction	Both, adopters and non-adopters and persons with positive and negative intention
Better water filtration	Both, adopters and non-adopters and persons with positive and negative intention
Fuel savings	Both, adopters and non-adopters and persons with positive and negative intention
Increase of humus content	Both, adopters and non-adopters and persons with positive and negative intention
Straight machine tracks	Both, adopters and non-adopters and persons with positive and negative intention
Better trafficability also under wet conditions	Both, adopters and non-adopters and persons with positive and negative intention
Farmers' journals	Adopters and persons with positive intention
Machine dealers	Not perceived as drivers by non-adopters and persons with positive and negative intention
Other farmers	Not perceived as drivers by non-adopters and persons with positive and negative intention
Barrier	
A CTF system would be very expensive	Both, adopters and non-adopters and persons with positive and negative intention
Cemented machine tracks	Non-adopters, persons with positive and negative intention

Machines do not have the same working width*	Both, adopters and non-adopters and persons with positive and negative intention
Not paying attention to a uniform working width when machines are bought*	Both, adopters and non-adopters and persons with positive and negative intention
The farm manager is old	Both, adopters and non-adopters and persons with positive and negative intention
Small farm with specialized technique	Both, adopters and non-adopters and persons with positive and negative intention
A lot of short-term tenure	Both, adopters and non-adopters and persons with positive and negative intention
No GPS*	Both, adopters and non-adopters and persons with positive and negative intention
Many investments in the last years	Non-adopters and persons with positive and negative intention
Not knowing any farm where CTF is implemented successfully*	Both, adopters and non-adopters and persons with positive and negative intention

Table 81: Main drivers for controlled traffic farming in 18A (The Netherlands - arable/specialised crops and cereals)

	Adopters	Non-adopters	p-value	Adopters	Non-adopters	p-value	Positive intention	Negative intention	p-value	Positive intention	Negative intention	p-value
Drivers	**Behavioural belief strength**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
controlled traffic improve rooting	4.57	4.13	0.234	4.71	4.86	0.476	4.30	4.15	0.628	4.90	4.84	0.735
With controlled traffic soil structure improves	4.14	3.93	0.651	4.71	4.85	0.535	3.70	3.98	0.492	4.90	4.83	0.698
controlled traffic reduces water troubles	4.14	3.51	0.197	4.71	4.82	0.605	4.00	3.50	0.235	4.80	4.82	0.924
controlled traffic improve yields	4.14	3.58	0.207	4.57	4.74	0.497	3.90	3.59	0.412	4.90	4.71	0.365
It if difficult to implement controlled traffic in the management	2.86	3.98	0.020	4.71	4.60	0.703	3.60	3.93	0.433	4.70	4.60	0.688
controlled traffic reduces diseases	3.57	2.56	0.030	4.43	4.75	0.269	3.30	2.56	0.062	4.80	4.72	0.748
Using controlled traffic allows you to use machines on the field with wet weather	3.86	3.18	0.176	4.14	3.60	0.252	3.60	3.18	0.332	3.70	3.63	0.871
	Normative belief			**Motivation to comply**			**Normative belief**			**Motivation to comply**		
Organic farmers have good results with it	4.14	4.07	0.834	3.71	3.31	0.306	4.50	4.02	0.102	3.50	3.32	0.591
Farmers with beds are positive	3.86	3.82	0.928	3.29	3.26	0.942	4.40	3.76	0.039	3.60	3.22	0.227
Research is positive	4.14	3.59	0.132	3.86	4.22	0.239	4.40	3.54	0.005	4.10	4.21	0.687
Magazines are positive	4.29	3.51	0.037	3.86	3.74	0.712	4.30	3.48	0.009	3.80	3.74	0.834

Demonstration trials of machines show good possibilities	3.71	3.19	0.195	3.43	2.87	0.144	4.00	3.13	0.011	3.30	2.87	0.182
Study club is positive	4.00	3.09	0.009	4.14	3.89	0.501	4.00	3.06	0.001	4.00	3.90	0.757
Other arable farmers are positive	3.71	2.94	0.047	3.43	3.60	0.661	3.70	2.91	0.018	3.50	3.60	0.769
	Control strength			**Control power**			**Control strength**			**Control power**		
I use non inversion tillage	3.43	2.46	0.089	4.00	3.46	0.297	2.90	2.49	0.399	3.90	3.45	0.310

Table 82: Main barriers for controlled traffic farming in 18A (The Netherlands - arable/specialised crops and cereals)

	Adopters	Non-adopters	p-value	Adopters	Non-adopters	p-value	Positive intention	Negative intention	p-value	Positive intention	Negative intention	p-value
Barriers	**Behavioural belief strength**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
Controlled traffic allows procedures such as spraying or mechanical weed control to be done easily	4.29	3.92	0.395	2.57	2.22	0.346	4.10	3.93	0.639	2.40	2.23	0.593
Controlled traffic requires a high investment for the right machinery	3.43	4.36	0.006	2.86	2.48	0.254	3.90	4.34	0.131	2.60	2.50	0.722
	Normative belief			**Motivation to comply**			**Normative belief**			**Motivation to comply**		
Buyers emphasize	3.29	2.38	0.029	4.00	3.20	0.061	3.40	2.33	0.002	4.00	3.17	0.022
Extension agents are positive	4.00	2.73	<0.001	3.71	3.86	0.663	4.00	2.68	<0.001	3.90	3.84	0.836
	Control strength			**Control power**			**Control strength**			**Control power**		
Converting to controlled traffic should be done at once	3.14	3.74	0.278	2.86	1.55	<0.001	3.80	3.68	0.804	2.20	1.59	0.072
Converting to controlled traffic requires a large investment	3.00	4.14	0.025	3.29	2.07	0.003	3.90	4.07	0.694	2.70	2.10	0.090
My machines are not suitable for controlled traffic	2.29	3.73	0.014	3.86	2.11	<0.001	2.50	3.76	0.012	2.80	2.17	0.132
Harvesting using controlled traffic is not yet developed	3.14	3.82	0.182	3.29	2.21	0.015	3.30	3.83	0.224	3.40	2.16	<0.001
The benefits of controlled traffic are not clear to me	2.00	2.75	0.131	3.00	2.02	0.033	2.20	2.76	0.191	3.10	1.98	0.004
I do not have colleagues with whom I can share the costs for the machines of controlled traffic	2.86	3.81	0.096	3.43	2.36	0.028	3.60	3.76	0.751	3.10	2.37	0.076
I am not convinced controlled traffic is technically possible	2.86	3.20	0.528	2.71	2.36	0.449	3.00	3.20	0.673	2.90	2.33	0.145
Not all machinery is available at 3 m wide	2.43	3.05	0.249	3.43	2.28	0.020	2.70	3.04	0.463	3.10	2.28	0.052
I plough my land	3.71	4.22	0.325	4.14	2.62	0.004	4.30	4.17	0.770	4.20	2.56	<0.001
I have to widen my concrete path to the field when I	2.57	2.19	0.535	3.29	2.53	0.171	2.30	2.21	0.860	2.90	2.55	0.457

want to convert to controlled traffic												
Field accessible only through the public roads require investments in special machines when practicing controlled traffic	2.29	3.16	0.148	3.86	2.86	0.064	2.40	3.18	0.130	3.40	2.88	0.259

Main barriers for controlled traffic farming in 10A (Spain - arable/cereals)

It is difficult to control the traffic in annual crops compared to permanent crops farms. Runoff is increased by the wheel tracks as a result of a greater soil compaction. Therefore, this compaction must be alleviated from time to time. The use of specialized tire can reduce the increase of bulk density in the tracks.

Topography and farm design are also limiting the implementation of this practice. Sometime the inherent characteristics of the farm are the one that establish the paths of the machinery. (rivers, gullies, etc.).

Machinery width should be standardized for all the machinery also to prevent different paths for different machinery.

Field demonstrations, dissemination of information by technicians and educate operators, are key factors in the implementation of this agricultural practice.

6.8.4 Reduced soil compaction

Table 83 provides an overview of the most important drivers and barriers of reduced soil compaction in 9A (Germany - arable+mixed/specialised crops). Reduced soil compaction was defined as 'reduction of soil pressure by either using reduced tire pressure of 1 bar at most or by using special tires like wide tires, caterpillar tracks or twin tires'.

Table 83: Main barriers and drivers for reduced soil compaction in 9A (Germany - arable+mixed/specialised crops).

Barrier/driver	Comments
Drivers	
Low soil pressure	Adopters and non-adopters and persons with positive and negative intention
Prevention of soil compaction	Adopters and non-adopters and persons with positive and negative intention
More even root penetration	Adopters and non-adopters and persons with positive and negative intention
Fuel savings	Adopters and non-adopters and persons with positive and negative intention
Farmers' journals	Adopters and non-adopters and persons with positive and negative intention
Other farmers	Not perceived as a driver by adopters and non-adopters and persons with positive and negative intention
Barriers	
No tire pressure control system*	Adopters and non-adopters and persons with positive and negative intention
Obligation to cross villages to reach more than 15 % of fields	Adopters and non-adopters and persons with positive and negative intention
Many fields only accessible by using streets	Adopters and non-adopters and persons with positive and negative intention
Consequent adjustment of tire pressure to field and street results in more work effort	Adopters and non-adopters and persons with negative intention
High price for special tires	Adopters and non-adopters and persons with positive and negative intention
High price for a tire pressure control system	Adopters and non-adopters and persons with positive and negative intention
Consequent adjustment of tire pressure to field and street delays the operating schedule	Adopters and non-adopters and persons with negative intention
Forgetting to increase the pressure again for the streets if pressure is reduced on fields	Adopters and non-adopters and persons with negative intention

6.9 Nutrient management

6.9.1 Under sowing green manure within maize

Table 84 provides an overview of the most important drivers and barriers of under sowing green manure within maize in 20C (The Netherlands - dairy cattle/permanent grass). This BMP was defined as ‘the mandatory green manure is sown just two weeks after maize sowing instead of after harvest’.

Table 84: Main barriers and drivers for under sowing green manure within maize in 20C (The Netherlands - dairy cattle/permanent grass)

Barrier/driver	Suggested solution	Stakeholder	Likelihood of success		comments
Main drivers			**Adoption**	**Success**	
Immobilization of nitrogen					
When under sowing the green manure no trip on the field after harvest is necessary					
Improves soil strength to the heavy machinery					
Increases the N-availability to the following crop					
Improve nutrient efficiency					
Organic matter increase					
Main barriers					
When under sowing fails double costs	- It does not fail, - You can prove you sowed green manure by showing the bill	Farmer	moderate	Unknown	
Competes on nutrients and water with maize	- On farm demonstrations - field days at experimental farms/demonstrations - tall fescue is very slow growing	Farmer	high	High	Further exploring under sowing: growth retardant, pilling seed, ... to prevent competition
More expensive than sowing after harvest	- That is only so when contractor is involved, - Sow green manure yourself at your on convenience	Farmer	Depends on personal situation	High	Seeding with fertilizer spreader is certainly easier done so explore /promote that
Under sowing a green manure in maize requires an additional trip through the maize	- Can be combined with mechanical weed control	Farmer/contractor	high	High	Different operational management examples in field demonstrations will

					show the extra trip is worth it
For the harvest of the green manure in the spring I need a good stand	- Change purpose of green manure	Farmer	low	Low	The need to mitigate the manure law has not yet been communicated enough
Under sowing a green manure in maize has not yet been tested sufficiently in practice	- On farm demonstrations	Government	high	High	Is confined to specific regions in the Netherland
Contractor does not have the right equipment to under sow a green manure in maize	- Use a fertilizer spreader and shallow harrowing - Collaborate with neighbours for the investment/share equipment	Farmer	moderate	High	These suggestions can only be done when farmers like to work together. Facilitate working together
After maize harvest I flat the soil	- Change purpose of green manure from feed to soil improver	Farmer	low	Low	The need to mitigate the manure law has not yet been communicated enough Farmer not aware enough that nutrient balance needs to be closed in near future
None of my neighbours tried to sow a green manure in the maize crop	- On farm demonstrations close by	Farmer	high	High	Confined to specific regions in the Netherlands
I do not have the knowledge to sow the green manure in maize	- On farm demonstrations close by - Field days at experimental farms	Farmer	high	High	Confined to specific regions in the Netherlands
The success rate of under sowing a green manure in maize is unknown	- On farm demonstrations - Leaflet with results	Farmer	high	High	Can be solved by demonstrations and leaf let

	- Field days at demonstrations				
The manure law decreases soil fertility	- Make farmers aware that under sowing mitigates decreasing soil fertility - Change purpose of green manure from feed to soil improver	Farmer	medium	High	Can be used as driver; farmer not aware enough that nutrient balance needs to be closed in near future

6.9.2 Organic fertilizer

Table 85 to 87 provide an overview of the most important drivers and barriers of application of organic fertilizers per FTZ. In Italy, this was defined as the application of farmyard manure, compost and sewage sludge. In Austria, this BMP was defined as the use of farm yard, slurry, plant compst, bio-waste compost, sludge compost application.

Table 85: Main barriers and drivers for organic fertilizer in 2M (Austria-mixed).

Barrier/driver	Suggested solution
Ecologically practical	-
Support of the soil life	-
Increased nutrient content	-
Good supply with trace elements	-
Dried farmland before use	-
Support of the catch crop quality	-
Appropriate fertilization	-
Sufficient amount of organic fertiliser	-

Less odour nuisance and higher acceptance in the population by use of drag hoses	-
Powerful technique	-
Experienced fertilisation plan	-
Reduced operating technical effort by use of drag hoses	-
Increased yield potential	-
Reduced operational costs	-
Colleagues in the working group	-
Other farmers	-
Higher costs	Technical training on advantages regarding costs/benefits, no furthermineral fertilizer necessary Financial compensation by ÖPUL Cooperation with farms that have higher amounts of organic fertilizers left (e.g. biogas / waste facilities); this enable a more balanced nutrient supply on stockless and livestock-intensive farms (even in the regions with intensive livestock farming, there are already about 30% of arable land without animal husbandry); for this legally traceable supply contracts are required
Increased use of fuel	Technical training on advantages regarding cost savings in fertilization
Limited storage capacity (slurry)	There should not be a problem. Storage capacity should be adapted to the amount of organic fertilizer (Austrian nitrat program) Cooperation with farms that have higher amounts of organic fertilizers left (e.g. biogas / waste facilities); this enable a more balanced nutrient supply on stockless and livestock-intensive farms (even in the regions with intensive livestock farming, there are already about 30% of arable land without animal husbandry); for this legally traceable supply contracts are required
Heavy equipment	Cooperation with farms that have higher amounts of organic fertilizers left (e.g. biogas / waste facilities); this enable a more balanced nutrient supply on stockless and livestock-intensive farms (even in the regions with intensive livestock farming, there are already about 30% of arable land without animal husbandry); for this legally traceable supply contracts are required
Increased weather dependence	Cooperation with farms that have higher amounts of organic fertilizers left (e.g. biogas / waste facilities); this enable a more balanced nutrient supply on stockless and livestock-intensive farms (even in the regions with intensive livestock farming, there are already about 30% of arable land without animal husbandry); for this legally traceable supply contracts are required

Table 86: Main barriers and drivers for organic fertilizer in 16A (Italy-arable/cereals).

Barrier/driver	Comments[1]
Main drivers	
Higher soil organic matter	The behavioural belief strength is significantly higher for adopters than for non-adopters. However, these differences are rather small and do not translate into significantly different attitudes, due to insignificantly different outcome evaluations. Among the outcomes, increased soil fertility is the most important driver.
Increased soil fertility	
Improved soil structure	
Reduced use of mineral fertilisers	
Advisors of professional organisations	A≠NA. In general, all the referents encourage the adoption, especially the advisors of professional organisations (farmers' unions).
Main barriers	
Slow and expensive distribution	The distribution is slow and expensive due to of the machinery used.
Manure is not available in the neighbouring farms	A≠NA. Non-adopters have significantly less manure from neighbouring farms compared to adopters. In addition, non-adopters are significantly more convinced that a lack of manure from neighbouring farms will hinder this BMP.
Lack of confidence in the compost and sludge quality	Adopters are more confident in compost and sludge quality. However, this did not translate into a significantly different perceived behavioural control.

Table 87: Main barriers and drivers for organic fertilizer in 17A (Italy-arable/cereals).

Barrier/driver	Comments[1]
Main drivers	
Higher soil organic matter	
Increased soil fertility	Among the outcomes, this is the most important driver.
Improved soil structure	A≠NA
Reduced use of mineral fertilisers	
Other farmers	
Neighbouring farmers	A≠NA. Neighbouring farmers are a different referent than 'Other farmers', because they are involved as potential providers of FYM.
Main barriers	
Higher cultivation costs	
No incentives for FYM	A≠NA. Incentives could solve the problem of having most livestock operations in northern Italy, while they are very limited in the Centre and in the South of Italy, where the survey took place.
FYM transport is expensive	A≠NA. These are the most important barriers. Note however, that these control factors act as barriers mostly because of the very low control power rather than for the low control strength. In other words, the farmers think that these control factors are limiting in principle, but do not find that the problem is particularly evident in their case.
Lack of adequate machineries	
I do not trust sludge and compost composition	
I do not have neighbours with excessive manure	
Unpleasant odours emission	A≠NA. Among the outcomes, this is the most important barrier. For adopters it is less difficult to apply the practice, compared to non-adopters, when there are unpleasant odour emissions.

6.9.3 Application of farm yard manure

Table 88 to 91 provide an overview of the most important drivers and barriers of farm yard application per FTZ.

Table 88: Main barriers and drivers for farm yard manure in 16A (Italy - arable/cereals).

Barrier/driver	Comments[1]
Main drivers	
Higher soil organic matter	The behavioural belief strength is significantly higher for adopters than for non-adopters. However, these differences are rather small and do not translate into significantly different attitudes, due to insignificantly different outcome evaluations. Among the outcomes, increased soil fertility is the most important driver.
Increased soil fertility	
Improved soil structure	
Reduced use of mineral fertilisers	
Advisors of professional organisations	A≠NA. In general, all the referents encourage the adoption, especially the advisors of professional organisations (farmers' unions).
Main barriers	
Slow and expensive distribution	The distribution is slow and expensive due to of the machinery used.
Manure is not available in the neighbouring farms	A≠NA. Non-adopters have significantly less manure from neighbouring farms compared to adopters. In addition, non-adopters are significantly more convinced that a lack of manure from neighbouring farms will hinder this BMP.
Lack of confidence in the compost and sludge quality	Adopters are more confident in compost and sludge quality. However, this did not translate into a significantly different perceived behavioural control.

Table 89: Main barriers and drivers for farm yard manure in 17A (Italy - arable/cereals) (Germany - arable+mixed/specialised crops).

Barrier/driver	Comments[1]
Main drivers	
Higher soil organic matter	
Increased soil fertility	Among the outcomes, this is the most important driver.
Improved soil structure	A≠NA
Reduced use of mineral fertilisers	
Other farmers	

Neighbouring farmers	A≠NA. Neighbouring farmers are a different referent than 'Other farmers', because they are involved as potential providers of FYM.
Main barriers	
Higher cultivation costs	
No incentives for FYM	A≠NA. Incentives could solve the problem of having most livestock operations in northern Italy, while they are very limited in the Centre and in the South of Italy, where the survey took place.
FYM transport is expensive	A≠NA. These are the most important barriers. Note however, that these control factors act as barriers mostly because of the very low control power rather than for the low control strength. In other words, the farmers think that these control factors are limiting in principle, but do not find that the problem is particularly evident in their case.
Lack of adequate machineries	
I do not trust sludge and compost composition	
I do not have neighbours with excessive manure	
Unpleasant odours emission	A≠NA. Among the outcomes, this is the most important barrier. For adopters it is less difficult to apply the practice, compared to non-adopters, when there are unpleasant odour emissions.

Table 90: Main barriers and drivers for farmyard manure in 4A (Belgium - arable/specialised crops).

Barrier/driver	Comments
Main drivers	
Better soil structure compared to slurry	adopters and non adopters, more pronounced for adopters
Better soil fertility	adopters and non adopters, more pronounced for adopters
More soil life	adopters and non adopters
Lower erosion risk	adopters and non adopters, more pronounced for adopters
More organic matter compared to slurry	adopters and non adopters
Improved water holding capacity of my soil	adopters and non adopters
Higher N supplying capacity of the soil	adopters and non adopters
Working with system of effective nitrogen	Most arable farmers seem to work with system of effective nitrogen. Nevertheless, this is only moderately stimulating them to apply manure. No difference between adopters and non adopters
Main barriers	
No appropriate storage capacity on my farm	More pronounced for non adopters and they also believe farmyard manure has to be stored
Transport of farmyard manure is more expensive compared to slurry	Especially believed by non adopters. If transport of farmyard manure is more expensive, it is a barrier to use manure for both adopters and non adopters
Supply of farmyard manure varies	adopters and non adopters
I have to invest time to find a supplier of farmyard manure in another region (West-Flanders, Limburg)	More pronounced for non adopters
Less sure in timing and quantity of N release by the soil compared	Adopters and non adopters

to mineral fertilizer	
Appropriate machinery not available	More pronounced for non adopters
Limited supply of farmyard manure in my area	More pronounced for non adopters
Slurry is less expensive to me	More pronounced for non adopters
I have to spread manure myself while I do not need to do this for slurry	Both adopters and non adopters but more experienced as a barrier by non adopters

Table 91: Main barriers and drivers for application of farmyard manure in 6M (Belgium - mixed).

Barrier/driver	Comments
Main drivers	
More humus, soil life, soil structure and soil fertility compared to slurry	Adopters and non adopters
Higher yield of the crops	Adopters and non adopters
Main barriers	
Legislation for fertilization is too strict	Both adopters and non adopters are convinced, but this is perceived as a barrier only by the non adopters
No production of manure on my farm	Most important difference between adopters and non adopters
Enough or too much slurry available	This barrier seems to be more pronounced by the non adopters,
Having to pay to get rid of slurry	Only barrier for non-adopters, non-adopters also have to pay more often to get rid of slurry
No appropriate machinery for spreading	Only a barriers for non adopters
Higher cost for spreading, depending on contractor for spreading	Non adopters perceive this as a bigger barriers
Cattle farmers, pig farmers, contractors	Barriers for both adopters and non-adoptes but more pronounced for non-adopters

6.9.4 Application of compost

Table 92 to 94 provide an overview of the most important drivers and barriers of compost application per FTZ. In the Netherlands, compost was more specified as composted vegetable, fruit and garden waste or composted tree cuttings and grass sods from communal maintenance activities.

Table 92: main barriers and drivers for use of compost in 20A (The Netherlands - arable/specialised crops)

	Adopters	Non-adopters	p-value	Adopters	Non-adopters	p-value	Positive intention	Negative intention	p-value	Positive intention	Negative intention	p-value
Drivers	**Behavioural belief strength**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
Compost provides organic matter	4.83	4.44	0.044	4.90	4.52	0.046	4.74	4.47	0.212	4.26	3.12	0.071
Can be applied in the fall/winter	4.90	3.56	<0.001	4.90	4.20	<0.001	4.68	3.41	<0.001	3.63	3.29	0.138
	Normative belief			**Motivation to comply**			**Normative belief**			**Motivation to comply**		
Extension agents are positive	4.67	3.48	<0.001	3.80	3.56	0.193	2.97	2.18	<0.001	3.53	3.88	0.274
Other arable farmers are positive	4.17	3.52	0.025	3.67	3.80	0.647	3.47	2.53	<0.001	3.58	4.00	0.360
Study club is positive	4.33	3.40	0.001	3.56	3.67	0.233	3.05	2.18	<0.001	4.68	3.41	0.327
	Control strength			**Control power**			**Control strength**			**Control power**		
It is not available in my region	3.27	3.20	0.861	3.67	3.12	0.075	2.53	1.76	0.403	3.34	3.00	0.117
Plenty of other possibilities to apply organic matter	3.13	2.80	0.337	3.83	2.48	<0.001	4.26	3.12	0.226	2.84	3.29	<0.001
Compost applications increase costs	3.77	3.20	0.085	3.63	2.64	<0.001	4.68	4.35	0.111	3.68	3.12	0.003
Barriers	**Behavioural belief strength**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
It can contain unwanted waste	3.53	3.92	0.282	1.13	1.12	0.900	3.58	4.00	0.276	3.82	3.53	0.386
Cost more labour to apply	3.60	3.68	0.824	2.47	2.08	0.197	3.53	3.88	0.357	3.87	3.53	0.016
	Control strength			**Control power**			**Control strength**			**Control power**		
Slurry is largely available	4.27	4.52	0.350	3.23	2.12	0.002	4.18	3.18	0.105	4.24	4.71	0.045
The levy free Phosphate level is too low	4.10	3.80	0.379	3.13	2.36	0.050	4.58	3.12	0.211	4.11	3.65	0.039

Table 93: Main barriers and drivers for application of compost in 4A (Belgium - arable/specialised crops).

Barrier/driver	Comments
Main drivers	
Improved soil quality and fertility (soil life, health, organic matter, less heavy soils, improved long term N release)	
Less erosion	
Main barriers	
Risks for weeds (and diseases)	
Other arable farmers	
No experience	Not for adopters
Composition: Uncertain, variable, may contain waste products	Adopters are less convinced compost contains waste products and are less insecure about the composition
Low and uncertain availability	
Costs (purchase, transport, variable prices, application)	The fact that slurry can be spread for them in contrast to compost is not really a barrier for adopters
Manure legislation (limited N and P application rates/risk for too high N residu)	
Being dependent on contractor for application	Both adopters and non-adopters need the contractor for application, but that is not barrier for the adopters. The same difference applies for people with positive vs negative intention
More than enough slurry available	This is especially a barrier for people with a negative intention

Table 94: Main barriers and drivers for applying compost in 6M (Belgium - mixed)

Barrier/driver	Comments (no adopters)
Main drivers	
More humus, soil life	
Better water infiltration and drainage	
Improved soil structure	
Main barriers	
More labor intensive	
Lack of knowledge, experience	

Offer is low, do not know where to get it	
No appropriate machinery for spreading	
Too much slurry available	
Agricultural magazines	
The municipality	
Extension	
Producers of compost	
Other farmers	
Experimental results	
Education	
Other alternatives for maintain humus content in soil	
Higher risks for diseases	

6.9.5 Use of digestate

Table 95 and Table 96 provide an overview of the most important drivers and barriers per FTZ of the use of digestate. This BMP was defined as the application of the non-treated product of a digester.

Table 95: Main barriers for the use of digestate in 20A (The Netherlands - arable/specialised crops)

	Adopt	Non-	p-	Adopt	Non-	p-	Positive	Negative	p-	Positive	Negative	p-
Drivers	**Behavioural belief**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
It is easy to apply	4.64	4.04	0.069	4.82	4.70	0.538	4.17	4.11	0.805	4.60	4.82	0.121
The composition is homogeneous	4.45	3.65	0.019	5.00	4.79	0.218	4.07	3.55	0.044	4.80	4.84	0.741
You know what minerals are in digestate	4.36	3.42	0.016	4.82	4.74	0.688	3.83	3.37	0.114	4.73	4.76	0.843
Digestate increases soil fauna	2.55	2.98	0.232	4.91	4.81	0.424	2.87	2.95	0.767	4.73	4.89	0.085
With digestate organic matter is applied	2.36	2.88	0.237	4.91	4.86	0.698	2.80	2.79	0.974	4.87	4.87	0.985
It is cheap	3.73	3.16	0.116	4.36	4.11	0.449	3.53	3.03	0.058	4.37	3.97	0.118
Digestate has fast mineralizing N	4.27	3.75	0.149	3.64	3.33	0.327	4.03	3.68	0.191	3.50	3.29	0.358
	Normative belief			**Motivation to comply**			**Normative belief**			**Motivation to comply**		
Salesmen are positive	3.55	3.72	0.605	2.73	2.63	0.794	3.60	3.76	0.51	2.93	2.42	0.057
Magazines are positive	3.82	3.21	0.029	3.64	3.88	0.303	3.63	3.05	0.00	3.80	3.87	0.694
Research is positive	3.73	3.11	0.015	4.36	4.09	0.280	3.47	3.00	0.01	4.13	4.13	0.993

Other arable farmers are positive	3.82	3.05	0.013	3.73	3.86	0.655	3.53	2.89	0.00	3.73	3.92	0.393
Extension agents recommend the use of digestate	3.64	2.91	0.011	4.00	3.98	0.949	3.33	2.79	0.01	3.90	4.05	0.450
Study club is positive	3.64	2.91	0.007	3.82	3.84	0.930	3.33	2.79	0.01	3.83	3.84	0.966
Neighbours are positive	2.73	2.54	0.575	2.45	2.25	0.583	2.77	2.42	0.15	2.70	1.95	0.006
Barriers	**Behavioural belief**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
Applying digestate increases the risk on contaminating my fields	2.27	2.91	0.106	1.00	1.39	0.125	2.43	3.11	0.021	1.37	1.29	0.681
Applying digestate increases diseases	2.00	2.33	0.287	1.09	1.30	0.309	2.13	2.39	0.260	1.47	1.11	0.015
	Control strength			**Control power**			**Control strength**			**Control power**		
There is a large supply of manure in my region	3.27	3.86	0.182	3.00	2.04	0.017	3.57	3.92	0.278	2.83	1.68	<0.00
The manure law is too strict to apply digestate	2.36	3.79	0.002	3.64	2.07	<0.00	2.97	4.03	0.002	3.00	1.79	<0.00
It is expensive	2.64	3.04	0.271	2.73	1.89	0.011	2.53	3.32	0.003	2.43	1.71	0.003
Digestate with a low phosphorus content is not available in my region	3.18	3.18	0.986	2.36	2.09	0.441	2.90	3.39	0.063	2.60	1.76	0.001
there is no guaranty it is diseases free	3.64	3.25	0.321	2.82	2.11	0.097	3.33	3.29	0.881	2.90	1.68	<0.00
The origin is in most cases unknown	4.09	3.46	0.090	3.27	2.51	0.047	3.23	3.82	0.035	3.30	2.11	<0.00
It is hardly available in my region	2.45	2.98	0.164	3.00	2.54	0.196	2.63	3.11	0.092	2.97	2.34	0.015
It is difficult to handle	1.27	2.30	0.001	3.36	2.84	0.180	1.87	2.34	0.045	3.17	2.74	0.136

Table 96: Main barriers and drivers for the use of digestate in 18A (The Netherlands - arable/specialised crops and cereals) (Germany - arable+mixed/specialised crops).

	Adopt	**Non-**	**p-**	**Adopt**	**Non-**	**p-**	**Positive**	**Negative**	**p-**	**Positive**	**Negative**	**p-**
Drivers	**Behavioural belief**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
It is easy to apply	4.29	3.59	0.016	4.71	4.62	0.663	3.12	2.89	0.313	4.36	3.76	0.941
The composition is homogeneous	3.79	3.28	0.103	4.86	4.70	0.410	3.60	3.27	0.181	4.88	4.67	0.168
You know what minerals are in digestate	3.86	3.30	0.072	4.93	4.62	0.122	3.68	3.28	0.106	4.88	4.59	0.069
With digestate organic matter is applied	3.21	2.98	0.470	4.93	4.73	0.311	3.40	2.88	0.046	4.72	4.77	0.732
Digestate increases soil fauna	2.50	2.86	0.190	4.79	4.71	0.672	3.16	2.69	0.033	4.64	4.75	0.460
It is cheap	3.93	2.79	<0.00	4.07	3.88	0.536	3.12	2.89	0.313	4.36	3.76	0.012
Digestate has fast mineralizing N	4.36	3.53	0.004	3.93	3.36	0.037	3.60	3.67	0.776	3.72	3.35	0.088
	Normative belief			**Motivation to comply**			**Normative belief**			**Motivation to comply**		
Salesmen are positive	4.07	3.71	0.223	3.14	2.43	0.031	3.80	3.75	0.823	3.00	2.37	0.018

Magazines are positive	3.21	3.15	0.779	3.57	3.77	0.390	3.44	3.07	0.036	3.80	3.72	0.662
Barriers	**Behavioural belief**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
Applying digestate increases the risk on contaminating my fields	3.29	3.03	0.429	1.07	1.29	0.262	2.64	3.21	0.022	1.36	1.23	0.396
Applying Digestate increases diseases	2.64	2.90	0.381	1.00	1.17	0.280	2.56	2.96	0.082	1.16	1.15	0.918
	Normative belief			**Motivation to comply**			**Normative belief**			**Motivation to comply**		
Study club is positive	3.07	2.72	0.124	3.79	3.94	0.558	3.04	2.68	0.048	4.08	3.87	0.317
Neighbours are positive	2.64	2.56	0.743	2.07	1.83	0.374	2.92	2.45	0.022	1.96	1.83	0.548
Other arable farmers are positive	3.00	2.86	0.539	3.50	3.56	0.836	3.20	2.77	0.017	3.72	3.49	0.313
Research is positive	3.07	2.93	0.469	4.29	4.20	0.698	3.28	2.84	0.004	4.36	4.16	0.270
Extension agents recommend it	3.14	2.93	0.361	4.07	3.81	0.286	3.32	2.84	0.009	4.16	3.75	0.031
	Control strength			**Control power**			**Control strength**			**Control power**		
No guarantee that it is disease free	4.07	3.62	0.162	2.21	1.74	0.086	3.48	3.75	0.308	2.28	1.65	0.004
There is much slurry in my region	3.07	2.97	0.781	3.14	2.07	0.001	3.08	2.95	0.664	2.92	1.99	<0.00
The origin of the basic products is unknown	4.07	3.44	0.067	3.29	2.21	<0.00	3.52	3.53	0.962	3.12	2.11	<0.00
Price is too high	2.64	3.08	0.062	2.14	2.16	0.944	3.16	2.97	0.325	2.24	2.13	0.640
In my region there is no digestate available with low P-content	3.29	3.09	0.530	2.50	2.30	0.567	3.00	3.16	0.515	2.68	2.21	0.089
The manure law is too tight to use it	3.00	3.00	<0.00	3.07	2.27	0.011	3.20	2.93	0.288	2.48	2.35	0.605
It is hardly available	2.36	3.38	0.003	3.07	2.40	0.015	3.24	3.24	1.000	2.84	2.37	0.036
Difficult to handle	1.93	2.44	0.049	3.14	2.71	0.139	2.28	2.40	0.569	2.96	2.71	0.281

6.9.6 Soil analysis/nutrient management plan

Table 98 to 101 provide an overview of the most important drivers and barriers per FTZ. In Table 97, an overview of the definition as formulated in the questionnaire in each country is given. This definition might be important in understanding differences in barriers and drivers between FTZs.

Table 97: Definition of this BMP across different countries.

Country	BMPs	Definition of BMP
Austria	soil analysis	Different methods and procedures to determine biological, physical and chemical soil parameters, e.g. supply with nutrients. Development and adoption of fertilization plans (for mineral and organic fertilizers).
Poland	nutrient management plan	Nutrient management plan a computed tool to calculate the amount of fertilizer needed by crops on the basis of expected yield, removal, and other entries.
Italy	nutrient management plan	A nutrient management plan is a tool allowing to define that amount of nutrients to be applied, their splitting (dates and amounts), and the type of mineral and organic fertilisers to be used. The calculation is carried out based on the expected yield, its quality, soil properties, climate, and rotation.

Table 98: Main barriers and drivers for nutrient management plan in 16C (Italy - dairy cattle/temporary grass).

Barrier/driver	Suggested solution	Stakeholder	Likelihood of	
			Adoption	Success
Main drivers				
Reduction of fertiliser costs	-	-	-	-
Use of the proper fertiliser amount	-	-	-	-
Valorisation of livestock manure	-	-	-	-
Higher yield stability	-	-	-	-
Higher forage quality	-	-	-	-
Higher livestock health	-	-	-	-
Improved milk quality	-	-	-	-
Advisors of producers associations	-	-	-	-

Main barriers	-	-	-	-
Increase of costs due to soil testing	Use soil maps	Farmers	We did not have the time to discuss the likelihood of adoption/success	
	Create groups to collectively buy soil analyses	Farmers		
	Only request analyses related to soil fertility	Farmers		
	Spread the use of NMP. Raise the interest of farmers regarding nutrient management. Set up programs to increase the interest, the awareness and the capacity of farmers regarding nutrient management	Advisors Researchers Officers / Policy makers		
	Help farmers to interpret soil analyses	Advisors		
	Be independent from companies selling products	Advisors		
	Contact laboratories with agreements on analytical costs	Advisors		
	Organise soil analyses that are already available	Advisors		
	Subsidise nutrient management	Officers / Policy makers		
	Contribute to costs for collectively manage soil analyses (both new analyses, and existing analyses collected from databases and other archives)	Officers / Policy makers		
	Provide agro-meteorological bulletins	Officers / Policy makers		
	Indicating which soil analyses are needed and which are ancillary	Researchers		
	Find cheaper techniques for soil analysis	Researchers		
Scarce information on the value of livestock manure			We did not have the time to discuss the likelihood of adoption/success	
Lack of an independent advisory services	Ask advice to the public sector. Do not settle for the free advices given by advisors selling production factors	Farmers		

	Create a network of advices, continuous training and presence in the farm. Try to re-create groups of advisors (as occurred in the past).	Advisors	
	Maintain and facilitate the access by farmers to the network of advisors	Officers / Policy makers	
	Propose programs to train the advisors	Officers / Policy makers	
	Advertise the role of the advisors	Officers / Policy makers	
	Subsidise the advisors using the funds of the Rural Development Program	Officers / Policy makers	
	Technological innovation, using ICT and databases	Officers / Policy makers	
	Close collaboration with advisors	Researchers	
	Evaluation and validation of the results of soil analyses	Researchers	

Table 99: Main barriers and drivers for soil analysis in 1A (Austria -arable/cereals).

Barrier/driver	Suggested solution
Overview of the nutrient supply	-
Shows nutrient deficiencies in the soil	-
Improved fodder and feed quality	-
Adaption of the fertilization to the crops needs	-
Development of fertilization plan	-
Additional fertilizer recommendation	-
Different soil indicator, e.g. pH-value, SOM, trace elements	-

Well organized delivery possibilities	-
Investigation of other soil parameter e.g. biologically activity	-
Use as a routine method	-
Investigation forms, labels and bags for the sample are easy available	-
Increase of the crop yield	-
Bad growth of the agricultural crops	-
Agricultural school	-
Literature	-
Support in soil sampling (by the Chamber of Agriculture or external service)	-
Advisor of the Chamber of Agriculture	-
Private agricultural advisors	-
Advisor of the sugar industry	-
Colleagues in the working group	-
Better advice by the agricultural advisors	-
Less information compared to the observation of the crops	Technical training on interpretation of soil analysis Improving of agricultural advice and training Advice, training both for plant diseases and nutrient deficiency (symptom recognition) and optimal nutrient supply
Higher costs	Technical training on advantages regarding cost saving in fertilization Financial compensation Better information about special offers and discounts

Time consuming	Technical training on advantages regarding costs/benefits Financial compensation Time is required for representative sampling, it is necessary for further advice and information; the result are more explainable
Mistakes in the evaluation by laboratories	-
Many small parcels	No sampling of every parcel necessary Start at some representative areas, then decide whether further areas will be sampled
Lack of know-how	Technical training on interpretation of soil analysis Improving of agricultural advice and training Advice, information
Lack of fertilizer recommendation and interpretation of results	Technical training on interpretation of soil analysis Improving of agricultural advice and training Advice, information

Table 100: Main barriers and drivers for soil analysis in 2M (Austria-mixed).

Barrier/driver	Suggested solution
Overview of the nutrient supply	-
Shows nutrient deficiencies in the soil	-
Improved fodder and feed quality	-
Adaption of the fertilization to the crops needs	-
Development of fertilization plan	-
Additional fertilizer recommendation	-
Different soil indicator, e.g. pH-value, SOM, trace elements	-
Well organized delivery possibilities	-

Use as a routine method	-
Investigation forms, labels and bags for the sample are easy available	-
Increase of the crop yield	-
Agricultural school	-
Literature	-
Support by a funding program	-
Support in soil sampling (by the Chamber of Agriculture or external service)	-
Advisor of the Chamber of Agriculture	-
Private agricultural advisors	-
Advisor of the sugar industry	-
Colleagues in the working group	-
Better advice by the agricultural advisors	-
Less information compared to the observation of the crops	Technical training on interpretation of soil analysis Improving of agricultural advice and training Advice, training both for plant diseases and nutrient deficiency (symptom recognition) and optimal nutrient supply
Higher costs	Technical training on advantages regarding cost savings in fertilization Financial compensation Better information about special offers and discounts
Time consuming	Technical training on advantages regarding costs/benefits Financial compensation Time is required for representative sampling, it is necessary for further advice and information; the result are more explainable

Many small parcels	No sampling of every parcel necessary Start at some representative areas, then decide whether further areas will be sampled
High technical complexity	Technical training on interpretation of soil analysis Opinion completely wrong, soil investigation is simple and comprehensible, practicable after a short training
Lack of fertilizer recommendation and interpretation of results	Technical training on interpretation of soil analysis Improving of agricultural advice and training Advice, information
Difficult interpretation of results	Technical training on interpretation of soil analysis Advice, information
Lack of know-how	Technical training on interpretation of soil analysis Improving of agricultural advice and training Advice, information
Mistakes in the evaluation by laboratories	-

Table 101: Main barriers and drivers for soil analysis in 3C (Austria - dairy cattle).

Barrier/driver	Suggested solution
Overview of the nutrient supply	-
Shows nutrient deficiencies in the soil	-
Improved fodder and feed quality	-
Improved soil life	-
Adaption of the fertilization to the crops needs	-
Development of fertilization plan	-
Additional fertilizer recommendation	-
Different soil indicator, e.g. pH-value, SOM, trace	-

elements	
Well organized delivery possibilities	-
Increase of the crop yield	-
Bad growth of the agricultual crops	-
Sufficient knowledge of soil	-
Agricultural school	-
Literature	-
Advisor of the Chamber of Agriculture	-
Association “Maschinenring”	-
Colleagues in the working group	-
Better advice by the agricultural advisors	-
Less information compared to the observation of the crops	Technical training on interpreation of soil analysis Improving of agricultural advices and training Advice, training both for plant diseases and nutrient deficiency (symptom recognition) and optimal nutrient supply
Higher costs	Technical training on advantages regarding cost savings in fertilization Financial compensation Better information about special offers and discounts
Time consuming	Technical training on advantages regarding cost/benefits Financial compensation Time is required for representative sampling, it is necessary for further advice and information; the result are more explainable
Many small parcels	No sampling of every parcel necessary Start at some representative areas, then decide whether further areas will be sampled
Fertilisation only based on the nutrient uptake of the crops	-
Lack of fertilizer recommendation and	Technical training on interpreation of soil analysis

interpretation of results	Improving of agricultural advices and training Advice, information
Difficult interpretation of results	Technical training on interpreation of soil analysis Advice, information
Mistakes in the evaluation by laboratories	-
Support in soil sampling (by the Chamber of Agriculture or external service)	It is already offered by the "Maschinenring"in the province Styria; it will be also offered by companies in the fertilizer commerce in future; it will be more important in future and crucial to observe previous experiences

6.9.7 Spring application of manure

Table 102 provides an overview of the most important drivers and barriers of spring application of manure in 18A (The Netherlands - arable/specialised crops and cereals).

Table 102: main barriers and drivers for spring application of manure in 18A (The Netherlands - arable/specialised crops and cereals)

	Adopters	Non-	p-	Adopters	Non-	p-	Positive	Negative	p-value	Positive	Negative	p-value
Drivers	**Behavioural belief strength**			**Outcome evaluation**			**Behavioural belief strength**			**Outcome evaluation**		
Financial beneficial	4.35	3.46	<0.001	4.56	4.51	0.725	4.43	3.54	<0.001	4.58	4.50	0.554
It delivers organic matter to the soil	3.74	3.26	0.072	4.60	4.74	0.286	3.81	3.27	0.040	4.74	4.56	0.195
It increases yields	3.69	2.41	<0.001	4.77	4.62	0.225	3.79	2.54	<0.001	4.79	4.63	0.189
It increases soil fauna	3.23	2.49	0.002	4.66	4.77	0.361	3.36	2.48	<0.001	4.74	4.67	0.549
The applied nitrogen is not manageable	3.31	4.00	0.002	4.24	4.00	0.299	3.19	4.00	<0.001	4.36	3.92	0.050
	Normative belief			**Motivation to comply**			**Normative belief**			**Motivation to comply**		
Magazines are positive	4.06	3.44	0.003	3.66	3.77	0.534	4.23	3.38	<0.001	3.66	3.75	0.596
Extension agents recommend the use of manure in the spring	3.95	3.10	<0.001	3.89	3.85	0.825	4.02	3.19	<0.001	3.79	3.96	0.359
Other arable farmers are positive	3.68	2.95	0.001	3.82	3.72	0.509	3.79	2.96	<0.001	3.77	3.79	0.907
The Dutch Union of Animal Husbandry is positive	3.94	3.33	0.007	1.85	1.46	0.034	4.04	3.33	0.001	1.79	1.60	0.302
The salesman is positive	3.48	3.05	0.125	2.63	2.44	0.401	3.43	3.19	0.372	2.70	2.40	0.176
	Control strength			**Control power**			**Control strength**			**Control power**		
No storage facility for the manure	4.65	4.95	0.098	4.52	4.44	0.657	4.58	4.96	0.036	4.58	4.38	0.232
Do not know origin of manure	2.79	3.41	0.068	3.24	3.08	0.568	2.74	3.35	0.062	3.32	3.02	0.286
Is demanding in organisation	3.03	3.18	0.633	3.18	2.51	0.021	2.98	3.21	0.449	3.30	2.50	0.004

Barriers	Behavioural belief strength			Outcome evaluation			Behavioural belief strength			Outcome evaluation		
It makes heavy tracks	3.89	4.36	0.033	1.48	1.13	0.005	3.85	4.31	0.032	1.45	1.23	0.072
It makes the soil fatty and sticky	3.31	3.87	0.025	1.55	1.21	0.015	3.23	3.85	0.010	1.55	1.27	0.046
The composition is untrusted	3.31	3.69	0.133	1.60	1.31	0.112	3.25	3.69	0.076	1.57	1.40	0.340
It makes you dependent of the contractor	4.55	4.64	0.569	2.26	2.10	0.409	4.55	4.63	0.624	2.21	2.19	0.913
	Normative belief			**Motivation to comply**			**Normative belief**			**Motivation to comply**		
Neighbours close by find manure smelling	2.47	2.82	0.207	2.84	2.51	0.232	2.434	2.792	0.190	2.849	2.563	0.281
	Control strength			**Control power**			**Control strength**			**Control power**		
The weather is often too wet to apply manure in the spring	2.98	3.87	<0.001	1.48	1.08	0.008	2.87	3.83	<0.001	1.55	1.08	0.002
I am not allowed to use a "sleepslang"	1.66	2.13	0.076	2.00	1.67	0.255	1.49	2.23	0.003	2.02	1.71	0.277
Not enough N or phosphate quotum	2.56	2.97	0.207	3.06	2.46	0.063	2.64	2.81	0.590	3.21	2.42	0.012
Not available in my area	2.45	2.46	0.973	3.03	2.15	0.002	2.42	2.50	0.768	3.15	2.19	<0.001
Composition not to be known	3.48	3.79	0.310	3.10	2.54	0.055	3.36	3.88	0.082	3.17	2.56	0.032

6.9.8 Row application of manure

Table 103 provides an overview of the most important drivers and barriers of row application of manure in 20C (The Netherlands - dairy cattle/permanent grass). This BMP was defined as ‘in maize the manure application is placed close to the planting rows using the precision GPS system. In this system manure is applied just before sowing in two parallel rows at approximately 9 cm besides the planting row.

Table 103: Main barriers and drivers for row application of manure in maize in 20C (The Netherlands - dairy cattle/permanent grass)

Barrier/driver	Suggested solution	Stakeholder	Likelihood of success		Comments
Main drivers			**Adoption**	**Success**	
Research					More valued by non-adopters than by adopters
On farm test of technique					More valued by positive intention than by negative intention
Less manure needed for the same yield					More valued by positive intention than by negative intention
Main barriers					
Increases cost to apply manure					More valued by non-adopters than by adopters
Increases time pressure of contractor					Positive intention mind less than negative intention
Increased physical damage					Positive intention mind less than negative intention
Contractor fails equipment					
Contractor not suited					More valued by negative intention than by positive intention
May cause root burn					
Technique in an early experimental phase					More valued by non-adopters + negative intention than by adopters + positive intention

6.10 Others

6.10.1 Pastoral plan

Table 104 provides an overview of the most important drivers and barriers of using a pastoral plan in 12C (Spain - beef and mixed cattle). This pastoral plan was defined as the document that reflects the management of the farm from a global perspective, taking into account its production organization, including hunting or livestock production through the use of pasture and woodland, agricultural and forestry production and biodiversity present therein, and other uses of the meadow.

Table 104: Main barriers and drivers for pastoral plan in 12C (Spain - beef and mixed cattle).

Barriers	Suggested solution	Stakeholder	Likelihood of		Comments
			Adoption	Success	
PHYSICAL					
The pastoral plan is rigid	The techniciand who prepare the pastoral plan should know the farm.	Farmers	Medium	High	Weather conditions are an important limitant in this practice.

	Flexible and adapted norms.	Policy makers	Medium	Medium	
	Facilities.	What farmers want from policy makers	Medium	Medium	
FINANCIAL					
Prices and markerts varies significantly from one year to another	Associations.	Farmers	Medium	High	Training about markets for farmers. Dissemination of this agro-forestry system to inform the consumer about the products coming from the dehesas.
	Norms that ensure diversification and a minimum price every year.	Policy makers	Medium	High	
	Subsidies for special situations.	What farmers want from policy makers	Medium	High	
There are not enough subsidies for implementing a pastoral plan	To have a plan fitted to the real situation of the farm.	Farmers	Medium	Medium	Training to let the farmers the possibility of chosing priority actions, identifying technical and educational technologies.
	To merge documents, procedures and simplify the burocracy for subsidies.	Policy makers	Medium	Medium	
	To perform consistent and flexible controls, and prevent them from becoming an element of punishment.	What farmers want from policy makers	Medium	Medium	
The pastoral plan involves a financial outlay that does not compensate	Training and information from other farmers already with a plan.	Farmers	Medium	Medium	Farmers do not want difficult burocracy processes.
	Flexible norms and subsidies.	Policy makers	Medium	Medium	
	Assesment and subsidies.	What farmers want from policy makers	Medium	Medium	
HUMAN					
The technicians that develop the pastoral plan do not know the farm properly	To look for a good technician.	Farmers	High	High	
	To elaborate a guideline describing the different parts of the plan.	Policy makers	High	High	
	To facilitate the assessment and the quality certuification of the plan.	What farmers want from policy makers	High	High	
More information about the management of the farms is needed	Training, assessment, and visits to other farms.	Farmers	Medium	High	
	To encourage the association of farmers.	Policy makers	Medium	High	
	To facilitate the assessment and training.	What farmers want from policy makers	Medium	High	
NATURAL					
The weather conditions differ from one year to another	To look for alternatives in case of adverse weather conditions.	Farmers	Medium	Medium	For this reason, the pastoral plan should be flexible.
	To promote insurances.	Policy makers	Medium	Medium	

	A flexible plan considering the uncertainties.	What farmers want from policy makers	Medium	Medium	
The size of my farm is very small	Information about the benefits of the plan. Training and flexibility. Support from the different Administrations.	Farmers Policy makers What farmers want from policy makers	Medium Medium Medium	Medium Medium Medium	Small farms have lower benefits and therefore, the investment in innovative activities is more difficult.
SOCIAL					
It is difficult to have a pastoral plan because of the burocracy it involves	Flexible planning. To reduce and simplify the burocracy. Assessment and flexibility	Farmers policy makers What farmers want from policy makers	Medio Medio Medio	Medio Medio Medio	Modifications of the plan are difficult as well.

6.10.2 Sprinkler and drip irrigation

Table 105 and 106 provide an overview of the most important drivers and barriers of sprinkler and drip irrigation per FTZ. Sprinkler irrigation distributes water in the form of small drops. This method includes: the self-retracting hose reel, the pivot and the micro sprinklers. Drip irrigation distributes water slowly to crops, either by putting water on soil surface near the plant, or directly in the root zone.

Table 105: Main barriers and drivers for sprinkler and drip irrigation in 16C (Italy - dairy cattle/temporary grass)

Barrier/driver	**Comments**[1]
Main drivers	
Less water consumption	Farmers are aware of the advantages of sprinkler and micro irrigation; all these outcomes have an outcome evaluation higher than 4 (median 5)
Higher crop yield	
Less soil compaction	
No crop water stress	
Higher water use efficiency	
Less waterlogging	
Lower diesel consumption (micro irrigation)	
Sellers of irrigation systems	The other referents had a subjective norm close to zero, because their normative belief was on average about 3.

	The normative belief of the sellers of irrigation systems was 4.19 for adopters and 3.64 for non-adopters. The subjective norm for adopters was higher than 2.0 for all referents. All the referents (other farmers, family members, feed advisors, advisors of companies selling production factors, sellers of irrigation systems and advisors of irrigation consortium) surrounding adopters are significantly more convinced that the interviewees should adopt IRG compared to the same referents that are around the non-adopters.
Shorter work in the case of pivot	
Main barriers	
Longer work in the case of self-retracting hose reel	
Higher costs	These irrigation systems require investments.
Higher diesel consumption (sprinkler)	

Table 106: Main barriers and drivers for sprinkler and drip irrigation in 16A (Italy - arable/cereals).

Barrier/driver	Comments [1]	
	Success	
Main drivers		
Higher crop yield	-	This is the most important outcome.
Control of soil water content	-	A≠NA
Drip irrigation reduces compaction	-	A≠NA. During semi-structured interviews, farmers have clearly complained about the compaction generated by surface water irrigation, due to the water covering the soil and flowing over it
High water availability	-	A≠NA. This result is counter-intuitive: during semi-structured interviews, farmers indicated the shortage of water availability as a factor that would promote water-saving sprinkler and drip irrigation. The questionnaire gave the opposite indication, with a high (3.85) control power for high water availability
Sandy soils	-	A≠NA. This is the most important control factor.
Drip irrigation allows fertigation	-	
Drip irrigation reduces energy and fuel costs	-	A≠NA
High-income crops	-	A≠NA. Farmers think that high-income crops (e.g. horticultural crops) are suitable for sprinkler and drip irrigation. However, most of the farmers interviewed cultivate cereals, grain legumes and forages. Therefore, this is more a potential rather than a real driver for most of them

Advisors of companies selling production factors	-	A≠NA. This is the most important referent. Production factors are seeds, fertilisers and pesticides.
Advisors of companies that withdraw the products	-	A≠NA
Main barriers		
Sprinkler irrigation causes high initial investments	-	
Drip irrigation increases operating costs	-	Compared to surface irrigation, the additional cost is represented by non-reusable hoses and by the costs of placing and removing them.
Reduced field size with impediments	-	Small fields with impediments are a barrier (control power of 2.09), which however does not appear to be very frequent (control strength of 2.38)

References

Ajzen, I. (1988). Attitudes, Personality and Behavior. Chicago, IL: Dorsey Press

Ajzen, I. (1991). The Theory of Planned Behaviour. Organizational Behaviour and Human Decision Processes, 50: 179-211.

Andersen, E., Elbersen, B., Godeschalk, F., Verhoog, D. (2007). Farm management indicators and farm typologies as a basis for assessments in a changing policy environment. Journal of Environemental management, 82, 3: 353-362.

Burton R.J.F. (2004). Reconceptualising the 'behavioural approach' in agricultural studies: a socio-psychological perspective. Journal of Rural Studies, 20: 359-371.

Derpsch, R. (2005). The extent of conservation agriculture adoption worldwide: implications and impact. In: proceedings 3rd world congress on conservation agriculture, Nairobi: p15

EC (1985). Commission decision of 7 June 1985 establishing a community typology for agricultural holdings. Brussels

Edward-Jones, G. (2006). Modelling farmer decision making: concepts, progress and challenges. Animal Science, 82: 783-790.

Garforth, C., McKemey, K., Rehman, T., Tranter, R., Cooke, R., Park, J., Dorward, P., Yates, C. (2006). Farmers' attitudes towards techniques for improving oestrus detection in dairy herds in South West England. Livestock Science, 103: 158-168.

Hijbeek, R., Wolf, J., & ittersum, M. K. v. (2013). A typology of farming systems, related soil management and soil degradation in eight European countries.

JRC European Soil Portal - Soil Data and Information Systems.

Knowler, D., Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: a review and synthesis of recent research. Food Policy, 32: 25-48.

Lahmar, R. (2010). Adoption of conservation agriculture in Europe. Lessons of the KASSA project. Land use policy, 27: 4-10.

Metzger, M.J., Bunce, R.G.H., Jongman, R.H.G., Mücher, C.A., Watkins, J.W. (2005). A climatic stratification of the environment of Europe. Global Ecology and Biogeography, 14, 6: 549-563.

Stonehouse, D.P. (1995). Profitability of soil and water conservation in Canada: a review. Journal of Soil and Water Conservation, 50(2): 215-219.

Vandeputte A., Govers, G., Diels, J., Gillijns, K., Demuzere, M. (2010). Assessing the effect of soil tillage on crop growth: a meta-regression analysis on European crop yields under conservation agriculture. European Journal of Agronomy, 33: 231-241.

Wauters, E. and Mathijs E. (2013). An investigation into socio-psychological determinants of farmers' conservation decisions: method and implications for policy, extenstion and research. Journal of Agricultural Education and extension, 19: 53-72.

7 Appendices

7.1 Means of soil degradation perceived by arable farmers in each FTZ

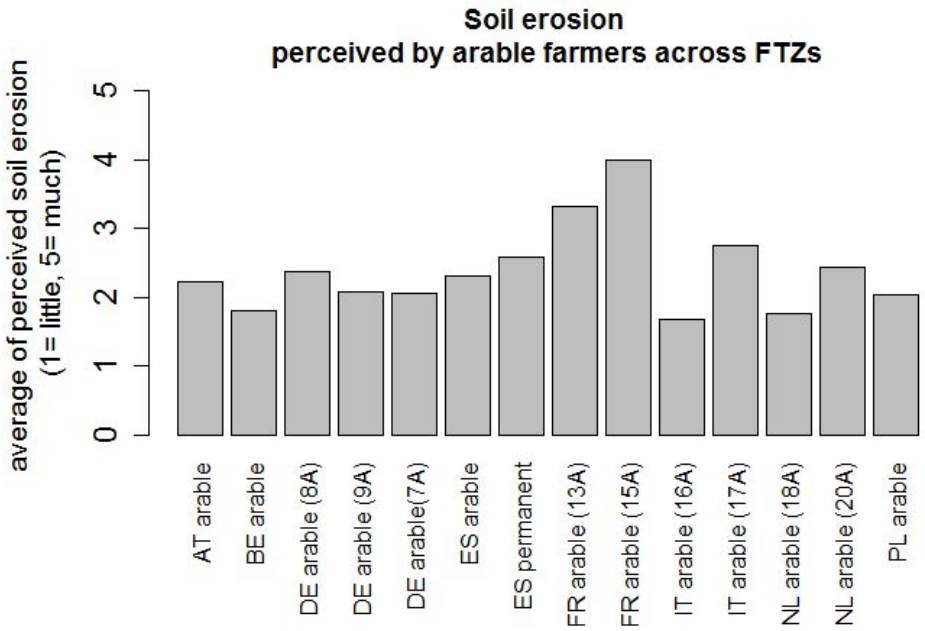


Figure 10: Average soil erosion perceived by arable farmers in each FTZ

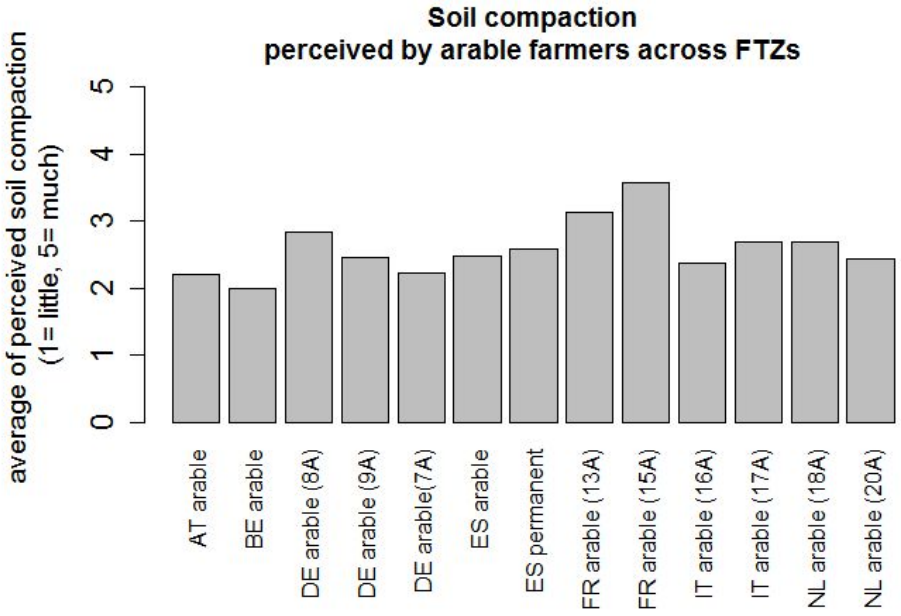


Figure 11: Average soil compaction perceived by arable farmers in each FTZ

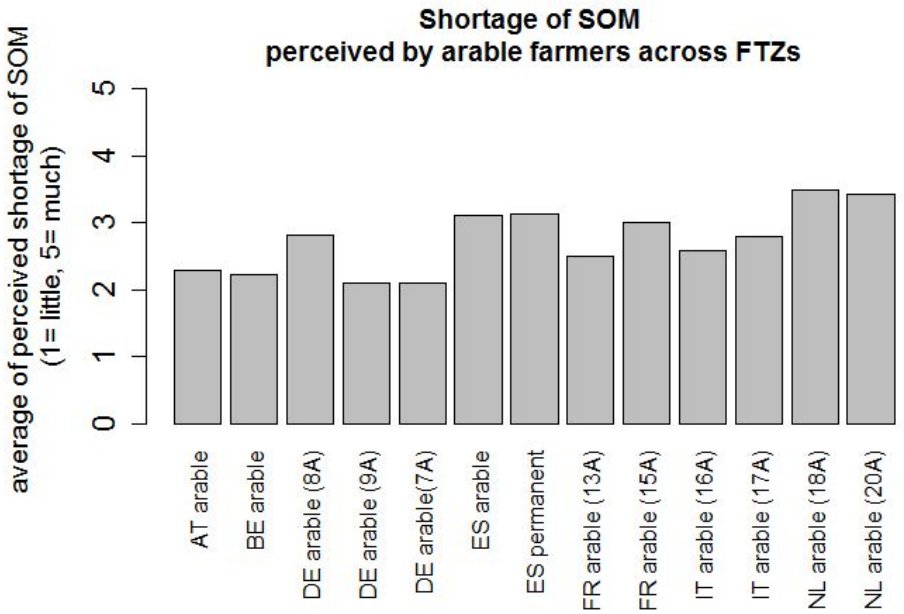


Figure 12: Average SOM shortage perceived by arable farmers in each FTZ

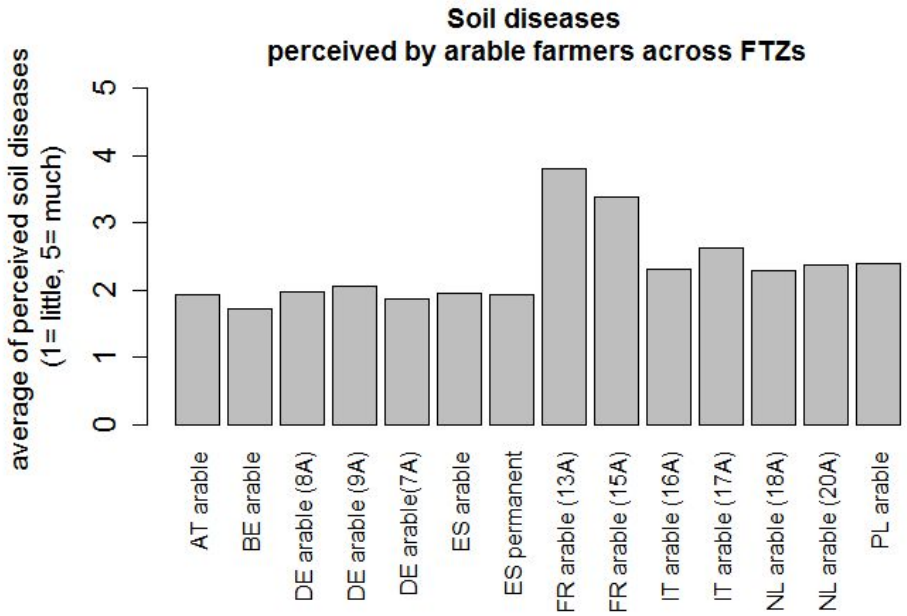


Figure 13: Average valuation of soil diseases by arable farmers in each FTZ

7.2 Means of soil degradation perceived by livestock farmers in each FTZ

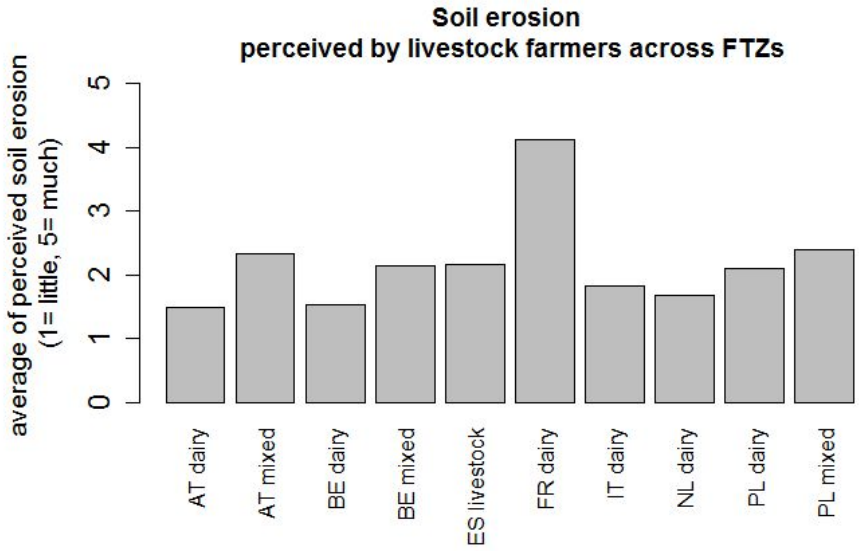


Figure 14: Average valuation of soil erosion by livestock farmers in each FTZ

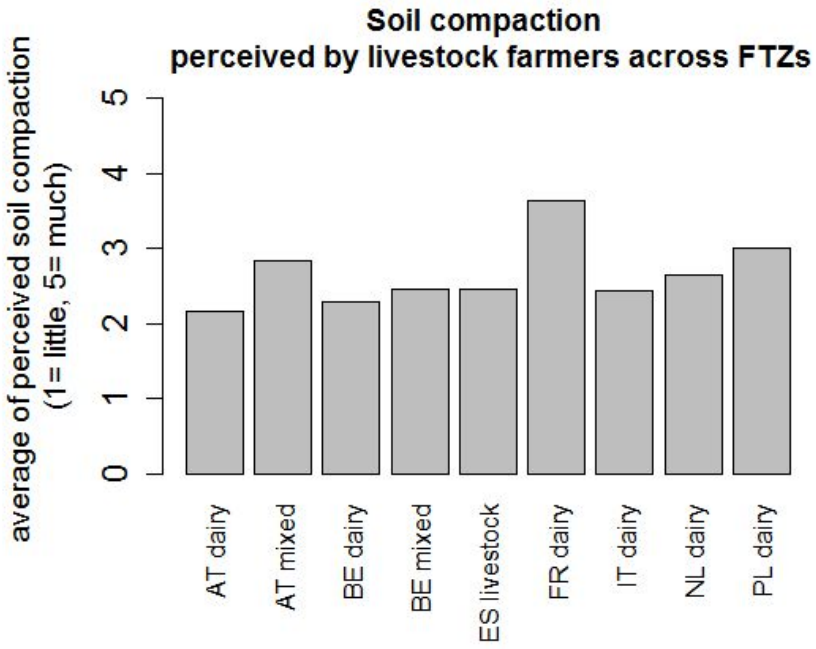


Figure 15: Average valuation of soil compaction by livestock farmers in each FTZ

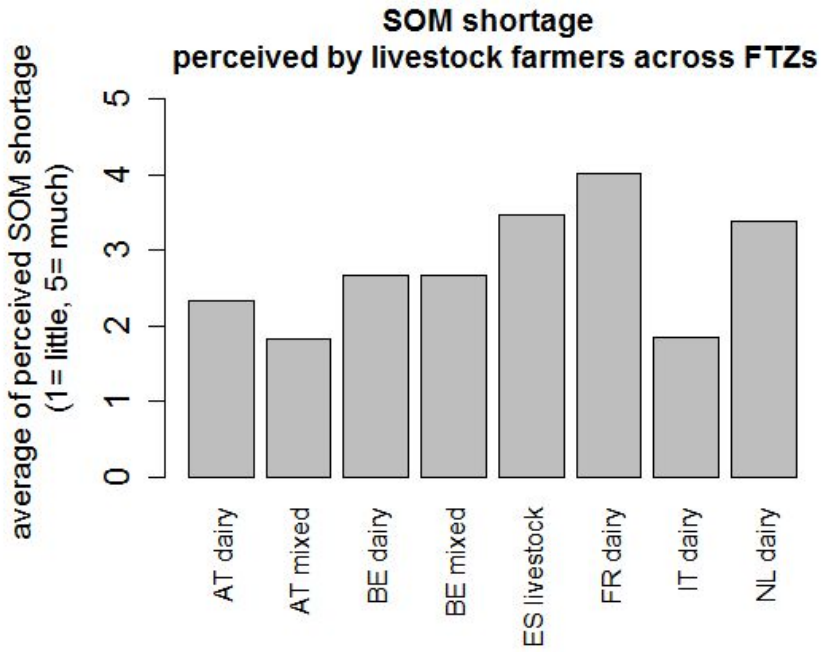


Figure 16: Average valuation of SOM shortage by livestock farmers in each FTZ

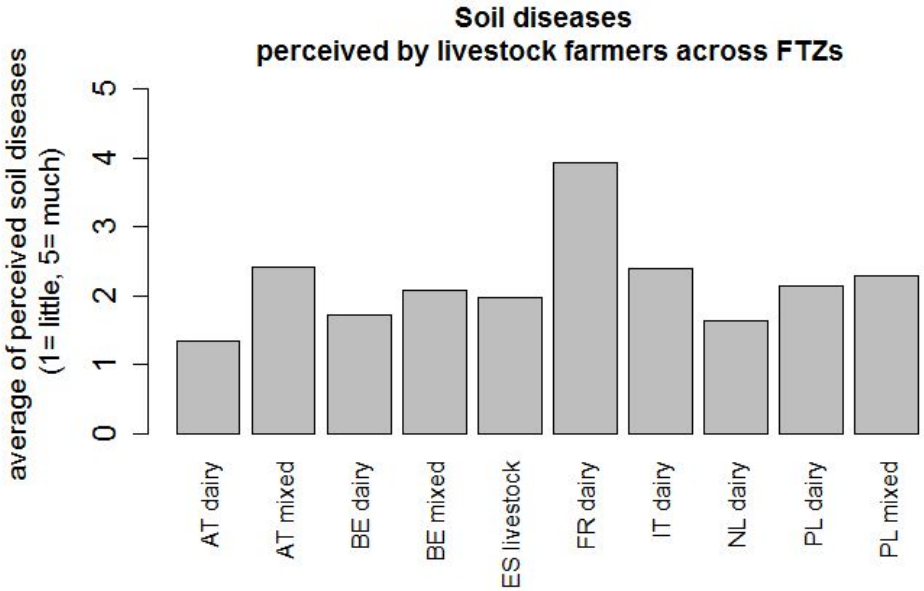


Figure 17: Average valuation of soil diseases by livestock farmers in each FTZ