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

List of Drivers and Barriers governing Soil Management by Farmers, including Cost Aspects

D4.434

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General information

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Executive summary

This report consists of two components: (i) an overview of drivers and barriers for the adoption of so-called 'Best Management Practices' (BMPs) in soil management, as seen through the eyes of farmers (the extensive Chapter 2); and (ii) an inventory of cost associated with the implementation of certain BMPs at the farm (the brief Chapter 3).

The overview of drivers and barriers presented in Chapter 2 is based on a survey held among 10,000 farmers in different farm types across all CATCH-C partner countries, 2520 of whom responded. The inventory of costs to implement BMPs is based on empirical information collected by the research team in the project partner countries, through various channels.

The BMPs studied in the farmer survey include options for crop rotation, tillage, nutrient management, crop residue management, water management, and grassland management. The survey was carried out in 24 major 'farm type x agri-environmental zone' (FTZ) units across eight partner countries, three per country. An FTZ unit is defined by the combination of an agri-environmental zone (with climate, slope, and soil texture as keys) with a farm type (arable-cereal, arable-specialised, dairy, mixed, etc.). 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. In most agri-environmental zones, one specific farm type was studied, or sometimes two. Our FTZ units were also called 'major farm types' in other project documents.

To identify drivers and barriers for adopting Best Management Practices (BMPs), we applied a behavioural approach, based on the T**heory of Planned Behaviour** (Ajzen, 1988; Ajzen, 1991), to identify the main barriers and drivers of farmers towards adoption of sustainable management practices. The theory and details of the results obtained were extensively reported in Deliverable D4.422 of the CATCH-C project (Bijttebier et al., 2014).

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, A), the feeling of social pressure from others (called referents) to perform or not perform a certain

BMP (Subjective Norm, SN) and the subjective beliefs about the ease or difficulty of successfully performing the BMP (Perceived Behavioural Control, PBC). In this approach, Attitude is formed by the belief that the behaviour (e.g. 'to perform 'no tillage') will be associated with a set of outcomes (e.g., 'no tillage reduces erosion'), weighted by a subjective evaluation of these outcomes (e.g. 'less erosion is very good'). Subjective Norm expresses how much the farmer perceives that others (called referents, e.g. 'neighbours') think the farmer should perform the behaviour (normative belief), weighted by the farmer's motivation to comply with those distinct referents. Finally, Perceived Behavioural Control is determined by the belief that a set of control factors (e.g. weather conditions, input prices, available equipment) facilitate or obstruct the behaviour (control beliefs), weighted by the expected impact that these factors would have if they were present (perceived power; e.g. 'in wet autumn it is very difficult to incorporate crop residues'). Combining attitude, subjective norm and perceived behavioural control, results in a positive or negative intention to actually perform the behaviour. 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. These constituent variables underlying the aggregate variables A, SN, and PBC were reported and discussed separately for adopters and non-adopters in the above-cited report D4.422.

In contrast, the current report is a concise overview of the most pronounced outcomes from the survey, in terms of the aggregate variables (A, SN, PBC) alone, with a focus on the highest scoring among these. Any of these (A, SN, PBC) can be a driver or a barrier. A positive score defines the variable as a driver, a negative score as a barrier. Drivers may rank from 0 to 10, barriers from -10 to 0. Where we state that one driver or barrier is 'stronger' than another, we mean that its absolute value is larger.

We qualified a driver / barrier as 'strong' if it meets two criteria simultaneously. For variables of attitude: both the absolute value for Attitude AND for its underlying 'belief strength' are 3 or more. For variables of subjective norm: both the absolute value for Subjective Norm AND its underlying 'motivation to comply' are 3 or more. For variables of Perceived Behavioural Control: both the absolute value for Perceived Behavioural Control AND its underlying 'control belief' are 3 or more. These criteria were applied to the *mean scores* over all respondents (to a particular question on a particular BMP in a particular farm type), adopters and non-adopters merged. (As stated, contrasts were evaluated in report D4.422.).

In our study, strongest expressions among categories (A, SN and PBC) were usually in category A. This holds both for drivers and barriers. Moreover, drivers were often stronger than barriers. Nevertheless, many cases were found where they appeared equally strong. Strong barriers were often found in categories A and PBC. Generally, variables of SN category were weak, relative to A or PBC.

Where necessary, short explanations per BMP of the local context are given. It is important to stress that all outcomes listed in this report are views (expectations, beliefs, judgements, etc.) held by farmers, and are not necessarily congruent with scientifically proven outcomes from experiments. Moreover, they have a local orientation because farmers were asked to judge BMPs for compatibility with their own farming situation. Nevertheless, where many farmers in different farm types and agri-environmental zones come up with similar evaluations of a certain BMP, a common view or understanding can be expressed in terms of drivers and barriers affecting uptake. In other cases, contrasts between FTZs illustrate that drivers or barriers depend on specific local conditions.

This report includes a compressed *overview table* showing all major drivers and barriers per BMP and farm type (see *Appendix 1*). Selected features illustrated by that table are briefly discussed below.

The first group of indicators relates *to soil quality*. Within this batch, all BMPs show (many) more drivers than barriers. Expected beneficial impacts on soil indicators are drivers for adopting the proposed BMPs. Farmers appear well aware of the benefits for soil quality. (Here we can say ‘aware’ because views on expected beneficial impacts are endorsed by scientific documentation, see Deliverables D3.324, D3.334, D3.344, D3.354, D3.364, D3.371). Their evaluations of soil benefits often rank highest among driver scores, and refer to the whole spectrum of commonly cited soil quality aspects (humus content, structure, workability, rooting, fertility (nutrient supply), soil life, soil borne diseases control, erosion control). In spite of overall benefits of most BMPs to a broad set of soil quality indicators, strong barriers against certain BMPs exist, *also within* the set of soil quality indicators. Here, the proposed BMPs deteriorate specific aspects of soil quality. Where this occurs, it often relates to physical damage (structure, compaction) and related water dynamics (infiltration, waterlogging, erosion).

The second batch of indicators relates *to crop growth, produce quality* and – in farms with livestock – feeding. One set of BMPs shows predominantly drivers (beneficial effect on production indicators). These BMPs are in the groups crop rotation, catch and cover crops and green manures (CCCGM), legumes in the rotation, controlled traffic, nutrient management, and water management. In contrast, the overall pattern for reduced tillage and no-tillage is that they reduce yield and produce quality.

The third indicator group relates *to crop protection*. Crop rotation and CCCGM show predominantly drivers, implying expected benefits in terms of reduced pest, diseases and/or weed pressure. In contrast, these unwanted pressures are believed to increase by the cultivation of legumes, reduced tillage, no-tillage, incorporation of crop residues, the use of compost and digestates.

The next group represent impacts *on farm inputs* (water, fertilisers, biocides, labour, fuel) but also equipment/machinery and storage capacity (for manures). These indicators, obviously, play a central role in farm economy and organisation, but are sometimes judged in their own right. For example, farmers often dislike an increased use of biocides irrespective of cost or net benefits. This group as a whole shows a rather balanced pattern of drivers and barriers. A BMP with predominantly drivers is crop rotation. A BMP dominated by barriers is the cultivation of CCCGM. For reduced tillage and no-tillage, our results reflect the well known trade-off between time and fuel saving on the one hand (drivers), and increased biocide use and need for adapted machinery on the other (barriers).

In the group of *financial indicators*, reduced tillage and no-till are dominated by drivers. All other BMPs show largely financial barriers, except in the special case of the Netherlands where economic benefits are associated with the acceptance of organic manures by arable farmers. (Note that – within this group - the lack of subsidies has been quoted in some countries/farm types as a barrier, too.)

The next group contains a large and highly *diverse set of indicators* or (control) factors, that farmers find themselves faced with. Virtually all outcomes here reflect barriers, rather than drivers.

The next group consists of only two stakes: *biodiversity* and *environment*. Here we find practically only drivers, but in very restricted numbers: only few FTZ units have expressed these drivers clearly (we cannot exclude that this is in part due to the formulation of questionnaires). ‘Environment’ was found relatively important in Belgium, France and The Netherlands, while ‘biodiversity’ was important in Germany and Austria.

Finally, there is another set of mixed aspects, including *legislation*. This set is again filled with both drivers and barriers. Some BMPs are drivers because they enable other practices preferred by farmers. Legislation is sometimes a driver, sometimes a barrier. See details in following chapters.

Outcomes can also be classified by other schemes (Section 1.4). Barriers are of mostly financial, agro-technical (‘physical’) or ecological (‘natural’) type. Some of them refer to direct positive or negative impacts on soil quality (‘natural’). Risk plays an important role, too, with reference to yield level, product prices, weather conditions (e.g. wet autumn, wet spring) and occurrence of diseases. This type of barrier (risks) was often recorded in the PBC category, and often refers to particular local control factors. For example, a BMP may promote yield in general, but may reduce yield on heavy soils, or in cold years. Or may promote yield of certain crops but not others. A fully consistent classification of all outcomes remains difficult. For example, we found barriers caused by legislation that aims to address environmental issues (e.g. nitrate leaching), but these could have been listed, instead, under the stake ‘environment’ as well.

We believe that the inventory of drivers and barriers presented here provides a concise and valuable complement to the more elaborate survey report by Bijttebier et al. (D4.422), and to the outcomes from other work packages, notably those evaluating long term experiments and the policy environment to soil management. Our survey outcomes reflect opinions and beliefs, rather than measured fact, but many aspects of soil management discussed here are hardly covered by the scientific literature. Moreover, while farmer views may provide no substitute for proven fact, they are perhaps more relevant to the design of effective policies to make soil management more sustainable. Finally, our outcomes refer to a very wide set of farming conditions across Europe, which is hard to cover by long term experiments.

Chapter 3 presents an assessment of costs related to the implementation of specific BMPs, collected from five CATCH-C partner countries. The key question is related to how costs for a farmer change when changing to the BMP. A common methodology to assess these costs is presented and applied to a range of farming systems in Europe. Because of structural differences in farms and differences in how the BMP is implemented, a direct comparison between countries remains difficult. The BMPs investigated were non-inversion / reduced tillage, and cover / catch crops / green manures.

In general, moving from conventional to non-inversion / reduced tillage has a small positive effect on the net return. Estimates vary from 0 to 20 € per ha for France and Poland, to 20 to 40 €/ha for Germany and The Netherlands. Most important cost factors are fuel consumption and labour requirements. When converting to non-inversion / reduced tillage, costs for fuel and labour generally reduce, while yields are often hardly affected and so net return will increase. Implementing non-inversion / reduced tillage sometimes goes well with introducing other BMP’s such as the incorporation of straw. This occurs for example in Poland. Incorporation of straw – instead of selling – obviously results in loss of income. The anticipated financial gain of implementing non-inversion / reduced tillage then seems too small for farmers to adopt this practice.

Cultivating cover / catch crops and green manures costs money where clear financial benefits are not identified. The additional costs are related to seed and labour to sow the cover / catch crop / green manures. Only in Spain, spontaneous cover crops in olive orchards have some financial benefits: the ‘practice’ implies skipping tillage operations that would otherwise be carried out to keep the land bare between the trees; and sowing costs are avoided (relative to a more active mode of cultivating cover crops). In other cases, cover / catch crops / green manures may be financially unattractive in the short term, but farmers have other incentives for this BMP. After all, our survey (Bijttebier et al., 2014) showed that adoption rates range between 42% in Poland to 88% in Germany (i.e. these percentages of respondents apply the practice on at least one of their fields). Such drivers are extensively documented in Chapter 2 of this report.

1 Introduction

This section is largely based on the Introduction and Methods sections of deliverable D4.422 by Bijttebier et al. 2014 and parts are identical with those sections.

1.1 Guide to readers

This report consists of two main sections.

Chapter 2 and corresponding appendices constitute the main body of the report, presenting the outcomes of an extensive farmer survey held in the major farm types of all CATCH-C partner countries. This section can be read as a complement to the study D4.422 presented by Bijttebier et al. (2015), and elaborates materials presented in the underlying national reports from the partner countries. This report reduces the survey outcomes into concise lists of drivers and barriers associated with a certain practice of soil management. Results are presented per Best Management Practice (BMP), grouping together the outcomes from different countries and farm types (FTZs) where the particular BMP was investigated. At the end of each BMP section, a table with the three highest scoring drivers and barriers is included. Detailed results grouped by country and – within countries – farm types with their particular BMPs are included in Appendices II-IX. The nature (human, financial, natural etc.) of all drivers and barriers is specified there, too.

Appendix 1 presents a summary table of the main survey results, where major drivers and barriers are listed for each combination of BMP x FTZ, and are grouped into sets of indicators or stakes that are affected by the BMP (e.g., a set of soil quality indicators, a set of farm inputs, financial indicators, etc.).

Chapter 3 presents the results of our attempt to quantify the costs associated with the on-farm application of selected BMPs. The material presented is based on an inventory held in CATCH-C partner countries (literature; extension materials; expert opinion), independent from the above farmer survey.

1.2 Background

During the past decades, so called **best management practices (BMPs)** have been proposed to maintain or restore soil quality 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 (Van den Putte *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 (Van den Putte *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 behaviour 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 & Bradshaw 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 & Bradshaw 2007). Farmers' attitudes towards specific conservation practices have also been investigated in a socio-psychological manner by using a behavioural approach, which refers to studies that employ actor-oriented quantitative methodologies for the investigation of decision making (Burton 2004; Edwards-Jones 2006; Wauters & Mathijs 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 drivers and barriers in adopting BMPs. Beforehand, drivers and barriers were anticipated to be of a financial kind of nature and therefore costs between traditional management practices were compared to costs of the best management practice.

1.3 Farm survey stratification

Farmers' views on drivers and barriers to implement BMPs were surveyed in all eight CATCH-C partner countries, covering 24 Farm Type Zone units (FTZs). The FTZs are characterized by land use and farm specialization (Andersen *et al.* 2007; EC 1985) and by agri-environmental zones, defined by slope, soil texture (JRC soil map) and climate zone (Metzger *et al.* 2005). The agri-environmental zones were described by Hijbeek et al (2013) and are shown in Figure 1. The criteria to select FTZs for the farm surveys as well as the methodology and data processing of these surveys, were described in detail by Bijttebier et al (2015) and covers the major agricultural land use types in Europa (Figure 2). Some characteristics of the selected Farm Type Zones (FTZ units) are presented in Table 1 and an overview of the best management practices investigated per country is shown in Table 2.

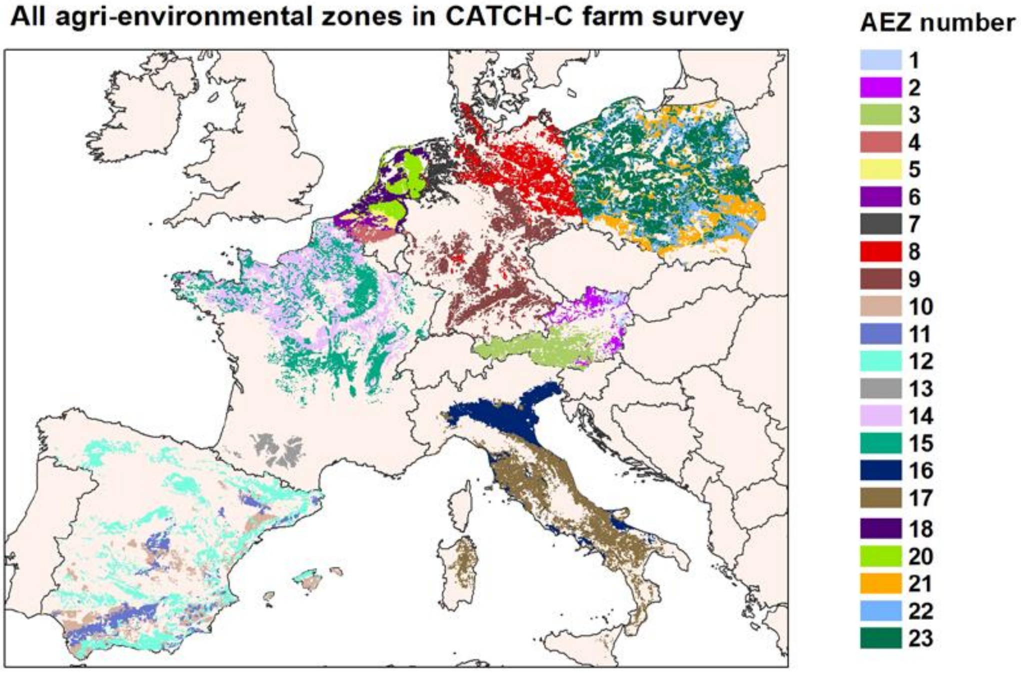

Figure 1: Overview of agri-environmental zones (AEZ) in which farm surveys were held (Bijttebier *et al.* 2015). Within AEZs, farm types (FTZ, see Table 1) were distinguished, usually only one FTZ but occasionally two FTZs.

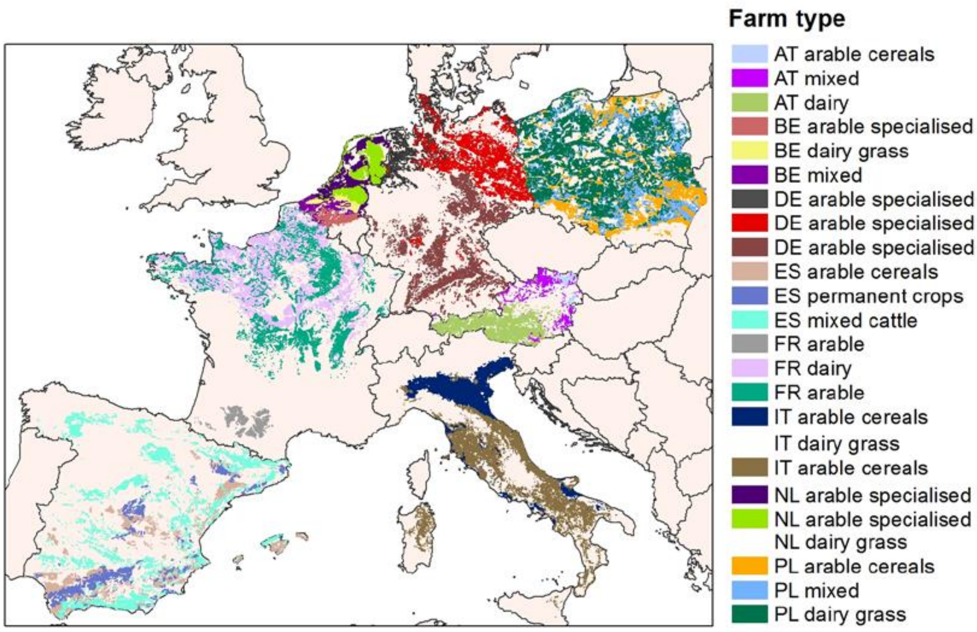

Figure 2: Overview of FTZs, in which farm surveys were held (Bijttebier *et al.* 2015)

Table 1: Specialisation, land use and soil texture of each farm type zone (FTZ) (Bijttebier *et al.* 2015).

Country	FTZ ID	Farm specialization	Land use	Soil texture
Austria (AT)	1A	arable (lowland)	cereals	medium soils
	2M	mixed (upland)	all land use types	medium soils
	3C	dairy cattle (Tirol)	permanent grassland	medium soils
Belgium (BE)	4A	arable	specialised crops	medium fine soils
	6C	dairy cattle	permanent grass	coarse soils
	5M	mixed (vegetable-pigs)	all land use types	medium soils
Germany (DE)	7A	arable+mixed (NW)	specialised crops	coarse soils
	8A	arable+mixed (NE)	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	dehesa	medium soils
France (FR)	13A	arable	cereals	fine soils
	14C	dairy cattle	temporary grass	medium fine soils
	15A	arable	cereals	medium soils
Italy (IT)	16A	arable (lowland)	cereals	coarse to medium fine soils
	16C	dairy cattle	temporary grass	coarse to medium fine soils
	17A	arable (upland)	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

Table 2: Number of FTZs in which each BMP was selected in the participating countries. The last column presents the overall number of FTZs where the BMP was included in the study (DE: German, AT: Austria, PL: Poland, ES: Spain, FR: France, BE: Belgium, IT: Italy, NL: the Netherlands) (Bijttebier *et al.* 2015).

	DE	AT	PL	ES	FR	BE	IT	NL	**Total**
Rotation									
Crop Rotation	2			1		2	1	1	**7**
Including Legume Crops in Rotation		2				1	2		**5**
Land Exchange						1			**1**
Catch & cover crops / green manures									
Catch / Cover Crops / Green Manures (incl. underseeding & early maize harvest)	3	2	3	1	3	3	3	4	**22**
Grazing systems									
Permanent Grazing / Rotational Grazing / Pastoral Plan		1		1					2
Tillage and transport									
Reduced / Non Inversion / Minimum / Light tillage	2	1	3	2	3	3	2	3	**19**
No Tillage / Direct Drilling				1	3		2		6
Controlled Traffic Farming	1			1				1	**3**
Low Soil Pressure Systems	1								**1**
Nutrient management									
Soil Analysis / Nutrient Management Plan		3	2				1		**6**
Application of Organic Fertilizer		1					2		**3**
Application of Farm Yard Manure						2			**2**
Application of Compost						2		1	**3**
Application of Reactor Digestate								2	**2**
Spring Application of Manure on Clay Soil								1	**1**
Row Application of Manure in Maize								1	**1**
Crop residue management									
Straw Incorporation			3			1	3	2	**9**
Water management									
Sprinkler & Drip Irrigation							2		**2**

1.4 Farm survey methodology

To identify drivers and barriers for adopting Best Management Practices (BMP's), we applied a behavioural approach, based on the **Theory of Planned Behaviour**, to identify the main barriers and drivers for farmers towards adoption of sustainable management practices. According to the theory of planned behaviour, individual beliefs about a behaviour or practice are believed to determine intention and behaviour (Ajzen 1988; 1991). The greater the intention to behave, the more likely one is to actually perform the behaviour. 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 behavioural control) (Figure 3**Error! Reference source not found.**). According to the theory of planned behaviour, ttitude is formed by the belief that the behaviour 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 behaviour (normative belief), weighted by our motivation to comply with these referents. Finally, perceptions of behavioural control are determined by the belief that a set of control factors facilitate or obstruct the behaviour (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 behavioural control, results in a positive or negative intention to actually perform the behaviour. 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.

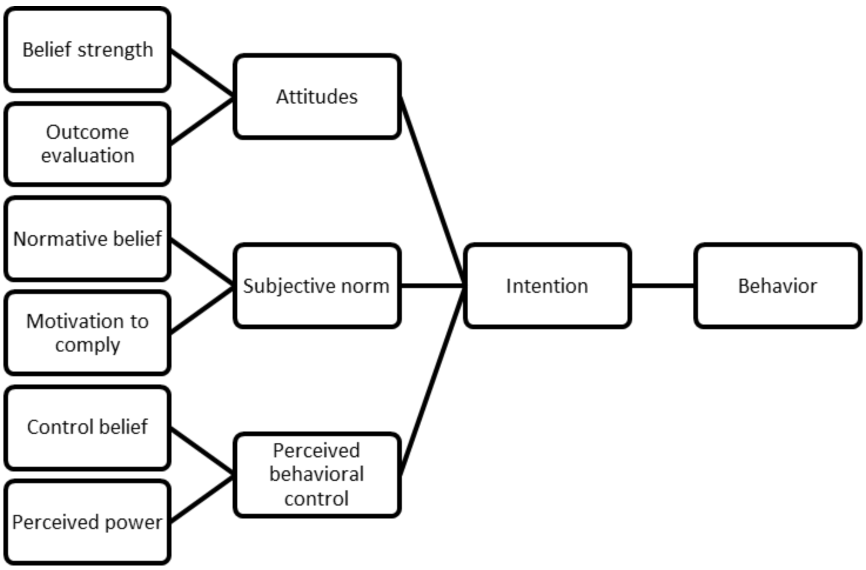

Figure 3: Theory of planned behavior, adapted from Ajzen (1991).

First, a face to face interviews were held with a limited set of farmers for each FTZ unit (farm type), to select key BMPs relevant to their farm type, and to make an inventory of the many aspects attached to that particular BMP. Based on these interviews, we composed a tailored questionnaire per BMP, usually consisting of 40 to 60 questions addressing the various aspects of that BMP. The questionnaires were then sent out to a larger group of farmers which varied per country and farm type. The total number of farmers reached (all countries and farm types) was about 10,000. Farmers were requested to return their responses either through regular mail or internet (depending on country / region). We received the response forms from 2,520 farmers. The responses per question were then processed following a standard protocol (Bijttebier et al., 2014) to yield a positive (driver) or negative (barrier) score. The strongest score for a driver is +10, the strongest score for a barrier -10. We qualified a driver / barrier as 'strong' if it meets two criteria simultaneously. For variables of Attitude: both the absolute value for Attitude AND for its underlying 'belief strength' are 3 or more. For variables of Subjective Norm: both the absolute value for Subjective Norm AND its underlying 'motivation to comply' are 3 or more. For variables of Perceived Behavioural Control: both the absolute value for Perceived Behavioural Control AND its underlying 'control belief' are 3 or more. These criteria were applied to the *mean scores* over all respondents (to a given question on a given BMP in a given farm type), adopters and non-adopters merged. (Contrasts between the groups were evaluated in report D4.422). All scores presented refer to means.

Furthermore, each question (i.e., all questions within categories Attitude, Subjective Norm and Perceived Behavioral Control) was classified (by the corresponding national project team) to be of a natural, human, financial, physical or social kind of nature (Figure 4**Error! Reference source not found.**). These characterizations are listed in the tables hat present the detailed outcomes per country (see Appendices II-IX for the respective countries). This classification allows the grouping of drivers and barriers for later applications. It also gives an explicit starting point for seeking ways to overcome barriers via technical, social innovation or other pathways.

Figure 4: The Fan chart used to classify each question asked in the farmers interviews (after Carney 1998).

2 Results: Drivers and Barriers per BMP

2.1 Rotation

2.1.1 BMP Crop Rotation

Belgium

- dairy farms on sandy soils (6C=ENZ7_SL1_TXT1)
  Rotation maize-grass (N=189)
  Rotation of maize with grass clover (181)
- mixed farms (5M=vegetables/pigs, ENZ7_SL1_TXT2)
  Rotation of vegetables with cereals (N=41)

Germany

- arable and mixed farms on sandy soil (7A=ENZ4_SL1-TXT1); N=53
- arable/cereal and mixed farms on sandy loam and loam soils (9A=ENZ6_SL2+SL3_TXT3); N=76

Italy

- dairy cattle/temporary grass (16C=ENZ12_SL1_TXT2,TXT1,TXT3)
  Rotation with grass meadows (N=92)
  Rotation with legume meadows (N=92)
- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2_TXT3)
  Rotation with legume ley crop (N=108)

The Netherlands

- dairy farms on sandy soils (20C=ENZ7_TXT0_SL1)
  rotation grass-maize (N=46)

Spain

- arable farms with cereals (10A=ENZ13_SL1, SL2, SL3, SL4_TXT4); N=96

Drivers for Crop Rotation

Belgium

In dairy farming on sand, growing maize in rotation with grassland was compared to maize monoculture. Drivers for the rotation are expressed stronger than barriers. Among drivers, those of category A are strong, and are of both natural (increased soil fertility and biological soil quality, and better weed control) and financial (increased maize yield) nature. Low fertilization cost is also a driver.
Strong drivers for maize in rotation with grass-clover are free nitrogen (due to biological N fixation) and associated reduction of fertiliser cost. Another driver is higher crude protein in fodder.

For mixed farms on medium-textured soil, the practice of including cereals in vegetable rotations was analysed. Among the drivers, those of category A were the strongest: higher yields, improved soil quality (humus, structure, workability), less erosion, and ease of sowing cover crops are all strong drivers.

Germany

For arable and mixed farms on sandy soils, the major drivers are again of category A: improved soil quality (fertility, health), crop yields and yield stability, and prevention/less escalation of pest and diseases and of certain problematic weeds all rank high as drivers. Supporting bees and breaking labour peaks are listed, too.

For arable/cereal and mixed farms on sandy loam and loam soils (central uplands), the strong drivers are again of category A: higher yield, soil quality (humus), avoidance of labour peaks, but also support to wildlife. Avoidance of nutrient deficiencies is a weaker driver.

Italy
On dairy farms with temporary grassland, strong drivers for the inclusion of this crop in the rotation are benefits to soil structure, lower need for herbicides and pesticides, better feed ration for cattle, and better work distribution (labour peaks). All of these drivers are of category A. High forage prices are a weaker driver (PBC).

Alternatively – on the same farm type – rotation with legume meadows scores still higher for the above drivers (all strong), and has several additional strong drivers: higher crop yields, soil fertility (besides soil structure) higher milk production, reduction of fertiliser, reduction of protein purchase cost (expensive soy bean), high level and diversity of forage production, lower insect and pathogen pressure in following crop. All of these are of category A. Besides, feed advisors are positive about this practice (not strong). High soy price and available expertise (growing alfalfa) are strong drivers of PBC category.

In arable/cereal systems, strong drivers for adopting legume leys in the rotation are of category A: higher soil fertility and crop yields, reduced cultivation cost and less weed pressure. An increase in pests, however, was recorded as barrier (albeit weak at -2.8, cf. drivers scoring 3.2 to 7.5).

The Netherlands
In dairy farming on sandy soil, strong drivers for growing grass and maize in rotation rather than both crops as monocultures are higher yields in both crops, better fodder quality, and reduction of soil borne diseases. Re-sowing improves sod quality. Besides (weaker driver), an advantage to this rotation particular to Dutch legislation is that plowing-up grassland (for re-seeding) is allowed only in spring. Cultivating first maize upon such plowing-up enables to re-seed the grassland in August, when establishment is better due to lower weed pressure.
Extension opinion is positive, as are outcomes from research. Arable farmers support the practice, too. All of these referents have strong SN values.

Spain
Strong drivers for crop rotation in cereal-based arable systems are better control of pest, diseases and weeds; better soil nutrient storage and environmental quality; and better financial profit. Farmer associations are a positive driver for rotations. Weaker drivers are push by the CAP, and the fact that fallow fields are not appreciated socially.

Barriers for Crop Rotation

Belgium
In dairy farming on sand, a strong barrier is high residual soil nitrate levels in autumn for maize after grassland. (farms are monitored in Belgium for this parameter, and can receive penalties for high values). The dispersed geographical position of fields (far from farm house) is a barrier, too.
For rotation with grass-clover, the fact that protein feeds are expensive seems insufficient trigger to adopt the rotation. Barriers for rotation with grass-clover are the higher cost of crop protection (strong), and the sensitivity of clover to some herbicides.

For mixed farms on medium-textured soil, strong barriers to the practice of including cereals in vegetable rotations are of category A (low financial return of cereals; additional fertiliser cost), but also of category PCB (wet weather conditions; cereal price). Interestingly, unwanted attraction of pigeons is mentioned, too.

Germany

For arable and mixed farms on sandy soils, the major barrier is of financial nature (higher cost; variable gross margin; high land rent); negative pressure from advisors and other farmers also discourages rotation. A ‘barrier’ perhaps exclusive to the German situation is that there is no alternative to maize as bio-energy crop (subsidised).

For arable/cereal and mixed farms on sandy loam and loam soils (central uplands), there is one very strong barrier: ‘my farm is not organic’ (score -7.2). This is somewhat problematic to interpret.
Other barriers recorded are (not strong) that some crops have low yields, and that work load is higher. SN is negative (strong) from fellow farmers and extension.

Italy

On dairy farms with temporary grassland, barriers (relatively weak) are the consumption of irrigation water, and the cost for meadow cultivation. Also, earnings to be made with selling maize was found to be a barrier (not strong). For rotation with legume meadows in these systems, no clear barriers were found.
In arable systems, barriers to including a legume ley in the rotation are the cost of specific machinery (strong), and increased pest incidence (almost strong).

The Netherlands

In dairy farming on sandy soil, strong barriers for growing grass and maize in rotation are physical damage to the soil (due to maize harvest under wet conditions); also loss of SOC (as compared to grassland) is a strong barrier. Strong barriers of financial nature are the cost of plowing and re-seeding, and lower grass yield and protein content in the first year of grassland phase. A barrier of the PBC group (not strong) is that poorly drained fields are kept in continuous grassland only.

Spain

No strong barriers were recorded for crop rotation in cereal-based systems.

Table 3: The top three of drivers and barriers per FTZ unit for BMP Crop Rotation (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	Question	Value	Type	Nature
BE	dairy farms on sandy soils 6C	Increased soil activity, biology	5.4	A	Natural	Often too high nitrate residue in autumn when grassland is followed by maize	-4.5	A	Natural
		Increased soil fertility	5.9	A	Natural	Most of the parcels are not close to the farm	-2.8	PBC	Physical
		Less weeds	4.8	A	Natural	Soil texture and quality are more appropriate for grass	-2.3	PBC	Natural
	mixed farms (vegetables /pigs) 5M	Less damage to soil structure	7.2	A	Natural	Wet weather conditions	-5.3	PBC	Natural
		Higher yields	6.6	A	Financial	Low prices for cereals	-4.9	PBC	Financial
		More humus	5.8	A	Natural	Yield of cereals is low	-4.7	A	Financial
DE	arable and mixed farms on sandy soil	Increase soil fertility	5.9	A	Natural	Crops that vary widely in respect to their gross margin	-4.3	PBC	Physical
		Support soil health	5.4	A	Natural	High land rents	-4.3	PBC	Financial
		Avoiding certain problematic weeds	4.9	A	Social	Considerable higher costs*	-3.9	A	Financial
	arable/cereal and mixed farms on sandy soils	Higher yields	5.9	A	Natural	My farm is not organic	-7.2	PBC	Physical
		Maintenance of humus content	5.4	A	Natural	I have plots that are far away	-2.9	PBC	Physical
		Mutual facilitation of crops within the crop rotation	5.3	A	Natural	I do not have a high range of different market and utilization opportunities for a lot of different crops	-2.9	PBC	Financial
IT	dairy cattle/temporary grass	Improve soil structure	5.9	A	Natural	High irrigation amount needed	-2.7	A	Natural
		Less insecticide needed	5.0	A	Physical	Cost for meadow cultivation	-2.2	A	Financial
		Less herbicide needed	5.0	A	Physical	High selling price of maize	-2.1	PBC	Financial
NL	dairy farms on sandy soils	The rotation of grass-maize favours yields of both crops	8.1	A	Financial	Harvesting maize when fields are very wet causes physical damage to the soil	-9.0	A	Natural
		The rotation of grass-maize improves the quality of the fodder	7.3	A	Financial	Costs of ploughing and the establishment of the sod are high	-6.2	A	Financial
		Regular resowing of grass improves the sod	6.7	A	Natural	The rotation of grass-maize decreases soil organic matter content	-4.9	A	Natural
ES	Arable farms with	Pests, diseases and weeds are better	4.7	A	Natural	Assessment on markets and profitable crops is needed	-1.6	PBC	Human

cereals	controlled							
	It enhances the storage of nutrients within the soil	4.4	A	Natural	Benefits and profitability are reduced	-1.6	A	Financial
	Environmental quality is improved	4.1	A	Natural	Weather conditions are very variable	-1.1	PBC	Natural

2.1.2 BMP Including Legume Crops in Rotation

Austria

- Lower Austria arable farms (1A=ENZ8_SL3+SL1_TXT2); N=20
- Upper Austria mixed farms (2M=ENZ6_SL3_TXT3); N=7

Belgium

- dairy farms on sandy soils (6C=ENZ7_SL1_TXT1); N=181

Italy

- dairy cattle/temporary grass (16C=ENZ12_SL1_TXT2,TXT1,TXT3)
  Rotation with legume meadows (N=92)
- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2_TXT3)
  Rotation with legume ley crop (N=108)

For Belgium, the BMP Legume Crops coincides with 'Rotation of maize with grass-clover'; outcomes listed are therefore identical to those in section 2.1.1 (Rotation).

For Italy, the BMP Legume Crops coincides with 'Rotation with legume meadows' (dairy) and Rotation with legume ley crop (arable) as specified in section 2.1.1 (Rotation); outcomes listed on these practices are therefore identical.

Drivers for Including Legume Crops in Rotation

Austria

In Lower Austria (arable), virtually all drivers are of category A and type 'natural': better soil structure, soil cultivation is easier, good deep loosening of the soil, positive effects on growth and uniformity of other crops, wider crop rotation, and feed value to cattle are all strong positive drivers. Weaker drivers of SN or PBC type are GM-free feeding, social demand (population), and lack of feed protein in the 'inland'.

In Upper Austria (mixed farms), strongest drivers are again in Category A, and here they are of mixed type (natural, financial, physical). Strong drivers are contribution to soil fertility (nitrogen, humus) and to feed protein supply, higher feed nitrogen content, good for next crop (winter cereals), and lower production cost (less fertiliser (strong); less labour and pesticides (both not strong)). The fact that same production technology as for grain can be used was also recorded as driver. There is however a long suite of barriers (see below).

Belgium

In dairy farming on sand, drivers for maize in rotation with grass-clover are free nitrogen (due to biological N fixation) and associated reduction of fertiliser cost (strong); and higher crude protein in fodder.

Italy

On dairy farms with temporary grassland, there are many strong drivers for the inclusion of legume meadows in the rotation: benefits to soil structure, lower need for herbicides and pesticides, better feed ration for cattle, better work distribution (labour peaks), higher crop yields, soil fertility (besides soil structure) higher milk production, reduction of fertiliser, reduction of protein purchase cost (expensive soy bean), high level and diversity of forage production, lower insect and pathogen pressure in following crop. All of these are of category A. Besides, feed advisors are positive about this practice (not strong), High soy price and available expertise (growing alfalfa) are strong drivers of PBC category.

In arable/cereal systems, strong drivers for adopting legume leys in the rotation are of category A: higher soil fertility and crop yields, reduced cultivation cost and less weed pressure. An increase in pests, however, was recorded as barrier (albeit weak at -2.8, cf. drivers scoring 3.2 to 7.5).

Barriers for Including Legume Crops in Rotation

Austria

In Lower Austria, strong barriers (although weaker than drivers) are again of category A but are (in contrast to drivers) mostly of 'financial' type: strong yield fluctuation, seed cost, poor marketability. Also, difficulties of crop management, higher pesticide use, poor seed quality, and lack of 'stable varieties' are quoted as barriers (none of them strong).

In Upper Austria (mixed farms), strongest barriers are in Categories A and PBC. They are of mostly natural and financial types. Foremost of all is the increased erosion risk (A=-7). Pest pressure is another important 'natural' and strong barrier. Other strong barriers are financial (low margin; yield fluctuation; yield decline over years; not competitive), and increased complexity. Seed cost, low market demand, and weather dependency (years without reaching maturity) are weaker barriers of Category A. Strong barriers are also mentioned in the PBC category: yield uncertainty and late maturity, low market price, and high precipitation. Other barriers are lack of good varieties ('breeding') and lack of effective pesticides.

Belgium

For rotation with grass-clover in dairy farming on sand, the fact that protein feeds are expensive seems insufficient trigger to adopt the rotation. Barriers for rotation with grass-clover are the higher cost of crop protection (strong), and the sensitivity of clover to some herbicides.

Italy

On dairy farms with temporary grassland, no clear barriers were found against rotation with legume meadows.

In arable systems, barriers to including a legume ley in the rotation are the cost of specific machinery (strong), and increased pest incidence (almost strong).

Table 4: The top three drivers and barriers per FTZ unit for BMP Legume crops (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	Question	Value	Type	Nature
AT	arable farms	Positive previous crops	6.9	A	Natural	Strong yield fluctuations	-5.0	A	Financial
		Better soil structure	6.5	A	Natural	Expensive seeds	-4.8	A	Financial
		Fixation of nitrogen	6.3	A	Natural	Bad marketing	-4.5	A	Financial
	mixed farms (arable farms)	Increased nitrogen content	7.3	A	Natural	Increased risk of erosion	-7.0	A	Natural
		Support the soil fertility	6.7	A	Natural	Poor contribution margin	-6.7	A	Financial
		Contribution to the local protein supply	6.5	A	Physical	Strong fluctuations in yield	-6.7	A	Financial
BE	dairy farms on sandy soils	Less use of mineral fertilizers	4.2	A	Financial	Higher costs for crop protection	-4.4	A	Financial
		N fixation	3.3	A	Natural	Purchase of feed protein is expensive	-2.5	PBC	Financial
		More crude protein in grass silage	2.8	A	Natural	Grassland is intensively cultivated on my farm	-2.5	PBC	Physical
IT	dairy cattle/temporary grass	Increase crop yield	7.4	A	Natural	no barriers			
		Increase soil fertility	6.7	A	Natural				
		Increase of milk production	6.4	A	Natural				
	arable/cereal	Increased soil fertility	7.5	A	Natural	Machineries are expensive	-3.2	PBC	Financial
		Higher crop yield	6.9	A	Natural	More pests	-2.8	A	Natural
		Increased soil nitrogen availability	6.5	A	Natural	Cereals have high price	-1.6	PBC	Financial

2.1.3 BMP Land Exchange

Belgium

- mixed farms vegetables-pigs (5M=ENZ7_SL1_TXT2)
  Land Exchange (N=101)

Drivers for Land Exchange

Belgium

All strong drivers for this practice are of category A and are of different types (financial, natural, physical): higher yields, less soil depletion, less diseases, more options for rotation, better nutrient balance.

Barriers for Land Exchange

Belgium

Many barriers are expressed of the following rated ‘strong’. Besides damage to soil structure and increase in specific weeds on own land, farmers face the situation that many surrounding farmers grow the same crops. Also, farmers are satisfied with their own rotation (no need for exchange) and don’t seem to benefit financially. Farmers are not sure (PBC category) about how others will treat their land, nor about the quality of land they get in return (notably pH concerns). The distance may act as a barrier, too.

Table 5: The top three drivers and barriers per FTZ unit for BMP Land exchange (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	Question	Value	Type	Nature
BE	mixed farms (vegetables/pigs)	Higher yields	6.0	A	Financial	Less good structure of my soil	-5.1	A	Natural
		Decreases soil depletion	5.4	A	Natural	Additional source of revenues	-4.7	PBC	Financial
		More possibilities for crop rotation	4.9	A	Physical	My rotation scheme is good	-4.2	PBC	Physical

2.2 Catch and cover crops and green manures

2.2.1 BMP Cover / Catch Crops / Green Manures

Austria (Cover/Catch Crops/green manures):

- Lower Austria arable farms (1A=ENZ8_SL3+SL1_TXT2); N=15
- upper Austria mixed farms (2M=ENZ6_SL3_TXT3); N=6

Belgium (cover crops)

- arable/specialized crop farms (4A=ENZ7_SL2_TXT3); N=196
- dairy farms on sandy soils (6C=ENZ7_SL1_TXT1); N=198
- mixed farms vegetables-pigs (5M=ENZ7_SL1_TXT2); N=101

France (catch-crops/cover crops)

- arable farms on Rendzina (13A=ENZ7_SL2_TXT2); N=16
- dairy farms on Cambisol and Luvisol (14C=ENZ7_SL2_TT3); N=17

Germany

- arable and mixed farms on sandy soil (7A=ENZ4_SL1-TXT1); N=60
- arable/cereal and mixed farms on sandy soils (8A=ENZ6_SL1_TXT1); N=96
- arable/cereal and mixed farms on loamy/clay soils (9A=ENZ6_SL2+SL3_TXT3); N=80

Italy

- dairy cattle/temporary grass (16C=ENZ12_SL1_TXT2,TXT1,TXT3); N=91
- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2_TXT3);N=109
- arable/cereal (17A=ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3); N=92

Poland

- arable farms (21A=ENZ6_SL2_TXT3), N= 93
- mixed farming (22M=ENZ6_SL2_TXT1) N=68
- dairy cattle (23C=ENZ6_SL1_TXT1) N=140

Spain

- Permanent crop farms (olive and fruit trees, vineyards) (11P=ENZ13_SL2,SL3,SL4_TXT3) N=150

The Netherlands

- dairy farms on sandy soils (20C=ENZ7_TXT0_SL1);
  undersowing of green manures under maize; N=49
  early maize harvest in favour of green manures; N=51
- arable farms on clay soils (18A=ENZ4,ENZ7_TXT2,TXT3_SL1) ; N=95
- arable farms on sandy soils (20A=ENZ4,ENZ7_TXT1_SL1); N=132

Drivers for Cover / Catch Crops / Green Manures

Austria (cover/catch crops/green manures)

On arable farms, strong drivers are of category A and type Natural: reduced erosion, better rooting, soil fertility, humus, soil life, nitrogen fixation, water storage over winter, value for insects, relaxing for crop rotation. Strong drivers in the PBC category are available machinery, sufficient precipitation, cheap seeds, and similar seeding technology as for other crops (e.g. cultivator).

In upper Austria (mixed farms), strong drivers of category A are same as above. Weaker drivers are reduction of soil borne diseases, and early tillage (seems in conflict with barrier of slow spring warming). Strong drivers are also found in category PBC: financial support by ÖPUL, the presence of early harvested crops (barley), and availability of well-adapted varieties. Crop experts are very positive (SN=5.43).

Belgium (cover crops)
In arable farms, strong drivers are improved soil (structure, health, nitrogen, carbon), lower erosion risk, less nitrate leaching, weed suppression, earlier tillage in spring, and the opinion of fellow farmers (SN). For the dairy farms roughly the same drivers are reported (all strong). Additional strong drivers are better rooting and yield of next crop, and less soil compaction. A subsidy compensates for extra cost (type PBC) and government encouragement (SN) counts as driver, too.
Most of the above drivers (given for arable, dairy) hold equally strong in mixed farms, where better aeration and drainage, and easier spring tillage (only for non-graminoid cover crops) are mentioned as additional strong drivers. Subsidy was no driver in mixed farms.

France (catch-crops/cover crops)
In both arable and dairy farms, strong drivers for catch-crop implementation are a decrease of the weeds pressure, an improvement of the biological activity of the soil, an increase of the organic matter content, and an improvement of top layers porosity and soil structure stability. All these drivers belong to category A. On the environmental side of category A drivers are also an impact on decrease of run-off and erosion (only for arable farm for the latter).

Specific drivers for arable farms are on the economic group of category A drivers with a decrease of herbicides and fertilisation costs. They are associated with a better water storage, that in turn decreases irrigation needs in these shallow soils. A strong driver is the limitation of soil borne diseases.

The dairy farms we have surveyed are located in vulnerable zones, where covering the soils in winter is mandatory. Farmers have two options, modify their rotations to include more winter crops, or implement catch-crops. Besides being mandatory, specific drivers towards implementation of catch-crops are the improvement of the following crop, and the crops in the succession. In line with the vulnerable zone stakes, dairy farmers mention that catch-crops mitigate nitrate issues and facilitate the reasoning of the N fertilisation.

For the two groups of farms, there are no drivers from the SN category. In the PBC category, a lack of OM and the heterogeneity of the soils are drivers in arable farms, but not in dairy farms (that suffer less from low SOC, because of animals).

Germany (cover crops)
On arable and mixed farms on sandy soil in the North-West, strong drivers are higher soil fertility and humus content, less erosion and nutrient leaching, food and shelter for wildlife, and soil drying. Also, cover crops allow slurry application and so reduce required slurry storage capacity. All of these are strong drivers of category A.

On arable and mixed farms on sandy soil in the North-East, the same strong drivers are mentioned, but scores are higher, notably various aspect of soil quality, workability and erosion. Facilitation of bees is an extra and well-expressed driver. Training is a driver of the SN category.
On the finer textured soils of central/south regions, major drivers are again in category A and of type Natural. Besides the above benefits for soil quality, strong drivers cited are

better soil life, soil aeration, and workability, and weed suppression. Faster spring warming is a weaker driver.

Italy (green manures)
On dairy farms with temporary grassland, strong drivers for green manures are soil improvement (structure, humus), nutrient retention and fertiliser saving, and less weed pressure. In arable/cereal systems, higher yields are an additional strong driver. For the third farm type in the Italian study (arable/cereal in accidented terrain) less erosion is a strong driver, as well as increased protein in following crops (in addition to the above soil benefits and fertiliser saving, all strong).

Poland (cover crops)
In all three farm types, soil fertility, organic matter and structure, and reduced erosion are strong drivers of category A. In the SN category, another strong driver is the opinion of advisors. For arable and mixed systems, better soil biological activity and soil phytosanitary condition, higher yields and lower fertiliser cost are strong drivers, too.

Spain
Cover crops were evaluated in Spain only for use in permanent crops (trees, vineyards). Here, strong drivers are erosion control, and better water retention and soil properties (category A). Technicians and farmers associations also encourage cover cropping (category SN).

The Netherlands
In dairy farms on sandy soil, drivers for (undersown) catch crops in maize are strong and of category A and mixed type (natural, financial, human): improved nutrient efficiency, N-availability to next crop, preventing N loss, soil organic matter. Increased soil bearing strength (machinery) is a strong driver, too, as is the saving on fields later in the season.

Still in dairy farming: early harvest of maize in favour of green manures has strong drivers: better development of the green manure, therefore more contribution to soil organic matter, more N interception, facilitates re-establishing the grass sod, and better nitrogen availability. On wet parcels: avoiding soil damage by late maize harvest. There are strong barriers, however (see below).

In arable farming (same for both clay and sand), strong drivers for green manures are soil improvement (soil N supply, structure, workability), organic matter, soil fauna, less erosion (wind, water) and less nitrate leaching. All of these are of category A, type Natural. There are strong drivers, too, in the SN category, again same for both sand and clay: extension, clubs, magazines, seed providers all encourage green manuring. A preference to plow down cereal straw seems to support this practice (PBC category, strong).

Barriers for Cover / Catch Crops / Green Manures

Austria(cover/catch crops/green manures)
On arable farms (Lower Austria), strong barriers are financial: higher cost, fuel use, and lower income. It was also recorded that more crop protection is needed, that there is risk of failure, and that residues may be difficult to handle (none of them strong barriers).

In upper Austria (mixed farms), strong barriers are of various types (financial, natural, physical): more demanding weed management, retarded spring soil warming, higher costs, overwintering of fungal diseases. Other barriers (not strong) are difficulties with seed placement (A), and availability of technical equipment (PBC).

Belgium (cover crops)
In arable farms, weak barriers are increased herbicide use, short time window after harvest for sowing (1 Sept.), and lack of appropriate machinery for sowing and incorporation.
For the dairy farms, strong barriers are bad weather in autumn (PBC), labour demand, and too dry soil in spring (in case of graminoid cover crop as rye or rye grass).
For mixed farms, additional barriers are bad autumn weather (PBC; strong), increased cost and herbicide use (after graminoids), and discouragement by contract workers (SN).

France (catch-crops/cover crops)
The main barriers towards implementation are of SN category, while neither accountants, advisors, family nor fellow farmers are favourable of the implantation of catch-crops. PCB barriers are all of low importance.

In arable farms, the risk of lower yields, the increase of fuel and mechanisation costs, work load, difficulty to destroy the crop and complexification of the nitrogen fertilisation reasoning are the main barriers, all from category A.

In dairy farms, barriers are of environmental type, with a shallow risk of erosion (especially in early autumn or during wet springs). Fuel, mechanisation and seed costs are also quoted, and might prevent adoption if the catch-crops weren't mandatory, but are not active barriers at the moment. The increase of work load and difficulties of organising work at time where seeding the catch-crop is needed, are also reported.

Germany (cover crops)
On arable and mixed farms on sandy soil in the North-West, barriers are of categories SN and PBC, and are weaker than drivers: fellow farmers, machinery for stubble management and seeding of cover crop, and rainy autumn.

On arable and mixed farms on sandy soil in the North-East, there is a long list of relatively weak barriers, all in the PBC category, including lack of irrigation on maize fields, labour, cost, late harvest, and bad weather.

On the finer textured soils of central/south regions, barriers are (again) numerically weaker than drivers. Still strong are fuel use, and difficulties to incorporate cover crops into the soil in spring. Work effort is a weaker barrier.

Italy
In all three Italian farm types, the strongest barrier is cost.
On dairy farms with temporary grassland, green manures go at the expense of own feed production (strong barrier). Here, other farmers and feed advisors do not encourage the practice (SN).
Lack of incentives is a (weak) barrier in level terrain (SL1 class), but in accidented terrain (SL3/4) having incentives is a (weak) driver. A weak barrier here is lack of appropriate machinery.

Poland
No strong barriers to cover crops were recorded. Limited technical knowledge was cited as weak barrier for dairy farmers.

Spain
Barriers cited are only weak and include local traditions, lack of subsidies, and increased contamination by herbicides.

The Netherlands
Cultivation of catch / cover crops after maize is an obligation on sandy soils in the Netherlands. The general problem is that such after-crops are seldom successful, due to late maize harvest. The obligation is therefore not often effective in reducing nitrate leaching (its goal). Two options were investigated for dairy on sandy soils: undersowing of the catch crop during the maize season; and earlier maize harvesting to give catch crops a better start.

Strong barriers for undersown catch crops in maize are: double cost in case of failure (due to obligation to re-establish catch crop), competition for water, and higher cost than sowing after maize harvest.

Strong barriers against early maize harvesting are lower yield and quality in maize, lack of financial compensation, lack of extra nitrogen quota (as reward; NL farmers feel that maize yields are nitrogen limited due to stringent nitrogen quotation), and lack of high yielding early maize cultivars. There is negative peer pressure among farmers.

In arable farming, strong barriers for green manures are (same for both clay and sand) extra cost and more nematodes. Increased labour requirement is a strong barrier on clay. A weaker barrier (both soils) is higher weed pressure in next crop. Other than in dairy, nitrogen quota seem to play no role here (either soil type).

Table 6: The top three drivers and barriers per FTZ unit for BMP Cover / Catch Crops / Green Manures (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	Question	Value	Type	Nature
AT	arable farms	Reduced erosion	7.5	A	Natural	Higher costs	-4.3	A	Financial
		Soil is rooted and loosened	6.9	A	Natural	Higher use of fuel	-4.2	A	Financial
		Enhanced soil life	6.7	A	Natural	Higher application of plant protection	-3.5	A	Natural
	mixed farms (arable farms)	Good soil structure	9.4	A	Natural	General weed management (e.g. weed control) is more demanding	-5.4	A	Natural
		Reduced soil erosion	9.4	A	Natural	Slower warming and drying of the fields in spring	-5.0	A	Natural
		Increase of the humus content	8.9	A	Natural	Caused costs	-4.9	A	Financial
BE	arable/specialized crop farms	Improved soil structure	6.8	A	Natural	Short time period harvest -sowing (before Sept 1)	-2.4	PBC	Physical
		Increased soil health	6.6	A	Natural	Increased use of herbicides	-2.1	A	Financial
		Lower erosion risk	5.4	A	Natural	No appropriate machinery for incorporation	-2.0	PBC	Physical
	dairy farms on sandy soils	Improved soil fertility	5.8	A	Natural	Bad weather in autumn	-4.1	PBC	Natural
		More soil humus	5.8	A	Natural	Seed for cover crop is expensive	-2.0	PBC	Financial
		Grass as cover crop results in additional roughage for my herd	5.6	A	Financial	Increase of total costs	-1.3	A	Financial
	mixed farms (vegetables/pigs)	More soil humus	7.1	A	Natural	Increase in total costs	-4.5	A	Financial
		Better soil structure	6.3	A	Natural	Weather conditions in autumn are often bad	-4.1	PBC	Natural
		More airy soil	6.2	A	Natural	Lots of administration to get a subsidy	-2.8	PBC	Human
DE	arable and mixed farms on sandy soil	Soil fertility	6.1	A		Beekeepers	-3.8	SN	Social
		High humus content in the soil	5.5	A		Lack of machine endowment for stubble cultivating and seeding of cover crops	-3.2	PBC	
		Soil erosion	5.5	A		High precipitation in autumn	-2.9	PBC	
	arable/cereal and mixed farms on sandy soils	Reduced nutrient leaching	7.8	A	Natural	No irrigation plots for maize cultivation	-3.6	PBC	Physical
		Prevention of erosion	7.6	A	Natural	I am at the limit with my workforce	-3.4	PBC	Physical
		Positive influence on humus content	7.4	A	Natural	Growing cover crops results in labour peaks on my farm	-3.3	PBC	Physical

	arable/cereal and mixed farms on sandy soils	More active soil life	8.0	A	Natural	I cannot easily incorporate cover crops in spring	-3.3	PBC	Physical
		Prevention of erosion	6.9	A	Natural	More fuel use	-3.2	A	Financial
		Looser and better aerated soil	6.9	A	Natural	Higher work effort	-2.7	A	Human
FR	Arable	improves soil biological activity	5.1	A	Environment	Accountants	-2.1	SN	Social
		increase organic matter content	3.7	A	Environment	bad quality	-2.0	PBC	Environment
		improves soil structure stability	2.9	A	Environment	Family	-1.9	SN	Social
	Dairy	improves soil biological activity	3.1	A	Environment	increase seed cost	-2.7	A	Economic
		increase organic matter content	2.7	A	Environment	increase fuel cost	-2.3	A	Economic
		mitigates nitrate issues	2.3	A	Environment	increase mechanisation cost	-2.3	A	Economic
IT	dairy cattle/temporary grass	Improved soil structure	6.1	A	Natural	Cost increase	-7.2	A	Financial
		Increase of SOM	5.76	A	Natural	Lower self-production of forage	-4.2	A	Natural
		Less weeds	5.23	A	Physical	Feed advisor	-4.0	SN	Social
	arable/cereal	Higher soil organic matter	6.8	A	Natural	Additional costs for green manure	-3.2	PBC	Financial
		Improved soil structure	6.8	A	Natural	No incentives for green manure	-2.3	PBC	Financial
		Higher soil nitrogen content	5.6	A	Natural	Other farmers	-2.2	SN	Social
	arable/cereal	Improved soil structure	6.3	A	Natural	Higher cultivation costs	-4.6	A	Financial
		Higher soil organic matter	6.0	A	Natural	Lack of adequate machineries	-2.3	PBC	Physical
		Reduced use of mineral fertilisers	5.4	A	Physical	Other farmers	-2.3	SN	Social
NL	dairy farms on sandy soils	Improve nutrient efficiency	6.8	A	Natural	When undersowing fails double costs	-6.7	A	Financial
		Increases the N-availability to the following crop	6.7	A	Financial	Competes on nutrients and water with maize	-4.9	A	Natural
		Organic matter increase	6.3	A	Natural	More expensive than sowing after harvest	-4.0	A	Financial
	arable farms on clay soils	Better soil structure	9.1	A	Natural	Increases costs	-5.2	A	Financial
		Support long term soil fertility	9.0	A	Natural	Requires extra time	-3.9	A	Human
		Improve soil handling	8.8	A	Natural	More nematodes	-3.8	A	Natural
	arable farms on	Better soil structure	8.7	A	Natural	Increases costs	-4.7	A	Financial

	sandy soils	Support long term soil fertility	8.3	A	Natural	More nematodes	-3.8	A	Natural
		More organic matter	8.3	A	Natural	Requires extra time	-2.8	A	Human
PL	arable farms	Prevent erosion	6.2	A	Natural	Not enough technical knowledge	-0.7		Human
		Better soil structure	6.0	A	Natural				
		Increase organic matter in the soil	5.8	A	Natural				
	mixed farming	Prevent erosion	6.0	A	Natural	Not enough technical knowledge	-0.3	PBC	Human
		More organic matter in the soil	5.8	A	Natural				
		Better soil structure	5.5	A	Natural				
	dairy cattle	Increase of organic matter in the soil	4.8	A	Natural	Not enough technical knowledge	-1.1	PBC	Human
		Better soil structure	4.7	A	Natural				
		Prevent erosion	4.6	A	Natural				
ES	Permanent crop farms (olive and fruit trees, vineyards)	Controls soil erosion	4.9	A	Physical	Increases contamination	-2.0	A	Physical
		Improves water retention	4.9	A	Natural	Traditions of the region	-1.9	PBC	Social
		Improves soil properties	3.4	A	Natural	Lack of subsidies	-1.8	PBC	Financial

2.2.2 BMP Early Harvest of Maize to enable cover crops

The Netherlands

- dairy farms on sandy soils (20C=ENZ7_TXT1_SL1);
  early maize harvest in favour of green manures; N=51

(Same results for this practice are given as were included under cover crops for The Netherlands dairy farms on sand, section 2.2.4.)

Drivers for Early Harvest of Maize to enable cover crops

The Netherlands

In dairy farms on sandy soil, early harvest of maize in favour of green manures has strong drivers: better development of the green manure, therefore more contribution to soil organic matter, more N interception, facilitates re-establishing the grass sod, and better nitrogen availability. On wet parcels: avoiding soil damage by late maize harvest. There are strong barriers, however (see below).

Barriers for Early Harvest of Maize to enable cover crops

The Netherlands

Cultivation of catch/cover crops after maize is an obligation on sandy soils in the Netherlands. The general problem is that such after-crops are seldom successful, due to late maize harvest. The obligation is therefore not often effective in reducing nitrate leaching (its goal). Two options were investigated for dairy on sandy soils: undersowing of the catch crop during the maize season; and earlier maize harvesting to give catch crops a better start.

Strong barriers against early maize harvesting are lower yield and quality in maize, lack of financial compensation, lack of extra nitrogen quota (as reward; NL farmers feel that maize yields are nitrogen limited due to stringent nitrogen quotation), and lack of high yielding early maize cultivars. There is negative peer pressure among farmers.

Table 7: The top three drivers and barriers per FTZ unit for BMP Early Harvest of Maize (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	Question	Value	Type	Nature
NL	dairy farms on sandy soils	A good green manure produces more organic matter	8.8	A	Natural	Early harvest of maize lowers yields	-8.3	A	Financial
		Early harvest of maize improves green manures	7.2	A	Natural	Early harvest reduces the quality of the maize	-7.2	A	Financial
		Early harvest of maize facilitates reestablishment of the grass sod	7.0	A	Natural	I do not get reimbursed for early harvesting my maize	-5.9	PBC	Financial

2.3 Crop residue management

2.3.1 BMP Incorporation of Straw

Belgium

- arable/specialized crop farms (4A=ENZ7_SL2_TXT3); N=179

Italy

- dairy cattle/temporary grass (16C=ENZ12_SL1_TXT2,TXT1,TXT3); N=91
- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2_TXT3);N=114
- arable/cereal (17A=ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3); N=93

Poland

- arable farms (21A=ENZ6_SL2_TXT3), N= 93
- mixed farming (22M=ENZ6_SL2_TXT1) N=68
- dairy cattle (23C=ENZ6_SL1_TXT1) N=140

The Netherlands

- arable farms on clay soils (18A=ENZ4,ENZ7_TXT2,TXT3_SL1) ; N=99
- arable farms on sandy soils (20A=ENZ4,ENZ7_TXT1_SL1); N=55

Drivers for Incorporation of Straw

Belgium

All strong drivers are of category A and type ‘Natural’: benefits to soil quality (structure, fertility, humus, potassium, trace elements). A strong driver of category PBC is that current legislation makes it difficult to maintain soil humus content. Weaker drivers in this category are that straw constitutes a ‘free’ source of N and P (not accounted for in the administrative nutrient quotation system), and that buyers for straw are not always easily found.

Italy

In dairy farms, strong drivers (category A) are soil quality (structure, organic matter), and higher yields. Suppression of weeds and fungi in next crop is a weaker driver. A conditional driver (PBC) is the availability of adequate machinery. Suppliers of farm product, and other farmers are positive (weak, SN) about the practice.
In arable/cereal farms in the plains, strong drivers are improved soil quality (structure, organic matter), lower fertiliser requirement; increased grain protein in wheat is a weaker driver. Within category A, slow decomposition and missed selling revenues rank as very weak drivers (indicating positive attitude in spite of these aspects). Advisors and fellow farmers are positive. A strong driver in PBC category is that straw burning is now prohibited.
In arable/cereal farms in the hills, strong drivers are again soil quality (fertility, structure, organic matter). There is positive opinion (SN) among advisors, family and fellow farmers. Strong drivers of PBC category are the ban on burning residues, and having adequate machinery.

Poland

All strong drivers are in category A, and are of type ‘Natural’. Arable farmers are most expressive (scores), followed by mixed farmers and then dairy farmers. Strong drivers are soil quality (structure, fertility), and prevention of erosion (in arable, dairy; weak in mixed). Weaker drivers are the reduction of water loss (all), and the inhibition of weeds (mixed, dairy).

Positive opinion (SN) is held with research, other farmers and advisors, but this holds only for the arable and mixed farmers. For the dairy farmers, a negative opinion among these referents is noted. Additional income is a weak driver in all three farm types (category PBC).

The Netherlands
The expression of drivers was very similar between the two groups of arable farms (on sand and clay, respectively). Strong drivers were found in all three categories (A, SN, PBC). Highest scores were for soil quality aspects (structure, organic matter, soil fauna, workability). Keeping the nutrients in the field, and ease of operation (versus straw removal) are strong drivers, too. Perceived opinion among referents ranks positive (press, study clubs, extension, other farmers). The cultivation of green manure after wheat is not seen as a barrier against straw incorporation (PBC category).

Barriers for Incorporation of Straw

Belgium
The fact that nitrogen is needed to digest straw was – surprisingly - recorded as weak barrier.

Strong barriers are the extra fuel consumption (category A), and the good price for straw on the market (category PBC). Weaker barriers (PBC) are that the practice complicates the land application of manure, and that insufficient nitrogen is allowed to digest the straw. Still weaker are (PBC): cost of chopping, night-time harvesting, agreements with livestock farmers, extra field operation, high biomass, an nitrogen requirement.
In category A, difficulties with digestion (in soil) or seeding of next crop are only very weak barriers. In the SN category, there is negative opinion from fellow farmers and contract workers.

Italy
In dairy farms, there is only one barrier (strong, category A), and that is the farm’s own straw requirement (bedding material).
In arable/cereal farms in the plains, the strongest barrier (category A) is increased risk of fungal diseases. Further, increased fertiliser use is a weak barrier (A=-2.28), contradicting the above driver (A=5.07). Weak barriers in category PBC are adverse environments for decomposition, and high selling price.
In arable/cereal farms in the hills, barriers are (category A) increased fertiliser requirement (strong) and (not strong) increases in weeds, pest and diseases, complications in sowing the next crop, and missed income from selling. Further, chopping and distribution of straw is expensive (weakest barrier; PBC category).

Poland
Barriers (category A, weak) are the cost of mechanisation, increase of fungal diseases, and lower seed germination (next crop). These hold for all three farm types. For dairy farmers, negative opinion among referents was recorded.

The Netherlands
The strongest barrier is the need for extra nitrogen to enable straw decomposition (both soil types). Other strong barriers on both soil types are extra cost, and an increase of fungal diseases. Another well expressed barrier (not strong) is the use of heavy machinery. (All of the above are in category A). Weak barriers of the PBC category are

the cultivation of whole crop silage (maize), the nitrogen quota system (statutory fertiliser limits), selling price for straw (clay only), alternative uses (covering harvested beets or potatoes), or relations with livestock farmers.

Table 8: The top three drivers and barriers per FTZ unit for BMP Incorporation of Straw (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	Question	Value	Type	Nature
BE	arable/specialized crop farms	Improved soil structure	6.6	A	Natural	Good prices for straw	-4.7	PBC	Financial
		Increased soil fertility	6.2	A	Natural	Additional fuel is needed	-3.8	A	Physical
		Good investment for my soil	6.1	A	Natural	Contract worker	-3.6	SN	Social
IT	dairy cattle/temporary grass	Improve soil structure	6.2	A	Natural	Increase straw requirements at farm scale	-4.2	A	Natural
		Increase crop yield	5.6	A	Natural				
		Availability of adequate machinery	4.9	PBC	Physical				
	arable/cereal	Improved soil structure	7.2	A	Natural	Increased risk of fungal diseases	-4.4	A	Natural
		Higher soil organic matter	6.8	A	Natural	Adverse environmental conditions that hinder residues degradation	-2.3		Natural
		Reduced use of mineral fertilisers	5.1	A	Physical	Increased nitrogen fertiliser use	-2.3	A	Physical
	arable/cereal	Increased soil fertility	6.7	A	Natural	More weeds, pests and diseases	-3.8	A	Natural
		Improved soil structure	6.4	A	Natural	Increased nitrogen fertiliser use	-3.9	A	Physical
		Higher soil organic matter	6.2	A	Natural	Following crop sowing hindered by residues	-3.9	A	Physical
NL	arable farms on clay soils	It improves soil structure	8.8	A	Natural	The decomposition of straw needs extra N	-6.4	A	Natural
		It provides organic matter to the soil	8.6	A	Natural	It increases fungal diseases	-3.9	A	Natural
		It improves soil fauna	8.3	A	Natural	It costs extra money	-3.8	A	Financial
	arable farms on sandy soils	Improves soil structure	8.7	A	Natural	Decomposition of straw needs extra N	-6.1	A	Natural
		Provides organic matter to the soil	8.4	A	Natural	Incorporation does not need heavy machinery	-4.8	A	Natural
		Improves soil fauna	8.1	A	Natural	Increases fungal diseases	-4.7	A	Natural
PL	arable farms	Better soil structure	6.4	A	Natural	Higher mechanization costs	-2.2	A	Financial
		Faster decomposition of straw with extra dose of nitrogen	6.0	A	Natural	Increase development of fungal diseases	-1.1	A	Natural
		Additional source of nutrients	6.0	A	Natural	Inhibition of seed germination	-0.7	A	Natural
	mixed farming	Additional source of nutrients	4.9	A	Natural	Increase development of fungal diseases	-2.1	A	Natural

	Faster decomposition of straw with extra dose of nitrogen	4.9	A	Natural	Higher mechanization costs	-1.4	A	Financial
	Better soil structure	3.8	A	Natural	Inhibition of seed germination	-1.2	A	Natural
dairy cattle	Faster decomposition of straw with extra dose of nitrogen	3.8	A	Natural	Increase development of fungal diseases	-2.2	A	Natural
	Better soil structure	3.3	A	Natural	Results on experimental fields	-1.8	SN	Human
	Additional source of nutrients	3.3	A	Natural	Other farmers	-1.7	SN	Social

2.4 Grazing

2.4.1 BMP Permanent grazing / rotational grazing / pastoral planning

Austria *(Tirol) (*(permanent/rotational grazing)

- dairy cattle/permanent grassland (3C=ENZ5_SL5_TXT2); N=6

Spain (pastoral planning)

- Mixed farms known as Dehesa (sheep, pigs and beef and permanent grass) (12C=ENZ12_SL2,SL3,SL4_TXT2; ENZ13_SL3_TXT1; ENZ13_SL2,SL3,SL4,SL5_TXT2) N=89

Drivers for Permanent grazing / rotational grazing/ pastoral planning

Austria (permanent / rotational grazing)
Main drivers here are of category A and are of mixed type (financial, natural, physical). Strong among these are financial: saving of time, money, feed concentrates, fertilisers; increased margin. Well-being of the herd (less stress, better health and metabolism, fodder quality) rank high (strong), too. Contributing to soil humus content is a weaker driver. All of these are of category A. Significant drivers of other types are ample availability of nearby grazing land (PBC), and encouragement by the Chamber of Agriculture (SN).

Spain (pastoral planning)
All drivers for this practice are relatively weak. They are of mixed types (natural, physical, human, financial). They include improved resource management, organisation of farm operations, improved livestock management, correcting wrong management in the past, improved profitability and productivity, and the establishment of clear guidelines. Advisors from some associations are positive (strong SN score).

Barriers for Permanent grazing / rotational grazing/ pastoral planning

Austria (permanent/rotational grazing)
There is one strong barriers of category A: trampling of the sward under wet conditions. Other barriers (not strong) of category A are insufficient animal viewing (distance), and heterogeneous nutrient input (patches). Barriers of category PBC are terrain steepness (strong), animal numbers (do not match under wet weather conditions), and long distances for animal travel. Erosion was cited as a weaker barrier of PBC category, too.

Spain (pastoral planning)
Barriers (all of category PBC) are lack of (or too low) subsidies for implementing a pastoral plan (strong) and a set of weaker barriers: fluctuations in markets, prices and weather conditions, lack of site-specific knowledge by advisors. Very weak barriers are the need for more management information, and aspects of bureaucracy.

Table 9: The top three drivers and barriers per FTZ unit for BMP Permanent grazing / rotational grazing / pastoral planning (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	Question	Value	Type	Nature	Question	Value	Type	Nature
AT	dairy cattle/permanent grassland	Saved time and money	7.5	A	Financial	Trampling damages in the sward with wet weather	-5.5	A	Natural
		Increased contribution margin	7.2	A	Financial	Animals are too far away and the animal viewing is insufficient	-2.75	A	Natural
		Improved animal health	6.6	A	Natural	Fertiliser irregularly distributed on the field surface	-2.6	A	Physical
ES	Mixed farms known as Dehesa (sheep, pigs and beef and permanent grass)	Technicians from some associations	3.2	SN	Social	There are not enough subsidies for implementing a pastoral plan	-3.4	PBC	Financia l
		It improves the natural resources management	2.3	A	Natural	Prices and markets varies significantly from one year to another	-2.9	PBC	Financia l
		The organization of the operations and management of the farm is improved	2.2	A	Physical	The weather conditions differ from one year to another	-2.8	PBC	Natural

2.5 Tillage and transport

2.5.1 BMP Non-Inversion / Minimum / Light Tillage

Austria (Non-inversion tillage):

- Lower Austria arable farms (1A=ENZ8_SL3+SL1_TXT2); N=28

Belgium (non-inversion tillage)

- arable/specialized crop farms (4A=ENZ7_SL2_TXT3); N=134
- dairy farms on sandy soils (6C=ENZ7_SL1_TXT1); N=186
- mixed farms vegetables-pigs (5M=ENZ7_SL1_TXT2); N=117

France (non-inversion tillage)

- arable farms on Rendzina (13A=ENZ7_SL2_TXT2); N=9
- arable farms on Cambisols (15A=ENZ12_SL3_TXT4); N=19
- dairy farms on Cambisols and Luvisols (long term grassland'; 14C=ENZ7_SL2_TXT3); N=25

Germany (non-inversion tillage)

- arable and mixed farms on sandy soil; NW (7A=ENZ4_SL1_TXT1); N=72
- arable/cereal and mixed farms on loamy/clay soils; central (9A=ENZ6_SL2+SL3_TXT3); N=95

Italy (non-inversion tillage)

- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2,TXT3);N=112
- arable/cereal (17A=ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3); N=94

Poland (reduced tillage)

- arable farms (21A=ENZ6_SL2_TXT3), N= 93
- mixed farming (22M=ENZ6_SL2_TXT1) N=68
- dairy cattle (23C=ENZ6_SL1_TXT1) N=140

Spain (minimum tillage, light tillage)

- Permanent crop farms (olive and fruit trees, vineyards)
  (11P=ENZ13_SL2,SL3,SL4_TXT3)
  minimum tillage; N=151
- Mixed farms known as Dehesa (sheep, pigs and beef and permanent grass,
  12C=ENZ12_SL2,SL3,SL4_TXT2; ENZ13_SL3_TXT1;
  ENZ13_SL2,SL3,SL4,SL5_TXT2)
  light tillage (N=101)

The Netherlands (non-inversion tillage)

- dairy farms on sandy soils (20C=ENZ7_TXT0_SL1); N=101
- arable farms on clay soils (18A=ENZ4,ENZ7_TXT2,TXT3_SL1) ; N=96
- arable farms on sandy soils (20A=ENZ4,ENZ7_TXT1_SL1); N=71

Drivers for Non-inversion / minimum / light tillage

Austria (non-inversion tillage)

There is a long list of strong drivers of the financial and natural types, and mostly in category A: efficient farming, saving energy and operational cost, less erosion, better soil life and structure and seedbed quality, increased soil moisture near surface, and the avoidance of plow soles and compaction (lanes).

In the SN category, encouragement by LOP (Landwirtschaft ohne Pflug) and literature count positive. Time saving is a driver in category PBC, as well as the availability of effective herbicides.

Belgium (non-inversion tillage)

Strong drivers in arable farming are the killing of volunteer potatoes (frost more effective), less erosion, saving of labour and fuel, increased moisture holding. Another driver (not strong) is increase in soil carbon. Positive is the combination with sowing of cover crop in August (PBC; strong).
On dairy farms (maize), saving of labour, fuel and tillage cost are strong drivers. Of type 'Natural', drivers are better moisture holding (strong), and some weaker drivers: faster germination of next crop, increased herbicide effectiveness, easy seedbed preparation, and less nitrate leaching.
On mixed farms (vegetables/pigs), saving of labour and fuel rank highest (strong), next (also strong) are soil quality (life, humus, less erosion, early spring warming). Weaker drivers are soil structure and smooth seedbed.

France (non-inversion tillage)
The main drivers in all farm systems and soils are improvement of soil quality components. Moreover, non-inversion tillage is expected to lower work load, fuel and fertilisation costs and to have a positive effect on erosion. The effect on erosion is much more important on Rendzina than on Cambisols. For arable farms on Cambisols, the existence of appropriate material and bad soil quality (lack of OM, eroded soils, compacted soils) are PBC drivers.

The positive effect of NIT on soil borne disease is a driver too, especially for dairy farms and on Rendzina for arable farms, although of lower magnitude.

Germany (non-inversion tillage)
High ranking drivers on sandy soils (arable and mixed farms) are increased work effectiveness, less erosion, better soil (life, moisture storage, structure,), lower fuel use, and easy employment of unskilled labour. All of these are strong drivers. Weaker are plant vitality, and the avoidance of undigested straw layers (which may occur in the plow system).
On heavier soils (arable/cereal and mixed farms), work efficiency and fuel saving rank highest, along with avoidance of plow pans. Keeping nutrients in the top layer is another driver, albeit weaker. Still, all of these are strong drivers.

Italy (non-inversion tillage)
Strong drivers for arable/cereal farms in both terrain types (level / accidented) are saving of cost and labour. Another strong driver for level terrain is improved timeliness while yields are similar to conventional tillage (plowing). For accidented terrain, *higher* yields are quoted as strong driver. Also reduced risk of waterlogging is a strong driver here (in contrast to flat terrain, where waterlogging is a strong barrier). Still in the hills, high fuel price is a strong driver in the PBC category.

Poland (reduced tillage)
The following set of strong drivers of category A applies to all three farm types (expression is generally strongest for the arable farm type): saving of fuel, labour, , fewer actions.
Lower cost, and reduction of water loss are drivers in all farm types, but strong only in arable. Weaker drivers are more soil organic matter and topsoil nutrients, and better soil structure.

Spain (minimum / light tillage)
In permanent crops, no strong drivers were recorded for reduced tillage. Weak drivers are better infiltration, cost saving, and less soil compaction. Technicians and farmer associations encourage the practice.

In the mixed Dehesa system, the only strong driver is the control of unwanted shrubs and weeds. Other drivers for light tillage are rather weak: maintenance of soil quality (increased porosity, water and nutrient retention, aggregate structure, organic matter, fertility), and higher yields. Technicians support the practice (strong SN).

The Netherlands (non-inversion tillage)
Strong drivers (all in category A) are expressed for dairy farms on sandy soils: time and cost saving, increased soil quality (topsoil organic matter, physical), better for soil fauna. Farmers feel encouraged by research outcomes.

For arable farms (both soil types), strongest drivers are of category A, next comes category SN, and weakest drivers are of category PBC. Drivers of the first group (A) are same as in above (dairy), with one additional strong driver: reduction of volunteer potato (killed by frost). Farmers feel encouraged by research, magazines, fellow farmers in USA/Canada, and the internet.

Barriers against Non-inversion/minimum/light tillage

Austria (non-inversion tillage)
The most important barriers in Lower Austria are increased weed pressure (strong), increased disease pressure (almost strong: A=-3.86, belief strength=2.86), and volunteer growth of previous crop (strong).

Belgium (non-inversion tillage)
There are many strong barriers on arable farms, mostly of categories A and PBC: weed control (more weed germination, herbicide use, more difficult), lower yields (and more yield risk / due to weather), higher risk of pests and diseases, uncertain seedbed quality (crop germination). Weaker barriers are damage to soil structure, the relation with contractors, inappropriate own machinery, the good results obtained by plowing, apparent need to adjust the rotation scheme, and the weed sensitivity of crops grown.

On dairy farms (sand, maize) and on mixed farms (medium texture; vegetable/pigs), there are again many barriers, of all types (financial, social etc) and categories (A, SN, PBC). For both farm types, there is a well-expressed negative pressure from extension, contractors, and (dairy only) fellow farmers. For both farm types, strong barriers are increased weed pressure, lower yields (uncertainty; quality), more soil compaction and less good rooting/aeration.
Additional strong barriers specific for dairy are higher sensitivity of maize to fungi, herbicide use, and lack of appropriate machinery. Weaker barriers are limited experience and knowledge.
Additional barriers (strong) specific to mixed farms (vegetable/pigs) are related to risk of diseases, difficulties with crop residues, and risk of tracks developing. Several other barriers (PBC category; strong) on the mixed farms are related to 'after harvest conditions': dealing with crop residues, damage to soil structure, and (weaker) remaining weeds. Intensity of production (vegetables) was also recorded as a strong barrier. Contract workers and extension have strong negative SN value.

France (non-inversion tillage)
The main barrier for all farms is the risk of crop yield losses on the short term. This barrier is much more important for arable farms on Rendzina. Weeds are an issue everywhere, but of lower magnitude than the risk of yield loss. SN group barriers are important too, especially for dairy farms. In the PBC group, absence of available material on the farm, difficulties in organising work, work available, disposition and size of fields, heterogeneity of soils, are all barriers against Nit.
The agri-environmental contracts the farmers already have, along with the agri-food industry requirements, can be barriers too. Last, in line with SN barriers, poor access to needed knowledge for implementation is reported as being of preventing implementation.

Germany (non-inversion tillage)
High ranking (all strong) barriers on sandy soils (arable and mixed farms) are a persistent weed (Elymus repens, quackgrass), herbicide use, slow soil warming, lack of measures preventing corn borer, skin quality of potato, and volunteer crops. Lack of specific machinery (mulch seeding) is also a strong barrier (related to capital access and farm size). Weaker barriers are lower maize yield, and poor crop emergence.
On heavier soils (arable/cereal and mixed farms), strong barriers are bad tilth, poor conditions for crop emergence, more disease pressure (root and stem diseases). All of these are in category A. Unevenness of fields is another barrier (almost strong).

Italy (non-inversion tillage)
Strong barriers for arable/cereal farms in level terrain are weeds and accentuated waterlogging. For accidented terrain, more weeds and lower crop yield are quoted as strong barriers (higher yield was a weak driver; the seeming conflict is possibly related to the merging of soil texture classes here). Reduced soil water retention is a weaker barrier. Clay soils and lack of machinery are listed as (weak) barriers in the PBC category.

Poland(reduced tillage)
For all three farm types, strong barriers are lack of appropriate machinery, increased weed pressure and increased need for crop protection. Somewhat weaker barriers are lower yields (nowhere strong), and lack of knowledge (strong in dairy only).

Spain(minimum / light tillage)
Permanent crop: as the drivers, also the barriers are expressed weakly: damage to shallow roots (as compared to no-till), increase of diseases and of soil loss (erosion), lack of subsidies, steep slopes, lack of adequate machinery.
In the mixed Dehesa system, a strong barrier is the lack of subsidies for soil conservation. Steep slopes and stoniness are weakly expressed barriers.

The Netherlands(non-inversion tillage)
Strong barriers (all in category A) are expressed for dairy farms on sandy soils: weed pressure, increased risk on diseases, increased pesticide use, and the formation of impermeable layers. Lower yields is a strong barrier of category PBC. Weaker barriers are lack of financial benefit, need to plow for incorporating green manures, and lack of suitable equipment with contractors.

For arable farms (both sand and clay) strong barriers are: the attraction of geese, increased weed pressure, pesticide use, risk on diseases (strong on sand; almost strong on clay), and desire to have weed-free seedbed (strong on clay; almost strong on sand).
Strong barriers in the PBC category on clay are: often too wet weather, lack of financial benefit, lower yields. On sand, lower yield and lack of financial benefit are clearly

expressed, too, but not strong barriers. Undesired soil drying is a weaker barrier on both soil types.

Weaker barriers are also the cultivation of potatoes (clay), and need to invest in machinery (clay, sand).

Table 10: The top three drivers and barriers per FTZ unit for BMP Non-inversion / minimum / light tillage (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	Question	Value	Type	Nature	question	Value	Type	Nature
AT	Lower Austria arable farms	Efficient way of farming	7.6	A	Financial	Higher weed pressure	-4.7	A	Natural
		Reduced erosion	7.6	A	Natural	Higher disease pressure	-3.9	A	Natural
		Saved energy	7.3	A	Financial	Growth of the previous crop in the following crop	-3.5	A	Natural
BE	arable/specialized crop farms	Promotes freezing of remaining potatoes	4.7	A	Natural	More germination of weeds	-4.7	A	Natural
		Less erosion	4.2	A	Natural	Lower yields in bad weather	-4.1	A	Financial
		Less labour intensive	3.8	A	Human	Higher risk of transfer of crop diseases	-4.0	A	Natural
	dairy farms on sandy soils	Lower use of fuel	5.0	A	Financial	Other farmers	-5.2	SN	Social
		Less labour intensive	4.3	A	Human	More weeds	-5.0	A	Natural
		Reduce of tillage costs	4.1	A	Financial	Lower yields in general	-4.6	A	Natural
	mixed farms (vegetables/pigs)	Less fuel	5.4	A	Financial	More weeds	-4.9	A	Natural
		Time saving	4.8	A	Human	Lower crop yields	-4.4	A	Financial
		Improved soil life	4.7	A	Natural	Higher risk on crop diseases	-4.2	A	Natural
DE	arable and mixed farms on sandy soil	Increased work effectiveness	6.5	A	Human	Difficulties with Elymus repens (quackgrass)	-6.4	A	Natural
		Prevention of erosion	6.4	A	Natural	Slow warming up of soil in spring	-6.3	A	Natural
		Support of soil life	6.3	A	Natural	Higher use of herbicides	-6.2	A	Physical
	arable/cereal and mixed farms on sandy soils	High work efficiency	6.4	A	Physical	More disease pressure	-5.5	A	Natural
		Prevention of plough pans	5.9	A	Natural	Root and stem diseases	-5.5	A	Natural
		Fuel savings	5.5	A	Physical	Bad conditions for crop emergence	-5.4	A	Natural
FR	Arable Rendzin	improves soil biological activity	7.1	A	Environment	soils are compacted	-1.9	PBC	Environment
		decrease erosion	5.2	A	Environment	soils are heterogeneous	-1.9	PBC	Environment
		increase organic matter content	4.8	A	Environment	bad quality	-1.9	PBC	Environment
	Arable Cambisols	improves soil structure stability	3.5	A	Environment	Accountants	-1.8	SN	Social

		increase organic matter content	3.3	A	Environment	modifies work organisation	-1.8	PBC	Human
		decrease run off	3.3	A	Environment	Fellow farmers	-1.6	SN	Social
	Dairy	improves soil biological activity	3.1	A	Environment	Accountants	-2.1	SN	Social
		increase organic matter content	2.9	A	Environment	Advisors	-2	SN	Social
		improves soil structure stability	1.7	A	Environment	soils are compacted	-2	PBC	Environment
IT	arable/cereal	Lower cultivation costs than in CT	7.2	A	Financial	More weeds than in CT	-6.2	A	Natural
		Improved timeliness of tillage compared to CT	5.4	A	Physical	Accentuated waterlogging	-4.6	A	Natural
		Less working time than in CT	5.3	A	Physical	Other farmers	-1.6	SN	Social
	arable/cereal	Lower cultivation cost	6.5	A	Financial	Reduced crop yield	-5.2	A	Natural
		Reduced working time	6.2	A	Physical	More weeds	-5.1	A	Natural
		Reduced risk of waterlogging	3.3	A	Natural	Reduced soil water retention	-2.5	A	Natural
NL	dairy farms on sandy soils	NIT better for soil fauna than ploughing	7.2	A	Natural	NIT increases weed pressure	-7.2	A	Natural
		NIT increases o.m. in top soil	7.1	A	Natural	NIT increases pesticide use	-6.4	A	Financial
		NIT saves time compared to ploughing	6.8	A	Human	NIT increases the risk on diseases	-6.3	A	Natural
	arable farms on clay soils	NIT saves time compared to ploughing	7.3	A	Human	NIT stimulates geese on my field	-7.2	A	Natural
		NIT reduces volunteer potatoes	7.1	A	Natural	Due to NIT weed pressure increases	-6.8	A	Natural
		NIT is cheaper than ploughing	6.6	A	Financial	With NIT pesticide use increases	-5.1	A	Financial
	arable farms on sandy soils	NIT stimulates soil fauna	6.6	A	Natural	NIT increases weed pressure	-6.7	A	Natural
		NIT cheaper than ploughing	6.5	A	Financial	NIT stimulates geese on my field	-6.0	A	Natural
		NIT saves time compared to ploughing	6.3	A	Human	NIT increases risk on diseases	-5.5	A	Natural
PL	arable farms	Lower fuel use	4.8	A	Financial	No appropriate machinery for RT application	-4.6	A	Physical
		Lower labour input	4.8	A	Human	Increase weeds	-4.2	A	Natural
		Lower financial costs	4.6	A	Financial	Increase crop protection	-4.1	A	Financial
	mixed farming	Lower fuel use	4.2	A	Financial	No appropriate machinery for RT application	-4.7	PBC	Physical
		Lower labour input	3.9	A	Human	Increases crop protection	-4.0	A	Financial
		Less agricultural practices	3.6	A	Financial	Increase weeds	-4.0	A	Natural

		Less agricultural practices	4.0	A	Financial	No appropriate machinery for RT application	-5.9	PBC	Physical
	dairy cattle	Lower labour input	3.9	A	Human	Not enough technical knowledge	-3.3	PBC	Human
		Lower fuel use	3.9	A	Financial	Increase weeds	-3.3	A	Natural
ES	Permanent crop farms (olive and fruit trees, vineyards)	Good for controlling shrubs and weeds	3.2	A	Physical	There are no subsidies for preserving soil conservation	-3.6	PBC	Financial
		Enhances the maintenance of soil quality	2.6	A	Natural	The slope of the farm is high	-2.4	PBC	Natural
		Higher yields	2.6	A	Natural	The farm has a high % of stones	-2.1	PBC	Natural

2.5.2 BMP No tillage / Direct Drilling

France

- arable farms on Rendzina, Champagne Berichonne (13A=ENZ7_SL2_TXT2),
- arable farms on Cambisols (15A=ENZ12_SL3_TXT4)
- dairy farms on Cambisols and luvisols (long term grassland, 14C=ENZ7_SL2_TXT3)

Italy

- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2,TXT3);N=105
- arable/cereal (17A=ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3); N=92

Spain

- Arable farms with cereals (10A=ENZ13_SL1, SL2, SL3, SL4_TXT4); N=94

Drivers for No tillage / Direct Drilling

France (no tillage)

The main drivers for no-tillage are improvements of soil biological activity, structure and organic matter content. Environmental effects on decreasing erosion and run-off are of a lower magnitude. Another group of drivers are the reduction of costs, mostly fuel in arable farms on Cambisols and dairy farms. The decrease of work load is of particular importance in the labour intensive dairy farms.

The perception that soil lack organic matter is driver in arable farms too.

Italy (no tillage)

In the arable farms of level terrain, the strongest drivers are again of category A, and of mixed types (financial, physical, natural). Foremost is cost saving. Better timeliness, and increased biological activity are other strong drivers. Weak drivers are that yields are similar to conventional, benefits to soil organic matter, and water retention.

In accidented terrain, strong drivers (all category A) are saving of labour and cost, improved soil structure; lower risk for waterlogging and higher yield are weaker drivers. The latter is expressed much weaker than the barrier of yield reduction.

Spain (direct drilling)

In the arable/cereal farms, strongest drivers are reduction of runoff and erosion, and the saving of fuel and labour time. Other strong drivers are conservation of soil fertility (organic matter, nutrients) and soil moisture retention, enhancement of biodiversity, reduced pollution. Farmers are encouraged by their associations, by technicians and research (all weak but positive SN, and high motivation to comply >3.3).

Barriers for No tillage / Direct Drilling

France (no tillage)

There is a handful of barriers against the use of no-tillage in France. The more important are of SN group, because no referent advice for this technique. In line, PBC highlight the lack of relevant advice and long life training on it.

In arable farms on the south of France (Cambisols) the heterogeneity of soils, scattering of fields, absence of appropriate material at the farm level combine with difficulties in weed management as a bundle of PBC barriers, which are even enforced by current contracts that prevent its adoption.

For arable farms on Rendzina, the main barrier is the decrease of yields along the crop succession, that combines, to a lower extent with difficulties in managing pests and weeds on soil that are perceived as hydromorphic and compacted.
A similar set of barriers apply for dairy farms, with the absence of material on first position, soil issues coming very close behind (heterogeneity, compaction, hydromorphic, sensitive to weeds). The weed issue is of particular magnitude, because of the current crop succession that involves grassland.

Italy (no tillage)
In the arable farms of both types (level and accidented terrain), the strong barriers are of categories A but also PBC. In category A are higher weed pressure, and lower crop yields. Additional barriers in the hills are diseases (in wheat; strong), and uneven field surface (almost strong).
Farmers do not feel encouraged for this practice by social factors. A strong barrier of PBC type is that machines required are expensive or unavailable. Other (weaker) barriers (all PBC) are lack of skills (direct drilling), heavy soil texture, lack of machinery market, and an 'unkempt look' of the fields.

Spain (direct drilling)
For direct drilling in Spain, there are no barriers of category A.
A strong barrier is the investment in machinery required (PBC category). Another well expressed barrier in the same category is that information and training are needed (PBC = -2.58).

Table 11: The top three drivers and barriers per FTZ unit for BMP No tillage / Direct Drilling (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	question	Value	Type	Nature
FR	Arable Rendzin	increase organic matter content	8.9	A	Environment	decrease yield for the following crop	-2.1	A	Economic
		improves soil biological activity	6.8	A	Environment	managing weeds is difficult on your farm	-2.1	PBC	Environment
		improves soil structure stability	5.8	A	Environment	hydromorphy	-1.9	PBC	Environment
	Arable Cambisols	increase organic matter content	4.8	A	Environment	lack available material	-3.6	PBC	Machinery
		improves soil biological activity	4.2	A	Environment	soils are heterogeneous	-3.3	PBC	Environment
		prevents erosion	3.1	A	Environment	managing weeds is difficult on your farm	-3.2	PBC	Environment
	Dairy	increase organic matter content	5	A	Environment	managing weeds is difficult on your farm	-3.3	PBC	Environment
		improves soil biological activity	5	A	Environment	lack available material	-2.9	PBC	Machinery
		decrease work load	3.9	A	Machinery	fields are too scattered to implement the technique	-2.3	PBC	Human
IT	arable/cereal	Lower cultivation costs	7.1	A	Financial	More weeds	-6.5	A	Natural
		Improved timeliness of tillage	5.4	A	Physical	Lower crop yield	-6.2	A	Natural
		Increased soil organic matter	4.4	A	Natural	Expensive machineries	-5.0	A	Financial
	arable/cereal	Lower cultivation cost	6.5	A	Financial	Reduced crop yield	-5.2	A	Natural
		Reduced risk of waterlogging	3.3	A	Natural	Reduced soil water retention	-2.5	A	Natural
		Reduced working time	6.2	A	Physical	More weeds	-5.1	A	Natural
ES	Arable farms with cereals	Reduces soil loss	4.58	A	Natural	Strong investment in machinery	-3.33	PBC	Physical
		Saves up fuel	4.55	A	Physical	Information and training is demanded	-2.58	PBC	Human
		Saves up time	4.39	A	Physical	High clay content	-1.15	PBC	Natural

2.5.3 BMP Controlled Traffic Farming

France

- arable farms on Rendzina, Champagne Berichonne (13A=ENZ7_SL2_TXT2),
- arable farms on Cambisols (15A=ENZ12_SL3_TXT4)
- dairy farms on Cambisols and luvisols (long term grassland, 14C=ENZ7_SL2_TXT3)

Italy

- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2,TXT3);N=105
- arable/cereal (17A=ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3); N=92

Spain

- Arable farms with cereals (10A=ENZ13_SL1, SL2, SL3, SL4_TXT4); N=94

Drivers for Controlled Traffic Farming

Germany
The strongest drivers are of category A and types natural and physical: better soil (root growth, loose structure, soil life, humus content, infiltration, avoidance of subsoil compaction), fuel savings and straight machine tracks. Better trafficability under wet conditions is a weaker driver.

Spain
Strong drivers are the avoidance of soil compaction, and ease of operations. Another driver (weaker) is higher yields. Technicians (advisors) are a positive drivers, too (SN=2.88).

The Netherlands
Strong drivers for CTF in category A are improved soil structure, rooting, higher yields, and less problems related to wetness. Weaker drivers are reduction of diseases, and the benefit of enabling field work under wet conditions (spraying, weeding). Research and fellow farmers are positive, especially organic farmers and those working on cropped beds. However, it is also recognised that CTF is difficult to implement.

Barriers for Controlled Traffic Farming

Germany
Strong barriers are the expectation that CFT results in cemented tracks (category A), and the fact that CTF systems are regarded very expensive. Weaker barriers are related to farm size, land ownership, specialisation, and (lack of) experience with GPS, and not having acquired equipment with standard working width.

Spain
The only strong barrier recorded is the lack of subsidies. Another well pronounced barrier (A=2.52) is that the track width of machinery is not normalised. A weaker barrier is that trailers and harvesting machines cannot yet be controlled.

The Netherlands
Strong barriers are that conversion is an all-at-once transition is costly, and that ‘standard’ machinery is not suitable. Other barriers are that CTF advantages are not always clear, and that harvesting from lanes is not yet possible.

Table 12: The top three drivers and barriers per FTZ unit for BMP Controlled Traffic Farming (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	Question	Value	Type	Nature	question	Value	Type	Nature
DE	arable/cereal and mixed farms on sandy soils	Better root growth	6.6	A	Natural	A CTF system would be very expensive for me	-3.2	PBC	Financial
		Support of soil life	6.1	A	Natural	Cemented machine tracks	-3.2	A	Natural
		Looser soil between machine tracks	5.5	A	Natural	Other farmers	-2.9	SN	Social
ES	Arable farms with cereals	In general terms, it reduces soil compaction	3.2	A	Natural	There is not enough subsidies	-3.2	PBC	Financial
		It makes easier some operations carried out in the farm	3.1	A	Physical	Width machinery is not normalized	-2.5	PBC	Physical
		Technicians	2.9	SN	Social	It is not easy to control the traffic when using trailers and harvesters	-1.5	PBC	Physical
NL	Arable farms on clay soils	Controlled traffic improve rooting	7.8	A	Natural	Converting to controlled traffic should be done at once	-4.9	PBC	Human
		With controlled traffic soil structure improves	7.4	A	Natural	Converting to controlled traffic requires a large investment	-3.6	PBC	Financial
		Controlled traffic reduces water troubles	6.6	A	Natural	My machines are not suitable for controlled traffic	-3.4	PBC	Physical

2.5.4 BMP Low Soil Pressure Systems

Definition: 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.

Germany

- arable/cereal and mixed farms on sandy soils (8A=ENZ6_SL1_TXT1); N=93

Drivers for Low Soil Pressure Systems

Germany

Strong drivers – all of category A - are more even root penetration, reduced soil pressure, prevention of compaction, and fuel savings. Farmer journals are positive about the practice.

Barriers for Low Soil Pressure Systems

Germany

Major barriers, besides not having adjustable tire pressure, are that farmers have to use streets and even cross villages if fields are dispersed. Weaker barriers are costs for adjustable pressure or special tire systems, and time required for adjusting pressure.

Table 13: The top three drivers and barriers per FTZ unit for BMP Low Soil Pressure Systems (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	question	Value	Type	Nature
DE	arable/cereal and mixed farms on sandy soils	More even root penetration	7.6	A	Natural	I do not have a tire pressure control system	-4.7	PBC	Physical
		Low soil pressure	7.9	A	Natural	I have to cross villages to reach more than 15 % of my fields	-4.0	PBC	Physical
		Prevention of soil compaction	7.7	A	Natural	I can reach a lot of my fields only by using streets	-3.4	PBC	Physical

2.6 Nutrient management

2.6.1 BMP Soil Analysis and / or making a Nutrient Management Plan

Austria (Soil Analysis):

- Lower Austria (1A=ENZ8_SL3+SL1_TXT2); N=28
- upper Austria (2M=ENZ6_SL3_TXT3); N=11
- Tirol (3C=ENZ5_SL5_TXT2); N=6

Italy (Nutrient management plan):

- dairy cattle/temporary grass (16C=ENZ12_SL1_TXT2,TXT1,TXT3); N=91

Poland (Nutrient management plan)

- mixed farming (22M=ENZ6_SL2_TXT1); N=62
- dairy cattle (23C=ENZ6_SL1_TXT1); N=136

Drivers for Soil Analysis and / or making a Nutrient Management Plan

Austria (Soil Analysis)

Austria. Of the three categories (A, SN, PCB), those in category PCB are weakest in all three regions. Among the other two categories (A, SN), A is the strongest in Lower Austria, while categories A and SN seem equally important in Upper Austria, showing more peer pressure in Upper Austria to perform this BMP.

Within 'Attitude', natural and physical drivers dominate in all three regions. Farmers appreciate better insight in nutrient supply, possible deficiencies and pH issues, and expect better recommendations from advisors. Lower Austria scores higher throughout the list of natural/physical drivers in the Attitude group, than Upper Austria or Tirol. In Lower Austria, strong drivers are overview/insight in nutrient demand, food and feed value, fertiliser planning, keeping track of soil properties (humus content, biological activity, trace elements, pH), and optimisation of crop yield. Most of these are strong drivers in Upper Austria and Tirol, too, with insight in pH especially relevant in Upper Austria (A=6, belief strength=4.58).

Within the SN group, agricultural schools and literature are strong drivers in all three regions (except schools in Lower Austria). Advisors (chambers; private) score higher in Upper Austria and Tirol than in Lower Austria.

Within the PCB group, the smooth organisation of sampling and sample delivery is important, notably in Upper Austria. Still in Upper Austria, the support by a funding programme is a strong driver (PBC), not so in the other two regions.

Italy (Nutrient management plan)

The strongest drivers are all in category A, and are mostly of type 'natural'. Proper valorisation of livestock manure, and proper dosage of fertilisers (and cost savings thereof) are very important drivers (6.1 to 6.6). Other strong drivers are yield stability, forage quality, animal health and milk quality. Strong drivers exist also in category SN, albeit with lower scores than the above.

Poland (Nutrient management plan)

The strongest drivers are all in category A, and are of both 'financial' and 'natural' types. Appropriate dosage of fertilisers, reduction of fertiliser cost, and high nutrient efficiencies are all enabled by proper estimation of nutrient supplies from soil and manures; this set of drivers is the most important (scores A=4.1 to 5.3). In mixed systems (as compared to dairy farms) nutrient planning is also valued as it pays attention to soil acidification. The subjective norm (SN) with respect to farmers is important for both farm types (strong in dairy farms). Strong drivers of TBC category are the preparation of a nutrient management plan (both farm types) and the help of advisers (mixed farms).

Barriers for Soil Analysis and / or making a Nutrient Management Plan

Austria (Soil Analysis)
In all regions, the strongest barriers are the expectation (group A) that observing the crop itself rather than soil) gives more information; and the cost of analysis. Time requirement is a barrier, too, notably in Upper Austria and Tirol. In the latter, the possibility of lab mistakes is a barrier, too.

Italy (Nutrient management plan)
There are not many, nor any strong barriers. The strongest is the cost of soil testing, but it is much weaker (-2.4) than the driver of fertiliser saving (+6.1).

Poland (Nutrient management plan)
No clear barriers were reported.

Table 14: The top three drivers and barriers per FTZ unit for BMP Soil analysis and / or making a Nutrient management Plan (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	Question	Value	Type	Nature	question	Value	Type	Nature
AT	arable farms	Overview of the nutrient supply	6.1	A	Natural	Less information compared to the observation of plant growth	-4.7	A	Natural
		Adaption of the fertilisation to the crops needs	5.6	A	Physical	Higher costs	-4.1	A	Financial
		Optimization of the crop yield	5.1	A	Financial	Mistakes in the evaluation by soil laboratories	-1.7	PBC	Social
	mixed farms (arable farms)	Adaption of the fertilisation to the crops needs	6.3	A	Physical	Less information compared to the observation of plant growth	-5.8	A	Natural
		Control of the pH value	6.0	A	Physical	Causing costs	-5.2	A	Financial
		Shows nutrient deficiencies in the soil	5.8	A	Natural	Higher time requirements	-2.4	A	Financial
	dairy cattle/permanent grassland	Adaption of the fertilisation to the crops needs	5.8	A	Physical	Less information compared to the observation of plant growth	-5.0	A	Natural
		Better advice by the agricultural advisors	5.4	A	Social	Causing costs	-6.4	A	Financial
		Literature	4.8	SN	Human	Higher time requirements	-3.0	A	Financial
IT	dairy cattle/temporary grass	Valorisation of livestock manure	6.6	A	Natural	Increase of costs due to soil testing	-2.4	A	Financial
		Use of the proper fertiliser amount	6.5	A	Natural	Scarce information on the value of livestock manure	-1.7	PBC	Human
		Reduction of fertiliser costs	6.1	A	Financial	Lack of an independent service for fertilisation advice	-1.0	PBC	Social
PL	mixed farming	Assistance of advisor	5.7	PBC	Social	no barriers			
		Good tool to determine the appropriate doses of fertilizers	5.1	A	Financial				
		Calculate nutrient in FYM	4.5	A	Financial				
	dairy cattle	Good tool to determine the appropriate doses of fertilizers	5.3	A	Financial	no barriers			
		Lower fertilization costs	5.1	A	Financial				
		Calculate nutrient in FYM	4.7	A	Financial				

2.6.2 BMP Application of Organic Fertilizers

This includes all common organic manure products (farm yard manure, slurries, composts of biowaste, plant, or sludge), unspecified in the surveys for Austria and Italy.

Austria (Non-inversion tillage):
- Lower Austria arable farms (1A=ENZ8_SL3+SL1_TXT2); N=11

Italy (non-inversion tillage)
- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2,TXT3);N=106
- arable/cereal (17A=ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3); N=90

Drivers for Application of Organic fertilizers

Austria
Many strong drivers of various types (natural, physical, financial) and categories (A, SN, PBC) were recorded for the use of organic fertilisers: ecologically practical, support to soil life, yield potential (appropriate/increased nutrient supply, trace elements). Other strong drivers are getting a better catch crop, reduced operational cost, and the condition of dry farmland before field application. Social factors are positive. Further conditions or stimulants (PBC) are (of course) availability of the organic product, the use of 'drag hoses' (less odour / nuisance to population), and experience in fertiliser planning.

Italy
In arable farms of both level and accidented regions, strong drivers of category A are soil quality (fertility, structure, organic matter), and lower fertiliser requirement.
The slower release of nutrients was also recorded as driver in the plains. Fellow farmers, professional organisations and suppliers are all in favour of the practice, but this is clearly expressed only in the plains.

Barriers for Application of Organic fertilizers

Austria
Strong barriers to the use of organic fertilisers are the higher cost, increased use of fuel, limited storage capacity (slurries), heavy equipment (soil damage), and increased dependence on weather conditions.

Italy
In arable farms both in the plains as in the hills, strong barriers are that the practice is time-consuming and expensive (distribution cost), low confidence in quality of compost/sludge. Another barrier (not strong) is low availability of manures among neighbours. Legislative constraints on transport and application are barriers, too. In the hills, additional barriers are odour (strong), lack of adequate machinery, and lack of incentives (strong).

Table 15: The top three drivers and barriers per FTZ unit for BMP Application of Organic fertilizer (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	Question	Value	Type	Nature	question	Value	Type	Nature
AT	mixed farms (arable farms)	Ecologically practical	8.6	A	Natural	Higher costs	-6.5	A	Financial
		Support of the soil life	8.6	A	Natural	Increased use of fuel	-6.2	A	Financial
		Increased yield potential	8.2	A	Financial	Limited storage capacity (slurry)	-5.8	A	Physical
IT	arable/cereal	Increased soil fertility	8.1	A	Natural	Lack of confidence in the compost and sludge quality	-4.9	PBC	Social
		Improved soil structure	7.7	A	Natural	Slow and expensive distribution	-4.2	A	Financial
		Higher soil organic matter	7.3	A	Natural	Manure is not available in the neighbouring farms	-3.7	PBC	Physical
	arable/cereal	Increased soil fertility	7.4	A	Natural	FYM transport is expensive	-5.5	PBC	Financial
		Improved soil structure	6.8	A	Natural	Unpleasant odours emission	-4.6	A	Physical
		Higher soil organic matter	6.7	A	Natural	I do not have neighbours with excess manure	-4.5	PBC	Physical

2.6.3 BMP Application of Farm Yard Manure

Belgium

- arable/specialized crop farms (4A=ENZ7_SL2_TXT3); N=152
- mixed farms (vegetables/pigs, 5M=ENZ7_SL1_TXT2); N=69

Drivers for Application of Farm Yard Manure

Belgium

All strong drivers are of type 'Natural' and category A and were recorded for both farm types: more soil life, better soil structure / aeration (compared to slurry), better soil fertility and water holding, lower erosion risk, more organic matter (than in slurry), higher soil N supply capacity or slow nitrogen release. Mixed farmers also mentioned higher yields, and the association with cover crops as strong drivers.

Barriers for Application of Farm Yard Manure

Belgium

For the arable farms: barriers of category A are uncertainty about nitrogen release (time, quantity) as compared to fertiliser and (weaker) as compared to slurry. Strong barriers are of category PBC: no storage capacity on farm, expense of transport, variable supply/availability of FYM. Weaker barriers are timeliness of contractor availability, uneven spreading on the field, no appropriate machinery, and time needed to find supplier.

Mixed farmers reported the high availability of slurry as a strong barrier to the use of FYM. Cost of spreading, and the fact that these farmers produce their own slurry (and no FYM) are barriers.

Table 16: The top three drivers and barriers per FTZ unit for BMP Application of Farm Yard Manure (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	Question	Value	Type	Nature
BE	arable/specialized crop farms	Better soil structure compared to slurry	6.1	A	Natural	No appropriate storage capacity on my farm	-5.3	PBC	Physical
		Better soil fertility	5.8	A	Natural	Transport of farmyard manure is more expensive	-3.9	PBC	Financial
		More soil life	5.5	A	Natural	Supply of farmyard manure varies	-3.4	PBC	Physical
	mixed farms (vegetables/pigs)	Improved soil structure	6.8	A	Natural	Short time period harvest -sowing (before Sept 1)	-2.4	PBC	Physical
		Increased soil health	6.6	A	Natural	Increased use of herbicides	-2.1	A	Financial
		Lower erosion risk	5.4	A	Natural	No appropriate machinery for incorporation	-2.0	PBC	Physical

2.6.4 BMP Application of Compost

Belgium

- arable/specialized crop farms (4A=ENZ7_SL2_TXT3); N=121
- mixed farms (vegetables/pigs, 5M=ENZ7_SL1_TXT2); N=61

The Netherlands

- arable farms on sandy soils (20A=ENZ4,ENZ7_SL1_TXT1; ENZ4_SL1_TXT0 (reclaimed peat sands).

Drivers for Application of Compost

Belgium

All strong drivers are of type 'Natural' and category A and were recorded for arable farms: more soil life, better soil fertility and health, increased humus content, lower erosion risk, long-term nitrogen release and less heavy soil.

Mixed farmers mentioned improved soil structure, soil life and humus, better infiltration and drainage as strong drivers; they showed a (weak) preference of compost over farm yard manure.

The Netherlands

The strong drivers (category A) are the contribution to soil organic matter, and the fact that compost may be applied in winter (there is strict regulation with closed periods for animal manures). All referents (SN drivers) are positive, too.

Barriers for Application of Compost

Belgium

In both farm types, long lists of barriers were found. For the arable farms these were of categories A and PBC, for the mixed farms all social factors (SN) were negative, too.

Strong barriers of category A in arable farms: contains waste products, risk for diseases and weeds, risk for high residual soil nitrogen in autumn. Strong barriers of category PBC include cost (transport and purchase), lack of experience/knowledge, uncertain availability of compost, variable prices, and the fact that land application of slurry is done by others, unlike of compost.
Weaker barriers are uncertainty about nitrogen release (time, quantity), and lack of appropriate machinery.

In mixed farms, strong barriers are the availability of (own) slurries, fear for diseases carried with compost. Having sufficient soil humus content already, and labour requirement count as (weak) barriers. Further, most of the above barriers hold for mixed farms, too. Mixed farmers do not feel encouraged (SN category) by any of referents: extension, farmers, producers, education, municipality, research and press.

The Netherlands

There is only one strong barrier: compost may contain unwanted waste. Weaker barriers are labour requirement, and ample availability of slurry (competing product) in the region. Legal restrictions on phosphate use are a (weak) barrier, in spite of the 'phosphate-discount' applicable for compost (a relaxation of the legislative constraint).

Table 17: The top three drivers and barriers per FTZ unit for BMP Application of Compost (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	Question	Value	Type	Nature
BE	arable/specialized crop farms	Improved soil fertility	5.1	A	Natural	Low offer of compost	-4.6	PBC	Physical
		Improved soil life	5.1	A	Natural	Expensive transport	-4.5	PBC	Financial
		Improved soil health	4.9	A	Natural	Contains waste products	-4.5	A	Natural
	mixed farms (vegetables/pigs)	Improved soil structure	5.9	A	Natural	Too much slurry	-5.8	PBC	Social
		Better soil life	5.5	A	Natural	Extension	-5.4	SN	Social
		More humus	5.3	A	Natural	Other farmers	-5.3	SN	Social
NL	arable farms on sandy soils	Compost provides organic matter	8.2	A	Natural	It can contain unwanted waste	-7.0	A	Natural
		Can be applied in the fall/winter	6.7	A	Natural	Cost more labour to apply	-2.5	A	Human
		Extension agents are positive	4.0	SN	Social	Slurry is largely available	-1.8	PBC	Natural

2.6.5 BMP Application of Reactor Digestate

The Netherlands

- arable farms on clay soils (18A=ENZ4,ENZ7_TXT2,TXT3_SL1) ; N=100
- arable farms on sandy soils (20A=ENZ4,ENZ7_TXT1_SL1); N=68

Drivers for Application of Reactor Digestate

The Netherlands

The strongest drivers are of category A and are similar between both soil texture groups: ease of application, homogeneous and well-specified (nutrient contents) product, organic matter supply, increase of soil fauna. Weaker drivers are the low cost (still strong on sand), and fast nitrogen availability. Suppliers are a (weak) driver of the SN category.

Barriers for Application of Reactor Digestate

The Netherlands

Barriers are present in each category (A, SN, PBC), with weakest barriers in the SN category.
Well expressed barriers (category A) for both soils are risk of contaminating the soil (strong on clay), and an increase in crop diseases (expressed but not strong on either soil type).
In the PBC category, there is a mix of natural, human, financial, and physical barriers. Strongest again ranks the lack of guarantee that the product is free of diseases (strong on clay, not on sand). In the sand district, high availability of untreated manure (competing product) is a barrier. Further weak barriers include cost, uncertainty of origin, and legal constraints related to phosphate input.

Table 18: The top three drivers and barriers per FTZ unit for BMP Application of Reactor Digestate (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	Question	Value	Type	Nature	Question	Value	Type	Nature
NL	arable farms on clay soils	It is easy to apply	6.1	A	Human	Applying digestate increases the risk on contaminating my fields	-5.5	A	Natural
		The composition is homogeneous	6.0	A	Natural	Applying Digestate increases diseases	-5.3	A	Natural
		You know what minerals are in digestate	5.8	A	Human	No guarantee that it is disease free	-4.4	PBC	Natural
	arable farms on sandy soils	It is easy to apply	7.4	A	Human	Applying digestate increases the risk on contaminating my fields	-4.8	A	Natural
		The composition is homogeneous	7.0	A	Natural	There is a large supply of manure in my region	-4.1	PBC	Natural
		You know what minerals are in digestate	6.2	A	Human	Applying digestate increases diseases	-4.1	A	Natural

2.6.6 BMP Spring Application of Manure on Clay

The Netherlands

- arable farms on clay soils (18A=ENZ4,ENZ7_TXT2,TXT3_SL1) ; N=101

Drivers for Spring Application of Manure on Clay

The Netherlands

In the Netherlands it is no longer allowed to apply manures to land in autumn. As a result, arable farmers on clay – where manures were traditionally applied only in autumn – were faced with the choice between abstaining from the use of animal manures, or adopting techniques enabling spring application without damaging the (then susceptible) soil structure. Technological innovations to enable spring application on clay soils include low-pressure tires, and drag hoses where the (heavy) slurry tank remains at the edge of the field.

Strong drivers for the spring application of manures are financial (arable farmers receive money for accepting manures from livestock farmers) but also benefits to yield, and soil organic matter content. A weaker driver are benefits to soil fauna. All of these are in category A. Extension and press are positive about this practice, too (no strong drivers).

Another driver requires more explanation. Manures are mostly produced in the sand district, but land application in the clay districts is often in a narrow time window when weather and soil conditions permit. This window is so tight that manures can only be successfully applied if they already stored in the clay regions. This requires capacity for temporary storage. Farmers expressed that enabling such storage facilities would be a strong driver. However, there are legal restrictions to building such facilities.

Barriers for Spring Application of Manure on Clay

The Netherlands

Strong barriers – apart from local storage capacity – are soil damage (tracks due to heavy equipment), slurry makes for fatty and sticky soils, uncertainty about composition, and unwanted dependence on contractors. Despite innovations, farmers still consider weather conditions often too wet for land application in spring (strong barrier). The fact that trailing hose manure spreading technology is no longer permitted (slurry exposed for too long on the soil surface, allowing ammonia loss) was also reported as barrier because that practice was 'friendly' to standing crops (winter wheat).

Table 19: The top three drivers and barriers per FTZ unit for BMP Spring Application of Manure on Clay (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	question	Value	Type	Nature
NL	arable farms on clay soils	No storage facility for the manure	7.2	PBC	Physical	It makes heavy tracks	-6.9	A	Natural
		Financial beneficial	6.2	A	Financial	The weather is often too wet to apply manure in the spring	-5.9	PBC	Natural
		It delivers organic matter to the soil	6.0	A	Natural	It makes the soil fatty and sticky	-5.7	A	Natural

2.6.7 BMP Row Application of Slurry

The Netherlands

- dairy farms on sandy soils (20C=ENZ7_TXT1_SL1)

Drivers for Row Application of Slurry

The Netherlands

There are virtually no drivers for this practice. There is only one driver of category A, which is of financial nature: less manure is needed to reach a certain yield. This is at the same time a barrier (see below). The low driver score also reflects that most dairy farmers have no shortage of manures.

Drivers of SN category are positive research outcomes (strong), and good on-farm results (weaker). All PBC variables show negative scores (weak barriers).

Barriers for Row Application of Slurry

The Netherlands

Several barriers of category A are expressed strongly: extra cost of land application, time constraints of the contractor, more physical damage to roots, , and technical complexity. Weaker barriers are the risk for ‘root burn’ damage to the crop, and the fear for (even tighter) legal restrictions (application standards: allowed nitrogen input quota) once it is shown that row application saves nitrogen while enabling the same yield. In category PBC, strong barriers are that contractors do not have proper equipment, and that the practice generates no extra profit.

Background. The suitable time window for land application of slurries is narrow. Large scale application by contractors requires a high working speed, which does not allow to combine slurry application with maize seeding. As a result, land application and seeding are two separate events. This rendered row application of slurry infeasible, until the widespread arrival of GPS guidance. With this technology, the two practices (slurry application, seeding) can remain separate while still achieving proper spatial matching of crop row with slurry row. In spite of this advance, however, the practice is still not broadly accepted.

Table 20: The top three drivers and barriers per FTZ unit for BMP Row Application of Slurry (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	question	Value	Type	Nature
NL	dairy farms on sandy soils	Research is positive on row application of manure	3.73	SN	Human	Row application increases the costs to apply manure	-6.8	A	Financial
		On farm tests of row application of manure show good results	2.52	SN	Social	With row application of manure the contractor faces increasing time pressure	-6.0	A	Human
		With row applications you need less manure for the same yield	2.30	A	Financial	With row application of manure you get more physical damage	-5.4	A	Natural

2.7 Water management

2.7.1 BMP Sprinkler and Drip irrigation

Italy

- dairy cattle/temporary grass (16C=ENZ12_SL1_TXT2,TXT1,TXT3); N=92
- arable/cereal (16A=ENZ12_SL1_TXT1,TXT2_TXT3);N=108

Drivers for Sprinkler and Drip Irrigation

Italy

On dairy farms, the strong drivers are again of category A: higher water use efficiency and crop yield, avoidance of drought stress and waterlogging, lower diesel consumption (for drip), lower water consumption, less soil compaction. A weaker driver is reduction of insects (sprinkler). Opinion among referents is positive or close to neutral. High water availability is a weak driver of the PBC category.

In the arable farms of the plain, additional strong drivers (besides all of the above) are avoidance of diseases, the possibility of fertigation, lower nutrient leaching. Other advantages (weak drivers) of sprinklers are the ‘washing’ of crop plants and an improved micro-climate. Suppliers and collectors (of farm inputs and products) have positive opinion about these techniques. Factors that support the BMP (PBC) are sandy soils, high water availability, and high-value crops.

Barriers for Sprinkler and Drip Irrigation

Italy

In both farm types (dairy, arable), the main barriers (all strong, category A) are higher investment cost, and higher operational cost (diesel consumption). Small field size is a barrier, too in arable farms.
For the dairy farms, the extra time required to handle the self-retracting hose reel is an additional barrier (not cited for the arable farms).

Table 21: The top three drivers and barriers per FTZ unit for BMP Sprinkler and Drip Irrigation (A = attitude, PBC = perceived behavioural control).

		Drivers				Barriers			
Country	FTZ	question	Value	Type	Nature	question	Value	Type	Nature
IT	dairy cattle/temporary grass	Higher water use efficiency	6.1	A	Natural	Higher costs	-6.8	A	Financial
		Higher crop yield	5.8	A	Natural	Higher diesel consumption (sprinkler)	-4.3	A	Physical
		No crop water stress	5.3	A	Natural	Longer work for self-retracting hose reel	-2.7	A	Human
	arable/cereal	Higher crop yield	6.9	A	Natural	Drip irrigation increases operating costs	-4.1	A	Financial
		Drip irrigation allows fertigation	4.6	A	Physical	Sprinkler irrigation causes high initial investments	-3.1	A	Financial
		Drip irrigation reduces energy and fuel costs	4.4	A	Financial	Reduced field size with impediments	-2.1	PBC	Physical

3 Short term financial costs associated with the application of Best Practices

3.1 Methodology

In the approach we distinguish two pathways to calculate costs. First pathway relates to management practices that affect the cultivation of a specific crop or field, second pathway relates to practices that affect the crop rotation on the farm. The implications of practices of the latter type are more complicated, as they depend on the share of farm area where the BMP is implemented. The calculations for the two pathways are further explained in sections 3.1.1 and 3.1.2.

3.1.1 Practices that affect the cultivation of a specific crop (First pathway).

In this situation the changes are limited to the plot of land or area on which the crop is grown. The baseline or reference costs of the standard practice can be obtained from the regular, often national, accounting systems and are commonly expressed in euro per ha. The costs related to the actions needed to implement the BMP are additional. If standard practices are no longer necessary when applying the BMP, then the associated costs need to be subtracted.

To quantify the cost of the BMP two steps are needed:

1. Start with a standard cost calculation for the crop in question. This is most likely to be available from the economic department or from farmers' organisations or national statics offices. For example in the Netherlands the "kwantitatieve informatie" or KWIN is used (Schreuder *et al.* 2012; Vermeij 2013).
2. Create a table describing the differences in costs between the standard practice and the BMP for the crop in question. Consider the following items:

a. Inputs (seed, fertilizers, pesticides, ...)
b. Labour (number of hours for different tasks)
c. Machine use (variable costs like petrol)
d. Machine ownership (investment costs, only differences when different machines need to be used with higher costs).

As example for the calculations we look at the BMP "undersowing a green manure in maize" in the Netherlands. The standard practice is to sow a green manure after the harvest of maize. The BMP is to sow the green manure three weeks after planting the maize. To implement this practice a more expensive machine is needed.

The reference costs items and the BMP cost items are presented in Table 22.

Table 22. The cultivation practices of a green manure after maize, standard (i.e. reference) and with BMP (i.e. 'underseeding').

Item	Reference		BMP		Remarks
		Labour (hr/ha)		Labour (hr/ha)	
Machine	-		More expensive		
Soil cultivation		1	No	-	
Sowing		1		2	Capacity of machine is lower
Incorporation of green manure	Yes		Yes		

The differences between the standard green manure and the BMP are that no soil cultivation has to be done and that an extra hour is needed to sow the green manure into the maize crop. In terms of total labour requirement no differences are expected. However, the machine is approximately €5000,- more expensive, the renewal percentage 11% (KWIN) so total cost of the BMP are € 550,- per farm per year.

3.1.2 When the BMP affects the crop rotation (Second pathway).

Here we will use the example of a grass-maize rotation in which we move from the reference practice of continuous grassland and continuous maize to a BMP with grass-maize rotation.

This BMP can be implemented in various ways, and on various percentages of the farm area. Therefore, a crop rotation of a reference farm has to be defined in detail before costs of the implementation of the BMP can be calculated. We consider the following steps:

1. Define the national standard (dairy) farm with area of grassland and maize
Standard farm size 120 ha total:
    a. 102 ha grassland, 18 ha maize
    b. Grassland area resown annually: 9 ha.
2. Implementation of BMP:
    a. 84 ha permanent grassland
    b. 18 ha grassland (rotation with maize)
    c. 18 ha maize (rotation with grassland)
3. Defining changes related to the implementation of BMP:
    a. Grass yield and maize yield
    b. More intensive use of equipment, in the Netherlands the contractor does the ploughing, spraying of pesticides and sowing and this is therefore not included.

These steps are worked out in more detail in the following sections.

Step 1

The standard farm is 120 ha, 18 ha maize, 102 ha grassland of which 93 ha is permanent and 7.5% or 9 ha is renewed annually. The cost of resowing grass is 935,- €/ha and permanent cultivation of grass costs 1340,- €/ha (Vermeij 2013). Consider the situation that maize is cropped continuously. The cost for this farm is 161,457 € (Table 23) and the financial yield is 231,555 €.

Step 2.

When maize is incorporated into the crop rotation every year 18 ha is resown.

Step 3

The main change due to the introduction of this BMP is the increase of the grassland area which is to be resown every year: 18 ha instead of 9 ha. In addition, yield levels of maize increase by approximately 6 ton dm/ha relative to the standard practice. The yield of renewed grassland is lower in the first year. Only 2 cuts are produced in that year, instead of the 5 cuts in the reference situation. The cost of cultivation is slightly lower in the BMP situation than for the reference situation and financial yield is slightly higher.

The direct financial benefits of implementing the BMP are approximately 370 €/ha.

Table 23. Overview of the cost calculation for the standard cultivation of maize on sandy and the BMP grass-maize rotation.

Crop	Ha	Cost (€/ha)	Crop yield (ton dm/ha)	Price (€/kg dm)	Financial yield (€/ha)	Profit (€)
Reference situation						
Maize	18	1449	13	0.149	1937	
Green manure	18	130	-	-	-	
Grass renewed	9	935	11	0.156	1704	
Grass permanent	93	1340	13	0.156	1950	
Total	120	161457			231555	70098
Grass-maize rotation						
Maize	18	1449	15	0.149	2228	
Green manure	18	130	-	-	-	
Grass renewed	18	935	11	0.156	1704	
Grass permanent	84	1340	13	0.156	1950	
Total	120	157812			234 573	76761
Cost €/ha						-370

3.2 France

The objective is to assess the cost of BMP adoption in France and is a contribution to MS442. In France, two BMPs have been chosen:

1. Simplified cultivation techniques (SCT) :
    a. deep reduced tillage: use of chisel plough or field cultivator to depths of over 15 cm.
    b. reduced tillage: use of chisel plough or field cultivator to depths of 5 - 15 cm.
    c. strip till : this type of tillage is performed with special equipment, to till up an 20 – 25 cm row, and at the same time incorporate fertilizers or chemicals, and just behind, seed.
2. Catch-crops (CC): soil is covered by specific crops during November to March.

Adoption costs for these BMPs are of several orders. First, prior to adoption, there are transaction costs, related to time the farmer allocates to look for information about drawbacks and advantages of the BMP, eventually to contact an advisor if there is an agri-environmental measure available, time devoted to administrative documents to be filled. INRA has estimated these costs for several BMPs in France, using outcomes from a EU project, ITAES[1]. We have relied on their measurements to assess the private transaction associated with the BMPs chosen for France.

Short term costs correspond to yield losses, difference in fuel consumption, adjustments of fertilisation, and they occur with the same magnitude over years. There are also long term costs, related to investment for specific material. Regarding investment, two options exist: either the farm totally converts to a technique, and then the new material is paid off as normal renewing of the material; or the farm adopts the BMP one year out of two, or four years out of five, and there is a need for new investment. INRA discounts investments at a 4% yearly rate (actualisation rate). All the costs described in this report come from the analysis performed by INRA (Pellerin *et al.* 2013).

Additionally, during the survey in three AENZ in France, we have asked the farmers about their perception of costs and how it impacts their decision of adopting a BMP. This enables us to extend the INRA analysis over a more local perspective.

3.2.1 INRA expertise on BMPs

Pellerin *et al.*(2013) analysed the direct costs of several BMPs: simplified techniques, simplified techniques once every other year, traditional ploughing once every 5 years, and direct seeding. From FADN data, material costs and expertise, they conclude that, compared to traditional ploughing, all the techniques result in a lower net return (**Error! Reference source ot found.**). For the BMP simplified cultivation techniques this lower net return is 12 €/ha. Notable are the reduction of fuel costs, the increase in herbicides use, and decrease of work load (Table 24).

For catch crops the costs estimates provided by Pellerin *et a.l* (2013) are not very detailed. They estimate costs of 41 €/ha. Other institutes report seeds cost ranging from 12 to 87 €/ha, seeding operations ranging from 25 to 67 €/ha, and destruction of the catch crop ranging from 7 to 25 €/ha (Charles *et al.* 2012).

Table 24: INRA estimations of product net return depending on the technique (€/ha).

	Product (€/ha)
Traditional ploughing	*1214*
Simplified cultivation techniques	1202
Simplified cultivation techniques once every other year	*1208*
Traditional ploughing once every 5 years	*1164*
Direct seeding	1121

[1] https://w3.rennes.inra.fr/internet/ITAES/website/Objectives.html

Table 25: INRA estimations of fuel use, herbicides costs, work time and associated costs depending on the technique.

	Fuel consumption		Herbicides	Labour	
	litres	Cost (€)	herbicides (€/ha)	Work (hours/ha)	€/ha
Traditional ploughing	*95*	*44*	*53*	*3.9*	*66*
Simplified cultivation techniques	67	31	67	3.4	57
Simplified cultivation techniques once every other year	*81*	*38*	*60*	*3.6*	*62*
Traditional ploughing once every 5 years	*62*	*29*	*66*	*2.7*	*45*
Direct seeding	54	25	73	2.4	40

Investment costs for direct seeding have been estimated between 7 and 56 €/ha, depending on the size of the seeder and the area of the farm. Altogether, changing from traditional ploughing to direct seeding can either lead to a cost of 56 €/ha or to a benefit of 25 €/ha (Table 26).

Table 26: INRA estimation of additional cost for direct seeding compared to traditional ploughing (€/ha)

Additional costs	Yield	Fuel	Herbi-cides	Labour	Investment	Total	Notes
Optimistic scenario	0	-19	20	-26	0	-25	No yield losses and total replacement of the seeder resulting in no investment on the long run
Pessimistic scenario	63	-19	20	-26	19	56	Yield losses and additional investments

Last, indirect costs have been estimated by INRA up to 16 €/ha for catch crops, and 17 €/ha for direct seeding, which is far from being negligible.

3.2.2 Are cost barriers?

As already mentioned in Task 4.2 report, there are no regional differences in the cost statements for the BMPs we have surveyed. First, contradictory with INRA expertise, surveyed farmer highlight no effect of catch crops on yields, and consider that SCT and NT will have a very small impact on it.

Farmers who have implemented catch crops report less increase of herbicides and fertilisation crops than non-adopters fear. On the contrary, adopters record higher seed costs than non-adopter foresee. Both groups have a similar opinion on slight increase of fuel costs, slight modification of work organisation and workload. Among costs, only herbicides costs are reported as being a barrier towards implementation of catch crops.

For SCT, both adopters and non-adopters agree that the BMP is liable to decrease fuel and fertilisation costs, and increase herbicides costs. Their opinion differs on mechanisation costs: non adopters consider the technique is neutral on that point, while adopters report a decrease. This outcome is consistent with INRA perspective of low impact on mechanisation costs on the long run. Adopters and non-adopters have very different opinion on the impact of SCT on work organisation and material: non-adopters fear reorganisation of work and need of new materials, while adopters report neutrality on material and improvement of work organisation.

For NT, both adopters and non-adopters report increase of herbicides costs and decrease of all other costs. They share the same opinion that NT would need a strong modification of the material and a slight one on work organisation. But their opinions differ on workload: non-adopters believe that NT will decrease workload, while adopters report neutrality.

Displaying the data with a Principal component analysis provides additional and interesting information (Figure 5): if we start from the objectives at farm level (in red on the figure), we can notice there are two main groups of variables. On the right side are farmers who declare themselves willing to be independent (in general), limit money losses, decrease taxes and debts, increase premiums; these are sensitive to increase in fuel, mechanisation, fertilisation costs, along with work load (in blue as additional variables). They also invest in land and either on family earnings or on new materials (which are a bit opposite).

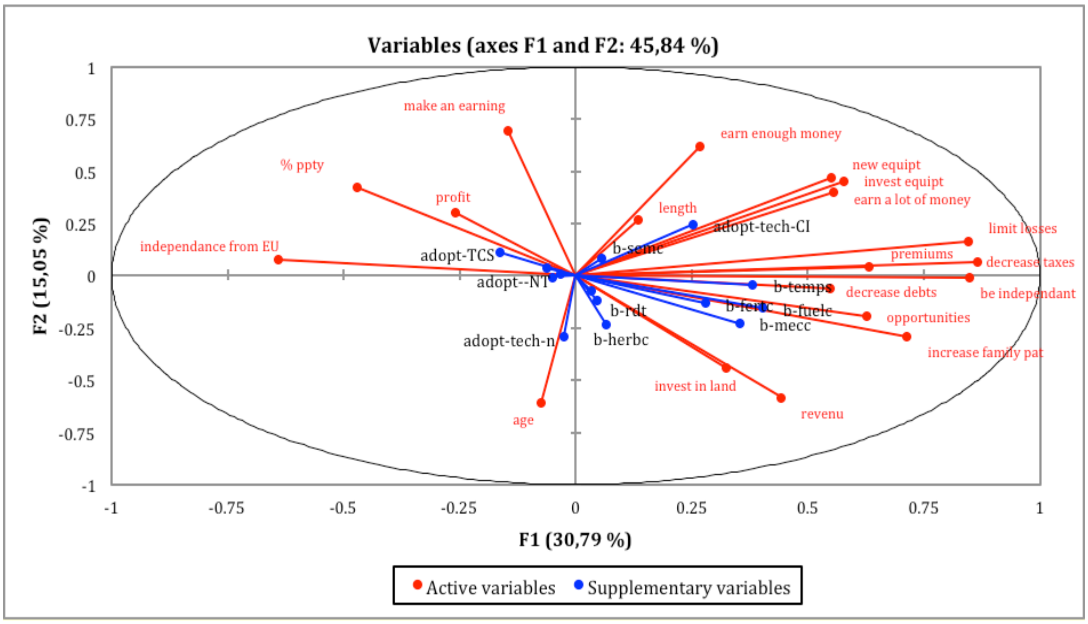

Figure 5: principal component analysis of cost in the French farm survey

In this group, adoption of catch crops seems to be opposite to high costs forecasts, but there is no clear distinction of farmers and we can find non-adopters in very close position to adopters.

On the left side, we can find farmers who already have a high share of their land in property, who talk about making profit and making an earning, and, maybe more important, seek to gets independence, not in general, but from EU decisions. Most of them are SCT adopters, but not all (Figure 6**Error! Reference source not found.**).

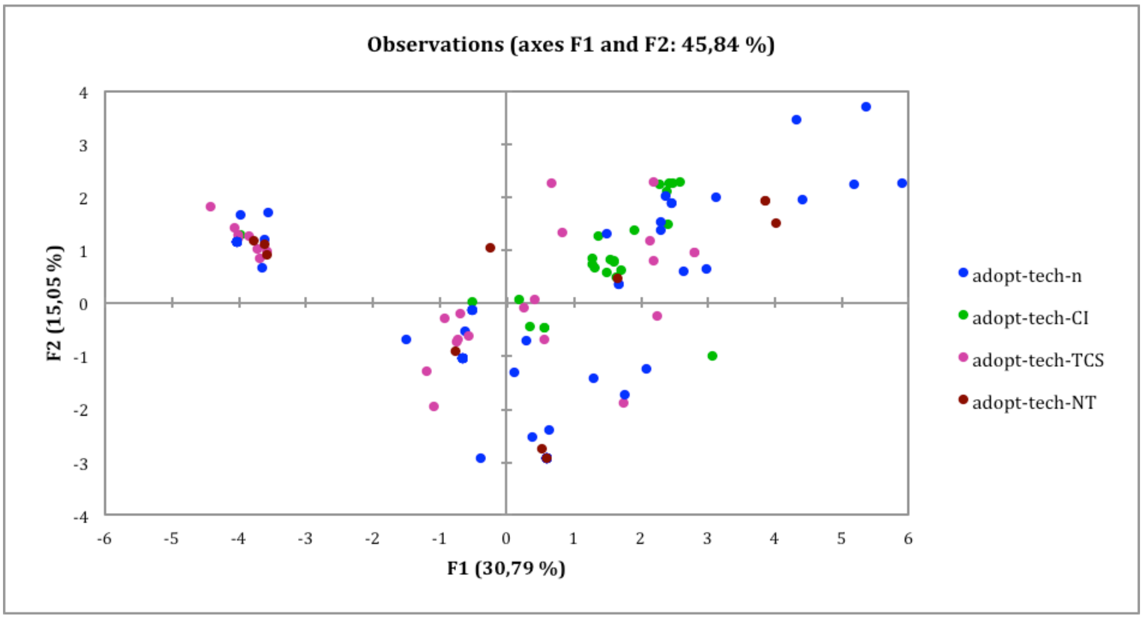

Figure 6: individuals in the principal component analysis of cost in the French farm survey

3.2.3 Conclusion (France)

From the literature survey, in France, there are strong discrepancies in cost estimations for catch crops, SCT and no tillage, ranging from high costs to some benefits. Maybe these discrepancies, due to the variety of technique combinations, create unclear messages that can be barriers towards adoption (non-adopters quoting higher costs than adopters).

Clearly, from our survey, some famers have adopted some BMP despite the costs (and not only catch crops in vulnerable zones). It can be because these farmers balance differently the expected benefits with costs, or hope that these costs can decrease over years (it is noticeable that the size of the period over which farmers have adopted a BMP is orthogonal to costs estimates in our survey).

The BMP Simplified Cultivation Techniques reduce net return by 12 €/ha and the BMP Cover Crops cost 45 €/ha.

3.3 Germany

The gross margin calculation is done using information from the Bayerische Landesanstalt für Landwirtschaft (LfL, 2014) online calculator and Kuratorium für Technik in der Landwirtschaft (KTBL, 2012). Also calculations of a regional commercial advisory office (Macke, 2012) were used. No direct payments are included.

Results for non-inversion tillage, catch crops and crop rotation are presented in Table 27, Table 28**Error! Reference source not found.** and Table 29, respectively.

3.3.1 BMP: Non-inversion tillage

Table 27: Non-inversion tillage. Three major crops for Germany (all data per hectare, ha) all financial data is given as € per ha (if no other unit is given). it is assumed, that no yield penalties occur due to BMB.

Crop	Variable/unit	Reference	BMP	Notes / differences
		Plough	Non inversion tillage (no plough, 1 more cultivator pass, 1 more herbicide appl.)	
Winter wheat	Yield (t/ha, marketable)	8	8	no yield difference
	Price €/t	224.90	224.90	default price
	Financial yield	1799.20	1799.20	
	Machinery costs	272.61	239.75	-32.86
	Total direct costs	928.30	913.40	-14.9
	net return / gross margin	870.90	885.80	14.9
	Workload (hrs./ha)[1]	4.54	3.78	-0.76
	Workload (hrs./ha)[2]	8.94	8.18	-0.76
Oilseed rape	Yield (t/ha, marketable)	4.2	4.2	
	Price €/t	469.00	469.00	default price
	Financial yield	1969.80	1969.80	
	Machinery costs	286.11	253.25	-32.86
	Total direct costs	1024.50	1007.80	-16.70
	Net return / gross margin	945.30	962.00	16.70
	Workload (hrs./ha)[1]	4.4	3.64	-0.76
	Workload (hrs./ha)[2]	8.8	8.0	-0.8
Silage maize (biogas)	Yield (t/ha, fresh weight)	50	50	no harvest costs, yield is harvested directly from the field by the biogas company
	Price €/t	30.08	30.08	default price
	Financial yield	1817.80	1817.80	
	Machinery costs	128.8	95.94	-32.86

Crop	Variable/unit	Reference	BMP	Notes / differences
	Total direct costs	1068.70	1063.90	-4.80
	Net return / gross margin	749.10	753.9	4.80
	Workload (hrs./ha)[1]	3.46	2.7	-0.76
	Workload (hrs./ha)[2]	7.86	7.1	-0.76

[1] machinery
[2] total system

3.3.2 BMP: Catch Crops

Table 28: Calculations for Catch Crop (Zwischenfrucht, that means sensu strictu green manure, not harvested).

	Additional costs
Conventional	
Cultivator (€ / ha)	16.40
Seeding material (€ / ha)	56.50
seeding machinery (€ / ha)	31.33
Cutting/mulching (€ / ha)	31.26
Total (€ / ha)	**135.70**
Workload (hr/ha)	**2.45**
In case of failure or low/hardly any frost	
Herbicide (glyphosate) (€ / ha)	20.00
Application (€ / ha)	4.56
Total (€ / ha)	**24.56**
Workload (hr/ha)	**0.18**

Note: It can happen, that due to low, hardly any frost an additional glyphosate application is required. Then, these costs have to be added.

3.3.3 BMP: Crop Rotation

Table 29: Calculations for Crop Rotation. Comparison of different typical rotations for central Germany including the valuation of beneficial value of pre-crop* (data according to Macke, 2012). Euro per hectare. Ranking according to gross margin. Reference rotation is continuous maize. The BMP Crop Rotation in defined as including at least four crops in the rotation

Rotation	Rank	Average Gross Margin of rotation (€/ha)	Comparison (extended > simple) based on ranks	Difference (benefit of extended rotation) (€/ha)
beet-wheat-wheat-barley	1	530	1 > 4	**38**
beet-wheat-barley-rape-wheat-wheat	2	509	2 > 3 2 > 4 2 > 5	**15** **17** **57**
rape-wheat-wheat-barley	3	494	3 > 5	**42**
beet-wheat-wheat	4	492		
rape-wheat-wheat	5	452		
rape-wheat-maize-wheat	6	451	6 > 8	**84**
rape-wheat-maize-wheat-wheat	7	445	6 > 7	**78**
maize-wheat-wheat	8	367	8 > 9	**35**
maize-maize-maize[1]	*9*	*332*		

* Comparisons are made for a diverse rotation and another (or a couple of) simple rotations of a similar structure. So, as an example #1 could be seen as a diversified type of #4, but not of #5.

[1] here, maize is calculated as a market crop, despite is often cropped in bioenergy or dairy farms for internal nutrient and raw matter cycling. So, rotation #9 does not reflect the overall picture. Many farmers grow biogas maize with higher profitability. Also dairy farmers get more financial benefits from maize.

3.3.4 Conclusions (Germany)

Non-inversion tillage

From the results (Table 27) it is clear that the BMP is equal to the reference system or slightly better. Whether gross margin calculations provide the best picture of the economics of reduced tillage is debatable. Another way is the use of the full cost approach. This is a more or less farm individual calculation including changes in investments, fix costs and general farm structure. It is estimated that under full costs non-inversion tillage has economic benefits about 60 (western part of Germany) to 160 (eastern part) Euro per hectare compared to conventional cultivation (Schneider, M., PhD Thesis Munich, 2009).

Catch Crops

For catch crops (Table 28) the implementation of the BMP is more costly when compared to the reference system. When calculating additional costs of the BMP per hectare (ha) it is assumed that farmers have to apply these processes on top of their regular business (data according to LfL/KTBL). The yield of the following crop is generally not affected.

Crop rotation

From Table 29**Error! Reference source not found.** it is clear that diverse crop rotations are more profitable than the reference system were continuously maize was cropped. Although, not all farmers are able to grow sugar beets, diverse combinations of oilseed rape, wheat and barley offer many chances for combination with maize. The BMP Crop rotation according to the definition of including at least four cultivations increases net return from 113 up to 198 €/ha depending on the extended crop rotation used.

3.4 Poland

3.4.1 BMP: Reduced tillage

In Poland two systems conventional (CT) and reduced tillage (RT) on private farms in Rogów are compared. The data are collected during 2007-2009. Results are presented in Table 30. The average yield in the RT system was lower than in the CT system (Table 30). Production costs (seeds, fertilizers, plant protection products) are the same for both systems. The key differences are the labour input and the use of machines (especially cultivation) which directly relates to differences in fuel consumption.

Table 30. Overview of the costs of winter wheat production in different technologies (winter wheat was cultivated after pea) (average yield from 2007-2009).

Item	Unit	Conventional Tillage (CT)	Reduced Tillage (RT)	Difference
Crop yield	t/ha	7.42	7.34	0.08
Value of production	Euro	1159	1149	10
Seeds	Euro	66	66	0
Fertilisers	Euro	215	215	0
Crop protection	Euro	192	192	0
Fuel	Euro	72	61	11
Total costs	Euro	545	534	11
Profit	Euro	614	615	-1
Labour input	hr/ha	8.2	7.6	-0.6
Machine	hr/ha	7.2	6.6	-0.6
Fuel	l	69.8	58.5	-11.3

Conversion factor from PLN to Euro is 0.25

The farm applying the RT did not buy additional equipment, and therefore was not forced to incur additional costs. RT was performed using a disc harrow that was available on the farm.

Table 31 presents differences in cultivation treatments performed between the conventional technique (using a plough) and RT (using a disc harrow). Disking and ploughing are applied in CT, whereas in RT, only double disking is performed.

Table 31. Overview labour input (hr/ha) in conventional tillage (CT) and reduced tillage (RT).

	Technique		
Item	CT	RT	Difference
Agricultural practices (hr/ha, tractor unit/ha):			
- ploughing	1.2	-	-1.2
- disking	1	1.6 (2x)	0.6

- ploughing by seed drill unit	0.7	0,7	0
Total input	2.9	2.3	-0.6

Conversion factor from PLN to Euro is 0.25

The same set of drill-seed was used in both systems. Other treatments, such as fertilization, plant protection and harvesting of wheat in both systems were performed using the same equipment.

Based on data from Table 31, implementing of RT instead of conventional tillage results in decrease of labour and machinery input per hectare, respectively of 0.6 h and 0.6 tractor unit. Reducing labour input is not included in the cost calculation because all labour is provided by the farmer (FADN methodology). The difference resulting from reduced consumption of 0.6 tractor unit is reflected in the lower fuel consumption of 11.3 l per ha (Table 30).

In the conventional tillage, straw was collected and sold. In the RT system straw was incorporated. Therefore, the additional benefits and losses should be considered. Harvest residues left on the field in the form of chopped straw, after mixing with the top layer of soil, improve its structure, and further provide additional quantities of phosphorus and potassium, allowing the farmer to reduce the dose of a mineral acid and potassium fertilizer for forthcoming cultivation.

For the calculation of the benefits of straw incorporation, the ratio of straw to winter wheat grain harvested by combine was adopted. The ratio is 1:0.97 (Harasim 2006).

In our experiment, 7.56 t of crop residues, mainly straw, remains in the field and is mixed with the topsoil. Straw contains 0.11% phosphorus and 1.06% potassium (Harasim 2006). Leaving wheat straw in the field, we supply the soil with 6.7 kg of phosphorus and 64.9 kg of potassium per hectare (in elemental form). After conversion to an oxide form, we obtain 15 kg P_2O_5 and 78 kg K_2O.

Table 32: Calculation of the cost of benefits and losses resulting from incorporation of a straw applying RT in winter wheat.

	Calculation in PLN	Calculation in Euro
Savings resulting from phosphorus and potassium supplied by crop residues (about 7 kg P_2O_5, 47 kg K_2O per ha)	15 kg ∗ 4.32 PLN/kg + 78 kg ∗ 3.00 PLN/kg = 298.80 PLN	+74.70
Loss of benefits from the selling of straw (7.34 t crop yield, 7.56 t straw)	7.56 dt ∗ 150.00 PLN/dt = 1134.00 PLN	-283.50
The costs of the additional nitrogen (to decompose the straw in a dosage of 30 kg N /ha)	56 kg ∗ 3.62 PLN/kg = 202.72 PLN	-51.00
Calculation of leaving crop residues on the 1 hectare in RT	-1037.92 PLN	-259.48

Conversion factor from PLN to Euro is 0.25

For winter crops, it is advised to provide an additional dose of nitrogen fertilization (8-10 kg N/t straw) (Harasim 2011). This will cause that nitrogen supplied before sowing of the crops will be able to be fully exploited. Nitrogen dose adopted on the straw was 56 kg / ha. The value of straw is set at 150 PLN/t (37.5 Euro/t) (prices for 2013) Ratios calculation to elemental form after Harasim (2006) are: potassium – K x 1,2 = K_2O, phosphorus – P x 2,29 = P_2O_5. An alternative calculation of the costs of leaving straw on the field shows that farmer suffers an economic loss of 260 Euros per hectare.

3.4.2 Conclusion (Poland)

Reduced tillage yields almost the same profit as conventional tillage (1€ difference).The somewhat lower financial yield of the product is compensated by less fuel use and although not included in the financial evaluation, by reduced labour needs. There is no additional need for crop protection.

3.5 Spain

Figure 7. Crop rotation (maize-cotton) in a permanent ridges planting system in Southern Spain.

3.5.1 BMP: Direct drilling in Spain

No-tillage research, or direct drilling research, as it is also known, started in Spain in 1982 as a way to reduce the economic and environmental problems cause by the traditional, or conventional tillage system, which started by the burning of the wheat stubble followed by successive tillage passes, from the mouldboard plough to harrows and tines until clod size was small enough to allow the drilling of the next crop. Direct drilling was successful on clay soils due to the reduction in erosion losses, energy consumption, production costs, and to a better water conservation profited by the crops especially in dry years with less than 400 mm of rainfall, as compared to both conventional and minimum tillage techniques (Giráldez & González 1994).

Ordóñez Fernández et al. (2007) compared the performance of two management systems, conventional tillage as describe above, (CT), and direct drilling where the residues of the previous crop were left on the soil surface, with chemical weed control, (DD), on fertility-related soil properties after 25 years of trial. The wheat–sunflower–legume rotation was adopted in a almost flat land surface with heavy clay soils without significant yield differences as a whole, confirming the long-term viability of these new alternative systems with the intensity tilling used today. Wheat gave somewhat lower mean yields in DD than in CT. These were estimated at 92% for DD over the yields obtained with CT. In dry years, sunflower in DD gave better harvests than in CT although in average or very rainy years, Sunflower in DD tended to produce less than in CT. However, decreasing tillage increased penetration resistance and dry bulk density, and diminished air filled pore volume and therefore, direct drilling would require mechanical loosening from time to time to alleviate that compaction.

As an example, Table 33**Error! Reference source not found.** from Hernanz et al. (1995), presents the costs of different cultural practices, expressed in kilograms of crop equivalent per hectare. The distribution of the energy associated with the inputs for different managements and crops is shown in Figure 7.

Table 33. Cost of the different management practices evaluated.

Input	Associated energy	Units	Costs Wheat (grain)	Barley (grain)	Vetch (hay)	Units[a]
Machinery[b]		MJ ha^{-1}				kg ha^{-1}
Moldboard plough	51.8		235.6	275.3	413.0	
Chisel plough	22.0		76.5	89.5	134.6	

Disc plough	34.3	90.3	104.8	156.8	
Cultivator	13.2	63.5	74.2	110.9	
Vibrocultor	11.9	69.6	81.1	122.4	
Conventional drill	21.7	60.4	70.4	105.5	
Zero-till drill	41.7	99.4	115.5	173.6	
Spreader	2.8	15.3	17.6	26.0	
Sprayer	2.7	11.5	13.0	19.9	
Combine	64.2	149.9	175.2		
Bar-mover	16.5			184	
Rake	6.4			87	
Baler	28.8			157	
Fuel	MJ l^{-1}				kg l^{-1}
Diesel	36.6	1.9	2.2	3.3	
Fertilizer	MJ kg^{-1}				kg kg^{-1}
N	61.2	2.4	2.8	4.2	
P	10.7	2.3	2.7	4.1	
K	5.4	0.9	1.1	1.6	
Seeds	MJ kg^{-1}				kg kg^{-1}
Winter wheat	9.9	2.2			
Winter barley	9.9		2.0		
Spring barley	9.9		2.3		
Vetch	7.6			2.8	
Herbicides[c]	MJ kg^{-1}				kg kg^{-1}
Glyphosate	344.2	151.4	175.9	263.9	
Paraquat	344.2	177.4		206.5	
Joxynil+MCPP+bromoxynil	141.5	99.4	115.5		

[a] Expressed in equivalent crop quantities, talking in account the sales prices of 1993 (converted from US$ to Pesetas to Euro's as 1: 127. 26 : 0.00601012 per ton); 200, 170 and 113 for wheat, barley and vetch respectively.
[b] Including implement and tractor but not fuel consumption.
[c] In units of active ingredient.

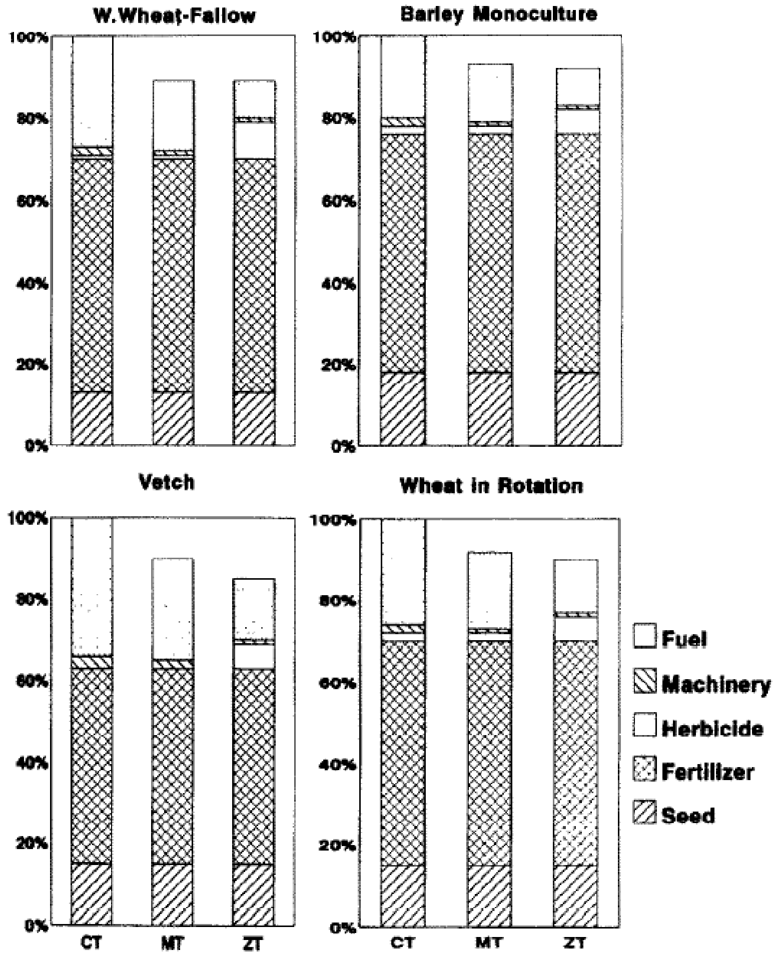

Figure 8. Energy inputs expressed as percentage of the inputs associated with conventional tillage.

The three experiments they considered, the energy consumption of the CT tillage system was higher than that for systems MT and ZT. The average values (**Error! Reference source not found.**) show that there are no differences between those for MT and ZT, in most of the cases.

Table 34. Production costs for three tillage systems in central Spain.

Experiment	Season	Crop	Production costs (t ha^{-1})		
			Conventional tillage	Minimum tillage	Direct drilling
E-1	1983-1985	F.-W. wheat	3.20	2.15 (67)	2.55 (79)
	1985-1987	F.-W. wheat	3.11	2.35 (75)	2.48 (79)
	1987-1988	W. barley	2.55	2.25 (88)	2.09 (81)
	1988-1989	W. barley	2.41	1.99 (80)	2.08 (86)
	1989-1990	S. barley	2.62	2.18 (83)	2.44 (93)
	1990-1991	W. barley	1.85	1.68 (90)	1.69 (91)
	1991-1992	W. barley	1.76	1.47 (83)	1.46 (83)
E-2	1985-1986	W. wheat	1.86	1.61 (86)	1.47 (79)
	1986-1987	Vetch	2.21	1.78 (81)	1.75 (79)
	1987-1988	W. wheat	2.56	1.96 (76)	2.16 (84)
	1988-1990	Vetch-W. wheat	3.33	2.82 (84)	2.97 (89)
	1990-1991	Vetch	2.50	2.13 (85)	2.06 (82)
	1991-1992	W. wheat	1.79	1.53 (85)	1.52 (85)
	1992-1993	W. wheat	1.58	1.34 (84)	1.29 (81)

E-3	1986-1987	S. barley	2.41	2.13 (88)	2.29 (95)
	1987-1988	S. barley	2.50	2.22 (88)	2.38 (95)
	1988-1989	S.barley	2.50	2.22 (88)	2.38 (95)
Mean	6 years	F.-W. wheat	3.21	2.44 (76)	2.67 (83)
	4 years	W. wheat in rotation	1.95	1.61 (83)	1.61 (83)
	2 years	Vetch in rotation	2.35	2.04 (86)	1.91 (81)
	4 years	W. barley	2.14	1.85 (86)	1.83 (85)
	4 years	S. barley	2.50	2.18 (87)	2.37 (94)

W. = winter; S. = spring; F. = fallow
Figures in parentheses are percentages with respect to the production costs of conventional tillage for each experiment and season.

In another long term study, Sánchez-Girón et al. (2004), assessed the economic feasibility of rainfed reduced (CP) and no-tillage (NT) systems compared to conventional-tillage (MP) for other rainfed crop rotation.

Table 35. Description of cultural operations performed by tillage method and crop rotation.

MP and CP			NT[a]		
Operation	Timing	Input	Operation	Timing	Input
Winter wheat + winter barley					
Moldboard plough[b]	October	1.47 h/ha	Sprayer	October	0.2 h/ha
Chisel plough[c]	November	1.04 h/ha	Herbicide	October	0.72 kg/ha
Cultivator	November	0.96 h/ha	Spreader	November	0.2 h/ha
Spreader	November	0.2 h/ha	Fertilizer		200 kg/ha
Fertilizer		200 kg/ha	Sowing	November	0.8 h/ha
Sowing	November	0.65 h/ha	Seed		180 kg/ha
Seed		180 kg/ha	Spreader	March	0.2 h/ha
Roller	November	0.4 h/ha	Fertilizer		200 kg/ha
Spreader	March	0.2 h/ha	Sprayer	March	0.2 h/ha
Fertilizer		200 kg/ha	Herbicide•		3 1/ha
Sprayer	March	0.2 h/ha	Harvesting	July	36 € ha^{-1}
Herbicide•		3 1/ha	Hauling	July	0.5 h/ha
Harvesting	July	36 € ha^{-1}			
Hauling	July	0.5 h/ha			
Vetch for hay					
Moldboard plough	October	1.47 h/ha	Sprayer	October	0.2 h/ha
Chisel plough	November		Herbicide[d]		0.72 kg/ha
Cultivator	November	0.96 h/ha	Spreader	November	0.2 h/ha
Spreader	November	0.2 h/ha	Fertilizer		200 kg/ha
Fertilizer		200 kg/ha	Sowing	November	0.8 h/ha
Sowing	November	0.65 h/ha	Seed		100 kg/ha
Seed		100 kg/ha	Cutterbar	May	0.4 h/ha
Cutterbar	May	0.4 h/ha	Windrowing	May	0.3 h/ha
Windrowing	May	0.3 h/ha	Baling	May	16.8 €/Mg
Baling	May	16.8 €/Mg			

[a] Tillage systems: MP, mouldboard ploughing; CP, chisel ploughing; NT, no-tillage.
[b] Primary tillage in MP was mouldboard ploughing.
[c] Primary tillage in CP was chisel ploughing.
[d] Glyphosate.

3.5.2 BMP: Cover crops for controlling water erosion in permanent crop farms. The particular case of olive trees

Figure 9. Conventional tillage and cover crop plots in a commercial olive orchard in Southern Spain.

In the following tables information is provided for the cost evaluation associated with the implementation of cover crops (CC), as compared to conventional tillage (CT) (according to our classification in the WP3 report). All the information in this report has been provided and adapted from Asociación Española Agricultura de Conservación / Suelos Vivos (AEAC/SV) and the literature mentioned in the text.

Table 36. Conventional tillage (CT) and cover crops (CC) in olive orchards: Common tasks, execution period and required machinery and equipment for the implementation.

Common tasks in CC and CT		
Task	**Execution period**	**Machinery and equipment**
Regular pruning or rejuvenation (biannual)	January-April	Chainsaw, axe pruning, ...
Pruning elimination	January-April	Wood chopping machine
Fertilization	January-March	Tractor + fertilization with centrifugal spreader + trailer
Application of phytosanitary products + fertilization	March	Tractor + sprayer or atomizer
Application of phytosanitary products+ fertilization	April-May	Tractor + sprayer or atomizer
Twig cut[1]	August-September	Tractor + sprayer
Herbicide application (pre and post emergence)	October-November	Tractor + sprayer
Application of phytosanitary products + fertilization	October-December	Tractor + sprayer + atomizer

[1] Chemical control during May-June.

Table 37. Implementation of conventional tillage in olive orchards: Specific tasks, execution period and required machinery and equipment.

Specific tasks in CT		
Task	**Execution period**	**Machinery and equipment**
Cultivator pass	February-April	Tractor + cultivator
Harrowing (once or twice depending on annual precipitation)	April-August	Tractor + harrow
Soil preparation	September	Tractor + roller compactor

Table 38. Specific tasks associated with the implementation of spontaneous CC.

Specific tasks in spontaneous (SpCC)		
Task	**Execution period**	**Machinery and equipment**
Mowing of CC (cleared + herbicide)	March-May	Tractor + weeding machine + sprayer

Table 39. Specific tasks associated with the implementation of sown CC.

Specific tasks in sown CC (SCC)		
Task	Execution period	Machinery and equipment
Mowing of CC (cleared + herbicide)	March-May	Tractor + weeding machine + sprayer
Sowing of CC in-between tree rows	September-November	Tractor + fertilizer spreader + sowing machine

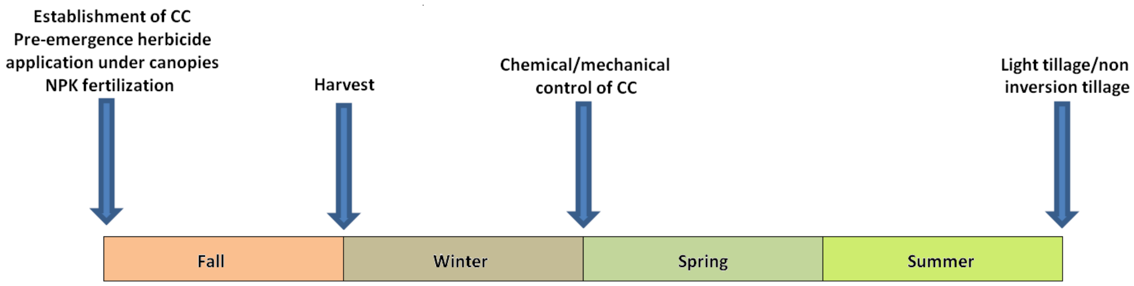

Figure 10. Scheme of the timing of the different tasks associated with the implementation of cover crops.

Table 40. Estimation of cost for fertilizers, pesticides and sowing a Barley cover crop.

Input	Unit	Amount	Unitary price €	Cost € /ha
Fertilization	ha	1	62.6	62.6
NPK fertilizer	kg	120	0.5	54
Sown	ha	1	62.6	62
Barley seed	kg	120	0.3	36
Total costs				≈ 215

Table 41. Required time and cost of operations for common tasks in of olive cultivation. Mechanization, labour and fuel costs are included.

Operation	h/ha	€/h	€/ha
With tractor			
+ Spreader for fertilization	0.3-0.5	32	9.6-16
+ Atomizer	0.5-2	35	17.5-21
+ Cultivator	0.7-1	35	24.5-35
+ Weeding machine	0.4-0.8	38	15.2-30.4
+ Harrow	0.4-0.7	30	12-21
+ Shovel	1.3-2	38	49.4-76
+ Wood chopping machine	1-2	41	41-82
+ Sprayer	0.5-1	40	15-43
+ Trailer	0.3-0.5	26	7.8-13
+ Roller compactor	0.7-0.9	29	19.6-25.2
+ Sowing machine + fertilization machine	0.7	35	24.5
+ Cultivator	0.4-0.7	30	12-21
Without tractor			
Twig cut	1.4-2	44	61.6-88
Pruning	3.3	40	132
Formation of branches	2.5	30	75
Sprayer	0.5-1	10	5-10

Table 42. Comparison of costs associated to conventional tillage (CT), spontaneous cover crops (SpCC), and sown cover crops (SCC) (costs of Table 40 not included).

MP	h/ha mechanized tasks	h/ha total tasks	€/ha mechanized tasks	€/ha fuel	€/ha total
CT	9.6	23.4	239	50	428
SpCC	7.4	21.2	186	39	363
SCC	7.8	21.6	196	29	364

Costs from management operations are shown in **Error! Reference source not found.** (Rebolledo *et al.* 2014; Taguas *et al.* 2012) where the highest costs are associated with CT (673.74€ ha^{-1} year^{-1}) and the lowest with SpCC (630.18€ ha^{-1} year^{-1}) (SpCC = spontaneous grass cover, CT = conventional tillage). In summary, and based on the study made by Taguas et al. (2012), SpCC was the most profitable alternative for soil management.

Table 43. Summary of annual income received by the farmer and cost analysis derived from the management operations in the study case.

	Olive yield (kg/ha)-olive oil (21% yield)	Unit price (€/kg)	Unit value (€/ha)
Harvest benefits	1100	2.33	538.23
(-) Transformation costs	1100	0.06	13.54
Subsidies	-	1.32	304.92
Annual income			829.61
Season	Operations SpCC	Components	Unit value (€/ha)
Autumn	Fertilization NPK 16, manual application	Fertilizers, 1 farmers	71.7
	Weed control with pre-emergence residual herbicide	Tractor, 1 farmer, herbicide	40.44
Winter	Soil preparation and olive harvest	Tractor, 8 farmers, rolling	379.99
Spring	Chemical elimination of weeds with herbicide around the trees	Tractor, farmer, herbicide	40.59
	Tractor driven over the land twice to destroy and limit the vegetation strips	Tractor, farmer, tires	97.46

Annual costs	SpCC		630.18
Net return	SpCC		199.43
Season	Operations CT	Components	Unit value (€/ha)
Autumn	Fertilization NPK 16.manual application	Fertilizers, 1 farmers	71.7
	Weed control with pre-emergence residual herbicide	Tractor, 1 farmer, herbicide	40.44
	Tillage operations	Tractor, farmer, plow	70.47
Winter	Soil preparation and olive harvest	Tractor, 8 farmers, rolling	379.99
Spring	Post-emergence herbicide	Tractor, 1 farmer, herbicide	40.67
	Tillage operations	Tractor, farmer, plow	70.47
Annual Costs	CT		673.74
Net return	CT		155.87

3.5.3 Conclusion (Spain)

Tillage

The three tillage systems were found to provide similar gross margins and risk regardless of the crop grown although they were highly sensitive to EU Common Agricultural Policy subsidies. The risk associated with crops and rotations was similar with the three tillage systems.

Cover crops

The costs for a sown cover crop is 215 € /ha and the benefits of reduced tillage is 71 €/ha, resulting in net increased costs of 144 €/ha. This is high compared to spontaneous cover crops (SpCC) which have no costs involved for sowing and only benefits for reduced tillage of 71 €/ha. Therefore, SpCC seems slightly beneficial in terms of net return as no costs for tillage operations are done in comparison to conventional tillage (CT).

3.6 The Netherlands

3.6.1 Non-inversion tillage

To estimate costs for the analysis of the Netherlands data is taken from the national database KWIN Akkerbouw (2012). When farmers move to non-inversion tillage (NIT) ploughing is often replaced by a soil treatment with a fixed tine cultivator. Most farmers cultivate up to 30 cm deep to loosen the soil. In addition, efforts for weed control a likely to increase when applying NIT. In general ploughing results in lower weed pressures than NIT.

The cost calculations for the BMP focus therefor on the replacement of fuel needed for ploughing by fuel needed of the fixed tine cultivator, the difference in labour and some increased costs for additional weed control, that is costs for herbicides, labour and fuel (Table 44). It is assumed that yields will not or not significantly affected by NIT as literature suggests that that is the case in the long run when using NIT.

Table 44. Non-inversion tillage for arable farming on clay soils with a standard crop rotation of potatoes, beets, winter wheat, carrots and onions.

		Reference	BMP	notes/differences
		Plough	NIT, one more cultivation needed	
Winter wheat:	yield (t/ha)	9.2	9.2	no yield differences
	price per ton	160	160	default price (KWIN 2012)
	financial yield	1472	1472	
	machinery costs	120	83	-37.15
	total direct costs	693	656	-37.15
	Net return /gross margin	779	816	37.15
	work load (hr/ha)	10	8	-2
Beets:	Yield	83	83	no yield differences
	Price	40	40	default price (KWIN 2012)
	financial yield	3320	3320	0
	machinery costs	102	59	-43
	total direct costs	1255	1212	-43
	Net return /gross margin	2065	2108	43
	work load (hr/ha)	17	15	-2
Carrots:	Yield	50000	50000	no yield differences
	Price	0.2	0.2	default price (KWIN 2012)
	financial yield	10000	10000	
	machinery costs	150	150	0
	total direct costs	3124	3081	-43
	Net return /gross margin	6876	6919	43
	work load (hr/ha)	109	107	-2
Onions:	Yield	28000	28000	no yield differences
	Price	0.265	0.265	default price (KWIN 2012)
	financial yield	7420	7420	
	machinery costs	68	68	
	total direct costs	4023	3996	-27
	Net return /gross margin	3397	3424	27
	work load (hr/ha)	123	122	-1

3.6.2 Conclusion (The Netherlands)

When adopting NIT the cost for ploughing is replaced by cost for a pass with the fixed tine cultivator. The pass with the cultivator is much faster than ploughing and fuel consumption is lower. However with NIT additional weed control when growing carrot and onion is often required and will come with additional costs. These cost maybe substantial especially when manual labour is involved. Burning and hand weeding are labour consuming activities. If labour is available within the family this may not cause great difficulties but when labour needs to be hired the costs may outweigh the benefits. Additional weed control is not needed in winter wheat, sugar beet or potato (Wilting 2007; www.spna.nl).

When adopting NIT in winter wheat, potato and sugar beet cultivation some money is saved on direct (fuel) costs. Also lowering the demand for labour during peak periods might be driver for farmers adopt NIT. An additional advantage and reason why farmers start to adopt that is that on clay soils potato volunteers are controlled.

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Appendix I: Overview of farmer views on drivers and barriers for best practices (BMPs) in soil management

				soil quality										growth and produce quality				crop protection				inputs use / equipment							financial			weather / technical (often control) factors										Biodiv		Various				
Management Practice	footnotes	Country	farm type	soil physical	compaction/ bearing	soil fertility	Humus	soil life	soil health	earliness	water storage	waterlog drainage	Erosion	yield stability	germination	fodder	animal welfare	weeds	volunteer crop	pests	diseases	water use	fuel use	biocide use	fertiliser use	labour / time	machinery	storage cap	subsidy	income	cost	weather	time window	incorporate-in soil	unevenness	seeding	input quality	input availability	slow/unsure N release	soil NO3/ leaching	fields far apart	wildlife biodiv	environ	enables other practices	management info	Legislation	contracts / colectors	other
footnotes				A	C	E					F					G										H											J									K		
ROTATION	1	BE	dairy-sand			D		D										D													DB									B	B							
	2	BE	dairy-sand													D									D																					B		
	3	BE	mix-veg	D			D						D																	B														D				
		DE	ar-mix-sand			D			D					D				D		D	D					D					B											D				B		
		DE	ar-mix-med			D	D																			DB																D						B
	4	IT	dairy	D												D						B		D		D				B	B																	
	5	IT	dairy	D		D										D				D				D	D	D					D																	
	5	IT	ar-cer-LO			D												D		B							B				D																	
	1	NL	dairy-sand	B			B					B				DB					D										B															D		
		ES	ar-cereal			D												D		D	D				D					D													D					
LEGUM		AT	Ar-LO	D										B		D								B							B																	DBBB
		AT	mixed-UP			D	D						B	B		D				B				D	D	D				B	DB																	BBB
	2	BE	dairy-sand													D		B						B	D						D																	
		IT	dairy	D		D										D				D				D	D	D					D																	
		IT	ar-cer-LO			D												D		B							B				D																	
LANDEX		BE	mix-veg	B		DB												B			D																				B							
CCCGM		AT	ar-LO			D	D	D			D		D										B	B			(D)			B	B	(D)										D						
		AT	mix-UP			D	D	D		DB	D		D					B			DB								(D)		B					B						D						(D)B
		BE	ar-spec	D		D	D		D	D			D					D						B			B						B	B		B							D					
		BE	dairy-sand	D	D	D	D		D	D			D					D				B				B			(D)			(B)											D					
		BE	mix-veg	D		D	D		D				D					D						B							B	(B)											D					
		FR	ar-rendzin	D			D(D)	D	D		D		D					D			D	D	B	D	D	B	B				B			B														
		FR	dairy	D			D	D	D				B					D					B			B					B									D			D			D		
		DE	ar-mix-sandNW			D	D						D									D					B					B				(B)						D	D	D				
		DE	ar-mix-sandNE			D	D						D									(B)				(B)					(B)		(B)									D	D					
		DE	ar-mix-med	D		D	D		D	D								D					B			B								B														
		IT	dairy	D		D	D											D							D						B																	
		IT	ar-cer-LO	D		D	D											D							D				B		B																	
		IT	ar-cer-UP										D																D		B																	
		PL	Ar	D		D	D	D					D								D				D						D																	
		PL	mixed					D													D				D						D																	
		PL	dairy																																													
		ES	tree crops	D		D					D		D											B					B																			
	6	NL	dairy-sand		D	D	D															B			D	D					(B)												D					
	7	NL	dairy-sand	(D)		D	D																						B							D										B		
		NL	ar-clay	D		D	D	D					D					B						B		B					B												D					
		NL	ar-sand	D		D	D	D					D					B						B		B					B												D					
CRESINC		BE	ar-spec	D		D																	B		D					B	B					B								B		DB		
		IT	Dairy	D			D																				(D)																					B
		IT	ar-cer-LO	D			D														B				DB					(B)		(B)														D		
		IT	ar-cer-UP	D		D	D											B		B	B				B		(D)			B	B					B										D		
		PL	Ar	D		D					D		D								B										B					B												
		PL	Mixed	D		D					D		D					D			B										B					B												
		Pl	Dairy	D		D					D		D					D			B										B					B												
		NL	ar-clay	D	B	D	D	D													B				B	D				(B)	B															B		
		NL	ar-sand	D	B	D	D	D													B				B	D					B															B		
GRAZE		AT	dairyTirol	(B)			D						B			D	D								D					D	D										B							B
PASTPLN		ES	Dehesa														D									D			B	(B)		(B)																

REDUCED TILLAGE	AT	ar-LO	D	D			D			D		D		D			B	B		B		D			(D)					D																	
	BE	ar-spec	(B)			D				D		D	B				B	D		B		D	B		D	B					(B)												D				
	BE	dairy-sand	B	B						D				D			B			B		D	DB		D	B				D											D						
	BE	mix-veg	DB	B		D	D		D			D					B			B		D			D								B															
	FR	ar-rendzin	D	D		D	D	D				D					B			D		D		D	DB																					B	
	FR	ar-cambi	D	D		D(D)	D	D				(D)					B					D		D	DB	(D)																				B	
	FR	dairy	D	D		D	D	D				(D)					B			D		D		D	DB																					B	
	DE	ar-mix-sandNW	D				D		B	D		D		B			B	B	B			D	B		D	B																					
	DE	ar-mix-med		D	D									B						B		D			D									B													
	IT	ar-cer-LO							D		B						B								D					D																	
	IT	ar-cer-UP								B	D						B								D					D																	
	PL	arable	D		D	D					D						B					D	B		D	B				D																	
	PL	mixed	D		D	D					D						B					D	B		D	B				D																	
	PL	dairy	D		D	D					D						B					D	B		D	B				D																	
	ES	treecrops		D						D		B								B						B		B		D																	
	ES	dehesa	D		D	D											D											B																			
	NL	dairy-sand	D	B		D	D				B						B			B			B		D	B			B	D			B														
	NL	ar-clay	D			D	D										B	D		B			B		D	(B)			(B)	D	(B)										B						
	NL	ar-sand	D			D	D										B	D		B			B		D					D											B						
NOTILL	FR	ar-rendzin	D			D	D					D					(B)		(B)																												
	FR	ar-cambi	D			D(D)	D				(B)	D					B									(B)				D										(B)						(B)	
	FR	dairy	D	(B)		D	D				(B)	D					B								D	B				D																	
	IT	ar-cer-LO				D	D			D							B					D				(B)				D																	
	IT	ar-cer-UP	D								D									B		D			D	(B)				D				B													
	ES	ar-cer			D	D				D		D										D			D	B			DB												D	D					
CTF	DE	ar-mix-sandNE	D	DB		D	D			D												D				B				B																	
	ES	ar-cer		D																						B		B																			
	NL	ar-clay	D								D															B																	D				
LOWPRES	DE	ar-mix-sandNE		D																		D			B	B				B										B							
NUTPLAN	AT	ar-LO			D																			D						DB														D			
	AT	mixed-UP			D																				B					B														D			
	AT	dairyTirol			D																				B					B														D			
	IT	dairy											D		D	D								D						D(B)														D			
	PL	mixed			D																			D						D														D			
	PL	dairy																						D						D														D			
ORGFERT	AT	ar-LO		B	D		D															B					B			DB	(D)(B)												D	(D)			
	IT	ar-cer-LO	D		D	D																			B					B						B	B								B		
	IT	ar-cer-UP	D		D	D																		D	B	B		B		B						B	B								B		
FYM	BE	ar-spec	D		D	D	D			D		D													B	B	(B)			(B)				B			(B)	B									
	BE	mix-veg	D		D	D	D			D		D																		B													D				B
COMPOST	Be	ar-spec	D		D	D	D					D					B			B					B	B				B						B	B	BD	B								B
	Be	mix-veg	D			D	D			D	D									B					B					B																	
	NL	ar-sand																																		B									D		
DIGEST	NL	ar-clay				D	D													B					D					D						B									B		
	NL	ar-sand				D	D													B					D					D						B									B		
SPRINGSL	NL	ar-clay	B	B		D	D																		B		(D)		D		B					B									B		
ROWSLU	NL	dairy-sand																							B	B			B	DB		B													B		
SPRI/DRIP	IT	dairy		D							D										D	B			B					B																	D
	IT	ar-cer-LO		D							D									D	D	B								B									D			D	D				D

1. maize / grass rotation
2. maize/grass clover rotation
3. vegetable/wheat
4. including grass ley in rotation
5. including legume ley in rotation
6. undersowing of catch crop in maize
7. enabling catch crop by early maize harvest

The header to the footnote includes:
A. includes structure, aeration, workability, rootability
C. includes formation of plow pan
E. includes soil nitrogen supply amount/rate, micronutrients, soil pH
F. includes water retention, infiltration, reduced loss
G. includes feed quality, feed ration, protein content, milk yield,
H includes dependence on contractors, ease of operations
J includes impurities/waste, disease germs, constancy of composition
K includes fear for tightening of legislation

ROT: crop rotation
LEGUM: including legume crops in rotation
LANDEX: land exchange with other farmers/farm types to widen rotation
CCCGM: catch & cover crops & green manures
CRESINC: retention & incorporation of crop residues in soil
GRAZE: grazing
PASTPLN: making a pastoral plan
REDUTIL: reduced/minimum/non-inversion tillage
NOTIL: no tillage; direct drilling
CTF: controlled traffic farming

LOWPRES: tire systems for low soil loading pressure
NUTPLAN: nutrient management plan / soil analysis
ORGFERT: application of organic fertilizers
FYM: application of farm yard manure
COMPOS: application of compost
DIGEST: use of digestate (from methane reactors)
SPRINGSL: spring application of slurry on clay
ROW SLU: application of slurry in rows
SPRIDRIP: sprinkler & drip irrigation (as opposed to flood irrig.)

B	Barrier
D	Driver
DB	Drivers as well as barrier
()	control factor; when used next to a letter without parenthesis it means that it is smaller than the next letter

Appendix II: Farm survey Austria

FTZ 1A: Lower Austria (ENZ8_SL3+SL1_TXT2), FTZ 2M: Upper Austria (ENZ6_SL3_TXT3) and FTZ 3C: Tirol (ENZ5_SL5_TXT2)

BMP: Soil Analysis (N=28; 11; 6)

Table 45. Drivers and barriers for the arable farms in Lower Austria arable farms (ENZ8_SL3+SL1_TXT2), upper Austria mixed farms (ENZ6_SL3_TXT3) and Tirol dairy farms (ENZ5_SL5_TXT2) for BMP: Soil Analysis. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Lower Austria arable	Upper Austria mixed	Tirol dairy
Drivers			A	
Overview of the nutrient supply	Natural	6.1	5.3	4.8
Adaption of the fertilisation to the crops needs	Physical	5.6	6.3	5.8
Optimization of the crop yield	Financial	5.1	4.8	4.2
Investigation of the humus content	Physical	4.9	3.2	3.2
Shows nutrient deficiencies in the soil	Natural	4.9	5.7	4.8
Development of an fertilisation plan	Physical	4.7	3.1	3.6
Improved food and feed quality	Natural	4.7	3.4	3.2
Additional fertiliser recommendation	Physical	4.6	2.8	3.6
Better advice by the agricultural advisors	Social	4.5	4.9	5.4
Investigation of the trace elements	Physical	4.5	3.5	4.2
Control of the pH value	Physical	4.3	6.0	3.4
Improved soil life	Natural	4.0	3.5	3.2
			SN	
Literature	Human	4.2	4.6	4.8
Advisor of the Chamber of Agriculture	Social	3.3	5.9	4.0
Private agricultural advisors	Social	3.0	6.6	2.0
Advisor of the sugar industry	Social	2.4	3.1	2.0
Colleagues in the working group	Social	2.2	4.6	2.4
Agricultural school	Human	2.2	4.0	4.0
Association "Maschinenring"	Social	1.2	2.9	2.2
Environmentalist	Social	1.1	1.2	-0.2
Other farmers	Social	1.1	1.7	1.0
Representative for mineral fertilisers	Social	1.1	1.8	0.6
			PBC	
Well organized delivery possibilities for soil samples	Physical	3.6	4.2	2.2
Investigation of other soil parameters: biological activity. humus content and trace elements	Physical	2.8	1.1	0.0
Use as a routine method	Physical	2.6	3.4	0.0
Support in soil sampling (by the Chamber of Agriculture or external service)	Social	2.5	3.4	-2.7
Investigation forms. labels and bags for the sample are easy	Physical	2.4	2.8	1.7

available				
Bad growth of the agricultural crops	Financial	2.3	1.3	3.5
Support by a funding programme	Social	1.8	3.2	0.7
Sufficient knowledge of soil	Human	1.8	2.0	3.5
Low-yield farm land	Financial	1.2	1.8	1.5
Fertilisation only based on the nutrient uptake of the crops	Physical	0.8	1.0	-2.5
Exclusive use of organic fertiliser	Physical	0.3	1.1	0.2
Closed nutrient cycle	Natural	0.3	1.6	1.0
Barriers			A	
Less information compared to the observation of plant growth	Natural	-4.6	-5.8	-5.0
Higher costs	Financial	-4.1	-5.2	-6.4
Higher time requirements	Financial	-1.2	-2.4	-3.0
			PBC	
Mistakes in the evaluation by soil laboratories	Social	-1.7	-1.6	-2.7
Many small parcels	Physical	-1.6	-1.7	-1.7
Lack of know-how	Human	-0.7	-0.5	0.0
Lack of fertiliser recommendation and interpretation of results	Human	-0.7	-1.1	-2.5
Difficult interpretation of results	Human	-0.5	-0.8	-2.0
High technical complexity	Physical	-0.5	-1.1	0.0

FTZ 1A: Lower Austria (ENZ8_SL3+SL1_TXT2)

BMP: Non-inversion tillage (N=28)

Table 46. Drivers and barriers for the arable farms in Lower Austria (ENZ8_SL3+SL1_TXT2) for BMP: non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Efficient way of farming	Financial	7.6
Reduced erosion	Natural	7.6
Saved energy	Financial	7.3
Reduced operational costs	Financial	7.2
Conservation of soil life	Natural	7.0
Improved soil structure	Natural	6.9
Increased soil moisture on the surface	Natural	5.5
Avoidance of a plowsole	Natural	5.2
Elimination of pressure damages by lanes	Natural	4.7
Crumbly seedbed	Natural	3.9
Reduced C/N ratio	Natural	2.0
		SN
Society "LOP - Landwirtschaft ohne Pflug"	Social	2.1
Literature	Human	2.0
Private agricultural advisors	Social	1.3
My family	Social	0.6
Other farmers	Social	0.5
		PBC

Higher time efficiency	Financial	3.7
Availability of effective herbicides	Natural	2.4
Machines by the association "Maschinenring" or contractors	Social	1.1
Fertilisation in autumn	Physical	1.1
Cultivation of short straw crops	Physical	1.0
Sowing by a contractor	Social	0.8
Higher and more precise fertiliser application rates	Physical	0.7
Barriers		A
Higher weed pressure	Natural	-4.7
Higher disease pressure	Natural	-3.9
Growth of the previous crop in the following crop	Natural	-3.5
Reduced seedbed quality for sugar beet	Natural	-1.5
		PBC
Use of clover grass and high amounts of crop residues	Physical	-0.3
Lack of know-how	Human	-0.8
Wet soils	Natural	-1.4

BMP: Legume crops (N=20)

Table 47. Drivers and barriers for the arable farms in Lower Austria (ENZ8_SL3+SL1_TXT2) for BMP: Legume crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Positive previous crops	Natural	7.0
Better soil structure	Natural	6.4
Fixation of nitrogen	Natural	6.3
Cultivation of soil is easier	Natural	6.3
Good deep loosening of the soil	Natural	5.9
Uniform and comprehensive growth of the following crop	Natural	5.0
Feeding of legumes to cattle’s	Natural	4.4
Funding or financial compensation	Financial	4.4
Wide crop rotation	Natural	4.3
		SN
Information about GM free feeding	Human	2.4
High demand in the population	Social	2.3
Agricultural experiments	Human	1.9
Literature	Human	1.7
Private agricultural advisors	Social	0.6
Consumers	Social	0.5
Advisors of seed companies	Social	0.4
Politicians	Social	0.4
Society "Donau Soja"	Social	0.3
		PBC
Lack of food and feed protein in the inland	Financial	2.0
Easy reproduction	Natural	0.9
Second income	Financial	0.5
Difficult to grow a new crop and adapt it to the economic	Financial	0.5

requirements		
Cultivation on irrigated fields	Natural	0.5
No use of legumes in mulch sowing	Natural	0.0
Barriers		A
Strong yield fluctuations	Financial	-5.0
Expensive seeds	Financial	-4.8
Bad marketing	Financial	-4.5
Higher pesticide applications	Natural	-3.7
Difficult crop management	Financial	-3.6
		PBC
No stabile variants	Natural	-2.4
Bad seed quality	Natural	-2.2
No progress in breeding	Natural	-1.7
Susceptibility to diseases and pests	Natural	-1.7
Regularly complete failures in yield by rain	Natural	-1.3
No adaption to our climate	Natural	-1.1
No intensive cultivation	Financial	-0.8
Crop rotation already sufficient divers	Natural	-0.4
Achieving a positive contribution margin by its own breeding	Financial	-0.4
Higher market price for maize	Financial	-0.4

BMP: Cover/catch crops, green manure >25% (N=15)

Table 48. Drivers and barriers for the arable farms in Lower Austria (ENZ8_SL3+SL1_TXT2) for BMP: Cover/catch crops, green manure >25%. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Reduced erosion	Natural	7.5
Soil is rooted and loosened	Natural	6.9
Enhanced soil life	Natural	6.7
Fixation of nitrogen	Natural	6.2
Increased humus content	Natural	6.1
Improved water storage over the winter	Natural	5.8
Food for the insects	Natural	5.6
Enriches the soil with nutrients	Natural	5.4
Relaxing of the crop rotation	Natural	5.4
Attractive for beneficial insects	Natural	5.3
More beautiful landscapes	Natural	5.1
Cultivation has to be matched to the entire operating system	Financial	2.2
		SN
Agricultural school	Human	2.6
Literature	Human	2.3
Advisors of "Bioforschung Austria"	Social	2.1
Advisor of the Chamber of Agriculture	Social	2.0
Other farmers	Social	1.1
Politicians	Social	0.4
Society "Distelverein" (Association for Agriculture and Nature	Social	0.4

Conservation)		
Advisors of seed companies	Social	0.3
		PBC
Available technical equipment	Physical	4.8
Sufficient precipitation	Natural	4.5
Cheap seeds	Financial	4.5
Same seeding technology for different crops	Physical	4.0
Use of an cultivator	Physical	3.2
Support by ÖPUL	Financial	2.9
Contiguous agricultural area	Physical	2.7
Combination with mulch or non-inversion tillage	Physical	2.2
Fodder for the animals	Natural	1.8
Gaps in the crop rotation are needed	Natural	1.5
Higher availability of agricultural area	Physical	1.2
Reduced livestock	Financial	0.3
Barriers		A
Higher costs	Financial	-4.3
Higher use of fuel	Financial	-4.2
Higher application of plant protection	Natural	-3.5
Reduction of the income	Financial	-3.5
Time consuming	Financial	-3.4
Higher weed pressure	Natural	-3.2
High risk of failure	Natural	-2.9
Loss of water that is no longer available for the main crop	Natural	-2.8
Difficult incorporation of crop residues	Natural	-2.6
Not possible to use the field for cash crops	Financial	-2.5
"Green bridges" cause a higher disease pressure	Natural	-0.7
		PBC
No sufficient know-how	Human	-0.8

FTZ 2M: Upper Austria, mixed farms (arable farms, ENZ6_SL3_TXT3)

BMP: Organic fertilizers (N=11)

Table 49. Drivers and barriers for the arable farms in upper Austria (ENZ6_SL3_TXT3) for BMP: Organic fertilizers. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Ecologically practical	Natural	8.6
Support of the soil life	Natural	8.6
Increased yield potential	Financial	8.2
Support of the catch crop quality	Physical	8.1
Dried farmland before use	Physical	6.9
Reduced operational costs	Financial	6.8
Appropriate fertilisation	Physical	6.3
Increased nutrient content	Natural	6.2
Good supply with trace elements	Natural	5.5

		SN
Colleagues in the working group	Social	4.3
Other farmers	Social	3.7
		PBC
Sufficient amount of organic fertiliser	Physical	4.9
Less odour nuisance and higher acceptance in the population by use of drag hoses	Physical	4.7
Powerful technique	Physical	3.8
Experienced fertilisation plan	Physical	3.7
Reduced operating technical effort by use of drag hoses	Financial	3.6
Required storage size	Physical	1.3
Support by the funding programme ÖPUL	Financial	0.9
Sophisticated operational management	Financial	0.7
Barriers		A
Higher costs	Financial	-6.5
Increased use of fuel	Financial	-6.2
Limited storage capacity (slurry)	Physical	-5.8
Heavy equipment	Physical	-4.6
Increased weather dependence	Natural	-3.8
		PBC
High fuel price	Financial	-0.1

BMP: Legume crops (N=7)

Table 50. Drivers and barriers for the arable farms in upper Austria (ENZ6_SL3_TXT3) for BMP: Legume crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Increased nitrogen content	Natural	7.3
Support the soil fertility	Natural	6.6
Contribution to the local protein supply	Physical	6.5
Good previous crop value for winter cereals	Natural	5.3
Increased humus content	Natural	5.3
Decreased production costs	Financial	4.7
Uncomplicated in cultivation	Natural	3.8
Requires no mineral fertiliser	Physical	3.2
Less labour intensive	Financial	2.5
Less use of pesticides	Natural	2.0
Suppress weeds	Natural	1.3
Requires high attention in tillage	Physical	0.2
		SN
Agricultural experiments	Human	1.3
Politicians	Social	0.5
Advisor of the Chamber of Agriculture	Social	0.3
		PBS
Grain production technology can be used	Physical	3.4
Use as fodder on its own farm	Physical	1.3
Changed crop rotation	Natural	1.2
No professional advice of agricultural advisors	Social	0.2
Barriers		A
Increased risk of erosion	Natural	-7.0

Poor contribution margin	Financial	-6.7
Strong fluctuations in yield	Financial	-6.7
Reduced yields over the years	Financial	-6.5
Problems with pests	Natural	-6.2
Not competitive	Financial	-6.0
Lack of maturity in some years	Natural	-4.7
Expensive seeds	Financial	-4.3
No market demand	Financial	-4.2
High weather dependency	Natural	-4.0
Low self-compatibility	Natural	-3.8
Increased complexity of the crop rotation and the farm management	Natural	-3.0
Higher opportunity costs	Financial	-1.2
		SN
Environmentalist	Social	-1.3
Seed trader	Social	-0.7
Population	Social	-0.3
Society "Donau Soja"	Social	-0.3
Trading	Social	-0.3
		PBC
High yield uncertainty	Financial	-5.5
Low market price	Financial	-5.3
No effective pesticides	Natural	-5.0
No professional plant breeding	Natural	-4.7
Late stage of maturity	Natural	-4.0
Fertilisation with slurry	Physical	-3.5
High local precipitation	Natural	-3.0
Low price for pork meat	Financial	-2.7
Cultivation of rape instead	Natural	-2.4
Seeds are not guaranteed GM free	Natural	-1.0
Need the farmland for maize cultivation	Physical	-0.7
Have to buy fodder (maize) otherwise	Financial	-0.2
No extensive management	Financial	-0.2
Cultivation is located in labour intensive time	Financial	-0.2

BMP: Cover/catch crops, green manure (N=6)

Table 51. Drivers and barriers for the arable farms in upper Austria (ENZ6_SL3_TXT3) for BMP: Cover/catch crops, green manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Good soil structure	Natural	9.4
Reduced soil erosion	Natural	9.4
Increase of the humus content	Natural	8.7
Stimulated soil life (especially the earthworms)	Natural	8.1
Loosening the soil	Natural	7.7
Nutrient storage till the main crop	Natural	5.3
Reduced soil-borne diseases	Natural	2.7
Early tillage	Physical	2.3
		SN
Crop experts	Social	5.4
Private agricultural advisors	Social	2.9
Community	Social	1.6

Other farmers	Social	1.1
Population	Social	0.6
		PBC
Support by funding program ÖPUL	Financial	5.4
Early harvestable crops (e.g. barley)	Natural	5.3
Good adapted varieties	Natural	3.3
Cultivation of rape	Natural	0.6
Less know-how	Human	0.3
Barriers		A
General weed management (e.g. weed control) is more demanding	Natural	-5.4
Slower warming and drying of the fields in spring	Natural	-5.0
Caused costs	Financial	-4.9
Overwintering of fungal diseases	Natural	-3.9
Problem with seed placement	Physical	-2.7
		SN
Seed trader	Social	-0.3
		PBC
No technical equipment	Physical	-2.7
Use of more herbicides	Natural	-0.3

FTZ 3C: Tirol, dairy cattle/permanent grassland (ENZ5_SL5_TXT2)

BMP: Permanent grazing and rotational grazing (N=6)

Table 52. Drivers and barriers for the dairy cattle/permanent grassland farms in Tirol (ENZ5_SL5_TXT2) for BMP: Permanent grazing and rotational grazing. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Saved time and money	Financial	7.5
Increased contribution margin	Financial	7.2
Improved animal health	Natural	6.6
Reduced concentrated fodder	Financial	6.0
Less stress for the herd	Natural	5.5
Improved fodder quality	Natural	4.3
Improved metabolic cycle of the cows	Natural	4.3
Increased humus content	Natural	4.0
Reduced mineral fertilisation	Natural	3.8
Closed and sustainable circle is possible	Natural	2.8
Requires a regularly overseeding	Physical	2.2
Increased milk output	Financial	1.4
		SN
Advisors of the Chamber of Agriculture	Social	4.3
Literature	Human	2.5
Working group milk	Social	0.0
		PBC
Enough adjacent pasture around the barn	Physical	4.3
Consequent observation of the herd	Physical	0.8
Seasonal calving’s	Physical	0.0
Operational and financial reorganisation does not worth	Financial	0.0
Barriers		A

Trampling damages in the sward with wet weather	Natural	-5.5
Animals are too far away and the animal viewing is insufficient	Natural	-2.7
Fertiliser irregularly distributed on the field surface	Physical	-2.6
Additional combat of cow parasites	Natural	-0.7
		SN
Parents	Social	-2.5
Other farmers	Social	-0.7
		PBC
Steep slopes	Natural	-5.5
Number of animals on the pasture do not fit with the precipitation or weather conditions	Natural	-4.3
Animals have to bridge long distances	Natural	-3.8
Planning safety regarding the upcoming CAP (Common Agricultural Policy) misses	Financial	-3.0
Leads to erosion	Natural	-2.3
Lack of know-how	Human	-2.0
Uncertainty about use of leased land in future	Financial	-1.7
More fixed drinking through for animal care	Physical	-1.5
Fence damages by wild animals	Financial	-1.5
Increased weather dependency	Natural	-1.0
Sinkholes (Sinks on the soil surface. mainly in karst areas)	Natural	-0.8
Low milk prices	Financial	-0.5

Appendix III: Farm survey Belgium (Flanders)

FTZ 4A: arable/specialized crop farms (ENZ7_SL2_TXT3)

BMP: Non-inversion tillage (N=134)

Table 53. Drivers and barriers for arable/specialized crop farms (ENZ7_SL2_TXT3) for BMP: Non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Promotes freezing of remaining potatoes	Natural	4.7
Less erosion	Natural	4.2
Less labour intensive	Human	3.8
Lower use of fuel	Financial	3.8
Increases moisture holding capacity of the soil	Natural	3.7
Increase of soil carbon	Natural	2.6
allows faster sowing	Natural	2.4
Only humus in top layer of soil	Natural	1.3
		SN
Research and experts	Social	1.0
Extension from the province	Social	0.2
Other farmers (arable farmers)	Social	0.1
		PBC
I sow cover crop in august	Human	3.8
Existence of a subsidy for NIT	Financial	1.2
I have a lot of erodible land	Human	1.0
My soil of often too dry under tillage	Natural	0.3
I incorporate cover crops	Human	0.0
Barriers		A
More germination of weeds	Natural	-4.7
Lower yields in bad weather	Financial	-4.1
Higher risk of transfer of crop diseases	Natural	-4.0
Increased use of herbicides	Financial	-3.9
Lower yields in general	Financial	-3.9
Less sure of a good preparation of seedbed	Natural	-3.5
More difficult elimination of weeds	Natural	-3.5
Higher risk of pests	Natural	-3.5
Less good germination of following crop	Natural	-3.5
Less security of a good yield	Financial	-2.7
More damage of soil structure	Natural	-2.6
Less good mix of soil with fertilizers	Natural	-2.5
Esthetical less beautiful fields	Social	-2.3
More nitrate leaching	Natural	-2.1
Drying of the soil is more difficult	Natural	-1.8
		SN
The machine contractor	Social	-2.1
European agricultural policy stimulates NIT	Social	-0.7

Results on experimental fields	Social	-0.5
Flemish Government stimulates NIT	Social	-0.5
Literature	Social	-0.4
Extension from agricultural associations	Social	-0.3
		PBC
Good results with ploughing	Social	-3.7
No appropriate machinery for NIT application	Human	-3.2
Lot of my crops are sensitive to weeds	Human	-2.8
I need to adjust my rotation scheme	Human	-2.2
Contractors (vegetables) want me to plough	Social	-1.6
No experience with NIT	Human	-1.6
My soil is often too wet under tillage	Natural	-1.4
Bad experience with NIT	Human	-1.2
Lot of my crops are cultivated on hills	Human	-1.2
A lot of conditions to obtain the subsidy for NIT	Financial	-1.2
Lot of my crops are vegetables	Human	-1.0
Lot of my crops start from small seeds	Human	-1.0

BMP: Incorporation of straw (N=179)

Table 54. Drivers and barriers for arable/specialized crop farms (ENZ7_SL2_TXT3) for BMP: Incorporation of straw. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil structure	Natural	6.6
Increased soil fertility	Natural	6.2
Good investment for my soil	Natural	6.1
More soil humus	Natural	4.9
Source of potassium to my soil	Natural	4.8
More trace elements in soil	Natural	4.0
Nitrogen is needed to digest the straw	Natural	1.8
		SN
Animal farmers	Social	2.0
		PBC
Hard to maintain humus content of soil (legislation)	Natural	4.3
Straw is not calculated as source of N and P in legislation	Social	2.5
Not easy to find a buyer for straw	Physical	2.0
Straw is often too wet and of bad quality	Natural	0.6
Barriers		A
Additional fuel is needed	Physical	-3.8
Sowing cover crops is difficult	Physical	-1.4
Straw is hard to digest	Natural	-0.6
		SN
Contract worker	Social	-3.6
Other arable farmers	Social	-3.6
		PBC
Good prices for straw	Financial	-4.7

I often use manure	Physical	-3.3
Not allowed to give enough nitrogen to digest straw	Social	-2.8
Increased cost for chopping straw	Financial	-2.1
I prefer to harvest cereals at night	Physical	-1.8
Agreement with animal farmer (straw against manure)	Social	-1.5
Two operations are needed instead of one	Physical	-1.3
Dry matter yield of straw is high on my field	Financial	-0.5
Additional nitrogen is needed to digest straw	Natural	-0.3

BMP: Application of farmyard manure (N=152)

Table 55. Drivers and barriers for arable/specialized crop farms (ENZ7_SL2_TXT3) for BMP: Application of farmyard manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Better soil structure compared to slurry	Natural	6.1
Better soil fertility	Natural	5.8
More soil life	Natural	5.5
Lower erosion risk	Natural	5.4
More organic matter compared to slurry	Natural	5.2
Improved water holding capacity of the soil	Natural	4.6
Higher N supplying capacity of the soil	Natural	3.1
		SN
Animal farmers offer more slurry	Social	1.3
Other arable farmers apply it a lot	Social	0.3
		PBC
Depending on the contractor	Physical	2.1
Working with system of effective nitrogen	Social	1.3
Barriers		A
Less sure on timing and quantity of N release by the soil compared to mineral fertilizer	Natural	-2.3
Less sure on timing and quantity of N release by the soil compared to slurry	Natural	-1.9
		PBC
No appropriate storage capacity on my farm	Physical	-5.3
Transport of farmyard manure is more expensive	Financial	-3.9
Supply of farmyard manure varies	Physical	-3.4
I have to invest time to find a supplier of farmyard manure in another region	Human	-2.5
Homogeneous spread of farmyard manure is not possible	Physical	-1.8
Contractor not available when farmyard manure has to be spread	Physical	-1.8
Appropriate machinery not available	Physical	-1.6
Limited supply of farmyard manure in my area	Physical	-1.4
Slurry is less expensive for me	Financial	-0.8
Farmyard manure has to be stored on the farm	Physical	-0.8
I have to spread manure myself while I do not need to do this for slurry	Human	-0.8

BMP: Application of compost (N=121)

Table 56. Drivers and barriers for arable/specialized crop farms (ENZ7_SL2_TXT3) for BMP: Application of compost. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil fertility	Natural	5.1
Improved soil life	Natural	5.1
Improved soil health	Natural	4.9
Lower erosion risk	Natural	4.7
Increased humus content of soil	Natural	4.3
Obtain less heavy soils	Natural	3.5
Improved long term N release by the soil	Natural	3.1
		SN
Other arable farmers make little use of compost	Social	2.8
I can do animal farmers in area a favour by using their slurry/farmyard manure	Social	1.0
agricultural magazines	Social	0.8
		PBC
I prefer organic fertilizer of animal origin	Natural	0.7
I prefer solid fertilizer compared to liquid	Natural	0.6
Barriers		A
Contains waste products	Natural	-4.5
Higher risk on too high N residue in autumn	Natural	-3.9
More weeds	Natural	-3.7
Higher risk on diseases	Natural	-3.6
Unsure on timing of N release for crop	Natural	-2.4
no homogenous spread	Physical	-1.8
Supply of nitrogen needed to digest compost	Natural	-1.5
		PBC
Low offer of compost	Physical	-4.6
Expensive transport	Financial	-4.5
More expensive compared to other organic fertilizers	Financial	-4.5
No experience with compost	Human	-4.3
Not sure on availability when needed	Physical	-3.9
Not enough knowledge on composition	Human	-3.6
Prices are variable	Financial	-3.5
Slurry is spread for me. compost not	Physical	-3.4
Much variation in quality	Natural	-3.2
Hard to find transporter	Physical	-3.2
No appropriate machinery available for spread	Physical	-2.9
Legislation for fertilization is too strict	Social	-2.8
Manure is easy available to me	Physical	-2.6
More than enough slurry available	Physical	-2.1
Dependent on contractor to spread compost	Physical	-1.5
I incorporate straw	Natural	-0.8

BMP: Cover crops (N=196)

Table 57. Drivers and barriers for arable/specialized crop farms (ENZ7_SL2_TXT3) for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil structure	Natural	6.8
Increased soil health	Natural	6.6
Lower erosion risk	Natural	5.4
Uptake of soil nitrogen	Natural	5.1
More carbon in soil	Natural	4.9
Prevents nitrogen leaching	Natural	4.8
Prevents development of weeds	Natural	4.2
Can be tilled earlier to till in spring	Physical	4.0
		SN
Other arable farmers	Social	3.3
Flemish government stimulates cover crops by providing subsidy	Social	2.3
		PBC
Subsidy compensates cost of cover crops	Financial	4.0
I fertilize as much as is allowed on my parcels	Social	3.9
High risk for too high N residue in autumn	Natural	2.0
I get a subsidy for cover crops	Financial	1.9
Additional fertilization is needed for white mustard	Financial	0.5
Barriers		A
Increased use of herbicides	Financial	-2.1
Might result in more weeds	Natural	-1.9
		SN
Owner of land	Social	-2.1
		PBC
Short time period harvest -sowing (before Sept 1)	Physical	-2.4
No appropriate machinery for incorporation	Physical	-2.0
No appropriate machinery for sowing	Physical	-1.7
Crops are harvested late in autumn	Physical	-1.6
Too much administration to get subsidy	Human	-1.3
Weather conditions are often bad in autumn	Natural	-1.1
Increase of total cost	Financial	-0.8
I sow cover crops before 1st of September to get a subsidy	Physical	-0.7
I grow seed for cover crop myself	Financial	-0.7
Additional labour for incorporating	Human	-0.4
Additional labour for sowing	Human	-0.3

FTZ 6C: dairy farms on sandy soils (ENZ7_SL1_TXT1)

BMP: Non-inversion tillage (N=186)

Table 58. Drivers and barriers for dairy farms on sandy soils (ENZ7_SL1_TXT1) for BMP: Non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Lower use of fuel	Financial	5.0
Less labour intensive	Human	4.3
Reduce of tillage costs	Financial	4.1
Less nitrate leaching	Natural	3.4
Increases moisture holding capacity of the soil	Natural	3.2
Faster germination of following crop	Natural	3.1
Increased effectiveness of the herbicides used	Natural	2.9
More easy preparation of seedbed	Natural	2.6
More attention for good crop protection	Natural	0.1
Higher yields in general	Natural	0.0
		PBC
My parcels are small	Physical	1.9
It’s often very busy when soil is prepared for sowing of maize	Human	0.4
Barriers		A
More weeds	Natural	-5.0
Lower yields in general	Natural	-4.6
Increased use of herbicides	Financial	-4.4
Higher sensitivity of maize to fungi related diseases	Natural	-4.3
Less good rooting of the crop after NIT	Natural	-3.8
Faster germination of weeds	Natural	-3.5
More soil compaction	Natural	-3.5
Less good quality of the harvested crop	Natural	-3.1
less certain of a good yield	Human	-3.1
Esthetical less beautiful fields	Natural	-2.6
		SN
Other farmers	Social	-5.2
Extension	Social	-4.8
The contractor	Social	-4.6
Results on experimental fields	Human	-0.3
		PBC
No appropriate machinery for NIT application	Physical	-4.4
Not enough technical knowledge	Human	-2.6
No experience with NIT	Human	-2.6
Other farmers have not much experience with NIT	Social	-2.2
I prefer to incorporate grass instead of destroying	Physical	-2.0
Bad experience with NIT	Human	-2.0
My soil is often too wet under tillage	Natural	-1.9
Maize is often preceded by Italian rye grass	Physical	-1.9
I do not have enough land to cultivate roughage for my herd	Physical	-1.5
NIT is new to me	Human	-0.6

BMP: Rotation maize-grass (N=189)

Table 59. Drivers and barriers for dairy farms on sandy soils (ENZ7_SL1_TXT1) for BMP: Rotation maize-grass. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Increased soil activity, biology	Natural	5.4
Increased soil fertility	Natural	5.9
Less weeds	Natural	4.8
Increased maize yield after grassland destruction	Financial	5.9
Less fertilization is needed on maize when sown after grassland	Financial	2.7
		PBC
I have mainly large parcels	Physical	1.9
Most of my parcels are drained	Physical	1.1
Barriers		A
Often too high nitrate residue in autumn when grassland is followed by maize	Natural	-4.5
		PBC
Most of the parcels are not close to the farm	Physical	-2.8
Soil texture and quality are more appropriate for grass	Natural	-2.3
Parcels close to the farm are used for grazing	Physical	-0.5
Soil texture and quality are better for maize production	Natural	-0.3

BMP: Cover crops (N=198)

Table 60. Drivers and barriers for dairy farms on sandy soils (ENZ7_SL1_TXT1) for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil fertility	Natural	5.8
More soil humus	Natural	5.8
Grass as cover crop results in additional roughage for my herd	Financial	5.6
Improved root formation of following crop	Natural	5.3
Less nitrate leaching	Natural	5.0
Higher yield of following crop	Natural	4.9
Less erosion	Natural	4.6
Soil is easier to till in spring	Natural	4.4
Reduces soil compaction	Natural	4.4
Less need of N fertilizers	Financial	2.5
		SN
Government	Social	3.3
		PBC
The subsidy for cover crops compensates the cost	Financial	3.4
I get a subsidy for sowing cover crop	Financial	2.4
Soil is hard to till in autumn	Natural	1.7
No derogation applicable on my parcels	Social	0.6
Barriers		A
Increase of total costs	Financial	-1.3
Shorter time period for sowing maize if first cut is taken from graminoid cover crop	Physical	-1.5
More labour	Human	-3.0

Labour peaks	Human	-3.5
Graminoid cover crops (e.g.. ryegrass. rye) results in too dry soil in spring	Natural	-3.8
		SN
Salesman for seeds	Social	-0.2
Other farmers disapprove bare soil in winter	Social	-1.0
The accountant disapproves	Social	-2.6
		PBC
Bad weather in autumn	Natural	-4.1
Seed for cover crop is expensive	Financial	-2.0
My crop is harvested after 15th of October	Physical	-0.9

BMP: Fast sowing of the cover crop (N=198)

Table 61. Drivers and barriers for dairy farms on sandy soils (ENZ7_SL1_TXT1) for BMP: Fast sowing of the cover crop. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Better developed cover crop in spring	Natural	4.5
Higher yield of cover crop	Natural	4.5
Higher uptake of lagging N	Natural	3.3
		PBC
Wet parcels	Natural	2.9
High risk on too high N residues in autumn	Natural	1.0
Labour peaks when cover crops needs to be sowed	Human	0.7
Barriers		A
Higher risk on too high N residue	Natural	-3.9
Italian rye grass might be too well developed before winter has started	Natural	-0.8
Better germination of the cover crop	Natural	-0.7
More difficult to incorporate cover crop	Natural	-0.7
		PBC
Bad weather conditions for sowing cover crop	Natural	-4.3
Appropriate machinery not available	Physical	-2.6
Harvest of maize short before sampling for N residues	Social	-2.0
Damage of soil structure by harvesting maize in wet conditions	Natural	-1.7

BMP: Rotation of maize with grass clover (181)

Table 62. Drivers and barriers for dairy farms on sandy soils (ENZ7_SL1_TXT1) for BMP: Rotation of maize with grass clover. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Less use of mineral fertilizers	Financial	4.2
N fixation	Natural	3.3
More crude protein in grass silage	Natural	2.8
		SN
Government	Social	2.1
		PBC
Derogation is not allowed on grass clover	Social	1.2

Barriers		
Higher costs for crop protection	Financial	-4.4
Higher sensitivity of clover towards some herbicides	Natural	-2.1
Germination of clover is more difficult compared to grass	Natural	-1.3
Disappearance of clover	Natural	-1.2
Lower DM yield of grass clover compared to grass	Natural	-0.9
Local dominance of clover in grass clover	Natural	-0.9
		SN
Adviser (feeds. ration) advises against	Social	-2.2
Adviser (cultivation. crops. soil) advises against	Social	-2.1
Other farmers	Social	-0.7
		PBC
Purchase of feed protein is expensive	Financial	-2.5
Grassland is intensively cultivated on my farm	Physical	-2.5
Positive N balance on my farm	Natural	-2.0
I get a subsidy for cultivation of grass clover	Financial	-1.9
other protein sources with relative good prices are available	Financial	-1.0
No extra support for cultivation of a new crop	Human	-0.6
Not enough land for roughage for my herd	Physical	-0.3

FTZ 5M: mixed farms (vegetables-pigs, ENZ7_SL1_TXT2)

BMP: Application of farmyard manure (N=69)

Table 63. Drivers and barriers for mixed farms (vegetables/pigs, ENZ7_SL1_TXT2) for BMP: Application of farmyard manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil fertility	Natural	6.6
Better soil structure compared to slurry	Natural	6.6
More soil life	Natural	6.5
More humus	Natural	6.4
Only visible long term effects	Natural	6.2
Higher dry matter yield of crops	Financial	5.4
Less marshy soil	Natural	5.3
More loose/aerated soil compared to slurry	Natural	5.2
Contains trace elements	Natural	4.9
Slower availability of nitrogen	Natural	2.5
		PBC
I sow cover crops	Physical	3.7
Manure by cooperation with neighbours	Social	0.8
More labour for spreading	Human	0.3
Barriers		SN
Cattle farmers	Social	-3.2
Contractor	Social	-2.7
Pig farmers	Social	-1.0
		PBC
Enough slurry available	Physical	-3.5
Too much slurry available	Physical	-2.5

Higher cost for spreading	Financial	-1.8
Legislation for fertilization is too strict for my slurry	Social	-1.7
No production of manure on my farm	Physical	-1.5
I have to pay for manure	Financial	-0.9
Depending on contractor for spreading	Financial	-0.9
No appropriate machinery for spreading	Physical	-0.8
I have to pay to get rid of slurry	Financial	-0.8

BMP: Compost (N=61)

Table 64. Drivers and barriers for mixed farms (vegetables/pigs, ENZ7_SL1_TXT2) for BMP: Compost. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil structure	Natural	5.9
Better soil life	Natural	5.5
More humus	Natural	5.3
Better water infiltration and drainage	Natural	5.3
Better soil improver than farmyard	Natural	2.6
		PBC
Vegetables do not need humus	Physical	0.6
Barriers		A
Higher risk for diseases	Natural	-4.7
More labour intensive	Human	-2.1
Faster nutrient release compared to farmyard manure	Natural	-1.9
		SN
Extension	Social	-5.4
Other farmers	Social	-5.3
Producers of compost	Social	-4.5
Education	Social	-4.0
The municipality	Social	-3.6
Experimental results	Social	-1.7
Agricultural magazines	Social	-1.2
		PBC
Too much slurry	Social	-5.8
Don’t know where to get it	Physical	-4.6
Lack of knowledge	Human	-4.5
Compost is expensive	Financial	-4.5
Offer of compost is low	Physical	-4.3
Other alternatives to maintain humus content	Physical	-4.1
Lack of experience	Human	-3.8
No appropriate machinery for spreading	Physical	-3.7
Humus content of my soils is good	Natural	-2.0

BMP: Land exchange (N=101)

Table 65. Drivers and barriers for mixed farms (vegetables/pigs, ENZ7_SL1_TXT2) for BMP: Land exchange. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Higher yields	Financial	6.0
Decreases soil depletion	Natural	5.4
More possibilities for crop rotation	Physical	4.9
Increased balance of soil nutrients	Natural	4.6
Less diseases	Natural	4.5
		SN
Other farmers are not convinced	Social	0.9
		PBC
I have a good relationship with other farmers	Social	1.0
For certain crops. I have to pay for land of other farmers	Financial	0.9
Barriers		A
Less good structure of my soil	Natural	-5.1
Increase of specific weeds	Natural	-3.5
Needs adjustment of rotation scheme	Physical	-0.3
		SN
Dairy farmers are prepared	Social	-1.0
		PBC
Additional source of revenues	Financial	-4.7
My rotation scheme is good	Physical	-4.2
Lot of farmers grow the same crops as I do	Physical	-4.0
I do lots of effort to maintain soil quality of my land	Human	-3.8
pH of land of other farmers is not good	Natural	-3.6
My land is of better quality compared to other farmers	Natural	-3.4
Unsure how other farmers fertilize my land	Human	-3.4
Not often applied in this region	Human	-3.3
Unsure how other farmers will deal with my land	Human	-2.9
Unsure on land quality I get in return	Human	-2.9
Other farmers will not take as good care of my soil as I do	Human	-2.8
I receive land that is further away	Physical	-2.2
I receive poor land in return	Natural	-0.2

BMP: Rotation of vegetables with cereals (N=41)

Table 66. Drivers and barriers for mixed farms (vegetables/pigs, ENZ7_SL1_TXT2) for BMP: Rotation of vegetables with cereals. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Less damage to soil structure	Natural	7.2
Higher yields	Financial	6.6
More humus	Natural	5.8
Easier sowing of cover crop	Physical	5.5
Less heavy soils	Natural	5.1
Prevents erosion	Natural	5.1
Less labour intensive compared to vegetables	Human	2.5
Recovery of the soil	Natural	2.3

More labour intensive than maize	Human	1.4
Decrease of moisture content of soil	Natural	0.2
		SN
Extension	Social	0.8
Agricultural fairs	Social	0.0
		PBC
I apply non inversion tillage on my parcels	Physical	0.1
Barriers		A
Yield of cereals is low	Financial	-4.7
Additional fertilization	Natural	-4.6
Economically less interesting crop	Financial	-2.6
More crop protection	Natural	-2.6
Higher risk on failure with cereals	Financial	-1.4
grain maize residue contains more organic matter	Natural	-0.2
		SN
Seller of seeds	Social	-2.0
Government	Social	-1.7
Other farmers are not convinced	Social	-1.3
My neighbours	Social	-0.1
		PBC
Wet weather conditions	Natural	-5.3
Low prices for cereals	Financial	-4.9
Limited surface area on my farm	Physical	-3.0
Easy access for pigeons	Natural	-3.0
No appropriate machinery to fertilize cereals in spring	Physical	-2.4
Seed is expensive	Financial	-2.4
No experience with cereals	Human	-1.6
No ingredient in pig feed	Physical	-1.3
Mainly vegetables on my farm	Physical	-0.8
Enough organic matter in my soils	Natural	-0.6
No appropriate machinery to incorporate straw	Physical	-0.6
soil quality is not appropriate	Natural	-0.5
Don’t fit in current rotation scheme	Physical	0.0

BMP: Non-inversion tillage (N=117)

Table 67. Drivers and barriers for dairy farms on sandy soils (ENZ7_SL1_TXT1) for BMP: Non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Less fuel	Financial	5.4
Time saving	Human	4.8
Improved soil life	Natural	4.7
More soil humus	Natural	4.6
Improved soil structure	Natural	4.4
Decrease of total cost	Financial	4.3
Faster warm up of soil in spring	Natural	4.1
Less erosion	Natural	3.7
Permits earlier sowing in spring	Physical	3.6

More smooth seedbed	Natural	3.2
Crop can be harvested earlier	Physical	2.7
		SN
Agricultural magazines	Social	1.9
		PBC
I have parcels with high erosion risk	Natural	1.5
A lot of small parcels	Physical	1.5
Barriers		A
More weeds	Natural	-4.9
Lower crop yields	Financial	-4.4
Higher risk on crop diseases	Natural	-4.2
Higher risk on soil compaction	Natural	-4.0
Higher risk on tracks	Natural	-3.9
Less airy soil	Natural	-3.7
Lagging crop residues hamper soil tillage activities	Physical	-3.5
Less good drainage	Natural	-3.3
Increased use of herbicides	Financial	-3.3
Faster germination of weeds	Natural	-2.2
Esthetical less beautiful fields	Social	-1.3
		SN
Contract worker	Social	-4.2
Extension services	Social	-4.2
Other farmers have less good results	Social	-0.7
Experimental results	Social	-0.6
		PBC
Intensive cultivation of vegetables	Physical	-3.9
After harvest. damaged soil structure occurs	Natural	-3.6
Not free of weeds before soil tillage practices	Natural	-3.5
After harvest. substantial amount of weeds remains	Natural	-3.4
After harvest. crop residues often remain	Physical	-3.3
Not well informed on the technique	Human	-2.4
A lot of crops are cultivated on hills	Physical	-2.4
Less dependent on good weather for good result	Natural	-1.9
No experience	Human	-1.7
Weeds are mechanically removed	Physical	-1.7
No appropriate machinery	Physical	-0.8
Not often applied in my surroundings	Human	-0.5

BMP: Cover crops (N=101)

Table 68. Drivers and barriers for dairy farms on sandy soils (ENZ7_SL1_TXT1) for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
More soil humus	Natural	7.1
Better soil structure	Natural	6.3
More airy soil	Natural	6.2
Increased drainage	Natural	5.8
Prevent nitrate leaching	Natural	5.7
Less erosion	Natural	5.6
Permits easier tillage of soil in spring for non-graminoid cover crops	Financial	5.5
Soil is protected in winter	Natural	5.5
Permits earlier tillage of soil in spring for non-graminoid cover crops	Financial	5.5
Increase in crop yields	Financial	5.4
More smooth soil surface in spring	Natural	4.9
Esthetical more beautiful fields during winter	Social	4.8
Lower N residue in autumn	Natural	4.3
Less risk for diseases	Natural	3.7
		SN
Government	Social	2.8
Other farmers	Social	2.8
Extension services	Social	2.7
Research institutions	Social	2.6
Seed salesman	Social	1.4
Agricultural press	Social	0.0
		PBC
I have too chose between many different cover crops	Human	1.8
I get a subsidy	Financial	0.7
No appropriate machinery for sowing cover crops	Physical	0.1
Barriers		A
Increase in total costs	Financial	-4.5
Increased use of herbicides after graminoid cover crops	Financial	-2.3
Soil is longer wet in spring after graminoid cover crops	Natural	-2.3
More weeds in the following crop	Natural	-2.3
More labour on my farm	Human	-2.2
Graminoid cover crops re appear in following crop	Natural	-2.1
		SN
Contract worker	Social	-3.1
		PBC
Weather conditions in autumn are often bad	Natural	-4.1
Lots of administration to get a subsidy	Human	-2.8
Graminoid cover crops need to be destroyed in spring	Physical	-2.0
Too busy when cover crops needs to be sown	Human	-0.7
Black oats are not easy available	Physical	-0.2

Appendix IV: Farm survey France[2]

FTZ 13A: arable farms on Rendzina, Champagne Berichonne (ENZ7_SL2_TXT2); and FTZ 14C: dairy farms on Cambisols and luvisols (long term grassland, ENZ7_SL2_TXT3)

BMP: cover crops (N=16; 17)

Table 69. Drivers and barriers for arable farms on Rendzina, Champagne Berichonne (ENZ7_SL2_TXT2) and dairy farms on Cambisols and luvisols (long term grassland, ENZ7_SL2_TXT3)for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Arable	Dairy
Drivers		A	
better yield for the following crop	Economic		0.1
better yield over the succession	Economic		0.0
decrease herbicide cost	Economic	0.3	
decrease fertilisation cost	Economic	0.5	
helps decreasing irrigation needs	Technical	0.5	
decrease evapotranspiration	Technical	0.3	
decrease weeds pressure	Technical	1.7	0.9
decrease soil borne diseases	Technical	0.8	
easy to implement in existing rotations	Technical	0.8	
facilitates nitrogen fertilisation	Technical		0.7
improves soil biological activity	Environment	5.1	3.1
decreases deep layers compaction	Environment	1.7	
improves top layers porosity	Environment	2.8	2.1
improves soil structure stability	Environment	2.9	2.0
increase organic matter content	Environment	3.7	2.7
mitigates nitrate issues	Environment		2.3
decreases run off	Environment	0.9	2.3
decreases erosion	Environment	2.1	
can be implemented within current contracts	Environment	0.1	
		SN	
Advisors			0.4
		PBC	
soils lack OM on the farm	Environment	1.6	
soils are heterogeneous	Environment	0.4	
managing weeds is difficult on the farm	Environment	0.1	
Barriers		A	
Lower yield for the following crop	Economic	-0.7	
Lower yield over the crop succession	Economic	-0.7	
increase fuel cost	Economic	-1.5	-2.3
increase mechanisation cost	Economic		-2.3

[2] Note: for France, the scaling of A, SN and PBC has not been done the same way as it has been done in the other countries. Attitudes below 8 can be considered as barriers, above as drivers, for A and PBC categories

increase seed cost	Economic	-1.2	-2.7
increase work load	Human	-1.1	-2.3
modifies work organisation	Human	-1.5	-1.0
increase pests	Technical	-0.1	
hard to destroy	Technical	-0.5	
increase erosion	Environment		-0.2
		SN	
Accountants	Social	-2.1	-1.3
Advisors	Social	-1.4	
Family	Social	-1.9	-1.1
Fellow farmers	Social	-1.9	-1.4
		PBC	
lack of available material on the farm	Machinery	-1.8	-0.8
work organisation	Human	-0.9	-0.3
work available	Human	-1.1	-0.7
fields are too scattered to implement the technique	Human	-0.5	-0.9
your crops need irrigation	Human	-0.9	-0.2
difficult access to fields	Human	-0.6	-0.3
rotation prevent implementing the BMP	Human	-1.1	-0.4
soils are eroded	Environment	-1.2	-0.8
soils lack OM	Environment		-1.0
soils are compacted	Environment	-1.8	-1.0
heavy metal contamination	Environment	-0.5	-0.2
soils are heterogeneous	Environment		-1.5
soil borne disease	Environment	-1.5	-0.6
Hydromorphy	Environment	-0.9	-1.0
bad quality	Environment	-2.0	-0.5
managing weeds is difficult on your farm	Environment		-1.0
contracts prevent implementing the BMP	Social	-0.7	-0.2
agri-food requirements prevent	Social	-0.5	-0.2
you can't access relevant formation	Social	-0.7	-0.4
no relevant advice available	Social	-1.0	-0.7
the technique is unknown	Social	-0.9	-0.3

Note: There were not enough despondences to include arable farming on Cambisols in the analysis

FTZ 13A: arable farms on Rendzina, Champagne Berichonne (ENZ7_SL2_TXT2); FTZ 15A: arable farms on Cambisols (ENZ12_SL3_TXT4); and FTZ 14C: dairy farms on Cambisols and luvisols (long term grassland, ENZ7_SL2_TXT3)

BMP: Non-inversion tillage (N=9; 19; 25)

Table 70. Drivers and barriers for arable farms on Rendzina, Champagne Berichonne (ENZ7_SL2_TXT2), arable farms on Cambisols (ENZ12_SL3_TXT4) and dairy farms on Cambisols and luvisols (long term grassland, ENZ7_SL2_TXT3)for BMP: Simplified cultivation techniques. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Arable. Rendzin	Arable. Cambisols	Dairy
Drivers			A	
increase yield over the succession	Economic	0.5	1.5	0.4
decrease fuel cost	Economic	2.9	2.3	1.1
decrease herbicide cost	Economic	1.2		
decrease fertilisation cost	Economic	1.5	2.1	1.1
decrease mechanisation cost	Economic	1.9	1.6	0.5
can be implemented with current material	Machinery	0.3		
decrease work load	Machinery	4.5	2.4	1.6
does not need more irrigation	Technical		0.6	0.1
decrease evapo	Technical	1.9		0.3
decrease soil borne diseases	Technical	0.8	0.3	0.5
does not modify rotations	Technical		0.1	0.1
improves soil biological activity	Environment	7.1	2.8	3.1
decrease deep layers compaction	Environment	3.3	2.0	0.6
improves top layers porosity	Environment	3.6	2.5	0.5
improves soil structure stability	Environment	4.1	3.5	1.7
improves soil homogenisation	Environment	0.9		
increase organic matter content	Environment	4.8	3.3	2.9
decrease run off	Environment	2.5	3.3	0.9
decrease erosion	Environment	5.2	2.9	0.3
no modification of current contracts	Social		1.0	0.5
			PBC	
material available	Machinery		2.6	1.0
work available	Human			0.1
your crops need irrigation	Human		0.3	
soils are eroded	Environment		1.3	
soils lack OM	Environment	2.5	2.7	
soils are compacted	Environment		2.2	
soils are heterogeneous	Environment		0.8	
bad quality	Environment		0.3	
managing weeds is difficult on your farm	Environment		2.3	1.1
you can't access relevant formation	Social		0.2	

no relevant advice available	Social		1.3	
unknown technique	Social		2.1	
Barriers			A	
decrease yield for the following crop	Economic	-1.5	-0.2	-0.2
increase herbicide cost	Economic		-0.4	-0.8
needs a modification of material	Machinery		-0.3	-0.7
modifies work organisation	Machinery	-0.6		-0.5
Increase weeds	Technical		-0.3	-0.4
increase pests pressure	Technical		-0.3	
modifies rotations	Technical	-1.5		
diminishes soil homogenisation	Environment		-0.6	-0.9
needs a modification of current contracts	Social	-1.5		
			SN	
Accountants	Social	-1.6	-1.8	-2.1
Advisors	Social	-0.3	-0.7	-2.0
Family	Social	-0.7	-1.3	-1.3
Fellow farmers	Social	-0.8	-1.6	-1.6
			PBC	
lack available material	Machinery	-0.7		
modifies work organisation	Human	-0.9	-1.8	-1.5
work available	Human	-0.1	-1.1	
fields are too scattered to implement the technique	Human	-1.0	-1.2	-1.7
your crops need irrigation	Human	-0.4		-1.2
difficult access to fields	Human	-0.3	-1.1	-1.3
rotation prevent implementing the BMP	Human	-0.4	-1.2	-1.3
soils are eroded	Environment	-1.2		-1.6
soils lack OM	Environment			-1.8
soils are compacted	Environment	-1.9		-2.0
heavy metal contamination	Environment	-0.2	-0.4	-0.6
soils are heterogeneous	Environment	-1.9		-1.9
soil borne disease	Environment	-1.5	-1.0	-1.5
Hydromorphy	Environment	-1.6	-1.5	-1.7
bad quality	Environment	-1.9		-1.6
managing weeds is difficult on your farm	Environment	-1.9		
contracts prevent implementing the BMP	Social	-0.1	-1.4	-1.1
agri-food requirements prevent the BMP	Social	-0.1	-1.0	-0.9
you can't access relevant formation	Social	-0.7		-1.6
no relevant advice available	Social	-0.5		-1.4
unknown technique	Social	-0.7		-1.8

BMP: No tillage (N=14; 14; 16)

Table 71. Drivers and barriers for arable farms on Rendzina, Champagne Berichonne (ENZ7_SL2_TXT2), arable farms on Cambisols (ENZ12_SL3_TXT4) and dairy farms on Cambisols and luvisols (long term grassland, ENZ7_SL2_TXT3)for BMP: No tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Arable, Rendzina,	Arable, Cambisols	Dairy
Drivers			A	
increase yield over the succession	Economic		0.3	0.3
decrease fuel cost	Economic	3.5	0.7	3.7
decrease fertilisation cost	Economic	1.3	1.7	0.5
decrease mechanisation cost	Economic	0.9	1.7	0.5
decrease work load	Machinery	1.1	1.7	3.9
need less irrigation	Machinery	0.5	0.1	
decrease evapo	Machinery	0.4		1.3
decrease soil borne diseases	Machinery		1.0	
Does not modify rotations	Machinery		0.6	0.1
improves soil biological activity	Environment	6.8	4.2	5.0
decrease deep layers compaction	Environment	0.1	0.5	
improves top layers porosity	Environment	2.1	1.9	2.1
improves soil structure stability	Environment	5.8	2.9	2.6
increase organic matter content	Environment	8.9	4.8	5.0
decrease run off	Environment	0.5	2.6	0.5
prevents erosion	Environment	2.2	3.1	2.2
			PBC	
available material	Machinery	0.1		1.6
soils are eroded	Environment		1.0	
soils lack OM	Environment	1.8	2.4	
soils are compacted	Environment	0.6	0.7	0.1
Barriers			A	
decrease yield for the following crop	Economic	-2.1	-1.4	-0.9
decrease yield over the succession	Economic	-1.1		-0.1
increase herbicide cost	Economic	-0.7	-0.7	-1.3
needs a modification of material	Machinery	-0.7	-2.0	-1.6
modifies work organisation	Machinery	-0.7	-1.4	
need more irrigation	Machinery			-0.7
increase evapo	Machinery		-1.1	
increase weeds	Machinery	-0.3	-1.2	-0.9
increase pests	Machinery	-0.4	-0.1	-0.8
increase soil borne diseases	Machinery			-0.7
modifies rotations	Machinery	-0.7		
increase deep layers compaction	Environment			-0.7
worsens soil heterogenity	Environment	-0.2	-0.6	-2.1
a modification of current contracts	Social	-0.9	-1.9	-0.9

			SN	
accountants	Social	-1.6	-2.1	-1.9
Advisors	Social	-0.6	-1.2	-0.9
Family	Social	-0.7	-0.9	-1.9
Fellow farmers	Social	-0.4	-1.1	-1.2
			PBC	
lack available material	Machinery		-3.6	-2.9
work organisation	Human	-0.2	-2.1	-1.0
work available	Human	-0.6	-1.6	-1.0
fields are too scattered to implement the technique	Human	-1.1	-2.4	-2.3
your crops need irrigation	Human	-1.0	-1.9	-0.6
difficult access to fields	Human	-0.6	-1.4	-0.7
rotation prevent implementing the BMP	Human	-0.8	-1.3	-0.4
soils are compacted	Environment	-1.8	-1.8	-2.2
heavy metal contamination	Environment	-0.5	-1.3	-0.5
soils are heterogeneous	Environment	-1.6	-3.3	-2.2
soil borne disease	Environment		-1.7	-1.2
hydromorphy	Environment	-1.9	-1.4	-2.0
bad quality	Environment	-1.7	-1.9	-1.3
managing weeds is difficult on your farm	Environment	-2.1	-3.2	-3.3
contracts prevent implementing the BMP	Social	-1.1	-2.8	-0.1
agri-food requirements prevent	Social	-0.2	-0.9	-0.6
you can't access relevant formation	Social	-1.1	-1.0	-1.8
no relevant advice available	Social	-1.8	-1.8	-1.4
unknown technique	Social	-0.4	-1.6	-0.8

Appendix V: Farm survey Germany

FTZ 7A: arable and mixed farms on sandy soil (ENZ4_SL1-TXT1)

BMP: Non-inversion tillage (N=72)

Table 72. Drivers and barriers for arable and mixed farms on sandy soil (ENZ4_SL1-TXT1) for BMP: Non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Increased work effectiveness	Human	6.5
Prevention of erosion	Natural	6.4
Support of soil life	Natural	6.3
Better storage of soil moisture	Natural	6.1
Better soil structure	Natural	5.4
Lower use of fuel	Physical	5.2
Prevention of layers of unrotten straw	Natural	4.7
Application of manure in upper 10 cm of the soil	Physical	4.1
More easy employment of unskilled labour	Human	3.8
More vital, strong plants	Natural	3.7
Diversified work	Human	1.8
A complex plant production system	Physical	0.6
		PBC
I have wet soils that require ploughing	Natural	1.4
It is often very dry when we need to work the soil	Natural	0.1
Barriers		A
Difficulties with Elymus repens (quackgrass)	Natural	-6.4
Slow warming up of soil in spring	Natural	-6.3
Higher use of herbicides	Physical	-6.2
Bad conditions for crop emergence	Natural	-6.0
No prevention measures against the corn borer	Natural	-4.6
Worse exterior quality of potatoes	Natural	-4.2
Non-durable machines	Physical	-4.1
Volunteer crops	Natural	-3.9
Lower maize yields	Natural	-3.7
Tearing up stones from bottom to soil surface	Physical	-3.3
Uneven fields	Natural	-2.8
High set up times	Human	-2.1
More use of contractor service	Human	-0.4
		SN
Other farmers	Social	-1.3
Extension	Social	-0.9
		PBC
I cannot do mulch seeding with my machines	Physical	-3.2
Capital is currently not so cheap that one can easily buy machines	Financial	-2.2
My farm size does not allow me to just buy a machine when I want to	Financial	-2.2
Not many of my neighbours successfully apply non-inversion tillage	Social	-2.1

I cannot easily borrow machines	Physical	-1.9
My cover crops often grow very high	Natural	-1.8
Glyphosate is not affordable	Financial	-1.7
I do not have a disc harrow	Physical	-1.6
A cultivator with features I would need is not on the market	Physical	-1.4
I do not have a big tractor	Physical	-1.0
I regularly apply dung on my land	Physical	-0.8
My seeder gets blocked more easily when I apply NIT	Physical	-0.4
With NIT I cannot save costs on my farm	Financial	-0.4

BMP: Cover crops (N=60)

Table 73. Drivers and barriers for arable and mixed farms on sandy soil (ENZ4_SL1-TXT1) for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers	A
Soil fertility	6.1
High humus content in the soil	5.5
Soil erosion	5.5
Provision of food and shelter for the wildlife	4.2
Less storage space for slurry needed	3.7
Dry soil	3.6
Nitrogen and potash leaking	3.0
High water buffering capacity of the soil	0.5
	SN
Water management	1.7
Advisors	0.2
	PBC
The effort for planting a cover crop does not pay off through higher yields in the succeeding crop	1.3
Labour peaks during springtime seeding	0.7
Barriers	SN
Beekeepers	-3.8
Fellow farmers	-2.4
Successor	-1.3
	PBC
Lack of machine endowment for stubble cultivating and seeding of cover crops	-3.2
High precipitation in autumn	-2.9
Without fields that can be irrigated cost-efficiently	-2.5
Impossible to start already during harvest with stubble treatment	-2.1
High cover crops‘ seeds prices	-1.7
No efficient contractor available in the region,	-1.4
Does not fit into the workflow	-1.3
A lot of unevenly spread straw on the fields after threshing	-1.2
Growing maize after sugar beets	-0.9
Higher costs	-0.3
Higher work effort	-0.1

BMP: Crop rotation (N=53)

Table 74. Drivers and barriers for arable and mixed farms on sandy soil (ENZ4_SL1-TXT1) for BMP: Crop rotation. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers	A
Increase soil fertility	5.9
Support soil health	5.4
Avoiding certain problematic weeds	4.9
Securing yield stability of each crop	4.5
Prevention of escalation of pests and diseases	4.4
Yield increase	4.2
Increase soil humus content	4.2
Contribution to a nice looking landscape	3.9
Support of bees	3.8
Breaking labour peaks	2.6
Acceptance of biogas plant increases	1.3
	PBC
Well running workflow	2.3
High cereal prices	0.6
Barriers	A
Considerable higher costs*	-3.9
Low income	-3.4
	SN
Other farmers	-3.3
Agricultural advisory	-3.1
	PBC
Crops that vary widely in respect to their gross margin	-4.3
High land rents	-4.3
No other biomass plants beside maize	-2.5
Having a biogas plant	-2.4
Specialized farm	-2.1
Cultivation on former grassland	-2.0
Needing a lot of straw	-0.8
Only limited market and utilization opportunities for the different crops	-0.4
No exchange of fields with fellow farmers possible	-0.3

FTZ 8A: arable/cereal and mixed farms on sandy soils (ENZ6_SL1_TXT1)

BMP: Cover crops (N=96)

Table 75. Drivers and barriers arable/cereal and mixed farms on sandy soils (ENZ6_SL1_TXT1) for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Reduced nutrient leaching	Natural	7.8
Prevention of erosion	Natural	7.6
Positive influence on humus content	Natural	7.4
Better soil tilth/ crumb structure	Natural	7.3
More nutrients for the succeeding crop	Natural	6.7
Better workability of soil	Physical	5.8
Facilitation of bees	Natural	5.0
Additional fodder for cattle and biogas plants	Natural	2.6
		SN
Training/ studies	Social	4.7
Predecessor/ successor	Social	0.7
Beekeepers	Social	0.6
		PBC
Cover crops do not fit into my crop rotation	Physical	3.5
I have plots to grow maize early in the year	Natural	2.0
Barriers		PBC
No irrigation plots for maize cultivation	Physical	-3.6
I am at the limit with my workforce	Physical	-3.4
Growing cover crops results in labour peaks on my farm	Physical	-3.3
I do not produce seeds for cover crops myself	Physical	-2.8
On my farm it is not profitable to grow lupines and peas	Financial	-2.8
We often have extreme wet conditions/ drought in autumn	Natural	-2.4
My financial situation is not relaxed	Financial	-2.4
I do not grow many summer crops	Physical	-2.3
On my farm harvest is relatively late	Physical	-2.2
No technical solutions for mulch drilling	Physical	-2.1
I am not motivated to prevent fallow fields in winter	Human	-1.9
Prices for cover crops’ seeds are currently high	Financial	-1.8
I cannot combine cover crops with direct drilling	Physical	-1.7
I cannot use cover crops as fodder or in a biogas plant	Physical	-1.7
I have bad experience with cover crops	Human	-1.5
Many cover crops have an early seeding time	Natural	-1.4
Adding organic matter to fields not necessary	Physical	-1.3
Higher workload	Physical	-0.0

BMP: Controlled traffic farming (N=86)

Table 76. Drivers and barriers arable/cereal and mixed farms on sandy soils (ENZ6_SL1_TXT1) for BMP: Controlled traffic farming. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Better root growth	Natural	6.6
Support of soil life	Natural	6.1
Looser soil between machine tracks	Natural	5.5
Higher yields	Natural	5.2
Prevention of subsoil compaction	Natural	5.2
Better water filtration	Natural	5.1
Fuel savings	Physical	4.8
Increase of humus content	Natural	4.2
Straight machine tracks	Physical	3.4
Better trafficability also under wet conditions	Physical	2.8
		SN
Farmers' journals	Social	0.1
Barriers		A
Cemented machine tracks	Natural	-3.2
		SN
Other farmers	Social	-2.9
Machine dealer	Social	-0.6
		PBC
A CTF system would be very expensive for me	Financial	-3.2
My machines do not have the same working width	Physical	-2.4
When I buy new machines I do not pay attention to a uniform working width	Physical	-2.2
The farm manager is old	Human	-1.7
I have a small farm with specialized technique	Physical	-1.7
I have a lot of short-term tenure	Financial	-1.6
I do not work with GPS	Physical	-1.5
I invested a lot in the last years	Financial	-1.1
I do not know any farm where CTF is implemented successfully	Human	-0.5

FTZ 9A: arable/cereal and mixed farms on sandy soils (ENZ6_SL2+SL3_TXT3)

BMP: Non-inversion tillage (N=95)

Table 77. Drivers and barriers for arable/cereal and mixed farms on sandy soils (ENZ6_SL2+SL3_TXT3) for BMP: Non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
High work efficiency	Physical	6.4
Prevention of plough pans	Natural	5.9
Fuel savings	Physical	5.5
Nutrients in upper soil layer	Natural	2.7
		SN
Farmers' journals	Social	1.84
Barriers		A
Uneven fields	Natural	-3.0
Bad soil tilth	Natural	-4.7
Bad conditions for crop emergence	Natural	-5.4
Root and stem diseases	Natural	-5.5
More disease pressure	Natural	-5.5
		SN
Other farmers	Social	-1.2
		PBC
I have wet soils	Natural	-1.4

BMP: Low Soil Pressure Systems (N=93)

Table 78. Drivers and barriers for arable/cereal and mixed farms on sandy soils (ENZ6_SL2+SL3_TXT3) for BMP: Reduced soil compaction. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
More even root penetration	Natural	7.6
Low soil pressure	Natural	7.9
Prevention of soil compaction	Natural	7.7
Fuel savings	Physical	6.1
		SN
Farmers' journals	Social	4.8
Barriers		SN
Other farmers	Social	-1.3
		PBC
I do not have a tire pressure control system	Physical	-4.7
I have to cross villages to reach more than 15 % of my fields	Physical	-4.0
I can reach a lot of my fields only by using streets	Physical	-3.4
Consequent adjustment of tire pressure to field and street results in more work effort on my farm	Physical	-2.8
The price for special tires is very high	Financial	-2.3

The price for a tire pressure control system is very high	Financial	-2.2
Consequent adjustment of tire pressure to field and street delays the operating schedule on my farm	Physical	-1.9
If I use low tire pressure on the field I/ my employees often forget to increase the pressure again for the streets	Human	-1.2

BMP: Cover crops (N=80)

Table 79. Drivers and barriers for arable/cereal and mixed farms on sandy soils (ENZ6_SL2+SL3_TXT3) for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
More active soil life	Natural	8.0
Prevention of erosion	Natural	6.9
Looser and better aerated soil	Natural	6.9
Humus enrichment	Natural	6.5
Better trafficability in autumn	Physical	5.5
Suppression of weed emergence	Natural	5.1
Less nutrient leaching	Natural	5.0
Food and shelter for wildlife	Natural	3.9
Faster warming of soil in spring	Natural	3.4
		PBC
I am selling straw from at least 30 % of my land	Financial	1.9
I do not have the machinery for mulch drilling or can easily borrow it	Physical	0.0
Barriers		A
More fuel use	Financial	-3.2
Higher work effort	Human	-2.7
No winter furrow	Natural	-2.1
		SN
Extension	Social	-1.1
		PBC
I cannot easily incorporate cover crops in spring	Physical	-3.3
I cannot easily try new practices on small plots	Physical	-2.1
I grow rape	Physical	-1.6

BMP: Crop rotation (N=76)

Table 80. Drivers and barriers for arable/cereal and mixed farms on sandy soils (ENZ6_SL2+SL3_TXT3) for BMP: Crop rotation. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Higher yields	Natural	5.9
Maintenance of humus content	Natural	5.4
Mutual facilitation of crops within the crop rotation	Natural	5.3
Breaking of labour peaks	Human	4.7
Food and shelter for wildlife	Natural	3.4
Prevention of nutrient deficiency	Natural	3.1
		PBC
Our crop rotation is quite well established	Human	1.3
Barriers		A
Crops with lower yields	Natural	-2.5
Higher work effort	Human	-2.1
Crops with high demands on weed control	Natural	-0.2
		SN
Extension	Social	-3.3
Predecessor/ successor	Social	-2.9
		PBC
My farm is not organic	Physical	-7.2
I have plots that are far away	Physical	-2.9
I do not have a high range of different market and utilization opportunities for a lot of different crops	Financial	-2.9
I do not have to grow legumes to stabilize yields	Physical	-2.6
I do not have the opportunity of direct marketing	Financial	-2.1
I do not grow legumes	Physical	-1.9
I could not utilize my machines better in a wider crop rotation	Physical	-1.8
I could not utilize my machines better in a changed crop rotation	Physical	-1.5
I have not solved a certain weed problem with crop rotation	Physical	-1.3
I do not have sufficient storage capacity for different crops	Physical	-1.1

Appendix VI: Farm survey Italy

FTZ 16C: dairy cattle/temporary grass (ENZ12_SL1_TXT2,TXT1,TXT3)

BMP: Sprinkler and drip irrigation (N=92)

Table 81. Drivers and barriers for dairy cattle/temporary grass (ENZ12_SL1_TXT2,TXT1,TXT3) for BMP: Sprinkler and drip irrigation. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Higher water use efficiency	Natural	6.1
Higher crop yield	Natural	5.8
No crop water stress	Natural	5.3
Less waterlogging	Natural	5.1
Lower diesel consumption (micro irrig.)	Physical	5.1
Less water consumption	Natural	4.8
Less soil compaction	Natural	4.3
Shorter work in case of pivot	Human	3.3
Less insects (sprinkler)	Natural	2.1
		SN
Sellers of irrigation systems	Social	2.2
Advisors of companies selling production factors	Social	0.8
Advisors of irrigation consortium	Social	0.8
Other farmers	Social	0.4
My family members	Social	0.1
		PBC
High water availability	Natural	1.4
Sandy soils	Natural	0.8
Barriers		A
Higher costs	Financial	-6.8
Higher diesel consumption (sprinkler)	Physical	-4.3
Longer work for self-retracting hose reel	Human	-2.7
		SN
Feed advisor	Social	0.0
		PBC
Small field size	Physical	-0.8

BMP: Green manure (N=91)

Table 82. Drivers and barriers for dairy cattle/temporary grass (ENZ12_SL1_TXT2,TXT1,TXT3) for BMP: Green manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil structure	Natural	6.1
Increase of SOM	Natural	5.8
Less weeds	Natural	5.2
Less inorganic fertiliser used	Physical	4.8
Less nitrogen losses from soil	Natural	4.5

		PBC
Low SOM	Natural	0.8
Bad soil structure	Natural	0.6
Barriers		A
Cost increase	Financial	-7.2
Lower self-production of forage	Natural	-4.2
		SN
Feed advisor	Social	-4.0
Other farmers	Social	-3.6
Advisors of professional organisations	Social	-1.7
Advisors of companies selling production factors	Social	-1.7
Contractors	Social	-1.5
		PBC
Availability of livestock manure	Natural	-2.8
Access to economic incentives for green manure	Financial	-0.3

BMP: Rotation with grass meadows (N=92)

Table 83. Drivers and barriers for dairy cattle/temporary grass (ENZ12_SL1_TXT2,TXT1,TXT3) for BMP: Rotation with grass meadows. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improve soil structure	Natural	5.9
Less insecticide needed	Physical	5.0
Less herbicide needed	Physical	5.0
Improve the ration of dairy cows	Physical	4.9
Better distribution of labour peaks in the farm	Human	4.3
		SN
Other farmers	Social	0.8
Feed advisor	Social	0.8
Advisors of companies selling production factors	Social	0.1
		PBC
High forage prices	Financial	2.5
Economic incentives for cultivating grass meadows	Financial	1.8
Barriers		A
High irrigation amount needed	Natural	-2.7
Cost for meadow cultivation	Financial	-2.2
Meadows have a lower N uptake compared to other crops, and thus limit the possibility to apply livestock manure	Natural	-1.0
		PBC
High selling price of maize	Financial	-2.1
Scarce availability of irrigation water in my farm	Natural	-0.7

BMP: Rotation with legume meadows (N=92)

Table 84. Drivers and barriers for dairy cattle/temporary grass (ENZ12_SL1_TXT2,TXT1,TXT3) for BMP: Rotation with legume meadows. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A

Increase crop yield	Natural	7.4
Increase soil fertility	Natural	6.7
Increase of milk production	Natural	6.4
Improved soil structure	Natural	6.2
Reduction of fertilisers in following crop	Natural	6.0
Less weeds	Natural	6.0
Reduce the cost of protein for the ration, compared to buying it	Natural	5.9
Diversity of forage production	Natural	5.8
High forage production	Natural	5.7
Reduction of insects and pathogens in following crop	Natural	4.4
Better distribution of labour peaks in the farm	Human	4.2
		SN
Feed advisor	Social	2.8
Advisors of producers associations	Social	1.9
Advisors of companies selling production factors	Social	1.0
Other farmers	Social	0.9
		PBC
High cost of soybean	Financial	4.3
Expertise to cultivate alfalfa	Human	4.2
Widespread cultivation of alfalfa in my area	Human	2.4
Scarce irrigation water availability	Natural	1.0

BMP: Crop residue incorporation (N=91

Table 85. Drivers and barriers for dairy cattle/temporary grass (ENZ12_SL1_TXT2,TXT1,TXT3) for BMP: Crop residue incorporation. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improve soil structure	Natural	6.2
Increase crop yield	Natural	5.6
Increase soil organic matter	Natural	4.6
Reduce weeds and fungi in following crop	Natural	2.6
		SN
Advisors of companies selling production factors	Social	2.1
Other farmers	Social	1.9
		PBC
Availability of adequate machinery	Physical	4.9
Access to market of winter cereals straw	Financial	1.2
Lack of knowledge of advantages of incorporation	Human	0.0
Barrier		A
Increase straw requirements at farm scale	Natural	-4.2

BMP: Nutrient management plan (N=91)

Table 86. Drivers and barriers for dairy cattle/temporary grass (ENZ12_SL1_TXT2,TXT1,TXT3) for BMP: Nutrient management plan. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Valorisation of livestock manure	Natural	6.6
Use of the proper fertiliser amount	Natural	6.5
Reduction of fertiliser costs	Financial	6.1
Higher forage quality	Natural	5.9
Higher yield stability	Natural	5.9
Higher livestock health	Natural	5.7
Improved milk quality	Natural	5.4
		SN
Advisors of producers associations	Social	3.9
My family members	Social	3.3
Feed advisor	Social	3.0
Advisors of companies selling production factors	Social	2.9
Other farmers	Social	1.8
		PBC
Legislative limitations to the amount of livestock manure that can be applied	Social	2.5
Low fertiliser prices	Financial	0.3
Barriers		A
Increase of costs due to soil testing	Financial	-2.4
		PBC
Scarce information on the value of livestock manure	Human	-1.7
Lack of an independent service for fertilisation advice	Social	-1.0

FTZ 16A: arable/cereal (ENZ12_SL1_TXT1,TXT2_TXT3)

BMP: Sprinkler and drip irrigation (N=108)

Table 87. Drivers and barriers for arable/cereal (ENZ12_SL1_TXT1,TXT2_TXT3) for BMP: Sprinkler and drip irrigation. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Higher crop yield	Natural	6.9
Drip irrigation allows fertigation	Physical	4.6
Drip irrigation reduces energy and fuel costs	Financial	4.4
Drip irrigation reduces compaction	Natural	4.3
Control of soil water content	Natural	4.2
Drip irrigation reduces crop diseases	Natural	3.7
Reduced leaching	Natural	3.4
Sprinkler irrigation improves vegetation microclimate	Natural	2.9
Sprinkler irrigation washes the plant	Physical	0.7
		SN
Advisors of companies selling production factors	social	2.3
Advisors of companies that withdraw products	social	1.8
Other farmers	social	0.7

		PBC
Sandy soils	Natural	3.2
High water availability	Natural	2.8
High-income crops	Financial	2.6
Barriers		A
Drip irrigation increases operating costs	Financial	-4.1
Sprinkler irrigation causes high initial investments	Financial	-3.1
		PBC
Reduced field size with impediments	Physical	-2.1

BMP: Green manure (N=109)

Table 88. Drivers and barriers for arable/cereal (ENZ12_SL1_TXT1,TXT2_TXT3) for BMP: Green manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Higher soil organic matter	Natural	6.8
Improved soil structure	Natural	6.8
Higher soil nitrogen content	Natural	5.6
Higher crop yield	Natural	5.3
Barriers		SN
Other farmers	Social	-2.2
Advisors of companies selling production factors	Social	-0.8
Advisors of professional organisation	Social	-0.3
Advisors of producer associations	Social	-0.2
		PBC
Additional costs for green manure	Financial	-3.2
No incentives for green manure	Financial	-2.3
I know green manure benefits	Physical	-2.3
Clay soils	Natural	-2.1
I do sod seeding	Physical	-1.0

BMP: Rotation with legume ley crop (N=108)

Table 89. Drivers and barriers for arable/cereal (ENZ12_SL1_TXT1,TXT2_TXT3) for BMP: Rotation with legume ley crop. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Increased soil fertility	Natural	7.5
Higher crop yield	Natural	6.9
Increased soil nitrogen availability	Natural	6.5
Reduced cultivation costs	Financial	5.3
Less weeds	Natural	3.2
Improved farm organisation	Physical	1.8
		SN
Advisors of professional organisations	Social	1.1
Buyers of legume forages	Social	0.9
		PBC
Adequate forage prices	Financial	0.8
Barriers		A

More pests	Natural	-2.8
		SN
Other farmers	Social	-0.9
Advisors of companies selling production factors	Social	-0.1
		PBC
Machineries are expensive	Financial	-3.2
Cereals have high price	Financial	-1.6
Lack of skills to cultivate alfalfa	Physical	-1.4
Legislation subsidises legume meadows cultivation	Financial	-0.6

BMP: Crop residue incorporation (N=114)

Table 90. Drivers and barriers for arable/cereal (ENZ12_SL1_TXT1,TXT2_TXT3) for BMP: Crop residue incorporation. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil structure	Natural	7.2
Higher soil organic matter	Natural	6.8
Reduced use of mineral fertilisers	Physical	5.1
Increased protein content in wheat grain	Natural	2.3
Gain through crop residues sale	Financial	1.2
Slow decomposition of crop residues in soil	Natural	0.5
		SN
Advisors of companies selling production factors	Social	3.0
Other farmers	Social	2.4
		PBC
Crop residues burn is forbidden	Social	4.7
Barriers		A
Increased risk of fungal diseases	Natural	-4.4
Increased nitrogen fertiliser use	Physical	-2.3
		SN
Farm that collect crop residues	Social	-0.4
		PBC
Adverse environmental conditions that hinder residues degradation	Natural	-2.3
Residues selling at a high price	Financial	-2.0

BMP: Application of farmyard manure, compost and sewage sludge (N=106)

Table 91. Drivers and barriers for arable/cereal (ENZ12_SL1_TXT1,TXT2_TXT3) for BMP: Application of farmyard manure, compost and sewage sludge. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Increased soil fertility	Natural	8.1
Improved soil structure	Natural	7.7
Higher soil organic matter	Natural	7.3
Reduced use of mineral fertilisers	Physical	7.1
Slow release of nutrients	Natural	3.0
		SN
Advisors of professional organisation	Social	3.7

Other farmers	Social	2.5
Advisors of companies selling production factors	Social	2.4
Barriers		A
Slow and expensive distribution	Financial	-4.2
		PBC
Lack of confidence in the compost and sludge quality	Social	-4.9
Manure is not available in the neighbouring farms	Physical	-3.7
The law imposes limits on manure transport	Physical	-3.2
Expensive purchase and distribution	Financial	-2.8
Legislation reduces the incentive to use	Financial	-2.5

BMP: Non-inversion tillage (N=112)

Table 92. Drivers and barriers for arable/cereal (ENZ12_SL1_TXT1,TXT2_TXT3) for BMP: Non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Lower cultivation costs than in CT	Financial	7.2
Improved timeliness of tillage compared to CT	Physical	5.4
Less working time than in CT	Physical	5.3
Similar crop yield to CT	Natural	3.9
		SN
Sellers and manufacturers of agricultural machineries	Social	0.6
Advisors of professional organisations	Social	0.2
Barriers		A
More weeds than in CT	Natural	-6.2
Accentuated waterlogging	Natural	-4.6
		SN
Other farmers	Social	-1.6
Contractors	Social	-0.7
		PBC
Clay soil	Natural	-1.2
Heavy rainfall	Natural	-1.2

BMP: No tillage (N=105)

Table 93. Drivers and barriers for arable/cereal (ENZ12_SL1_TXT1,TXT2_TXT3) for BMP: No tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Lower cultivation costs	Financial	7.1
Improved timeliness of tillage	Physical	5.4
Increased soil organic matter	Natural	4.4
Increased soil biological activity	Natural	3.6
Similar crop yield	Natural	2.2
Increased soil water retention	Natural	1.0
		SN
Information from technical journals	Social	0.4
Barriers		A
More weeds	Natural	-6.5

Lower crop yield	Natural	-6.2
		SN
Other farmers	Social	-2.3
Contractors	Social	-1.4
Advisors of companies selling production factors	Social	-1.3
Advisors of professional organisation	Social	-1.3
Sellers and manufacturers of agricultural machineries	Social	-0.4
		PBC
Expensive machineries	Financial	-5.0
Lack of skills to do sod seeding	Physical	-3.2
Lack of machineries market	Financial	-2.6
Clay soils	Natural	-2.2
Nice-looking field	Physical	-1.5
Wheat monoculture	Physical	-0.5
Low fuel price	Financial	-0.2

FTZ 17A: arable/cereal (ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3)

BMP: Green manure (92)

Table 94. Drivers and barriers for arable/cereal (ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3) for BMP: Green manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improved soil structure	Natural	6.3
Higher soil organic matter	Natural	6.0
Reduced use of mineral fertilisers	Physical	5.4
Increased protein content in following crop	Natural	4.1
Reduced erosion	Natural	3.3
		PBC
I have incentives for green manure	Financial	2.0
Cultivation contracts that remunerate high protein content	Financial	1.7
Barriers		A
Higher cultivation costs	Financial	-4.6
Green manure depletes the soil water content	Natural	-1.8
		SN
Other farmers	Social	-2.3
Family members	Social	-2.0
Advisors of companies selling production factors	Social	-1.0
Advisors of producer associations	Social	-0.6
		PBC
Lack of adequate machineries	Physical	-2.3
Low prices of mineral fertilisers	Financial	-1.2
Clay soils	Natural	-0.4

BMP: Crop residue incorporation (93)

Table 95. Drivers and barriers for arable/cereal (ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3) for BMP: Crop residue incorporation. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Increased soil fertility	Natural	6.7
Improved soil structure	Natural	6.4
Higher soil organic matter	Natural	6.2
		SN
Advisors of producer association	Social	2.3
Family members	Social	1.5
Other farmers	Social	1.3
		PBC
I have adequate machineries	Physical	5.0
Legislation forbids crop residues burning	Social	4.2
Incorporation is important	Social	3.6
Crop residues given for free	Financial	0.2
Barriers		A
More weeds, pests and diseases	Natural	-3.8
Increased nitrogen fertiliser use	Physical	-3.9
Following crop sowing hindered by residues	Physical	-3.9
Loss of income if residues are not sold	Financial	-3.9
		PBC
Residues chopping and distribution is expensive	Financial	-2.5
Crop residue sale is possible	Financial	-1.9
High price of crop residues	Financial	-1.8

BMP: Application of farmyard manure, compost and sewage sludge (N=90)

Table 96. Drivers and barriers for arable/cereal (ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3) for BMP: Application of farmyard manure, compost and sewage sludge. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Increased soil fertility	Natural	7.4
Improved soil structure	Natural	6.8
Higher soil organic matter	Natural	6.7
Reduced use of mineral fertilisers	Physical	6.0
		SN
Other farmers	Social	1.6
Neighbouring farmers	Social	1.2
Advisors of companies selling production factors	Social	0.4
Public administration	Social	0.2
Barriers		A
Unpleasant odours emission	Physical	-4.6
Higher cultivation costs	Financial	-4.4
Increased time spent for fertilisation operation	Physical	-3.5
		PBC
FYM transport is expensive	Financial	-5.5
I do not have neighbours with excess manure	Physical	-4.5

Lack of adequate machineries	Physical	-4.1
No incentives for FYM	Financial	-3.7
Legislation that limits odour emissions	Social	-3.4
I do not trust sludge and compost composition	Social	-3.4
I have cultivation contracts which reward cereal quality	Financial	-1.1
Low prices of fertilisers	Financial	-1.0

BMP: Non-inversion tillage (N=94)

Table 97. Drivers and barriers for arable/cereal (ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3) for BMP: Non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Lower cultivation cost	Financial	6.5
Reduced working time	Physical	6.2
Reduced risk of waterlogging	Natural	3.3
Higher crop yield	Natural	2.9
Earlier crop emergence	Natural	0.9
		SN
Sellers and manufacturers of agricultural machineries	Social	0.4
Information during technical visit	Social	0.3
Advisors of companies selling production factors	Social	0.1
Family members	Social	0.0
Barriers		A
Reduced crop yield	Natural	-5.2
More weeds	Natural	-5.1
Reduced soil water retention	Natural	-2.5
		SN
Other farmers	Social	-0.8
		PBC
Clay soils	Natural	-2.5

BMP: No tillage (N=90)

Table 98. Drivers and barriers for arable/cereal (ENZ12_SL3_TXT2; ENZ12_SL4_TXT2,TXT3) for BMP: No tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Reduced working time	Technical	6.5
Lower cultivation costs	Financial	6.5
Improved soil structure	Natural	4.7
Higher crop yield	Natural	2.6
Reduced waterlogging risk	Natural	2.1
		PBC
Scarce farm labour	Technical	2.7
Barriers		A
More weeds	Natural	-6.0
Lower crop yield	Natural	-5.8
Increased wheat diseases	Natural	-5.4
Less levelled soil	Natural	-3.8

		SN
Family members	Social	-2.8
Other farmers	Social	-2.6
Companies buying the product	Social	-1.6
Professional organisation	Social	-0.7
Advisors of producers association	Social	-0.6
Manufacturers of agricultural machineries	Social	-0.5
Information from technical journals	Social	-0.2
Information from technical visits	Social	-0.2
		PBC
Lack of adequate machineries	Technical	-5.3
Clay soils	Natural	-3.3

Appendix VII: Farm survey Poland

FTZ 21A: arable farms (ENZ6_SL2_TXT3); FTZ 22M mixed farming (ENZ6_SL2_TXT1); and FTZ 23C: dairy cattle (ENZ6_SL1_TXT1)

BMP: Reduced tillage (N=93; 68; 140)

Table 99. Drivers and barriers for arable farms (ENZ6_SL2_TXT3), mixed farming (ENZ6_SL2_TXT1) and dairy cattle (ENZ6_SL1_TXT1) for BMP: Reduced tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Arable	Mixed	Dairy
Drivers			A	
Lower fuel use	Financial	4.8	4.2	3.9
Lower labour input	Human	4.8	3.9	3.9
Lower financial costs	Financial	4.6	2.9	2.7
Less agricultural practices	Financial	4.4	3.6	4.0
Limits water losses	Natural	3.0	1.8	2.4
Increase organic matter in the soil	Natural	2.2	1.5	3.9
Higher nitrogen content in the top layer	Natural	1.8	1.8	1.7
Better soil structure	Natural	1.1	0.6	0.6
			SN	
Advisors	Social	1.8	0.6	0.0
Results on experimental fields	Human	1.0	0.0	0.0
Other farmers	Social	0.1	0.0	0.0
			PBC	
No experience with RT	Human	0.1	0.0	0.0
Barriers		A	A	A
Lower yields	Financial	-1.9	-2.1	-1.9
Increase crop protection	Financial	-4.1	-4.0	-3.3
Increase weeds	Natural	-4.2	-4.0	-3.3
			SN	
Other farmers	Social		-1.1	-1.9
Results on experimental fields	Human		-0.1	-1.4
Advisors	Social			-0.04
			PBC	
No appropriate machinery for RT application	Physical	-4.6	-4.7	-5.9
Not enough technical knowledge	Human	-2.3	-2.8	-3.3
No experience with RT	Human		-0.8	-1.9

BMP: Cover crops (N=93; 68; 140)

Table 100. Drivers and barriers for arable farms (ENZ6_SL2_TXT3), mixed farming (ENZ6_SL2_TXT1) and dairy cattle (ENZ6_SL1_TXT1) for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Arable	Mixed	Dairy
Drivers			A	
Higher nitrogen content in the soil	Natural	5.3	4.5	3.9

Better soil structure	Natural	6.0	5.5	4.7
Increase organic matter in the soil	Natural	5.8	5.8	4.8
Prevent erosion	Natural	6.2	6.0	4.6
Better soil phytosanitary conditions	Natural	4.8	5.0	0.0
Improves biologic activity of top layer	Natural	3.7	3.9	0.0
Higher cereal yields	Financial	5.5	4.1	0.0
Lower fertilization costs	Financial	5.4	4.6	3.7
			SN	
Results on experimental fields	Human	2.8	3.0	2.4
Advisors	Social	4.5	5.3	4.4
Other farmers	Social	1.2	1.9	1.5
			PBC	
No experience with GM	Human	1.1	0.8	0.0
Barriers		PBC	PBC	PBC
Not enough technical knowledge	Human	-0.7	-0.3	-1.1

BMP: Incorporation of straw (N=93; 68; 140)

Table 101. Drivers and barriers for arable farms (ENZ6_SL2_TXT3), mixed farming (ENZ6_SL2_TXT1) and dairy cattle (ENZ6_SL1_TXT1) for BMP: Incorporation of straw. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Arable	Mixed	Dairy
Drivers			A	
Better soil structure	Natural	6.4	3.8	3.3
Faster decomposition of straw with extra dose of nitrogen	Natural	6.0	4.9	3.8
Additional source of nutrients	Natural	6.0	4.9	3.3
Prevent erosion	Natural	5.0	2.3	3.2
Reduce water losses	Natural	2.7	2.1	2.0
Inhibition of seed germination	Natural			1.5
Inhibition of weeds development	Natural		1.0	0.6
Increase development of fungal diseases	Natural			
Higher mechanization costs	Financial			
			SN	
Results on experimental fields	Human	4.3	1.9	
Other farmers	Social	1.8	1.0	
Advisors	Social	4.9	2.5	
			PBC	
Large market for straw	Financial	1.3	-0.7	2.4
Additional income	Financial	2.9	2.1	2.3
Barriers			A	
Higher mechanization costs	Financial	-2.2	-1.4	-0.6
Increase development of fungal diseases	Natural	-1.1	-2.1	-2.2
Inhibition of seed germination	Natural	-0.7	-1.2	
Inhibition of weeds development	Natural	0.0		
			SN	
Results on experimental fields	Human			-1.8
Other farmers	Social			-1.7
Advisors	Social			-1.2

FTZ 22M: mixed farming (ENZ6_SL2_TXT1) and FTZ 23C: dairy cattle (ENZ6_SL1_TXT1)

BMP: Nutrient management plan (N=62; 136)

Table 102. Drivers and barriers for mixed farming (ENZ6_SL2_TXT1) and dairy cattle (ENZ6_SL1_TXT1) for BMP: Nutrient management plan. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Mixed	Dairy
Drivers		A	A
Good tool to determine the appropriate doses of fertilizers	Financial	5.1	5.3
Calculate nutrient in FYM	Financial	4.5	4.7
Lower fertilization costs	Financial	4.1	5.1
Increase efficiency use of N and P	Natural	4.1	4.7
Lower acidification of the soil	Natural	3.6	1.3
		SN	SN
Advisors	Social	2.5	4.5
Results on experimental fields	Human	1.7	2.5
Other farmers	Social	1.4	1.4
		PBC	PBC
Assistance of advisor	Social	5.7	2.1
Preparation of NMP	Human	3.2	3.5

Appendix VIII: Farm survey Spain

FTZ 10A: Arable farms with cereals (ENZ13_SL1, SL2, SL3, SL4_TXT4)

BMP: Crop rotation (N=96)

Table 103. Drivers and barriers for arable farms with cereals (ENZ13_SL1, SL2, SL3, SL4_TXT4) for BMP: Crop rotation. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Pests, diseases and weeds are better controlled	Natural	4.7
It enhances the storage of nutrients within the soil	Natural	4.4
Environmental quality is improved	Natural	4.1
Benefits and profitability improve	Financial	3.3
Fertilization is reduced	Physical	2.9
Crop rotations reduce the economic risk	Financial	1.9
Pests, diseases and weeds are worse controlled	Natural	0.0
		SN
Farmers associations	Social	2.9
Other farmers and neighbours	Social	1.8
Government	Social	0.2
		PBC
Traditionally fallow is not well seen	Social	2.0
The CAP establish which management practices farmers have to do	Financial	1.4
Crop rotations are defined by the available subsidies	Financial	0.5
Farmers need training	Human	0.3
Barriers		A
Benefits and profitability are reduced	Financial	-1.6
Fallow does not produce any benefits	Financial	-0.9
		PBC
Assessment on markets and profitable crops is needed	Human	-1.6
Weather conditions are very variable	Natural	-1.1
Farmers do not have the proper machinery	Physical	-1.1
More general information is required	Human	-0.9
It is difficult to sell the product when there is surplus	Financial	-0.4

BMP: Direct drilling (N=94)

Table 104. Drivers and barriers for arable farms with cereals (ENZ13_SL1, SL2, SL3, SL4_TXT4) for BMP: Direct drilling. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Reduces soil loss	Natural	4.6
Saves up fuel	Physical	4.6
Saves up time	Physical	4.4
Organic matter and nutrients improvement	Natural	3.7
Less contamination	Physical	3.6
Soil moisture is improved	Natural	3.5
Reduces runoff	Natural	3.3

Enhances biodiversity and soil quality	Natural	3.1
More herbicides are required	Physical	2.0
More pests and diseases	Natural	1.0
Efficiency of fertilization is maintained	Physical	1.0
Higher soil compaction	Natural	0.5
Some operations in the farm are more complicated	Physical	0.3
		SN
Technicians	Social	2.0
Farmers associations	Social	1.9
Universities and research centres	Social	1.8
Other farmers and neighbours	Social	1.0
Barriers		PBC
Strong investment in machinery	Physical	-3.3
Information and training is demanded	Human	-2.6
High clay content	Natural	-1.2
People think that the farm is abandoned	Social	-0.6
This practice is not well established	Physical	-0.4
Lack of subsidies	Financial	-0.2
The available machinery do not work well	Physical	-0.1

BMP: Controlled traffic farming (N=93)

Table 105. Drivers and barriers for arable farms with cereals (ENZ13_SL1, SL2, SL3, SL4_TXT4) for BMP: Controlled traffic farming. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
In general terms, it reduces soil compaction	Natural	3.2
It makes easier some operations carried out in the farm	Physical	3.1
Crop yield increases	Natural	2.2
		SN
Technicians	Social	2.9
Other farmers and neighbours	Social	1.5
Barriers		A
Crop are not able to grow properly because of the wheel tracks	Natural	-1.1
More runoff is observed trough the wheel tracks	Natural	-0.7
		PBC
There is not enough subsidies	Financial	-3.2
Width machinery is not normalized	Physical	-2.5
It is not easy to control the traffic when using trailers and harvesters	Physical	-1.5
The characteristics of my farm are not compatible with the controlled traffic	Natural	-0.2
It is hard to make people follow the same tracks	Human	-0.2

FTZ 11P: Permanent crop farms (olive and fruit trees, vineyards, ENZ13_SL2,SL3,SL4_TXT3)

BMP: Minimum tillage (151)

Table 106. Drivers and barriers for permanent crop farms (olive and fruit trees, vineyards, ENZ13_SL2,SL3,SL4_TXT3) for BMP: Minimum tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Water infiltration is improved	Natural	2.1
It saves up money	Financial	1.6
It reduces soil consolidation	Natural	1.4
		SN
Technicians	Social	3.0
Farmers associations	Social	2.1
Other farmers	Social	0.8
Neighbours and relatives	Social	0.4
		PBC
Not compatible with cover crops	Human	0.1
Changing weather conditions	Natural	0.0
Farm design	Natural	0.0
Barrier		A
Top roots are damaged	Physical	-1.4
It enhances diseases	Natural	-1.3
It increases soil loss	Natural	-1.2
Operations in the farm are more difficult	Physical	-0.9
Herbicides are reduced	Physical	-0.8
It increases runoff	Natural	-0.7
		SN
Salespeople	Social	-0.5
		PBC
Lack of subsidies and economical support	Financial	-1.9
There is no adequate machinery	Physical	-1.4
Steep slopes	Natural	-1.1
Many stones in the farm	Natural	-1.0
High amount of clay	Natural	-0.6
Local traditions	Social	-0.2

BMP: Cover crops (N=150)

Table 107. Drivers and barriers for permanent crop farms (olive and fruit trees, vineyards, ENZ13_SL2,SL3,SL4_TXT3) for BMP: Cover crops. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Controls soil erosion	Physical	4.9
Improves water retention	Natural	4.9
Improves soil properties	Natural	3.4
Competes with the main crop	Natural	0.8
It reduces the use of pesticides	Physical	0.6

		SN
Technicians	Social	2.8
Associations of farmers	Social	2.1
Salespeople	Social	0.9
Neighbours/relatives	Social	0.3
Other farmers	Social	0.1
Barriers		A
Increases contamination	Physical	-2.0
Enhances pests and diseases	Natural	-0.4
Harvesting is more complicated	Physical	-0.1
		PBC
Traditions of the region	Social	-1.9
Lack of subsidies	Financial	-1.8
More research in cover crops	Human	-1.4
Bare soils for a long time	Natural	-1.1
Technical limitations	Physical	-0.9
Risk of fire	Human	-0.7
The cost of maintenance	Financial	-0.5
Steep slopes in the farm	Natural	-0.3
Clay soils in farms	Natural	-0.2

FTZ 12C: Mixed farms known as Dehesa (sheep, pigs and beef and permanent grass, ENZ12_SL2,SL3,SL4_TXT2; ENZ13_SL3_TXT1; ENZ13_SL2,SL3,SL4,SL5_TXT2)

BMP: Light tillage (N=101)

Table 108. Drivers and barriers for permanent crop farms (olive and fruit trees, vineyards, ENZ13_SL2,SL3,SL4_TXT3) for BMP: Light tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Good for controlling shrubs and weeds	Physical	3.2
Enhances the maintenance of soil quality	Natural	2.6
Higher yields	Natural	2.6
Increases soil porosity	Natural	2.6
Improves the retention of nutrients and water	Natural	2.4
Reduction of water retention capacity	Natural	2.0
Damage to roots is lower	Physical	1.9
It increases organic matter and fertility	Natural	1.9
Improves aggregates structure	Natural	1.5
Contamination decreases because CO2 emissions are lower	Physical	1.3
It saves up money	Financial	1.1
Enhances the development of a plough sole	Natural	0.4
		SN
Technicians from some associations	Social	3.4
Other farmers and neighbours	Social	1.4
University and research institutes	Social	0.7
Government	Social	0.2

		PBC
The size of the farm is small	Natural	0.3
Barriers		A
Water retention capacity is reduced	Natural	-0.8
Increases soil compaction	Natural	-0.6
Contamination increases because more herbicides are required	Physical	-0.5
There are more gullies and soil loss	Natural	-0.5
More runoff	Natural	-0.4
Is not helpful for controlling shrubs and weeds	Natural	-0.1
		PBC
There are no subsidies for preserving soil conservation	Financial	-3.6
The slope of the farm is high	Natural	-2.4
The farm has a high % of stones	Natural	-2.1
Organic farming is not compatible	Human	-1.4
It is difficult to reduce costs if tillage is necessary	Physical	-0.7
The legislation of these farms is very restrictive	Social	-0.7

BMP: Pastoral plan (N=89)

Table 109. Drivers and barriers for permanent crop farms (olive and fruit trees, vineyards, ENZ13_SL2,SL3,SL4_TXT3) for BMP: Pastoral plan. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
It improves the natural resources management	Natural	2.3
The organization of the operations and management of the farm is improved	Physical	2.2
It improves the livestock management	Natural	2.2
It helps to correct wrong management operations carried out in the past	Physical	2.1
The pastoral plan establish guidelines that prevent from changing criteria	Human	1.7
The pastoral plan involves a financial outlay that does not compensate	Financial	1.7
The pastoral plan increases the profitability and the productivity of the farm	Financial	1.6
		SN
Technicians from some associations	Social	3.2
Other farmers and neighbours	Social	1.4
University and research institutes	Social	1.2
Government	Social	0.3
		PBC
The size of my farm is very small	Natural	0.3
Barriers		A
The pastoral plan is rigid	Physical	-0.1
		PBC
There are not enough subsidies for implementing a pastoral plan	Financial	-3.4
Prices and markets varies significantly from one year to another	Financial	-2.9
The weather conditions differ from one year to another	Natural	-2.8
The technicians that develop the pastoral plan do not know the farm	Human	-2.2

properly		
It is difficult to have a pastoral plan because of the bureaucracy it involves	Social	-0.8
More information about the management of the farms is needed	Human	-0.8

Appendix IX: Farm survey The Netherlands

FTZ 20C: Dairy farms on sandy soils (ENZ7_TXT1_SL1)

BMP: Non-inversion tillage (N=101)

Table 110. Drivers and barriers for dairy farms on sandy soils (ENZ7_TXT0_SL1) for BMP: Non-inversion tillage (NIT). A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
NIT better for soil fauna than ploughing	Natural	7.2
NIT increases o.m. in top soil	Natural	7.1
NIT saves time compared to ploughing	Human	6.8
NIT cheaper than ploughing	Financial	6.7
NIT increases o.m. content of the soil	Natural	6.2
NIT improves physical quality of soil	Natural	5.8
		SN
Research is positive on NIT	Human	2.5
		PBC
I use mechanical weed control	Physical	0.3
Barriers		A
NIT increases weed pressure	Natural	-7.2
NIT increases pesticide use	Financial	-6.4
NIT increases the risk on diseases	Natural	-6.3
With NIT more impermeable soil layers form	Natural	-5.2
		SN
Neighbours with whom I collaborate favour NIT	Social	-0.5
Other farmers are positive on NIT	Social	-0.4
Focus group is positive	Social	-0.1
		PBC
Yields are lower	Natural	-4.1
No financial benefits when using NIT	Financial	-2.9
I have to plough to incorporate a non-hardy green manure correctly	Physical	-1.6
Unsolvable weed problem	Human	-1.3
Contractor does not have right equipment	Human	-1.1

BMP: Rotation grass-maize (N=46)

Table 111. Drivers and barriers for dairy farms on sandy soils (ENZ7_TXT0_SL1) for BMP: Rotation grass-maize. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
The rotation of grass-maize favours yields of both crops	Financial	8.1
The rotation of grass-maize improves the quality of the fodder	Financial	7.3
Regular resowing of grass improves the sod	Natural	6.7
With the rotation of grass-maize you have less soil diseases	Natural	6.1
With a rotation of grass-maize I can establish the sod in August	Natural	4.4
		SN
Arable farmers like to engaged in grass-maize rotations	Social	4.4
Projects like Cows and Chances favour grass-maize rotations	Social	3.3

Extension agents favour grass-maize rotations	Social	3.0
Other dairy farmers are positive on rotation of grass-maize	Social	2.3
		PBC
My costs for feed continuously increase	Financial	2.0
The rotation of grass-maize requires a lot of organization	Human	1.8
I have fields at large distances	Natural	1.7
I feed my cattle in the stables	Physical	1.4
To grow grass I need an irrigation system	Financial	1.4
Rotation grass-maize on wet fields needs investment in drainage	Financial	1.0
My fields are difficult to visit	Physical	0.8
Barriers		A
Harvesting maize when fields are very wet causes physical damage to the soil	Natural	-9.0
Costs of ploughing and the establishment of the sod are high	Financial	-6.2
The rotation of grass-maize decreases soil organic matter content	Natural	-4.9
When practicing rotation of grass-maize pesticide use increases	Financial	-3.6
Yields are lower when resowing the sod	Financial	-3.6
The protein content is low in the first year of resowing the sod	Financial	-3.0
		PBC
I have continuous grass on wet fields	Natural	-2.6
Standard application of N for grass too low to establish the sod	Natural	-0.6
The derogation is too strict to rotate grass-maize	Social	-0.1

BMP: Undersowing a green manure in maize (N=49)

Table 112. Drivers and barriers for dairy farms on sandy soils (ENZ7_TXT0_SL1) for BMP: Undersowing a green manure in maize. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Improve nutrient efficiency	Natural	6.8
Increases the N-availability to the following crop	Financial	6.7
Organic matter increase	Natural	6.3
Improves soil strength to the heavy machinery	Natural	5.9
When undersowing the green manure no trip on the field after harvest is necessary	Human	4.8
Immobilization of nitrogen	Natural	4.8
		SN
Projects like Cows and Chances	Social	2.5
Agricultural agencies	Social	1.3
		PBC
The manure law decreases soil fertility	Natural	0.0
Barriers		A
When undersowing fails double costs	Financial	-6.7
Competes on nutrients and water with maize	Natural	-4.9
More expensive than sowing after harvest	Financial	-4.0
The undersown green manure is harvested with the maize and ends up in the silage	Financial	-0.3
		SN
Other dairy farmers	Social	-0.6

		PBC
Undersowing a green manure in maize requires an additional trip through the maize	Human	-2.4
For the harvest of the green manure in the spring I need a good stand	Human	-2.3
Undersowing a green manure in maize has not yet been tested sufficiently in practice	Human	-1.9
The contractor does not have the right equipment to undersow a green manure in maize	Physical	-1.8
Undersowing a green manure in maize requires an additional trip through the maize	Human	-1.2
None of my neighbours tried to sow a green manure in the maize crop	Social	-1.2
I do not have the knowledge to sow the green manure in maize	Human	-1.1
The success rate of undersowing a green manure in maize is unknown	Human	-1.0

BMP: Early harvest of maize in favour of green manure (N=51)

Table 113. Drivers and barriers for dairy farms on sandy soils (ENZ7_TXT0_SL1) for BMP: Early harvest of maize in favour of green manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
A good green manure produces more organic matter	Natural	8.8
Early harvest of maize improves green manures	Natural	7.2
Early harvest of maize facilitates reestablishment of the grass sod	Natural	7.0
I need high yields in order to be self-sufficient for my fodder	Financial	6.7
A good green manure immobilizes more nitrogen	Natural	6.6
		SN
Civil servants like an early harvest of maize so a successful green manure can be cropped	Social	0.5
		PBC
Sometimes I want to establish a sod after maize	Human	4.6
Some of my fields suffer from wet conditions during maize harvest	Natural	4.0
An early harvest and warm weather during silage coincide	Natural	2.3
A high yield is possible by sowing maize under plastic	Financial	1.5
Barriers		
Early harvest of maize lowers yields	Financial	-8.3
Early harvest reduces the quality of the maize	Financial	-7.2
Early cultivars yield less	Financial	-3.0
		SN
Other dairy farmers favour the early harvest of maize	Social	-4.2
The contractor favours a late harvest of maize	Human	-3.0
Salesmen from seed companies are positive about the early harvest of maize	Social	-0.2
		PBC
I do not get reimbursed for early harvesting my maize	Financial	-5.9
I do not get additional N-quota when I crop a green manure after maize harvest	Social	-5.5
I do not know early cultivars with comparable high yields as late cultivars	Financial	-4.4
Once in a while my silage stock is insufficient	Physical	-2.5
I do not have the knowledge to crop early cultivars	Human	-0.4

The contractor has difficulties with the early harvest of maize	Human	-0.1

BMP: Row application of manure (N=56)

Table 114. Drivers and barriers for dairy farms on sandy soils (ENZ7_TXT0_SL1) for BMP: Row application of manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
With row applications you need less manure for the same yield	Financial	2.3
		SN
Research is positive on row application of manure	Human	3.7
On farm tests of row application of manure show good results	Social	2.5
The contractor is not suited to apply manure in rows	Social	1.9
The fertilizer lobby dislikes the row application of manure	Social	0.9
Other farmers favour row application of manure	Social	0.5
Barriers		A
Row application increases the costs to apply manure	Financial	-6.8
With row application of manure the contractor faces increasing time pressure	Human	-6.0
With row application of manure you get more physical damage	Natural	-5.4
Row application of manure may cause root burn	Natural	-4.7
As row application turns out to be successful the current standard application may be reduced	Human	-4.4
To apply manure in rows is technical complex	Human	-3.2
		PBC
The contractor does not have the right equipment for row application of manure	Physical	-5.3
I do not profit from row application	Financial	-4.0
Row application of manure is in an early and experimental phase	Human	-1.8
Row application with manure cannot be done together with planting	Human	-1.3
I have never seen a successful demonstration of row application of manure	Social	-1.2

FTZ 18A: arable farms on clay soils (ENZ4,ENZ7_TXT2,TXT3_SL1); and FTZ 20A: arable farms on sandy soils (ENZ4,ENZ7_TXT1_SL1)

BMP: Non-inversion tillage (N=96; 71)

Table 115. Drivers and barriers for arable farms on clay soils (ENZ4,ENZ7_TXT2,TXT3_SL1) and arable farms on sandy soils (ENZ4,ENZ7_TXT1_SL1) for BMP: Non-inversion tillage. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Clay	Sand
Drivers		A	
NIT saves time compared to ploughing	Human	7.3	6.3
NIT reduces volunteer potatoes	Natural	7.1	5.4
NIT is cheaper than ploughing	Financial	6.6	6.5
NIT stimulates soil fauna	Natural	6.5	6.6
Due to NIT organic matter in the top soil increases	Natural	6.2	6.1
NIT increases organic matter content of the soil	Natural	5.6	6.1

The physical quality of the soil improves when using NIT	Natural	5.4	6.0
For NIT I have to invest in new machines	Financial	0.1	0.0
		SN	
Farmers in the USA or Canada use NIT	Social	3.5	3.8
Magazines are positive on NIT	Social	3.3	3.0
Internet is positive on NIT	Social	2.9	1.8
Research is positive on NIT	Human	2.5	2.6
Extension agents recommend NIT	Social	1.0	0.5
Employees are positive	Social	0.6	0.7
In my focus group NIT is approached positively	Social	0.2	1.3
Other arable farmers are positive on NIT	Social	0.1	1.5
		PBC	
The contractor does not have the right equipment for NIT	Physical	1.2	0.7
I share my machines with other arable farmers	Social	1.0	0.1
I do not have enough ha for NIT	Physical	0.8	0.8
My sowing machine is not suitable for NIT	Physical	0.6	0.5
I grow many beets	Human	0.5	1.2
Barriers		A	
NIT stimulates geese on my field	Natural	-7.2	-6.0
Due to NIT weed pressure increases	Natural	-6.8	-6.7
With NIT pesticide use increases	Financial	-5.1	-5.3
NIT increases the risk on diseases	Natural	-5.0	-5.5
With NIT you do not get a weed less seed bed	Financial	-4.5	-2.9
Due to NIT the soil dries more out	Natural	-2.8	-3.7
		PBC	
The weather is often too wet to apply NIT	Natural	-4.8	-0.6
I have no financial benefits when using NIT	Financial	-3.6	-2.8
Yields are lower using NIT	Financial	-3.1	-3.5
Due to NIT I have more geese on my land	Natural	-2.0	-1.0
I do not have the right machines for NIT	Financial	-1.6	-1.1
I grow many potatoes	Human	-1.0	2.6
I have not enough knowledge for NIT	Human	-0.9	-0.2
I don't have a solution to the weed problem due to NIT	Human	-0.7	-0.8
I have to plough to incorporate a non-hardy green manure correctly	Natural	-0.5	-0.1
To apply NIT I need to invest in machinery	Financial	-0.2	-0.1

FTZ 18A: arable farms on clay soils (ENZ4,ENZ7_TXT2,TXT3_SL1); and FTZ 20A arable farms on sandy soils (ENZ4,ENZ7_TXT2,TXT3_SL1)

BMP: Use of green manures (N=95; 132)

Table 116. Drivers and barriers for arable farms on clay soils (ENZ4,ENZ7_TXT2,TXT3_SL1) and arable farms on sandy soils (ENZ4,ENZ7_TXT1_SL1) for BMP: Use of green manures. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Clay	Sand
Drivers		A	

Better soil structure	Natural	9.1	8.7
Support long term soil fertility	Natural	9.0	8.3
Improve soil handling	Natural	8.8	7.6
More organic matter	Natural	8.8	8.3
Increase soil fauna	Natural	8.2	7.9
Less wind and soil erosion	Natural	8.1	8.1
More nitrogen mineralisation	Natural	7.9	7.5
Less nitrogen leaching	Natural	7.3	7.5
		SN	
Extension agents recommend green manures	Social	6.2	6.0
Magazines are positive	Social	5.7	6.0
Study club is positive	Social	5.6	5.6
Other arable farmers are positive	Social	5.4	4.9
Green manure seed salesmen are positive	Social	5.3	4.8
		PBC	
I like to plough down my straw	Human	5.0	3.6
Enough other ways to apply organic matter	Human	3.0	1.9
It is not always possible to apply liquid manure in time	Human	2.7	1.2
I mainly grow winter wheat	Human	2.7	1.1
I grow a lot of early potatoes	Human	2.1	1.4
Sometimes growing season is too short for good crop	Natural	0.6	1.5
I exchange land with husbandry farmers	Social	0.4	0.9
In the fall there are not enough dry days to sow green manures	Natural	0.4	0.5
Barriers		A	
Increases costs	Financial	-5.2	-4.7
Requires extra time	Human	-3.9	-2.8
More nematicides	Natural	-3.8	-3.8
More weeds in following crop	Natural	-3.1	-2.8
		PBC	
Nitrogen quota too low to grow green manures	Natural	-0.7	-0.8
With green manure nitrogen quota increases	Natural	-1.3	-0.5

BMP: Application of reactor Digestate (N=100; 68)

Table 117. Drivers and barriers for arable farms on clay soils (ENZ4,ENZ7_TXT2,TXT3_SL1) and arable farms on sandy soils (ENZ4,ENZ7_TXT1 _SL1) for BMP: Application of reactor Digestate. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Clay	Sand
Drivers		A	
It is easy to apply	Human	6.1	7.4
The composition is homogeneous	Natural	6.0	7.0
You know what minerals are in digestate	Human	5.8	6.2
With digestate organic matter is applied	Natural	5.4	5.2
Digestate increases soil fauna	Natural	4.9	5.3
It is cheap	Financial	2.7	3.9
Digestate has fast mineralizing N	Natural	1.8	1.7

		SN	
Salesmen are positive	Social	2.1	2.0
Magazines are positive	Social	0.8	1.4
Extension agents recommend it	Social	0.0	0.2
Barriers		A	
Applying digestate increases the risk on contaminating my fields	Natural	-5.5	-4.8
Applying digestate increases diseases	Natural	-5.3	-4.1
		SN	SN
Study club is positive	Social	-0.9	0.2
Neighbours are positive	Social	-0.8	-0.6
Other arable farmers are positive	Social	-0.4	0.8
Research is positive	Human	-0.1	1.1
		PBC	
No guarantee that it is disease free	Natural	-4.4	-2.4
There is a large supply of manure in my region	Natural	-2.5	-4.1
The origin of the basic products is unknown	Human	-2.5	-1.7
Price is too high	Financial	-2.5	-3.1
Digestate with a low P-content is not available in my region	Natural	-2.2	-3.0
The manure law is too strict to apply digestate	Human	-2.2	-3.6
It is hardly available	Natural	-1.7	-1.1
Difficult to handle	Physical	-0.8	-0.3

BMP: Incorporating straw (N=99; 55)

Table 118. Drivers and barriers for arable farms on clay soils (ENZ4,ENZ7_TXT2,TXT3_SL1) and arable farms on sandy soils (ENZ4,ENZ7_TXT1 _SL1) for BMP: Incorporate straw. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

		Clay	Sand
Drivers		A	
Improves soil structure	Natural	8.8	8.7
Provides organic matter to the soil	Natural	8.6	8.4
Improves soil fauna	Natural	8.3	8.1
Improves soil cultivation	Natural	8.0	7.6
When straw is not removed nutrients stay in the field	Natural	6.1	3.7
Easier to incorporate straw than to remove it	Human	5.7	4.6
		SN	
Magazines are positive	Social	4.1	4.4
Extension agents recommend the incorporation of straw	Social	2.8	2.3
Study club is positive	Social	2.8	3.1
Other arable farmers are positive	Social	2.7	2.3
Husbandry farmers are not happy when I incorporate my straw	Social	0.3	0.8
		PBC	
I sow a green manure after my wheat	Human	4.7	4.1
The weather is often too wet to remove the straw	Social	1.4	1.9
There are enough other ways to apply organic matter	Human	0.1	0.9

Barriers		A	
Decomposition of straw needs extra N	Natural	-6.4	-6.1
Increases fungal diseases	Natural	-3.9	-4.7
Costs extra money	Financial	-3.8	-4.3
Incorporation does not need heavy machinery	Natural	-2.4	-4.8
		PBC	
I have silage corn; to incorporate straw of corn I need to change to corn cop mix	Financial	-2.1	-1.2
The manure law makes it impossible to apply the necessary N to the straw to decompose	Social	-1.2	-0.1
Price is often too good to incorporate it	Financial	-1.1	0.0
I use the straw to cover beats and potatoes	Human	-0.7	1.9
I have a corporation with a husbandry farm for the straw	Social	-0.1	-0.2

FTZ 18A: arable farms on clay soils (ENZ4,ENZ7_TXT2,TXT3_SL1)

BMP: Spring application of manure on clay (N=101)

Table 119. Drivers and barriers for arable farms on clay soils (ENZ4,ENZ7_TXT2,TXT3_SL1) for BMP: Spring application of manure. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Financial beneficial	Financial	6.2
It delivers organic matter to the soil	Natural	6.0
It increases yields	Financial	5.6
It increases soil fauna	Natural	5.1
The applied nitrogen is not manageable	Natural	4.0
		SN
Magazines are positive	Social	2.9
Extension agents recommend the use of manure in the spring	Social	2.4
Other arable farmers are positive	Social	1.6
The Dutch Union of Animal Husbandry is positive	Social	1.3
The salesman is positive	Social	1.2
		PBC
No storage facility for the manure	Physical	7.2
Do not know origin of manure	Human	1.3
Is demanding in organisation	Human	0.0
Barriers		A
It makes heavy tracks	Natural	-6.9
It makes the soil fatty and sticky	Natural	-5.7
The composition is unthrusty	Human	-5.2
It makes you dependent of the contractor	Social	-3.8
		SN
Neighbours close by find manure smelling	Social	-0.7
		PBC
The weather is often too wet to apply manure in the spring	Natural	-5.9

I am not allowed to use a "sleepslang"	Physical	-2.0
Not enough N or P quota	Natural	-1.3
Not available in my area	Natural	-1.1
Composition not to be known	Human	-0.1

BMP: Controlled traffic (CTF, N=92)

Table 120. Drivers and barriers for arable farms on clay soils (ENZ4, ENZ7_TXT2, TXT3_SL1) for BMP: Controlled traffic (CTF). A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
CTF improve rooting	Natural	7.8
With CTF soil structure improves	Natural	7.4
CTF reduces water troubles	Natural	6.6
CTF improve yields	Financial	6.4
It is difficult to implement CTF in the management	Human	6.4
CTF reduces diseases	Natural	4.7
Using CTF allows you to use machines on the field with wet weather	Human	2.8
		SN
Organic farmers have good results with it	Social	3.8
Farmers with beds are positive	Social	3.1
Research is positive	Human	2.8
Magazines are positive	Social	2.2
Demonstration trials of machines show good possibilities	Social	1.1
Study club is positive	Social	0.8
Other arable farmers are positive	Social	0.1
		PBC
I use non inversion tillage	Human	1.8
Barriers		A
CTF allows procedures such as spraying or mechanical weed control to be done easily	Human	-2.8
CTF requires a high investment for the right machinery	Financial	-2.1
		SN
Buyers emphasise	Social	-1.6
Extension agents are positive	Social	-0.7
		PBC
Converting to CTF should be done at once	Human	-4.9
Converting to CTF requires a large investment	Financial	-3.6
My machines are not suitable for CTF	Physical	-3.4
Harvesting using CTF is not yet developed	Physical	-3.0
The benefits of CTF are not clear to me	Financial	-2.7
I do not have colleagues with whom I can share the costs for the machines of CTF	Social	-2.3
I am not convinced CTF is technically possible	Human	-2.3
Not all machinery is available at 3 m wide	Physical	-2.1
I plough my land	Human	-0.9
I have to widen my concrete path to the field when I want to convert	Financial	-0.7

to CTF		
Field acceptable only through the public roads require investments in special machines when practicing CTF	Physical	-0.5

FTZ 20A: arable farms on sandy soils (ENZ4,ENZ7_TXT1_SL1)

BMP: Application of compost (N=55)

Table 121. Drivers and barriers for arable farms on sandy soils (ENZ4,ENZ7_TXT1_SL1) for BMP: Application of compost. A = Attitude, SN = subjective norm, PBC = perceived behavioural control.

Drivers		A
Compost provides organic matter	Natural	8.2
Can be applied in the fall/winter	Natural	6.7
		SN
Extension agents are positive	Social	4.0
Other arable farmers are positive	Social	3.6
Study club is positive	Social	3.5
		PBC
It is not available in my region	Natural	0.6
Compost applications increase costs	Financial	0.6
Plenty of other possibilities to apply organic matter	Human	0.4
Barriers		A
It can contain unwanted waste	Natural	-7.0
Cost more labour to apply	Human	-2.5
		PBC
Slurry is largely available	Natural	-1.8
The levy free Phosphate level is too low	Social	-1.4