AgriLink. Agricultural Knowledge: Linking farmers, advisors and researchers to boost innovation

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Partner: Wageningen University and Research

The role of advisory services in farmers' decision making for innovation uptake. Insights from case studies in *The Netherlands*

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List of contents

List of Boxes

List of Figures

List of Tables

List of acronyms

AgriLink	Agricultural Knowledge: Linking farmers, advisors and researchers to boost innovation
AOS	Advisory Organisation Supplier
AKIS	Agricultural Knowledge and Innovation System
AVeBe	Aardappelmeel Verkoop Bureau' (Potato starch Sales Office)
CAP	Common Agricultural Policy
DoA	Description of the Action
DLV	Dienst Landbouw voorlichting
EIP-AGRI	European Innovation Partnership for Agricultural productivity and Sustainability
EU	European Union
Ha	Hectare
ICT	Information and communications Technology
Micro-AKIS	Micro-level Agricultural Knowledge and Innovation System
NGO	Non-Governmental Organisations
NIT	Non-Inverse Tillage
NUTS	Nomenclature of Territorial Units for Statistics
PP	Pratylenchys Penetrans
R&D	Research and Development
R-FAS	Regional Farming Advisory System
TCM	Trigger-Cycle Model
WP	Work package

Executive Summary

WP2 aims to understand why, how and from whom European farmers and farm managers gather and exchange information to underpin their decision-making on development and /or implementation of different types of innovation. A second goal of WP2 is to analyse the role played by advisors in these processes accounting for the range of advisory services available in a series of focus regions across Europe.

In the Netherlands, WP2 was carried out over two case studies: Case Study 1 studied the introduction of Tagetes cultivation as a means to control nematode infestation in the soil, this was carried out in various focus regions characterised by arable agriculture on sandy soils. Case Study 2 studied the adoption of non-inverse tillage as a means to improve soil management. This case study was carried out in different regions with predominantly clay soils. The two innovation processes differ on aspects such as history, effect, benefits, type of farmer, region, thus providing a rich basis for learning about the role of advisors in different contexts and innovation processes.

This report introduces WP2 and its aims and objectives, describes the two case studies and presents findings from interviews with farmers and advisors across the two case studies, as well as narratives exploring key cases in more detail.

Data was collected via interviews with farmers and key AKIS actors across the different focus regions. The interviews were structured around both open and closed questions, therefore the results are drawn from both qualitative and quantitative data. For both cases, farmers were selected for interview that had adopted or at least seriously considered to adopt the innovation. The first adopting farmers were identified through colleagues and advisors from the network. This was followed by a snowball sampling approach. Over the two case studies 38 farmers were interviewed 21 adopters and 14 non-adopters and 1 dropper of the innovation. In addition, 7 AKIS experts were interviewed. These were selected based on recommendations of the farmers in terms of their track record in the innovation area.

In case study 1 almost all farmers in the target group have successfully adopted the cultivation of tagetes. This success is the result of changing legislation stimulating the urgency to adopt alternatives to chemical disinfestation, in combination with research showing the effectiveness of tagetes and farm advisors supporting individual farmers to implement the new practices on the farm. This case also shows how even in the case of a clear win-win situation for all aspects of sustainability a strong outside trigger can be needed to justify the extra effort required for changing the familiar ways of working and adopting the biological control option. In case 2, the strong role of only one or two advisors in the adoption of non-inverse tillage is remarkable. It illustrates the value of presenting new ideas and alternative options at various occasions to create awareness and inspire change. Besides general support in all phases of the innovation process. This case study illustrates how Dutch farmers once their interest is raised, are capable of organising the specific knowledge and support they think they need. There are big differences in the role the farmer gives to the advisors in this process.

1 Introduction

The general goal of WP2 (Innovation case studies in Focus Regions: micro to meso analysis) is twofold. Firstly, WP2 aims at understanding why, how and from whom European farmers and farm managers gather and exchange information to underpin their decision-making on development and /or implementation of different types of innovation. A second aim of WP2 is to analyse the role played by advisors in these processes accounting for the range of advisory services available in a series of focus regions across Europe. The Focus Region is a key concept adopted by AgriLink, and was defined as a farm census region supplying the socio-demographical and farm structural context that might help to explain the farmers' micro-AKIS diversity and its implications to innovation up-take and the role played by advisors.

The conceptual framework (Deliverable D1.1) underlying the implementation of these goals relied on three major assumptions. The first was that the diversity of farmers and farms leads to different decision-making processes and influences the type of advisors and the roles they play on them. Second assumption consisted in assuming that innovation might not be in convergence with the sustainable development purposes, meaning that innovation can affect negatively or be indifferent regarding the sustainability dimension. Hence our willingness to investigate both adoption and non-adoption situations. Finally, a third assumption establishes that the diversity and the transformation in advisory landscape in European countries and regions is a relevant variable explaining the role advisors play (or not) in the farmers' decision-making processes related with the innovation uptake.

AgriLink developed an integrated research framework (Deliverable D2.1) aimed at gathering empirical data for the micro-scale concept of AKIS (Agricultural Knowledge and Information System), the farmer micro-AKIS, and for the mesoscale concept of R-FAS (Regional Farming Advisory System), in relation with the up-take processes of diverse types of innovation by farmers across the EU. This deliverable (D2.2) prepared by the 13 partners involved in WP2 offers a synthesis of the qualitative insights on the farmers' micro-AKIS and the role played by advisors in the selected case studies. These were delimitated at the census region level and focused on a group of farmers representative of a specific innovation (e.g. biologic pest control), comprising both adopters and non-adopters.

In the Netherlands, we selected two innovations in two innovation clusters. In the cluster 'Biological pest control' we studied the introduction of Tagetes cultivation as a means to control nematode infestation in the soil, and in the cluster 'Soil improving cropping systems' we studied the adoption of Non inverse tillage. For each case the relevant focus region was selected. The two innovation processes differ on aspects such as history, effect, benefits, type of farmer, region, thus providing a rich basis for learning about the role of advisors in different contexts and innovation processes. The two innovations are introduced below.

Tagetes cultivation

The use of chemical pesticides for soil disinfestation is under pressure due to concerns from citizens and consumers and regulations by government. These chemical products are also harmful to the environment. The pesticides are used to control nematodes that can cause damage to the crops. An alternative to chemical soil disinfection is the cultivation of *Tagetus patula*, which is currently used in fruit, strawberries, potatoes, roses and lily cultivation to control the nematode species *Pratylenchus Penetrans*. Cultivation of

Tagetes is considered an innovation since it uses biological principles to control nematodes. Adopters of this innovation do not have to use chemical pesticides anymore to protect their crops from the specific nematode species, because comparable control effectiveness levels have been reached.

Since *Pratylenchys Penetrans* causes problems to crops on sandy soils in the Netherlands, our focus regions are also sandy soils. These regions are in the North-East of the Netherlands (NUTS 3 regions NL111, NL132, NL131, NL133, NL211) and in the South-Eastern of the Netherlands (NUTS 3 regions NL413, NL414, NL421, NL422).

Experts from Wageningen University and Research have been involved in the development of this innovation and have been working together with advisors in the field. Therefore, we used their networks to identify and approach farmers who use Tagetes cultivation as a way to control nematodes. Additionally, we used the snowball effect to identify other adopting farmers and tried to find non-adopters too.

Non-inverse tillage

Farmers in the Netherlands are facing decreases in soil quality due to soil compaction by heavy machinery and intensified cropping plans. Other problems are the leaching of nutrients and, in some cases, erosion. Ploughing has a soil degrading effect on the soil because it disturbs soil life and affects soil structure. Nowadays, soil quality receives increasing attention and farmers are becoming more aware of the negative effects of ploughing on soil quality. Non-inverse tillage combined with specific cover crops is an innovative cultivation system that has the potential to improve soil quality. Non-inverse tillage is defined as refraining from ploughing or spading in order to reduce compacting or disturbing the soil. The intention of non-inverse tillage is to maintain organic matter in the soil and to allow improvement of the soil structure by soil life and plant roots.

Since the practice of non-inverse tillage is not widely spread among farmers, three areas were selected as focus regions in order to be able to interview enough adopters. Non-inverse tillage to improve soil quality is mainly practiced on clay soils. Non-inverse tillage is also practiced on sandy soils but that is mainly for complying with legal requirement than for improving soil quality. Therefore, we selected areas with clay soils. The focus regions are: Flevoland, a part of Zeeland and North-West Brabant (NUTS 3 regions NL230, NL342, NL411).

Farmers were initially selected through the networks of experts at Wageningen University and Research, the personal network of one of the researchers and through the networks of advisors and used. Additionally, we used the snowball method to identify more adopters and also some non-adopters of non-inverse tillage.

Advisory challenges

The advisory landscape in the Netherlands has not seen many great changes in recent years. In the early 1990s, a considerable transformation took place in the Dutch AKIS when governmental support and public funding of research, advise and agricultural education decreased substantially. These developments made

knowledge into a commodity and reduced the cooperation between research, advice and education that had characterised the Dutch AKIS. Currently various types of private advisors both independent and dependent of agricultural supply sales provide different kinds of advice to farmers. The education level among Dutch farmers is generally high with professional education and even quit some university education. Farmers differ greatly in the way they use the available advisory services. The range differs from farmers strictly following the given advise to farmers experimenting for themselves or finding the information they need. A first challenge in the Dutch advisory landscape is to provide knowledge that suits the individual needs of each specific farmer. Another challenges for the role of advisory support in sustainability is to put and keep sustainability and other public issues on the advisory agenda of private advisors. Related to this is the challenge of finding a balance between sustainability and other interests of advisors such as good client relations and sales of agricultural supplies. This tension between sustainability and other aspects is expected to manifest themselves more severely in the non-inverse tillage than in Tagetes. This is because in Tagetes the benefits of the innovation are more direct than in non-inverse tillage where investments are needed in the short term and benefits only expected in the longer term. Some questions that are related to the advisory challenges are:

- To what extent are different types of advisors, sales dependent and independent advisors, able and willing to transform the perspective on farm management?
- What is the role of dependent advisers in promoting more sustainable agricultural practices?
- What interest do they have? How do advisors deal with tensions between profitability and environmental sustainability?
- How are advisors contributing to change in agricultural practices?
- What role do dependent advisors play in the development of non-inverse tillage practices?
- Revenues of this innovation will come in the long term by increased soil quality: what will stimulate/hinder farmers to start with this innovation and how to integrate this in advice?

Outline of the report

The report outline is as follows. First, we describe AgriLink key concepts and research questions in chapter 2. Chapter 3 presents an overview of the case studies and methodological approaches used to elaborate them. The next part, chapter 4, comprises the result from the two case studies. In chapter 5, we discuss results according to the research questions and chapter 6 presents narratives of the innovation process of specific farmers in each of the case studies. This provides a richer picture of the innovation process and provides more detail and nuanced insights. In the final chapter 7 we summarize some of the main insights and highlights of each of the case study and also from comparing the two case studies.

2 AgriLink key concepts and research questions

AgriLink key concepts which are relevant for data collection in WP2 comprise the: Focus Region, farmers' micro-level Agricultural Knowledge and Information System (micro-AKIS), mesoscale concept of R-FAS (Regional Farming Advisory System), and the trigger-cycle model (TCM). These concepts were established in the AgriLink DoA and elaborated by the project conceptual framework (see Deliverable D1.1).

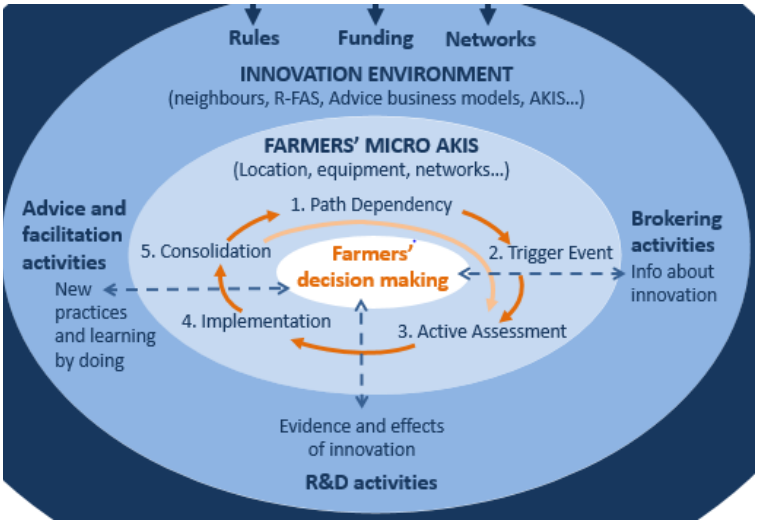
The Focus Region is as a farm census region that establishes the boundaries of the case study for data collection on micro-AKIS and R-FAS. Preferential geographical region is defined at NUTS 3, which is in certain cases replaced by NUTS 2 to achieve a better case study delimitation.

The micro-AKIS describes the micro scale knowledge-system that farmers personally assemble, including the range of individuals and organisations from which they seek service and exchange knowledge with, the processes involved, and how they translate this into innovative activities (or not). Empirical uptake of this concept entails answering two questions: a) who influences farmers (and farm households) in decision-making on adopting or choosing to not adopt innovations; and, b) how, i.e., what are the processes describing the knowledge assemblage by the farmers and role played by the different sources involved (see D2.1)

AgriLink defines the R-FAS as the set of organisations that enable farmers to develop farm-level solutions, enhance skills and coproduce knowledge with advisors. These are envisaged by AgriLink in a pluralist view, including traditional advice providers (chambers of agriculture, public bodies, etc.), farmer-based organisations (unions, associations, cooperatives, etc.), independent consultants, NGOs, upstream or downstream industries, and high-tech sectors. Hence, R-FAS covers the full range of these organisations in a given region, and their connection to wider AKIS organisations, and as well as a range of services, including research, advice and brokering, meaning they can be active at different steps of the farmers' decision-making processes, and use different methods at these different steps.

The trigger-cycle model established that farmers' decision-making regarding the innovation uptake is driven by a triggering event that initiates a path-dependency break cycle composed by three main phases, that can be described to account for the advisors role: a) farmers' awareness of the innovation, encompassing brokering activities developed by advisors to disseminate the innovation and to (co-)create trigger events influencing farmers' decision-making processes; b) active assessing innovation entailing advisors assemblage of information on the innovation costs, benefits, and side-effects by developing and involving in R&D activities; c) supporting farmers in innovation implementation by delivering advice and carrying out facilitation activities. The Figure 1 offers an integrated view of the TCM and the key concepts that were implemented in WP2 through the case studies delimitation and the data collection at farm micro-level and at the R-FAS meso-level.

Figure 1: Integrated view of the TCM and AgriLink key concepts



Source: AgriLink

The research questions to be answered with the empirical approach of WP2 are synthesised in Box 1. The research questions aim at responding the WP2 goals through the empirical approach delineated in D2.1 build on the AgriLink conceptual framework (presented by the deliverable D1.1).

Box 1: AgriLink empirical research questions for WP2

1. ***What roles do advisory services play in the cycles of farmers' decision making?***
   - The cycles comprising the trigger-cycle model developed by the AgriLink conceptual framework to understand farmers' decision-making processes regarding innovation up-take and to describe respective micro-AKIS; Advisor's role is investigated at three phases of this model: a) Farmers' awareness of the innovation, encompassing brokering activities developed by advisors to disseminate the innovation and to (co-)create trigger events influencing farmers' decision-making processes; b) active assessing innovation entailing advisors assemblage of information on the innovation costs, benefits, and side-effects by developing and involving in R&D activities; c) supporting farmers in innovation implementation by delivering advice and carrying out facilitation activities.
2. ***What is the relationship between different types of farmer and advisory suppliers in the decision-making process?***
   - Comprising heterogeneity in farmers profile, farm structural features and farm business models; the nature of the innovation; regional context; R-FAS landscape and business models (including models associated to digitization of agriculture); role of advisory in different stages of farmers' decision making cycles and if these are creating new advisory supply opportunities and /or new functions, and as well as new forms of path dependency
3. ***How does the transformation of advisory suppliers landscape influence farmers' decision-making and uptake of innovation?***
   - Accounting for R-FAS history and on how new configurations of R-FAS (generally depicted as more fragmented and pluralistic) play on the relation between farmers and advice, and respecting this relation: a) allow for more creativity, triggers, and a diversity of knowledge and information channels for farmers; b) influence farmers' access to information and knowledge, and equity on farmers' information access.

Source: AgriLink

3 WP2 case studies overview and methodological approach

3.1 WP2 case studies selection

The case study delimitation in AgriLink was built through two dimensions. One of the dimensions was the spatial delimitation of the R-FAS boundaries at the focus region level, and the second the farmers selection in relation to the innovation type. Table 1 presents the selected innovation according respective innovation type and the sustainability challenge addressed by innovation.

Table 1: Selected innovations and sustainability challenges

Type of innovation	Innovation cluster	Selection focus	Sustainability challenge addressed
Technological	Autonomous vehicles, robots, drones, intelligent sensors/Precision Farming	IT (Information technologies)	Climate change, Eco-efficiency, Pests & diseases
			Growth and jobs – Digitalization
			Food security - Biodiversity, Food provision
Process (farming practices)	Biological Pest Control	Integrated ecological farming	Climate change, Eco-efficiency, Pests & diseases
	Soil Improving cropping systems		Food security - Biodiversity, Food provision
Marketing and financing	Retro-innovation	Diversification	Growth and jobs - Business diversification, Social cohesion
	Introducing new crops		
	Direct marketing		Eco-efficiency
	Developing new activities		
Social and organisational	Natural resources common management	Collaborative organisations	Growth and jobs - Social cohesion, Digitalization
	Labour Innovative arrangements		Food security – Biodiversity
			Eco-efficiency, Pests & diseases

Source: AgriLink

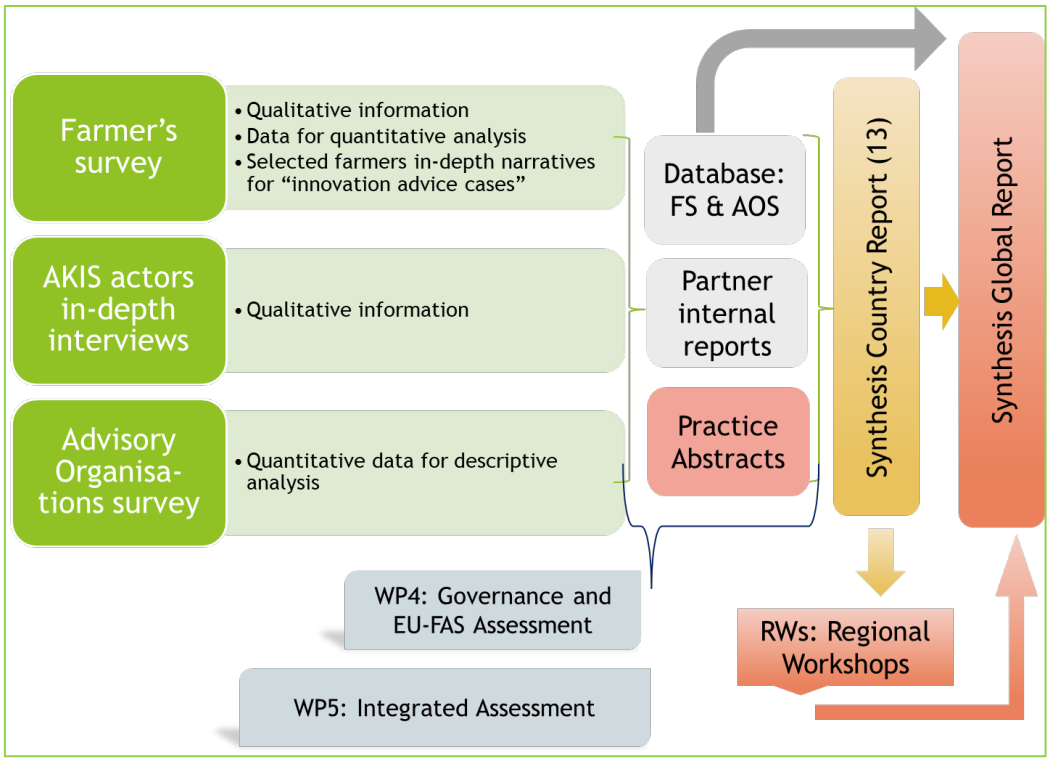
The farmers' selection in each case study built on targeting groups of farmers amongst whom the innovation is already widespread, so that it would be possible to characterise the micro-AKIS supporting innovation up-take of adopters, as well as the micro-AKIS of non-adopters.

3.2 WP2 methodological framework

The methodological framework implemented in WP2 consists on mixed-method strategy (for a detailed description see WP2 research protocol in D2.1), combining case study approach with quantitative survey-type data collection. It is implemented in three steps. Firstly the case studies selection, already described. Second step consisted on delineating and implementing two major surveys: a) to farmers to collect the data for describing the micro-AKIS and the role the advisory providers play on it; and, b) to advisory providers to enable describing R-FAS in relation with the innovation addressed by each case study.

Figure 2 depicts an overview of the WP2 data collection strategy, highlighting the intermediate outputs and the outcomes to be generated from the data analysis, including the inputs to subsequent WPs.

Figure 2: Overview of WP2 data collection and reporting



Source: AgriLink

Farmers' survey was conducted through a question-guide comprising both open-ended and closed-ended questions intended to gather quantitative data on whom and how type of questions (who are the advisory services providers and how these are provided), along with qualitative data on the why and how type of questions allowing for in-depth understanding of farmers' micro-AKIS. Quantitative data from farmers' survey (FS) were entered on a database, while qualitative information and narratives descriptions were recorded and analysed in order to provide the descriptive and analytical insights. This deliverable, the synthesis country report, presents the outputs of both, the data analysis and description and the qualitative insights for each case study.

The farmers' survey was implemented through face-to-face interviews, conducted by members of research teams or duly trained students, following a question-guide including open, mixed and closed questions to collect data on the trigger events, the farmers' innovation evaluation, knowledge and information sources, flows and social networks, farmer profile and demographics, business model and farm structure. FS comprised a set of matrixes to gather data to describe farmer micro-AKIS for the three main stages of the TCM (awareness, active assessment and implementation of the innovation), and on the micro-AKIS used by the respondent for farm management in general, and as optional the household micro-AKIS for the family farms when family members show to be influential actors for information and knowledge flows assembled by farm decision-maker(s). Detailed information on the farmer survey and respective question-guide is available at the Deliverable D2.1.

The advisory organisation supplier's (AOS) question-guide builds mainly on closed-ended questions and addressed formal providers of advice (see Box 2), excluding informal providers. Formal advisory suppliers

comprise organisations providing advisory services as a secondary activity and /or providing them for free (e.g. associated with the supply of inputs or software). In-depth information on the R-FAS is gathered through complementary in-depth semi-structured interviews delivered to a small number of regional AKIS actors.

Box 2: Definitions on advisory for R-FAS survey

Advisory services
- A service activity that enable farmers to develop farm-level solutions, enhance skills and coproduce knowledge with advisors.

Advisory suppliers
- Any organisation that delivers advisory services to farmers.

Advisory organisations
- Traditional suppliers specialized in the supply of advisory services to farmers. This corresponds to former 'extension suppliers'

Source: AgriLink

The question-guide for advisory organisations comprised mostly closed questions and addressed data collection to: a) describe the organisation, including its ownership status, action level, advisory services supplied, funding resources and in-house R&D facilities; b) characterise its human resources, their distribution according to front-office and back-office activities, qualifications, certification and training, and on the methods they use for supplying advisory services; c) describe the type of advisory services clients and the main topics of these services; d) identify the national and regional public support to the advisory organisation, including funding and other type of support to back-office activities (training, R&D and networking activities); e) assess organisation benefit from current EU level policy instruments, such as EU-FAS, EIP-AGRI, and rural development programmes; f) describe the organisation advisory services supplied in relation with the innovation at stake in the case study, and the back-office activities undertaken by the organisation to support the supply of these services; and, g) collect the organisation's vision regarding the major challenges to be faced in the next years by the advisory suppliers, in the focus region, regarding the innovation development.

The in-depth interviews to AKIS key actors collected their knowledge on the innovation path in the region, on major innovation triggers, and on their evaluation on the farmers' knowledge and information needs and demands along the various stages of the innovation TCM and to what extent R-FAS is responding to these demands. The target number of interviews to key actors was established as five, whereas they can be lesser depending on the number of relevant actors is each case study.

The data analysis and qualitative insights obtained in each case study are also part of this deliverable, the synthesis country report. Detailed information on the advisory organisation supplier survey and respective question-guide is available at the Deliverable D2.1.

In addition, this deliverable comprises the description and the insights gathered from detailed narratives of farmers' decision-making processes regarding the uptake of the innovation build on the TCM and addressing the advisory supplier's role. Three narratives per case study were included in the data collection conducted by the WP2 to generate information for the integrated assessment to be carry on by the WP5.

3.3 WP2 sampling strategy

The target population for sampling purposes was a group of farmers with similar technical-economic orientation amongst whom the innovation is already widespread, enabling to identify adopters and non-adopters that choose to not adopt the innovation. Hence the target population to be sampled is defined by two criteria: a) innovation adopters and (informed) non-adopters; with, b) a similar technical-economic orientation, whilst addressing farm structural heterogeneity among the targeted group of farmers, which might lead to the inclusion of farmers with different farm styles and/or business models. In addition, specific categories of non-adopters, such as droppers, or of adopters, such as partial adopters, were accounted for sampling purposes when found to be relevant in the targeted population.

A sample of 40 to 50 farmers was the target for each case study. A snowball-type sampling procedure was adopted relying on the support of key-informants ('gatekeepers') familiar with the targeted group of farmers, which might include farmer associations, researchers, and other AKIS actors and experts. To reduce selection bias, different information sources need to be used and cross-checked (See Deliverable D2.1 for a detailed description of farmers sampling strategy).

The advisory organisations were sampled through a snowball process relying on diverse sources to ensure that the complete spectrum of advisory organisations supplying (or that could supply) advisory or related services is included in the sample. A minimum of 20 organisations was established for the cases were sampling was needed to cover the advisory diversity. In other cases, with little formal suppliers on the ground the strategy was to interview the maximum of existing organisations.

4 Country case-studies, farmers groups and advisory suppliers

This chapter presents the two case studies that were conducted in the Netherlands in two different innovation clusters. These are the following:

- Innovation Clusters: Soil improving cropping systems: non-inverse tillage
- Biological pest control cultivation of tagetes for nematode disinfestation.

Table two show the number of adopters and non-adopters that were interviewed in each of the case studies.

Table 2: Farmers surveyed per case study

Innovation case study	Adopters	Non-adopters	Droppers	Total
Cultivation of Tagetes	14	1	0	15
Non-inverse tillage	9	13	1	23

Source: AgriLink - The Netherlands

In the next paragraphs each of the case studies and the focus region is introduced, the target group of farmers and AKIS experts are explained.

4.1 Case study 1: The cultivation of tagetes for soil disinfestation

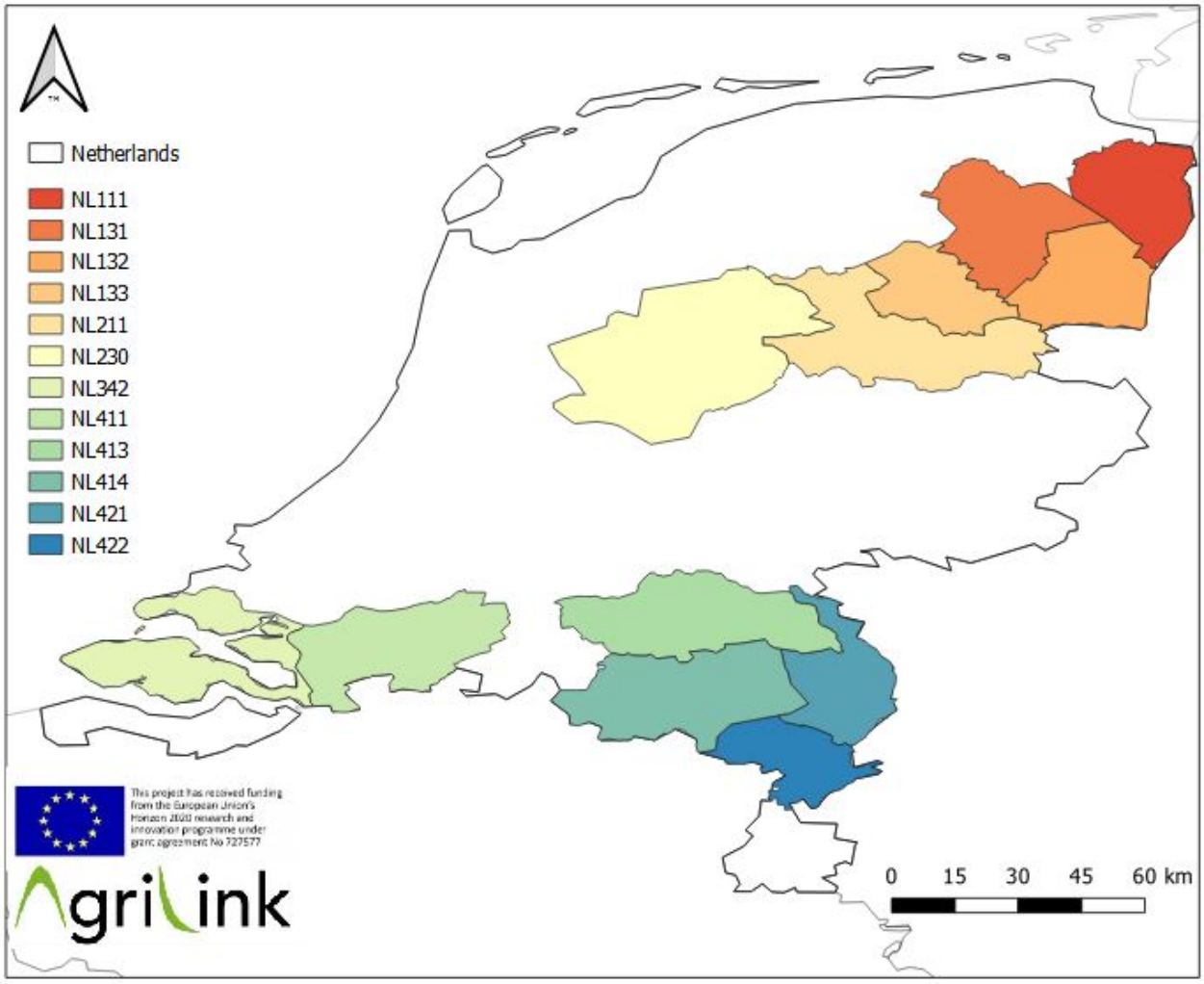
4.1.1 The case study and focus region – cultivation of Tagetes for soil disinfestation

Infestation of soils with the nematode *Pratylenchus Penetrans* is a severe threat to the production of fruit, strawberries, potatoes, roses and lily. This is especially the case in sandy soils. In these crops infestation with nematodes seriously reduces quantity and especially quality of the product, thus reducing the marketing possibilities and farmers' income. This makes soil disinfestation an important topic in farm management. Soil disinfestation used to be done with chemical pesticides. The use of these soil disinfestation chemicals is under pressure, due to concerns from consumers and regulations from the government. These chemical products are harmful for the environment and kill most of the soil life when applied. Due to the stricter regulation, and the related higher prices for chemical soil disinfestation, farmers and researchers are and have been looking for alternative methods to control nematodes. An alternative to chemical soil disinfection is the cultivation of *Tagetus patula*, which is currently used in the cultivation of fruit, strawberries, potatoes, roses and lilies to control the specific nematode species *Pratylenchus Penetrans (Handbook Green manure 2019)*. The cultivation of *Tagetes* is considered an innovation since it uses biological principles to control nematodes. Furthermore, it requires farmers to adopt a different approach. The chemical soil disinfestation was a rather simple measure executed by contract workers. If tagetes is applied, a whole new cultivation needs to be adopted, integrated in the cropping plan and implemented. Adopters of the tagetes innovation do not have to use chemicals anymore to protect their crops for the nematode species *Pratylenchus penetrans*, because the alternative is highly effective.

The effects of tagetes on *Pratylenchus Penetrans* (hereafter PP), is already known since the 1990s. Researchers executed field trials to verify the effects on the nematode population and demonstrate it to farmers. The advisors also played an active role and they cooperated closely with the researchers.

Since PP is only present on sandy soils, the focus areas of the innovation tagetes are located on the sandy soils of the Netherlands where arable crop production occurs. These regions are in the North-East of the Netherlands (NUTS 3 regions NL111, NL132, NL131, NL133, NL211) and in the South-Eastern of the Netherlands (NUTS 3 regions NL413, NL414, NL421, NL422). The regions are located in different parts of the country and are quite different in terms of cultivated crops (strawberries, flower bulbs, potatoes and tree-nursing), but the challenges related to nematodes (PP) are comparable.

Figure 3: The focus regions for the tagetes case study in the Netherlands



All the farmers in the area consult advisors for their daily farm management, crop management and also about tagetes. Most advisors in the field already have a long history in advising farmers. They have had close links with research and field trials related to tagetes. Researchers tried to actively involve, convince

and assist farmers to implement tagetes cultivation on their farm. The main advisory challenge is to provide farmers with the information and skills to successfully integrate tagetes in their farming system.

4.1.2 Group of farmers target and sampling strategy – cultivation of Tagetes

The target group for the tagetes case study consists of those farmers who are within a PP area and who cultivate crops that are vulnerable for PP nematodes. These are farms on sandy soils where strawberries, flower bulbs, potatoes and trees are cultivated. Key-actors within the tagetes-field (scientists, advisors) and managers of experimental farms were used to identify farmers in each region. They provided us with the contact details of farmers that where mostly pioneers in the innovation and that were involved into research and experiments related to tagetes. These farmers were approached for an interview. From then onwards we used these pioneers to identify more farmers (snowballing technique). A good representation for the different relevant crops was a point of attention. Non-adopters or droppers of the innovation were actively sought, but none were identified within the target group. In other words most of the farmers that have a problem with PP use tagetes for disinfestation. This can be understood from the good results that are generally reached with tagetes. Table 2 above provides and overview of the farmers interviewed in this case study.

Two adopting farmers were selected for a case narrative. They were selected because their stories gave us rich insights in their decision making process regarding the adoption of the tagetes innovation.

4.1.3 AKIS experts and advisory organisations – Cultivation of tagetes

In total five AKIS experts were interviewed and this included scientists and advisors. All these experts have seen the development and increasing interest in tagetes through the lens of research and adoption. Advisors and researchers are committed to making farmers aware and assisting them with the implementation of tagetes. The research was and is mainly executed on experimental farms in the focus areas, and can be seen as a hotspot for innovations. The advisors use the collected data from research and inform farmers about the results, thus creating awareness of the innovation.

Nowadays there are several advice organisations present in the focus region, ranging from large to small. The larger ones have their own research departments, which provide the advisors with the required knowledge. The small organizations are dependent on an advisor's personal knowledge and judgement about the advantage of tagetes for each of his clients. The advisors and their organisations were identified with the help of researchers in the field of nematodes and tagetes.

4.2 Case study 2: Non-inverse tillage for soil improvement

4.2.1 Case study and focus region – Non-inverse tillage

The agricultural soils in the Netherlands are degrading due to intensive agricultural production systems. This is now acknowledged by most farmers so they are searching for practices to restore their soil quality. Non-inverse tillage is one of these practices and in recent years has gained the interest of many farmers. Also research substantiates that non-inverse tillage can improve soil quality. Non-inverse tillage is seen and experienced as an effective innovation to improve soil quality, nevertheless it is a currently only applied by

a few farmers mainly because it is quite a challenge to apply it into the farming system and the benefits occur only in the longer term.

Non-inverse tillage can be defined in different ways but for this case study we defined it as: 'Refraining from ploughing or spading in order to minimize disturbing the soils to improve soil quality'. The idea of non-inverse tillage is that in non-disturbed soil, soil life will develop better, which will result in good soil structure. Also the organic matter is kept more at the surface of the soil which is beneficial for the crops and some other soil characteristics like sensitivity to dust storms.

For this case study the Dutch regions with clay soils were selected because on these soils non-inverse tillage is done specifically for the purpose of improving soil quality, thus coinciding with the cluster theme. On sandy soils non-inverse tillage is more widely applied, however mostly for other purposes than improving soil quality. Sometimes it is required by the government or it is the only way to gain sufficient yields. The farmers who choose to apply non-inverse tillage on clay soils do this primarily because of their desire to improve soil quality. Therefore, these areas are most interesting for studying the innovation processes and type and roles of advisory providers involved.

In these regions the farmers can get general farm advice from different kind of advisors. There are independent advisors who work at big or small advisory organisations, but there is also advice from dependent advisors who work for companies that also sell agricultural supplies like pesticides, seeds or fertilisers. These dependent advisors provide advice as a service free of charge, and their revenues come from the sale of supplies. For the topic of non-inverse tillage advice is mostly provided by independent advisors, because for dependent advisors there is no revenue since non-inverse tillage does not involve the sale of agricultural supplies. The main challenge in non-inverse tillage is to find the optimal soil cultivation options to prepare a good seed bed for the crops, without ploughing. This is especially challenging for small seeded crops. Another challenge is the control of weeds.

4.2.2 Group of farmers target and sampling strategy – Non-inverse tillage

The target group of farmers consist of both organic and conventional farmers on clay soils who considered non-inverse tillage. These are farmers that are more than averagely interested in soil improvement. Mostly they already had applied extra measures for improving soil quality. Most of these farmers were already known by the researchers of Wageningen University and Research since they have been involved in research on non-inverse tillage in the past 10 years. Like in the other case study, farmers who were interviewed were asked if they knew some other farmers who are focussing on soil improvement. In this way quite a diverse group of farmers was selected in both regions. It was a challenge to find enough adopters, therefore it was decided to interview some more non-adopters. Table 2 provides and overview of the farmers interviewed in this case study.

The farmers for the case narrative were selected to illustrate different approaches to information collection and the use of advisory support. It is remarkable that each of the interviewed farmers has a particular perspective, creating a wide variety of information gathering and roles for advisors. For example at the extremes some farmers did not use any advisor at all, while others quit heavily depend on them. The farmers selected for the case narrative were somewhere between these two extremes. They all made use of advice but they also used their own experiences and searched for information themselves. This diversity provides a good basis for understanding the diversity in roles of advice and the dynamics and considerations in the decision making process in this innovation process.

4.2.3 AKIS actors and advisory organizations – Non-inverse tillage

Two AKIS experts were interviewed with regard to non-inverse tillage these are the key players in the focus region. One of them is a researcher who is working on non-inverse tillage ever since it was introduced in the Flevoland region (2009). He conducts field experiments where non-inverse tillage is compared to ploughing. He is known by a lot of farmers because he used to be an advisor before his job as a researcher. As a facilitator of several farmers study groups he has frequent contact with the farmers about non-inverse tillage. The annual open field day on the experimental field is another moment with a wider group of farmers about the subject.

For the non-inverse tillage innovation there are only a few advisors who are specialized in this topic. In the focus regions there is only one advisor who was mentioned by almost all of the adopters interviewed. This advisor is involved in the innovation from the beginning. He advises most of the farmers who apply non-inverse tillage. The other adopters did not made use of any advisor on this topic. This independent advisor works on his own, so he is not part of an advisory company.

5 Results

5.1 Case 1: the role of farm advice in the introduction of Tagetes

5.1.1 Findings related to the Farmers' survey

5.1.1.1 Farmers' profile and farm structure

Most surveyed farmers were conventional farmers, mostly cultivating fruit (strawberries) or crops such as potatoes and union, or flower bulbs. Due to the great variety of crops in this case study, the farms differed a much in size, ranging from large (200 ha) to very small (6 ha) farms. Most farmers own part of their land and rent additional hectares. The average area of total arable land cultivated was 103 ha (owned and rented). All farmers sell practically all their produce to buyers/retailers. Some farmers especially in strawberries sell a small part of their harvest directly to consumers. However, this amount is so small that farmers consider it a negligible part of their total income. While some farmers receive financial support (e.g. subsidies to support innovation), this was never a substantial part of their income. Some farmers actively try to apply for subsidies wherever possible, but others find the process of applying and getting subsidies too cumbersome and have stopped to actively obtain subsidies.

Of all the farmers interviewed, only one was a non-adopter. However, even this one non-adopter is considering starting cultivating tagetes in the near future. The reason so many farmers adopted the innovation is that there are no real alternatives other than chemical soil disinfestation. As mentioned before, chemical soil disinfestation is increasingly more costly to apply due to stricter rules and regulations. Since tagetes cultivation has been proven to be an effective method to control PP in the soil, farmers see tagetes cultivation as the most effective and useful method. Because tagetes cultivation is already widely accepted as a good way to control PP, there are very few farmers with PP incidence in their soils, who have *not* adopted the innovation.

All of the farmers interviewed live on the agricultural holding. With the large variety of crops in this case study, the amount of workers on the farm differs considerably between small and large farms, ranging from 0 to 19 permanently hired workers. In addition many farmers hire temporary seasonal workers every year. The number of temporary workers differs greatly between the farms though (0 up to 300 temporary workers). This mostly depends on the labour requirements of the crops cultivated, for example strawberries is a labour intensive harvest.

All of the interviewed farmers were male, of varying ages between 21 and 70 years old. All of the surveyed farmers have access to Internet and use digital applications on their farms, mostly for crop management. Although all farmers have access to the Internet, many complain that Internet connection is poor in the rural area in comparison to more urbanised areas in the Netherlands.

Besides the differences between farms in terms of farm size (both surface and labour force) and types of crops, there are also many similarities between the surveyed farmers. Especially in terms of business models, not many differences exist between the farmers, and most sell practically all the harvested crops to buyers/retailers.

5.1.1.2 *Farmers' attitude towards innovation and change*

All farmers stay in regular contact with an advisor, this being an advisor working for himself or an advisor from an advisory organisation (e.g. Delphy). Many farmers were introduced to tagetes cultivation as a solution to their PP problem by their advisor. Farmers generally have frequent face-to-face contact with their advisor. In general the advisor visits the farm weekly during the high season and monthly during the low season. Because these advisors visit the farms so often and know so many farmers with similar problems, they play an important role in getting the farmer acquainted with innovations.

Even though advisors play an important role in introducing the farmer to new innovations and making the farmer familiar with the use of new practices, farmers also use other sources to decide whether they want to implement the innovation or not. When farmers need to decide whether or not they want to start cultivating tagetes, farmers often visit neighbouring or experimental farms that have already started cultivating and promote tagetes. Peer farmers are therefore also an important source of advice and support. Some farmers directly implemented tagetes cultivation after observing that it works for their colleagues, while others first tested it on a small patch of their own land. Many farmers are also part of 'study groups'; groups of farmers that come together regularly to discuss the problems they are facing and exchange solutions and new developments. Often these groups are facilitated by an advisor or researcher. These groups are also an important source of information.

Farmers were mainly looking for practical support on the tagetes cultivation, with topics such as optimal sowing techniques and timing and weed control. For example, the seeds of tagetes are difficult to sow, so farmers were looking for advice and good examples how they could adapt their own machines so that they could sow tagetes without having to buy new machinery. Nowadays, this challenge has been tackled since contract workers have specialized in cultivating tagetes for farmers.

5.1.1.3 *Farmers' innovation paths and trigger cycle change model*

As we saw earlier, by now most farmers who face PP infestation in their soils have implemented tagetes cultivation on their farm. In fact, the surveyed farmers were unable to name other farmers who consciously decided **not** to cultivate tagetes. The only farmers they could think as non-adopters are farmers who did not have any problems with PP in their soils. Obviously, those farmers also do not have a need to start cultivating tagetes. So within the target group of the case study no real non-adopters were identified.

Farmers in the South-east of the Netherlands adopted the innovation before their colleagues in the North-East. The southern farmers are perceived as more innovative by advisors and their peers and were willing to give it a try. The farmers in the North-East waited for further experiments and positive results. They wanted to see successes elsewhere before implementing it on their own farm.

<u>Innovation awareness</u>

For many of the farmers an important trigger event was the declining soil quality and decreasing options to control nematodes. If sampling of their soil showed that the quality of their soil was declining, many farmers started to look for advice about how to fix this. They mainly looked for advice from their advisor and from their peers. Related to this, tests and experiments that proved that tagetes cultivation was

effective in improving soil quality was another trigger event for many farmers. Lastly, the reducing opportunity to use chemical soil disinfestation methods encouraged many farmers to look for alternatives.

Active assessment

Farmers were often unable to give a clear indication of the duration of the assessment phase. Some farmers first tested tagetes on a small patch of their land while others directly implemented tagetes cultivation in their rotation. Similarly, some farmers take regular soil samples to keep track of the soil quality, while others only sample their soil sporadically. This has mostly to do with whether or not the farmer can financially afford to do regular sampling.

During the assessment phase, farmers again regularly consult their advisor or researchers from experimental farms and ask for advice regarding specific problems (e.g. sowing technique, when to sow, weed management). They also shared experiences with other farmers regularly either farmer-to-farmer or in study groups. Demonstrations on each other's farms were also a source of information and advice for some farmers.

Most farmers stated that they 'just started doing it'. When soil tests proved that what they were doing was working, they continued tagetes cultivation or adapted their techniques slightly if necessary (e.g. started sowing the seeds earlier or later in the year). Many farmers mentioned some form of trial and error when going from assessment to full-scale implementation.

Since tagetes cultivation is a relatively expensive investments (more expensive than soil disinfestation, time consuming to sow, it often replaces another yieldable crop, etc.), farmers wanted to be sure that the results were worth this investment by testing it on a small patch of their fields first or by doing regular soil tests. Most farmers assessed whether the investment in tagets was worth it in the long run with questions like: does it improve soil quality? Do yields improve? Are nematodes controlled to an acceptable level?

Implementation of the innovation

For most of the farmers the process from awareness to implementation on their own farm took quite a while. This is because when the first positive results from experiments with the cultivation of tagetes were communicated, many farmers did not yet have a sense of urgency to change practices. When farmers were aware of tagetes, but chemical soil disinfestation was still allowed and affordable, not many farmers were implementing tagetes on their farms. Nowadays tagetes is commonly known and also cultivated in most PP-prone areas. However, already since 1997 clear brochures have been available. For some farmers implementation took 10 years or so, but for others it went faster, especially when the method was already implemented by neighbouring farms, or when regulations became stricter and the need for alternative became higher.

Nowadays, a lot of farmers are convinced of the effectiveness of tagetes cultivation because they have seen the achievement on other farms or on their own farm. However, many farmers struggle with implementation in *their specific situation*. For example, it might be difficult to cultivate tagetes in combination with their other crops. For some farmers it was difficult to implement the innovation on their whole land. A solution to this was combining tagetes cultivation with other solutions to improve soil quality.

Farmers that implemented the tagetes cultivation into their crop rotation made a very conscious decision. Tagetes cultivation is not easy since it demands several skills and knowledge, especially compared with chemical soil disinfestation, which is a fairly easy method to apply.

Evaluation of the innovation

The main reason farmers start cultivating tagetes is that the chemical alternative becomes increasingly difficult due to stricter rules and regulations. Besides the reduction in nematode populations to acceptable levels, there are other advantages. The soil quality improves due to tagetes cultivation because it delivers a lot of organic matter. Some farmers mention positive effects on health now that they do not have to work with chemicals anymore. The yields of the following crop also become higher if tagetes is cultivated correctly, this may be due to increased soil life as a result of less chemicals in the soil. Higher yields and the resulting higher income for the farmer can outweigh the investment cost of cultivating tagetes. The costs of the innovation consist of substituting a harvestable crop in the rotation with tagetes, thus reducing income. Other costs are the seeds and time to cultivate the tagetes successfully. The innovation also has a positive effect on the public image of agriculture. Especially in the north-east of the Netherlands, there has been public concern in the past about the effects of chemical soil disinfestation. Tagetes cultivation as a substitute to chemical methods has therefore also relieved these societal concerns in that area around soil disinfestation and its negative health effects. Thus also improving the relations between farmers and citizens.

5.1.1.4 Farmers' innovation micro-AKIS

Awareness. The three main actors that made farmers aware of tagetes as a method to control PP nematode populations are advisors, researchers and peer farmers. The contact between the farmer and these actors was mostly face-to-face. The frequency of contact was the highest with advisors, which often visited the farmer on an individual basis. Contact with researchers was mostly organized in groups or demonstration events.

Assessment The same three actors (advisors, research and peer farmers) were relevant during the assessment phase. Farmers were mostly experimenting with the technique and monitoring and discussing the results with the actors. Two-thirds of the farmers received support from advisors and researchers in improving their practices regarding tagetes cultivation.

Farmers were actively assessing the cost of tagetes cultivation, and off course the benefits for the production of the other crops in the rotation and the soil quality. Nowadays, not many uncertainties exist about the effects of tagetes. In the past, farmers were concerned about how the optimal results could be achieved from tagetes (weed management, timing of sowing, other nematode species). Research, peer farmers and advisors helped the farmers to resolve these concerns.

Implementation Farmers did the same things in the implementation phase, as they did during the assessment phase: experiment, register and monitor results, and discuss the technique with others. They also used the same actors as mentioned before. However, most support came from advisors (individual meetings) in this phase, and less from research and peers.

General micro-AKIS. In their general farm management, farmers do comparable things as they did during the tagetes decision-making process. No large differences are observed. Generally, farmers attend group meetings, go to agricultural fairs, demonstrations and read magazines to stay up to date for general farm practices. Advisors are, as in tagetes innovation, the most important actors in the farmers' micro-AKIS.

They normally have contact individually and in person. Research is also an important actor. The interaction of farmers and research is mostly in technical study groups or workshops.

5.1.2 Findings from the AKIS experts interviews and advisory organisations survey

5.1.2.1 Advisory landscape in the focus region

The Dutch AKIS is a very dynamic system, presenting private extension services with direct payments from farmers, coupled with state funding for research and for improving different forms of *Public Private Partnership* and multi-stakeholder networks. Agricultural entrepreneurship has a central role in the organization of the AKIS; farmers are highly educated, have an entrepreneurial attitude and are willing to pay for advisory services. Dutch farmers are heavily involved in processes of knowledge co-production and innovation through peer-to-peer information exchange.

The Dutch AKIS experiences a great crossbreeding of functions with respect to the classical roles of research, extension and education. This aspect makes it difficult to have a comprehensive and clear profile of the players involved. In addition, the geographical boundaries of the AKIS actors are not well defined, increasingly the players in the AKIS are also active outside of the Netherlands or have foreign business units. The advisory service in the Netherlands includes a multitude of actors with very different characteristics. They are mainly private firms or farmer-based organizations (cooperatives, farmers' unions or study groups); to a lesser extent the providers are R&D institutions, NGOs or Foundations. The services market is a very competitive arena, increasingly affected by a trend of internationalization.

In the focus region for tagetes the advisory landscape consists of Wageningen University & Research that has an experimental farm in the region and organizes field trials and demonstrations. Independent advice provider Delphy, individual advisors and smaller advisory organizations are also involved. Increasingly also suppliers engage in research and provide knowledge. A number of cooperatives operate in the region the most important being Agrifirm and AVeBe. In addition contractors and farmers study groups play a role in farmers' decision making.

5.1.2.2 Key players of advice for the innovation area in the focus region

Three players are considered the most important for the tagetes innovation: Wageningen university and research Field crops, the independent advice provider Delphy, and suppliers Agrifirm.

Delphy (before DLV): The largest independent advisory provider providing technical, economic and management advice to farmers and other agri-food businesses, as well as consultancy services to private and public institutions. About 200 experts are working at Delphy. In 1990 Delphy has transformed from a public funded extension organization providing free advice to a private advisory service with farmers as paying clients. The core of the Delphy business over the years has expanded widely to include all the technical, economic and environmental issues required to optimize farmers' production. Delphy experts also work outside of the Netherlands.

Agrifirm: is a cooperative enterprise in which more than 17.000 Dutch farmers and horticulturalists have combined their purchasing power. Agrifirm in its current form was founded in 2010 due to a successive merger of regional cooperatives. The enterprise provides products (such as fertilizer, crop protection and

seeds) and services (knowledge and advise) to farmers throughout the entire Netherlands. The business model is based on the sales of agricultural supplies, the advice is provided to the farmers without charge. Agrifirm also participates in knowledge creation and research projects. The head office is located in Apeldoorn, the Netherlands but Agrifirm has business units in many other countries

Wageningen University & Research Field Crops. Organisation for Applied research specialized in arable crops, bridging sciences with practice since 1950s, on an international level. Wageningen Field Crops has several experimental farms of which one in the focus region on which both research and demonstration activities are organised. Wageningen University and Research has been involved in the research on the effectiveness and optimal cultivation of tagetes from the start.

Study groups: The study groups are farmers' organizations for peer-to-peer exchange and are based upon a cooperative spirit of self-help and solidarity. They are based on a sectorial perspective and/or geographical proximity. While most of the study groups are established at local or regional levels, their boundaries are expanding thanks to ICT support.

The interviewed AKIS experts described the history of the tagetes innovation clearly from a research and advisors perspective: Once it became clear that tagetes was a promising method to combat PP, researchers and advisors actively approached farmers and involved them into further research on the implementation of the crop in practice. The sectors that experienced the most problems with both PP and chemical soil disinfestation (tree nursery and strawberries) were the first ones to adopt the innovation. This can be understood from the high sense of urgency to control the nematode infestation in these crops. They are highly vulnerable to PP and already low populations of PP can endanger successful crop production.

It was already known that tagetes was able to reduce the population of PP, but not yet in detail. So due to the stricter regulations, farmers became interested in new methods. Therefore experiments started in different sectors; firstly roses, strawberries and tree-nurseries. These were the high value crops that need to deliver clean starting materials or that are very vulnerable to even low populations of PP. So, these farmers were eager to try another method for nematode control. Later on the flower bulbs, potato and vegetables sectors became also interested.

The acquired knowledge from research and experiments was actively shared with advisors and farmers to show them that tagetes were an effective alternative to chemical soil disinfestation. In 1992 the first leaflet about tagetes as an alternative for nematode control was created by research institutes. The researchers and advisors worked closely together, and governmental funding was available to advise farmers about innovations. In the pioneer sectors (strawberries, tree-nursery) a lot of experience has been built up by the farmers. They know how to cultivate tagetes themselves.

Table 3: Interviewed key actor tagetes cultivation

Key actor	Profession	Organization
Leendert Molendijk	Nematode expert- researcher	Wageningen University and Research
Marc Kroonen	Manager of Experimental farm Vreedepeel	Wageningen University and Research
Gerard Hoekzema	Manager of Experimental farm Valthermond	Wageningen University and Research
Thea van Beers	Knowledge coordinator and former nematode researcher	Agrifirm
Harrie Pijnenburg	Farm advisor and former agricultural researcher	Delphy

The advisory organisations and key-actors all mentioned that the stricter regulations on chemical soil disinfestation was the trigger event that caused more interest from farmers to alternative methods to control the PP nematode. If the regulations had become stricter, most farmers would have continued with their normal practices because the inputs would be widely available. As for the active assessment, research experiments showed that tagetes is an effective way to combat the PP nematode. This results were demonstrated and provided to farmers by advisors and could be used in the decision making process whether or not to implement tagetes. During implementation of the innovation, advisors were helping the farmers with the new practices of tagetes cultivation. The consolidation phase is mainly in the domain of the farmers themselves, assisted by the advisors. The advisors and experts mentioned that tailor made advice is necessary in the awareness, assessment and implementation phase. Tagetes is not an easy crop to cultivate, so there was and is an important task for advisors to inform farmers about crop management (time and way of seeding, weed management).

Experts perceive the farmers in the south of the Netherlands as more innovative compared to their colleagues in the north-east. Next to the differences in cultivated crops, these regional differences in attitude towards innovation also determined the speed of uptake of tagetes, resulting in the early adopters in the south and late adopters in the north-east.

The introduction of tagetes as an innovation was a long time ago (in the 1990s). Looking back together with the experts, it has been a successful innovation since most farmers for whom tagetes is feasible and relevant, nowadays have adopted it. From the awareness stage of the innovation might take several years, but when the active assessment has taken place, implementation can and did happen rather fast (within a year). Some indirect public support occurred to stimulate tagetes, through financing research projects.

5.1.2.3 *Transformation of advisory landscape*

Involved advisory organizations

Table 4: Overview of the active advice organization in tagetes cultivation.

Organisation	Activities	Scale	Sector(s)	Number of certified advisors (of which involved in tagetes)	Number of clients	Back office facilities
Delphy	Advice	Worldwide	Arable farming and vegetables	160 (5)	Several thousand	Yes
ALBGroot	Advice and products	Regional/national	Flower bulbs	7 (1)	50-100	No
Agrifirm	Advice and products	Worldwide	Arable farming and animal feed	100 (only plant group) (25)	2000-3000	Yes

All three organizations are active advisors in the innovation area of tagetes. They all combine this with integral crop and farm advice. The advisors from Delphy and Agrifirm were also interviewed as key-actors, since they were involved in the research and experiments during the 1990s into the effectiveness of tagetes and the further development and adoption of the cultivation by farmers. The advisor from ALBGroot followed these research outcomes closely and enthusiastically spreads these results among his clients.

All three advising organizations give priority to individual farmer-advice. In the high season, they speak to the farmer almost every week. They also organize meetings for small or large groups of farmers to share knowledge and demonstrate new techniques. Most advice is about plant production, followed by environmental issues, marketing and business development. All three organizations do not receive any governmental funding. Their sources of income are paid advice and selling of products (ALBGroot and Agrifirm), such as fertilisers and crop production products.

Tagetes advice is only a minor part of their activities and is integrated in their regular advice activities. The required knowledge is acquired by cooperating with universities, research institutes and farmers. The advisors think that the demand for advice about tagetes will slowly decrease because most farmers from most sectors nowadays know how to cultivate tagetes themselves. However, experiments are still going on and positive (financial) results might boost in late-adopting sectors (like potatoes in the north-east of the Netherlands). In addition to that, stricter governmental regulations on the pesticides used for weed control in tagetes might negatively affect interest for tagetes cultivation.

The advice of Delphy, ALBGroot and Agrifirm is always in line with the EU Directives (water, pesticides) and helps farmers to achieve these goals. They also work on rural development (Leader projects), but are not aware of EU-FAS or EIP regulations.

5.2 Case 2: the role of farm advice in innovation case study Non-inverse tillage

5.2.1 Findings related to the Farmers' survey

5.2.1.1 Farmers' profile and farm structure

From the total group of farmers interviewed, half are organic and the others are conventional. One of the farmers combines organic and conventional cultivation on his farm. The farmers interviewed cultivate potatoes, onions, wheat, sugar beets (only conventional) and some vegetable crops. The size of the farms varies from 30 to 325 ha with an average of 115 ha. Most farmers own a big part of their land and rent some extra land. Only a few farmers do not own their land but have a life-long lease. Almost all farmers in Flevoland can irrigate all of their fields. In the south-west of the Netherlands there were a few farmers who could not irrigate their fields due to the location of the farm. All farmers interviewed sell all of their products. Mostly they sell to wholesalers. Only two farmers also sell a small part directly to consumers, but the farmers considered the share as negligible. This also accounts for other gainful activities related to the agricultural holding. All farmers receive direct payments from CAP and just a few receive some extra subsidies. This is mostly for buying a new piece of equipment.

Except for one farmer (farm manager), all farmers live on their farm. Seven of the farmers surveyed have permanent hired workers and almost all have temporary hired workers; this is mostly for harvest time for the conventional farmers and for the organic farmers also for weed management. For four of the farmers surveyed there is a full-time family worker and for seven of the farmers surveyed there is one or more part-time family worker. This is mostly the wife or son of the farmer. With a few of the farmers there has been talked about the influence of the family workers on innovation decision and some mentioned that they do have influence on their decision, especially when they work full time on the farm.

All of the farmers interviewed are male except for one interview, which was with a couple that both worked full-time on the farm. The age of the farmers varies between 21 and 70 years old. Most of the farmers interviewed were between 51 and 60. They all have access to the Internet and were mostly satisfied with the connection. Almost all farmers have had agricultural education and therefore also have worked mostly their whole working life in agriculture. The digital skills of the farmers differed from doing almost all the administrative work on paper to working with advanced ICT programs. In most cases older farmers work less with ICT.

There is a lot of diversity within the farms, both in terms of farm size and in cultivation system used, for example some use a lot of green manures others do not. The difference between organic and conventional is most striking in the length of the crop rotation and the hired labour. Organic farmers have a longer rotation with more crops and hire more labour especially for weeding. Also the perspective and vision on agriculture differed between the farmers. However, all farmers in the sample are focussed on improving soil quality.

5.2.1.2 Farmers' attitude towards innovation and change

The general micro-AKIS of a farmer mostly consists of contact with other farmers and advisors. The contact with other farmers can take place in a study group or in informal contact with neighbours and befriended farmers. 16 of the interviewed farmers receive advice from an independent advisor, but also

dependent advisors, for example suppliers or traders give advice to these and other farmers. The advice mostly focuses on specific topic (e.g. crop protection or fertilizing) or crop. All the personal advice is given one to one, but sometimes general information can be obtained by a presentation of an advisor/expert or through for example a field day. Some farmers are also participating in research projects that provide them with information, mostly by a researcher. All farmers are satisfied with their general micro-AKIS. If they would not be satisfied, it would be easy to go to another advisor in most cases.

One of the skills to be a good farmer that was often mentioned in the interviews is planning. For the soil and for the crop it is important to do the right activities at the right time. Also knowledge about the soil was mentioned by a lot of farmers as a requirement for success. Important to note that these farmers are more than average interested in soil quality. Most farmers developed this knowledge and skills during their education, from their parents or by talking to and watching other farmers. Knowledge about the soil also comes from the advisors. Fertilisation issues are discussed with all advisors. For soil quality it is mostly the independent advisor who provides information.

5.2.1.3 Farmers' innovation paths and trigger cycle change model

Out of the interviewed farmers 9 were adopters, 14 non-adopters and 1 dropper. Of the 9 adopters 4 were organic farmers, while the other 5 were conventional farmers. There are only few adopters of non-inverse tillage in the focus regions. As far as known, most of the adopters in the focus regions were interviewed. However, there are many other farmers who have experimented with non-inverse tillage in one or a few years of their rotation. For some crops the main reason for being hesitant with shifting to non-inverse tillage is the challenge of managing weeds without ploughing. Most of these farmers indicate that when they see a good example of a non-inverse tillage farmer they would find it easier to apply non-inverse tillage on their own farm. A good example on a neighbouring farm is more important for most farmers than an advice from an advisor.

This can also be seen in the evaluation of the farmers about non-inverse tillage. They mostly base their opinion on their own experience and examples from other farmers. The general background knowledge they mostly obtained from experts or advisors, but the applicability and practical knowledge is generally obtained from personal experience or other farmers. In general most farmers evaluated the innovation as neutral to beneficial for most of the evaluation points. Especially for product quality and environment the innovation is seen as beneficial. Most of the farmers see the benefit of non-inverse tillage for soil quality, but, according to the non-adopters, the disadvantages, such as weed control and seed bed preparation, outweigh the benefits. The difference between adopters and non-adopters can be understood from both the occurrence of disadvantages on their farm, but also the value given to these disadvantages. Furthermore the weigh given to the advantages of soil quality and the environment. Instead of an objectified weighing of costs and benefits the decision to adopt non-inverse tillage is based on personal preferences and values.

The farmers became aware of non-inverse tillage at different moments during a period of almost 35 years. Some of the farmers heard about the practice in Canada as early as 1981, while others only became aware of the practice in 2014. Between 2007 and 2009 non-inverse tillage became more known in the Netherlands. This also resulted in experimental research on non-inverse tillage in Flevoland from 2009 onwards. Most of the farmers became aware of non-inverse tillage through one independent advisor who

is specialized in non-inverse tillage. Some farmers got to know the practice through his presentation during study group or seminars, while others read an article about it in an agricultural journal.

Most farmers assessed the value of the innovation for the own farm soon after they became aware of it. More than a technical assessment of the innovation, the assessment of non-inverse tillage is an experimentation process of getting acquainted with the practice and the performance of the soil. Most farmers first tried it on a small part of the farm. If this trial gave positive results they expand it to the rest of the farm. Sometimes field by field, or crop by crop, sometimes the whole rotation at the same time. Adopters indicated that the most important requirement to start non-inverse tillage is knowledge about the soils on the farm, and knowledge about green manures was also mentioned. Some adopters mentioned the training of an independent advisor as very useful to gain this knowledge about soil and green manures.

In general, most farmers learn the most by doing and non-inverse tillage is in particular a practice that requires experience and understanding the functioning of the soil on the own farm. Therefore the interviewed farmers first try the practice on a small part of their farm and then expand it. When they start trying, the advisor is often actively approached for advice especially in the first few years of implementation. This is one to one advice provided mostly by the one advisor expert in non-inverse tillage in the focus regions, but he is also one of the few experts in the Netherlands. This advice is mostly perceived as very useful.

In the assessment stage a few things were assessed: the benefit to improving soil quality, the risk of weed pressure, the benefit of the effect on yield and the costs for the machines to terminate the green manures. Sometimes the advisor assists in the assessment, but mostly it is done by the farmer himself, based on his personal experience.

The implementation phase takes a few years (in general about 4-5 years) because the soil needs to adapt to the new system. Furthermore, the farmers need to discover and learn how to cultivate the soil in the best way to still grow good crops of high quality. As mentioned before, the advisor is important for the majority of farmers in this stage since he has a lot of experience in a variety of contexts. It is difficult to say when exactly the implementation is complete, as almost all adopters indicated that they keep on learning and fine tuning the system. The preparation of the soil and cultivation of green manures are the most common points of attention.

In the group of non-adopters about half do not intend to implement non-inverse tillage, while the others might apply it, but not in the near future. The reasons for not (yet) adopting vary from perceiving too many risks such as high weed pressure and reducing yield, to not having seen a good example of non-inverse tillage. One dropper was interviewed. His reason to drop the innovation was he did not manage to get rid of the green manures and crop residues. Therefore he started ploughing again, but not as deep as he used to do. By ploughing shallow he is trying to optimise the advantages of not disturbing soil life too much with the advantages of ploughing. Instead of a non-adopter he could be seen as an adjuster of the innovation. There are more farmers who opt for this shallow tillage system.

5.2.1.4 *Farmers' innovation micro-AKIS*

Since there is only one advisor active in the focus regions he is also the one who is most frequently mentioned at the different stages of the trigger change cycle. Mostly in the awareness stage there is a single interaction with the advisor or with colleague farmers. The assessment stage is mostly done by the farmer himself by trying non-inverse tillage on his farm, and during the implementation phase the advisor helps to improve the system. Although, there are also farmers who do it all by themselves without any assistance from an advisor. This is mostly because these farmers feel they have enough background knowledge and farming experience or because they prefer to work it out themselves and trust their own common sense.

5.2.2 Findings form the AKIS experts interviews and advisory suppliers survey

5.2.2.1 *Advisory landscape in the focus region*

The general advisory landscape is the same for both case studies. The Dutch AKIS is a very dynamic system, presenting private extension services with direct payments from farmers, coupled with state funding for research and for improving different forms of *Public Private Partnership* and multi-stakeholder networks. Agricultural entrepreneurship has a central role in the organization of the AKIS; farmers are highly educated, have an entrepreneurial attitude and are willing to pay for advisory services. Dutch farmers are heavily involved in processes of knowledge co-production and innovation through peer-to-peer information exchange.

The Dutch AKIS experiences a great crossbreeding of functions with respect to the classical roles of research, extension and education. This aspect makes it difficult to have a comprehensive and clear profile of the players involved. In addition, the geographical boundaries of the AKIS actors are not well defined, increasingly the players in the AKIS are also active outside of the Netherlands or have foreign business units. The advisory service in the Netherlands includes a multitude of actors with very different characteristics. They are mainly private firms or farmer-based organizations (cooperatives, farmers' unions or study groups); to a lesser extent the providers are R&D institutions, NGOs or Foundations. The services market is a very competitive arena, increasingly affected by a trend of internationalization.

For non-inverse tillage, the advisory landscape consists of two individual advisors and Delphy as an independent advisory organization. However, in the focus region only one independent advisor was mentioned by all farmers. A number of mechanization companies play a role in the innovation because they provide specific machines that are required for non-inverse tillage. However, these companies do not give advice to the farmers concerning non-inverse tillage. It is the farmer who takes the initiative and asks the mechanization companies for the right equipment and not the other way around. In addition, contractors and farmers study groups also influence farmers' decision making in general, from the interviews it cannot be generally said how these sources of information influence the specific innovation of non-inverse tillage. Some study groups the practice is discussed whereas others do not, same some contractors facilitate the practice whereas others are more sceptical. Wageningen University & research has an experimental farm in the region and organizes field trials and demonstrations. A number of cooperatives operate in the region, the most important being Agrifirm; however, they do not advise on non-inverse tillage.

5.2.2.2 *Key players of advice for the innovation area in the focus region*

For non-inverse tillage the first key player is a Belgian advisor who has been working on the sandy soils in Belgium Limburg. He presented his experiences in the focus region, thus triggering awareness and the interest of farmers in this region. Shortly afterwards, a Delphy advisor started working on non-inverse tillage with the farmers in the focus region. He continues to play an important role in providing advisory support to the farmers in the focus region. In recent years, this advisor left Delphy and started work under his own name. Wageningen University and Research played a role in this advisory landscape, because of the long-term field experiment with non-inverse tillage and ploughing. Because of this experiment a lot of data about non-inverse tillage is obtained. Contractors provide services in cultivation and in doing so also provide advice and influence the farmers' decision making.

Delphy (before DLV): The largest independent advisory provider providing technical, economic and management advice to farmers and other agri-food businesses, as well as consultancy services to private and public institutions. About 200 experts are working at Delphy. In 1990 Delphy transformed from a public funded extension organization providing free advice to a private advisory service with farmers as paying clients. The core of the Delphy business over the years has expanded widely to include all the technical, economic and environmental issues required to optimize farm production. Remarkably, both most important supporters of non-inverse tillage, the independent advisor and the researcher leading the field trials used to work for Delphy. Delphy experts also work outside of the Netherlands.

Wageningen University & Research Field Crops. Organisation for Applied research specialized in arable crops bridging sciences with practice since 1950s, on an international level. Wageningen Field Crops has several experimental farms of which one is in the focus region on which both research and demonstration activities are organised. Since 2009 Wageningen University and Research runs a field trial on non-inverse tillage and measures the performance and comparing in to shallow ploughing and conventional practice of soil cultivation. Wageningen organises demonstrations for farmers and advisors.

Study groups: The study groups are farmers' organizations for peer-to-peer exchange and are based upon a cooperative spirit of self-help and solidarity. They are based on a sectorial perspective and/or geographical proximity. While, most of the study groups are currently established at local or regional levels, thanks to the ICT support their boundaries are expanding.

6 Discussion: Answering research questions

6.1 Role of advisory suppliers in the farmers' TCM and innovation paths

What roles do advisory services play in the cycles of farmers' decision making?

Awareness

The initial start of the innovation process differs considerable between the two case studies. The cultivation of tagetes is a practice that was used before the introduction of chemical pesticides. In the 1990s, in search for more natural alternatives of pest management, research started investigating the effectiveness of the practice. Non-inverse-tillage was already practiced in other countries. Farmers who were interested to conserve the soil and improve fertility started experimenting with this practice and adjusting it to their Dutch farm context. Independent advisors supported the farmers in this search. Remarkably, these same advisors are still the main providers of advisory support with regard to non-inverse-tillage. So in each Dutch case study different advisory providers have played a role in influencing farmers' awareness of the innovation. For tagetes, research had the lead in the early development of good cultivation practices and gathering evidence on the benefits of this innovation. On farm and on station trials demonstrate the possibilities of the new practice. Through presentations, articles and leaflets researchers provided information that contributed to public awareness. In the case of non-inverse tillage, pioneer farmers supported by independent advisors started the innovation in the Dutch context. These first advisors who started working with non-inverse tillage, shared their experiences at various events and meetings, thus making other farmers also aware and acquainted with the practice of non-inverse tillage. These two advisors were involved in all the farms that are currently using the practice.

Though both innovative practices clearly have the potential to improve the sustainability of the farming practice, for most farmers an increased awareness of sustainability is not the starting point of the innovation process. The role of sustainability is different in each of the cases. In non-inverse tillage, the farmers' desire to develop more sustainable soil management is the driving force of the innovation process. The adopting farmers are more interested in and concerned with soil quality than other farmers. In the tagetes case, sustainability may be the main driving force for the research and for the government financing the research. However, for the adopting farmers the drive originates in the desire to reduce the risk of damage due to PP nematodes infestation and to find alternatives for chemical disinfestation when regulations became more restrict.

A striking difference between the two innovation processes is that for non-inverse tillage getting acquainted with the innovation seems to be the trigger for some farmers to start assessing the possibilities to implement it on their own farm, whereas for tagetes it seems that farmers got acquainted with the possibilities and effects of tagetes to control PP long before they started to actively assess the possibilities to implement it on their own farm. Only when stricter regulations on chemical disinfestation were introduced, farmers and advisors became more interested to actively assess alterative solutions like tagetes. An existing solution was no longer allowed, and research showed that tagetes provides a better solution. In brief, sometimes getting acquainted is the trigger to innovation, sometimes it is not enough

stimuli to move out of path dependency and other external triggers are needed to move to active assessment.

Besides advisors and research organisation, in both innovation processes the viewpoints and experiences of neighbouring farmers play an important role throughout the adoption process.

Besides technical information about the practice and the feasibility in different farming systems, information about the economical results and ecological effects is also needed. It is important that the information provided meets the interests and concerns of the farmer. The motivation differs between the two case studies. The introduction of tagetes was mostly motivated by the desire to reduce damage to the crop, thus it was economic in nature. The question whether the innovation is able to solve the problem is key. In non-inverse-tillage the desire to improve soil quality plays the biggest role. With improving soil quality the farmers hope to develop a future proof farming system with good production levels. The key question for adopting is whether the innovative practice improves soil quality and resilience of the farming system.

Assessment

The initiation of the assessment phase is different nature between the two cases. In tagetes, the assessment starts when the farmer assumes that tagetes could be a solution to the PP problem, whereas in non-inverse tillage as a practice resonates with an ideal of how farming and soil management ought to be done. Non-inverse tillage is appealing to some farmers as an alternative way of farming. During the assessment phase advisors play an important role in supporting farmers in their evaluation of the possibilities, requirements and consequences of implementing the practice on the specific farm. This requires technical as well as economic and ecological information. Especially in non-inverse tillage, trials on a small part of a plot are an important way of obtaining practical knowledge and experience. For tagetes, assessment consists of gathering knowledge, trial and error and calculating investments and benefits. Besides technical support, especially in the non-inverse tillage also the role of 'moral' support to exploring the new practice seems to be important. Non-inverse tillage requires a more drastic transformation of the farming system, whereas tagetes is the introduction of a new crop in the rotation. Advice is provided mostly by the few independent advisors specialised in non-inverse tillage. Most farmers switch to these advisors to assist them in the assessment and implementation stages. In tagetes researchers and dependent advisors also provide advice in the assessment phase. The one non-adopter in the tagetes case was hesitant because it felt counterintuitive to replace a wheat crop with tagetes and thus directly loose income in the short term. Some farmers who are highly educated and naturally inquisitive and innovative are able to find the required information they need to assess the innovation without formal advise. The decision to adopt the innovation is of a different nature between the two case studies. Though evidence of the benefits of non-inverse tillage to soil health are increasing, the decision to change to non-inverse tillage is more ideological in nature, whereas tagetes is more generally agreed to be the best solution to a problem.

Implementation

During implementation the role of advisory support changes but remains important for success. Whereas in the assessment phase the advisor provides information to assess the feasibility and the calculation of costs and benefits, during the implementation the role of the advisor consists of facilitating the farmer in making the best decisions to make the innovation to a success. The cultivation of tagetes as an innovation is quite straightforward as it just requires including tagetes in the rotation. However tagetes is a sensitive crop that requires attention and knowledgeable fine-tuning to be successfully cultivated. The role of the advisor is different between the two case studies. In tagetes it is to provide the required information and support to successfully grow a crop. There are many different advisors who are able to provide this information. In non-inverse tillage, the role of advice is more to support the farmer in its own search and learning process, and in the transformation of the farm. Only a few specialist advisors provide this kind of support and most farmers who implement the innovation are in touch with these three advisors. In this phase, contractors and mechanisation firms play a role in providing technical advice to enable optimal implementation of non-inverse tillage on the farm.

6.2 Farmers diversity and role of advisory in innovation uptake processes

What is the relationship between different types of farmers and advisory providers in the decision-making process?

In both case studies a general image of the role of advice was obtained. In tagetes this role seems to be similar for most farmers. In non-inverse tillage, there seems to be some more variation in the role of advice that is related to differences in farmers' attitude. Though advisors play a role in the adoption processes of non-inverse tillage, some farmers depend more on their own wisdom and knowledge in finding their way forward where others strongly depend on the specialist advisor. These differences are probably more pronounced in non-inverse tillage because this innovation is more ideologically driven and it affects the farming system in a more profound way than the introduction of tagetes.

In tagetes, the differences in the innovation process between crops are striking. In strawberries and lilies the innovation developed earlier and faster than in farms with potato as their main crop. This difference is because the investment is more easily compensated in high value crops such as strawberry and lily. Furthermore in Lilies and strawberries PP infestation presents a bigger risk to the farmer because PP damages these crops more easily compared to potatoes. Thus stimulating these strawberry and Lilly farmers to look for alternatives more anxiously when chemical disinfestation was discouraged. It seems that tagetes can also be integrated more easily in these cropping systems. Despite these differences between the possibilities and the perspectives of the innovation, the role of advisors is not so different between these crops. In non-inverse tillage there seems to be less variation between farms and as such the opportunities are similar. It can be observed that crops with small seeds present a bigger challenge in non-inverse tillage and weeds are more of a problem in organic farms. The role of the advisor seems to depend mostly on the vision and attitude of the farmer. One main difference between the innovations is that in non-inverse tillage advice is only provided by independent advisors, whereas in tagetes also dependent advisors provide advice. This difference can be understood from the nature of the innovation, tagetes is just perceived the best solution to a problem and thus part of mainstream advice. Non-inverse

tillage is not seen as the only solution for increasing soil quality and requires more drastic changes in the farming system, it takes more courage and expertise to advise on. Furthermore, the innovation does not involve extra sales in fertilizers seeds or pesticides. These two aspects make non-inverse tillage a less interesting subject for advisors who depend on supply sales for their income.

The role of policy is different per case study. In tagetes the change in regulations presented an important trigger for farmers and advisors to consider tagetes as an alternative solution. In non-inverse tillage policy measures were only reported to have a negative influence on the adoption of the practice. In addition to the direct effect of policy on the innovation, for both innovations policy supports investment in research to define benefits and improve the practice, thus creating the information needed to provide advice to farmers. In tagetes the results from research had a leading role in the advice provided in the innovation process, whereas in non-inverse tillage advisors and farmers had the lead role, and research is more in a supporting role of providing evidence.

6.3 Transformation of advisory suppliers and farmers' innovation uptake processes

How does the transformation of advisory providers landscape influence farmers' decision-making and uptake of innovation?

In both case studies little mention was made of new business models for advisory services affecting the advisory process. The privatisation of extension services and the coexistence of dependent and independent advisors exists for decades and does not seem to have much influence on these innovation processes. One could wonder if the innovation processes would have been any different if more independent advice or public funded advisors would have been available. For tagetes the adoption of the innovation is almost complete in the target group, and is mainly triggered by changes in legislation. It is to be expected that it would not have had much influence if public advisors had been available. For non-inverse tillage active promotion of the practice by public advisors could contribute to more widespread use of the practice. Nevertheless the non- adopters did not indicate the lack of appropriate advice had a role in their decision not to adopt.

As mentioned above, the main transformations of the advisory landscape have taken place at the end of the previous century when public funding of extension and research was cut, reducing the cooperation between research extension and education in agriculture. As a hypothesis it could be probed that that innovations to improve environmental performance of the agricultural system e.g. soil management are affected more by this transformation than innovations that solve a problem that farmers experience and that thus serve an economic purpose, such as tagetes. In the latter case dependent advisors may provide same advise in terms of content and intensity as independent advisors.

7 Case study narratives

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8 Conclusions: Insights & Highlights

Insights

The innovation process of tagetes can be called a success story, all farmers in the target group have successfully adopted the innovation. This success is surely not only the merit of successful advisory provision, but also more due to the combination of changing legislation blocking the chemical option, research having developed evidence of the effectiveness of an alternative in combination with farm advisors supporting individual farmers. Advisors support farmers to implement the new practices on the farm. The innovation is relatively straightforward since the agronomic benefits come together with ecological benefits. The practice does require new knowledge and skills, and the advisors support the farmer in developing them. This case also shows how even in the case of a clear win-win situation for all aspects of sustainability a strong outside trigger can be needed to justify the extra effort required for changing the familiar ways of working and adopting the biological control option.

The strong role of only one or two advisors in the non-inverse tillage case is remarkable. An interesting example how individual people can make a difference in the agricultural practice. It illustrates the value of presenting new ideas and alternative options at various occasions to create awareness and inspire change. Though the case does not show that a lack of advisory services is a reason for farmers choosing not to adopt the innovation. It seems that more specialised independent advisors on the topic would speed up or broaden the innovation process. Besides general support in all phases of the innovation process, they should focus on improving the quality of implementation under difficult circumstances and in explaining the advantages of the practice.

The non-inverse tillage case shows that once awareness and the aspiration to adopt are raised these farmers are very capable of organising the specific knowledge and support they think they need.

The case further shows the importance of independent advice. This innovation is not supported by dependent advisors since it is not related to agricultural supplies such as seeds, fertilizer or pesticides. The adoption of this innovation strongly depended on an individual advisor taking an interest in the subject and starting to provide information to farmers. This role could also be taken by public independent advice. The advisory support in these cases was mainly provided by the usual suspects - advisors, researchers and study groups.

Highlights

The cases provide some lessons about possibilities for effective policy support to sustainable innovation. The non- inverse tillage case suggests that in case the public deems a specific innovation desirable it can be a fruitful intervention to support the provision of advice on that specific subject. It further suggests that providing information and examples on innovative agricultural practices can indeed trigger innovation. The tagetes case suggests that legally restricting the use of chemical pest control can be an important trigger for the awareness and assessment of more biological options. Furthermore it shows the importance of investing in developing more sustainable alternatives and providing evidence for their effectiveness, even when farmers and advisors or the market does not seem to be interested yet. Most probably the legal restriction on the use of chemical disinfestation would not have been politically feasible without the

evidence of the effectiveness of the biological control alternative. Advisors of different types do play a considerable role in the dissemination of the knowledge on tagetes cultivation. However it seems that public funded research on alternative disinfestation methods played a key role in this innovation process.

In the non-inverse tillage case, in contrary, farmers and advisors are the main drivers of change, with research in a supportive role. It seems that these differences in the roles played by different stakeholders has to do with the people that happen to be involved in the subject, but also with the nature of the innovation. However, on the basis of these case studies we can only formulate hypotheses to try to understand these differences. One aspect that might play a role is whether the innovation entails a proven technical solution to a problem, as in the case of tagetes, or a long-term improvement to a management practice, as in the case of non-inverse tillage. Solving problems has traditionally been the role of research and fits in an agricultural AKIS designed to improve production, as the Dutch AKIS has long functioned. The improvement of soil management requires a more in- depth change in the perspective on production - from short-term to long-term, from controlling production circumstances to supporting biological processes. Furthermore, gathering evidence on the effectiveness of pest control is more straightforward than assessing the long-term effect of a practice on something as complex as soil fertility. The first is a clear research challenge, whereas the latter is served by an exploratory approach in a practice where farmers and advisors take the lead. It would be interesting to compare these insights with the other case studies in Agrilink to strengthen the understanding of the role of advice on innovation for sustainability.

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