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

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

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List of acronyms

ADV	Alto Douro Vinhateiro (Alto Douro vineyard)
AgriLink	Agricultural Knowledge: Linking farmers, advisors and researchers to boost innovation
AKIS	Agricultural Knowledge and Innovation System
AOS	Advisory Organisation Supplier
CAP	Common Agricultural Policy
CONFAGRI	National Confederation of Agriculture Cooperatives and Farm Credit Cooperatives
DoA	Description of the Action
DOC	Denomination of Controlled Origin
EEC	European Economic Community
EEI	Enhancement of Ecological Infrastructures
EU	European Union
FBO	Farmer based organisation
FS	Farmers' survey
ICT	Information and Communication Tools
INE	Instituto Nacional de Estatística (Office for National Statistics)
IVDP	Porto and Douro Wines Institute
LDA	Local Development Action
Micro-AKIS	Micro-level Agricultural Knowledge and Information System
NGO	Non-Governmental Organisations
NUTS	Nomenclature of Territorial Units for Statistics
NWC	New World Countries
R-FAS	Regional Farming Advisory System
R&D	Research & Development
RDP	Rural Development Programme
RMAG	Regional Multi-Actor Group
TCM	Trigger-Cycle Model
UNESCO	United Nations Educational, Scientific and Cultural Organization
VAT	Value-Added Tax
WP	Work Package

Executive Summary

This synthesis country report contributes to the WP2 (Innovation case studies in Focus Regions: micro to meso analysis) goals, which comprise understanding why, how and from whom European farmers and farm managers gather and exchange information to underpin their decision-making on developing and/or implementating of different types of innovation, and as well as analysing the role played by advisors in these processes. It introduces the three case studies conducted in Portugal: *BIO-Douro*, *TECH-Lezíria*, and *DMAR-Tâmega.* The selection of these case studies and the methodological approach followed for data gathering were defined by the WP2 empirical framework, which is briefly introduced by the report. Data was collected with interviews applied face-to-face to a snowball selected sample of 35 to 45 farmers, depending on the case study, including innovation adopters, non-adopters and droppers (adopters whom have abandoned the innovation). The interviews were structured comprising both close and open questions, generating both qualitative and quantitative data. Advisors and AKIS key actors relevant for the innovation were also surveyed. Data collected allow to depict farmer's micro-AKIS across the different stages of the trigger cycle change model (TCM) and to relate this with the farm and farmer characteristics and with the main features of regional farming advisory systems (R-FAS).

BIOP-Douro case study focus on an innovation comprised by Biological Pest Control (BIOP) cluster, which consists on the enhancement of ecological infrastructures (EEI) in the Douro region vineyards. Douro (NUTS 3 Douro) is an agrarian remote rural area located in the Northeast of Portugal and its landscape, as well as its history and economy are closely related to the grapevine and wine growing activities. The contextual trigger for the EEI innovation in the region was a constellation of three major events which took place in the 1990s. These involve the landscape classification as world heritage by the UNESCO (in 2001) and the wine sector global dynamics, which competitiveness become (in the nineties) extremely dependent on high differentiated wines communicated through "good stories" and a sustainability good reputation. The pioneers of the innovation were a small group of wine growers supported by a vine growers association they had created in the 1980s with an innovative approach. It's a farmer based association (FBO) largely funded by the wine growers and oriented towards back-office activities, by investing in scientific training of their advisors, involving in R&D, and enhancing the region wine sector networking with the best practices from vine growing to wine marketing around the world. The EEI innovation goes beyond the no-tillage cover crops practices (soil improvement cropping systems, an innovation also selected by AgriLink) and consists on introducing, recovering, restoring and maintaining an ecological network in the vineyards. This network comprises the soil green cover, live hedgerows, schist walls, bushes and grassy vegetation in the slopes of land terraces, aiming at enhancing the eco-functionally of the landscape. The development of this innovation mobilises both scientific and intensive in-field knowledge creation through learning-by-doing and "peers" experiences exchange. Nevertheless, publicly funded R&D and demonstration projects were key to the launching of the innovation and to raise awareness about it among grapevine and wine growers in the region. Large and medium wine growers with a business model based on own brands and reputational capital, were the early adopters and played a relevant role in triggering awareness on other producers. The innovation assessment is done through experimental implementation, hence largely dependent on the farmers themselves, whereas strongly backed up by the mentioned FBO which is pretty much imbricated with the R&D sector through close relationships with a group of researchers from the regional university, the UTAD, that had introduced years ago the integrated protection and production in the region. Currently the implementation of the innovation, along with the awareness and assessment stages for new potential adopters, supports on a "triple helix" knowledge and innovation system, comprising: the mentioned FBO, the R&D represented by a small group of researchers, and the vine growers themselves, most of them farm managers of commercial wine estates. There is, however, a large group of non-adopters encompassing the majority of small and medium familiar grapevine growers that by doing grapevine bulk sell don't experience benefits from the innovation and face resources constraints to implement it. These include land and labour shortage along with limited access to the scientific and empirical knowledge demanded by the innovation.

The *TECH-Lezíria* case study focus on the adoption of smart irrigation sensors by the farmers with irrigated crops in the Tagus flatlands (Lezíria do Tejo, NUTS 3) region. Lezíria do Tejo is an agrarian region nearby the Lisbon conurbation. In this case the innovation was also triggered by a dynamic FBO, a farmer's association launched by a group of innovative farmers back to the 1980s, with the aim of boosting the irrigated maize in the region in order to benefit from the CAP direct supports to cereals production at that time. The successive CAP reforms led to the total withdrawal of direct payments to the production raising major challenges to the maize producers that were forced to diversify their crops and to invest in the farms environmental performance to meet policy and eco-efficiency

sustainability requirements. In this case study the mentioned FBO played a key role in raising awareness about the innovation, both amongst the farmers and other FBO that have more recently become involved in supporting the innovation. The adopter's micro-AKIS doesn't change much along the TCM, although it broadens along the cycle, the implementation stage encompasses in addition to the FBOs, the irrigation equipment suppliers, less often the hi-tech companies, and the agro-industry that buys vegetables directly to large farmers. The R&D sector and the independent private advisors are mentioned as complementary sources of advice for a residual number of farmers. The dropping and non-adoption of the innovation is justified by most of the farmers in these groups by the fact they hold (or rent) fragmented and relatively small plots of land what entails the use of too many sensors (at least one per plot), situation they evaluate as excessively costly in face of the low economic benefits they perceive from the sensors when sparsely used. In this case study non-adoption appears mainly related with farm structure aspects and isn't related with lack or poor support from advisory. In general, appear to be satisfied with the support they receive to irrigation, and with the sensors in the case of the adopters of the innovation. In addition, although the innovation has been launched and be still led by the FBO related with irrigated maize expansion in the region, the regional AKIS and R-FAS related with irrigation (suppliers and other FBO) and with the bulk buying and processing of the irrigated crops (FBO and industry) are currently involving with the innovation at all stages of the TCM. The high technology companies developing the software for sensors tend to involve with the FBO and not directly with farmers. Direct involvement of R&D sector with the farmers is also not evident in this case study. The importance of advisors in this case is clearly related to the nature of the innovation, which is used by the majority of the famers as an "off-the-shelf" technology. Only a very small number of adopters show to be able of mobilising the intense flow of synthetic knowledge generated by the sensors and to combine it with information from other technological devices, such in-field weather and irrigation monitoring equipment's.

DMAR-Tâmega is a case study exploring direct sell by small-scale farmers, marketing /organisational type of innovation, in the Tâmega e Sousa (NUTS 3) region. This is an intermediated consumption countryside region in the Northwest of Portugal. In this case the innovation was largely triggered by two regional Local Development Action (LDA) groups that first introduced in the region a currently nationwide programme the PROVE, that developed a methodology to support the direct sell from farmers to consumers of seasonal fresh vegetables and fruits grown by small-scale farmers. The scheme is based on the weekly delivering by the farmers themselves of fresh vegetables and fruits baskets to consumers, which previously order them, at pre-established meeting points in urban areas. This region was one of the most successful at the time that the programme PROVE was launched and went well during the period the LDAs benefited from funding to implement the programme. At the awareness stage the adopters micro-AKIS depended pretty much on the LDAs, while encompassed other actors involved by the LDAs, that built on a network approach involving local institutions and other organisations, such as the local cooperatives and the local governments. Assessment was basically done through implementation and at these two stages the farmers' micro-AKIS broaden a little encompassing the FBO (local cooperatives and farmers associations) and the local governments, while evidencing an intense exchange between "peers". The interaction between farmers was expected given it was part of the PROVE approach to provide only support to early-stage implementation to groups of adopters that were supposed to be afterwards autonomous. That didn't happen, and with the end of the funding to the programme the groups dissolved. A substantial number of adopters abandoned the innovation, the totally in the more peripheral part of the region, and the adopters that continued or that joined the PROVE approach more recently (including organic producers) are individually-led or group with a maximum of two permanent partners. This case study highlights the absence of an advisory system able to support marketing and organisational innovation addressing small-scale farmers. In spite food short supply chains are a proven solution to enhance the sustainability of small-scale farming, the development of a fitted AKIS seems to be far away. Such an AKIS needs to involve cooperation between the farmers and the consumers and to go beyond the sphere of conventional advice in agriculture, by offering support in a number of competences, from logistics, packaging, food safety and financial legislation, marketing and cooperation.

These three cases studies present different features of the innovation in agriculture highlighting the need to develop place-based advisory systems able to shape different AKIS, attending to: a) the different nature of the knowledge demanded by the innovation; b) the farm structure heterogeneity; c) the innovation demand for territorial scale to address sustainability challenges.

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 Portugal an inventory of potential case studies to render relevant insights on the advice role for the innovation domains targeted by AgriLink was carried out between July and October of 2017. Four case studies were selected:

- Douro grapevine and wine growers (*BIOP-Douro*). This case study focus on an innovation comprised by the Biological Pest Control (BIOP) cluster, consisting on the enhancement of ecological infrastructures in the vineyards of the Douro region (NUTS 3 Douro). The group of farmers addressed by the case study were the commercial grapevine growers. The focus region Douro is an agrarian rural remote region located in the Northeast area of Portugal.
- Direct selling by small-scale farmers in the Tâmega e Sousa region (*DMAR-Tâmega*). This case explores short food supply chains promoted by small-scale farmers of the NUTS 3 Tâmega e Sousa (previously designated Tâmega, until the NUTS 2013 revision, enforced in Portugal in 2015), an intermediate consumption countryside region in the North of Portugal.

- The smart irrigation sensors in the Tagus flatlands (*TECH-Lezíria*). Smart farming innovation was addressed related with irrigated crops, in an agrarian rural region but close to the metropolitan conurbation of Lisbon. The region is included in the NUTS 2 Alentejo into the South part of Portugal, but it's a specific agrarian region characterised by high fertile soils in the Tejo river valley, in both North and South side of the river. Commercial farmers of irrigated crops, such as cereals, mostly maize, and vegetables are predominant in this region, and were targeted by this case study.
- The forth selected case was a small emergent case comprised by the LABO innovation cluster. It was selected due to the relevance of the sustainability challenge it addresses, the social and environmental impacts of land abandonment in the rural remote areas of the Centre region of Portugal. However, it was not possible to implement the fieldwork due to difficulties in identifying and interviewing the farm owners (emigrants and land heirs living in urban areas) contracting the services of a cooperative that launched the subcontracting services in 2017.

The advisory services in Portugal are mainly supplied by farmer based organisations (FBO). However, in general, the FBO are focused in supporting farmers with the agricultural subsidies applications, under the Common Agricultural Policy (CAP) and in particular of the Portuguese Rural Development Programme (RDP). Portugal never had, historically, a universal and consolidated public agricultural extension service (Baptista et al., 2014). After the Portugal entrance at the European Economic Community (EEC), in 1986, a major programme named PROAGRI was launched aiming at strengthening the capabilities of farmers' organisations in the areas of management and technical support to farmers, both members and non-members of these FBO. Hence, in 1990s a FBOs advisory system was relatively consolidated in Portugal, reflecting the advisory services privatisation trend at the time in Europe, whilst being mostly publicly funded, given the predominance of small-scale farming in the country and the impossibility of promoting a universal private advisory system. FBOs comprise numerous regional and/or sectorial farmer associations and cooperatives, which are networked through three major umbrella nationwide confederations. The larger one is the Confederation of Portuguese Farmers (CAP) with more than 250 members, comprising all the different types of FBO. The National Confederation of Agriculture (CNA) focus on small-scale farmers associations, and has currently around 80 members. The National Confederation of Agriculture Cooperatives and Farm Credit Cooperatives (CONFAGRI) includes exclusively cooperatives. This FBO advisory system although spread across the regions, sub-regions and agricultural sectors, is mainly composed by financially weak organisations that are heavily dependent on the funds from the agricultural and rural development programmes and agricultural policies. Its weakness reflects on significant limitations to supply technical individual support and regular training to farmers, although they show helpful to farmers participating in collective advice and training sessions, that FBOs organise resorting to funding opportunities offered by the RDP (namely Measure 2.1 funding information and training actions organised by FBO). More recently in some municipalities, local governments provide support to these farmers' organisations, using own funds, namely by making available facilities and supporting respective maintenance costs. Less often they support as well as costs with human resources allowing to the organisations the offer of more personalised technical advice.

The R-FAS in the three selected focus regions can be described as the Portuguese typical FBO advisory system, comprising regional and sectorial farmer associations, farmer organisations and cooperatives. However, they depict different cases of advisory roles and challenges in the introduction, support and dissemination of the innovations.

In the *BIOP-Douro* a FBO played a determinant role in the introduction of the innovation, "enhancement of ecological infrastructure in the vineyards" by promoting and leading R&D projects developed in partnership with R&D national and international institutions, and a small group of grapevine growers. These were medium to large grapevine and wine growing companies operating in the wine sector focused on producing high quality DOC (Denomination of Controlled Origin) wines, along with the traditional production in this region of Porto wine. This FBO is a sectorial association created in1982 by a small group of medium and large winegrowers with the aim of developing R&D activities, build on projects and partnerships at regional, national and international level, driven by enhancing competitiveness of regional brand of Douro DOC wines. The sustainable challenges directly addressed by the innovation in this case study were environmental, although closely interrelated with social and economic issues. High quality wine sector is a globalised one and addresses sophisticated consumers that value hedonistic attributes, meaning that they buy a wine with a narrative associated. Wine growers rely on creating good stories around the wine, highlighting extrinsic attributes, resumed by the term "terroir", which comprises the history and culture of the region of origin, the landscape aesthetics, and values related to sustainability and authenticity. These issues are reinforced in the case of the Douro region because its mountainous vineyards define a landscape that was classified by UNESCO as world heritage in 2001. The classification gave visibility to the region's landscape, and the tourism, in particular the wine-tourism, is growing since then.

The *DMAR-Tâmega* case study targeted small-scale farmers, producing vegetables, legumes and fruits, like berries and kiwis, including adopters, non-adopters and droppers of short marketing chains business models aimed at increasing added value from their agricultural production. The idea was introduced in the region in 2009 through the launching of the programme PROVE (Promote and Selling)[1] by the Local Development Association (LDA) ADER-SOUSA. This LDA was among the three LDA that initiated the dissemination of the programme across the country. The proximity with urban consumers of the Porto metropolitan area was the main reason for the launching of the programme in this region. The focus region Tâmega and Sousa NUTS 3 (at the time only designated Tâmega) is an intermediate consumption countryside nearby of the Porto conurbation. This case study highlights the role of not conventional R-FAS actors, as the LDA, that were responsible for the introduction and dissemination of this marketing and organisational innovation which remains largely outside of the range of conventional R-FAS. The large number of droppers and the business model reorientation of most of the early adopters observed in this case study shows the R-FAS limitations to support marketing and organisational innovations. Hence, the case study underlines how promising innovation to respond to social dimension sustainability challenges, by empowering small-scale farmers and increasing territorial cohesion, can fail to create a sustainable transition path due to advice shortage and incomplete AKIS.

The *TECH-Lezíria* case study shows a best-fit case of advisory organisation. The innovation "smart irrigation sensors" addressing eco-efficiency challenges, specifically to save water and costs related to the irrigation of annual crops, mainly maize and vegetables, was introduced and it's implemented with the support of a regional FBO. This FBO works closely with the R&D sector and the hi-tech companies involved in the development of this ICT innovation, enabling a dynamic innovation development focused on responding to the farmers needs and addressing the agro-ecological specificities of the agriculture in the region. This case study introduces a strong FBO build on an innovative business model that enables it to supply direct and

[1] More information available on the website http://www.prove.com.pt/www/english.T9.php

in-person advice to farmers by being also an inputs supplier, what allows it to supply advice to all types of commercial farmers from small-scale to large ones.

In the following two sections the report introduces the conceptual framework and the research questions (Section 2) and presents the empirical framework developed by AgriLink for data collection (Section 3). Section 4 describes with more detail the three case studies implemented in Portugal. Section 5 presents the main results obtained from data analysis for the three case studies. Section 6 offers a discussion of the results presented in the previous section according to the research questions addressed by WP2. Section 7 describes through narrative format the sequence of decisions undertook by adopters and non-adopters along the trigger cycle change model for the three innovation at stake in this report, with a focus on the role of advice and respective suppliers. Finally, Section 8 offers the main insights and highlights obtained from the observation and analysis of the three 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).

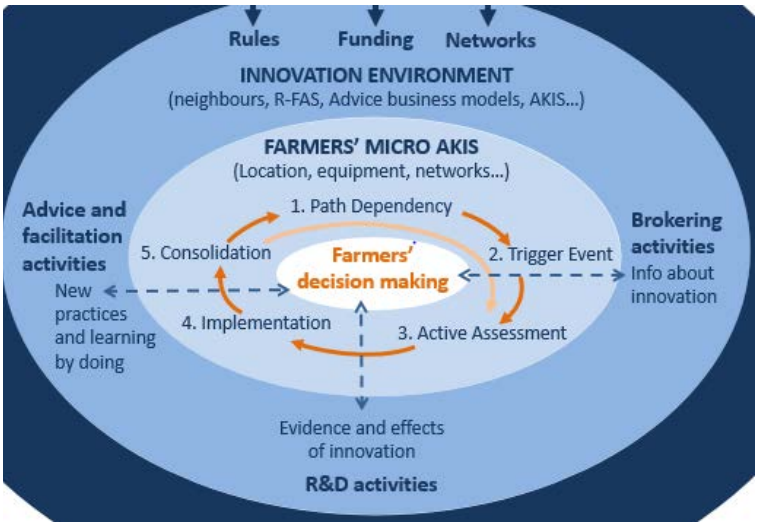
The Focus Region is as a farm census region that establishes the boundaries of the case study for data collection on micro-AKIS and R-FAS. Preferential geographical region is defined at NUTS 3, which is in certain cases replaced by NUTS 2 to achieve a better case study delimitation.

The micro-AKIS describes the micro scale knowledge-system that farmers personally assemble, including the range of individuals and organisations from whom 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

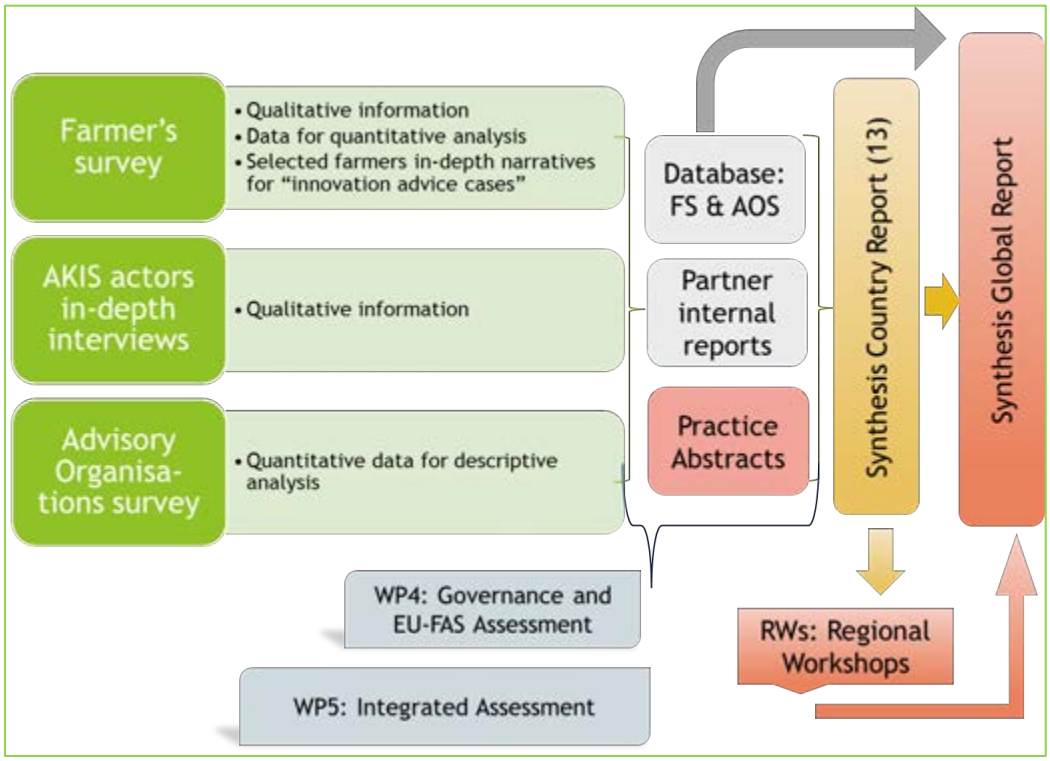
The farmers' selection in each case study built on targeting groups of farmers amongst whom the innovation is already widespread, so that it would be possible to characterise the micro-AKIS supporting innovation up-take of adopters, as well as the micro-AKIS of non-adopters.

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.

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 close 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 suppliers' (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 suppliers' role. Three narratives per case study was 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 required by 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 avoid selection bias, different information sources need to be used and cross-checked (See Deliverable D2.1 for a detailed description of farmers sampling strategy).

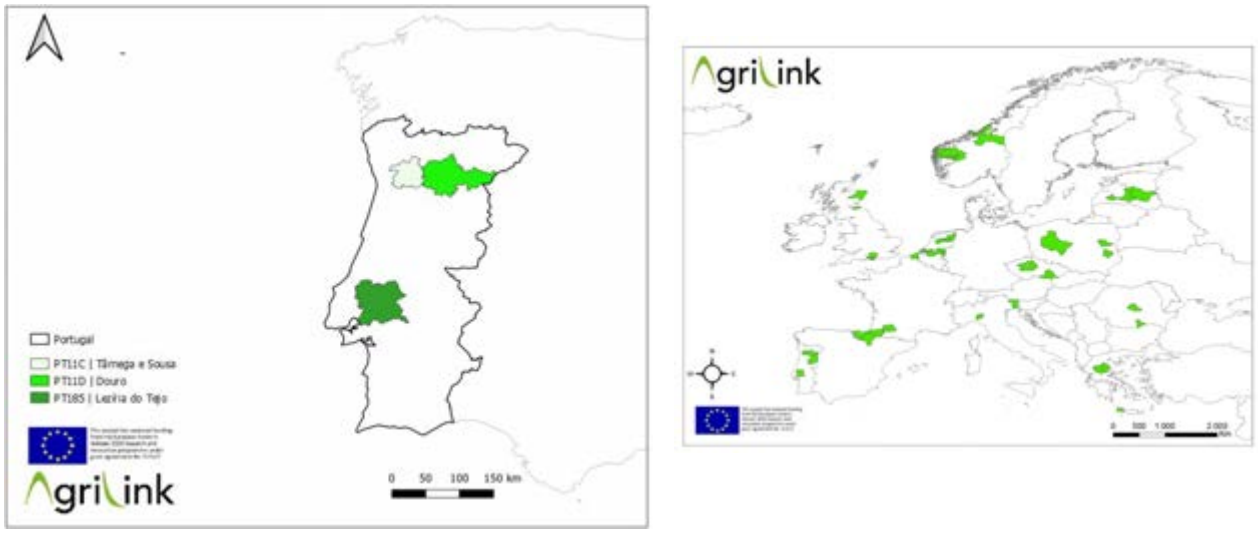
The advisory organisations were sampled through a snowball process relying on diverse sources to ensure that the complete spectrum of advisory organisations supplying (or that could supply) advisory or related services are included in the sample. A minimum of 20 organisations was established for the 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

4.1 The case studies and focus regions

In Portugal three case studies were developed, as explained in the introduction to this report (Section 1). **Figure 3** shows the location of the respective focus regions in Europe and in Portugal.

Figure 3: Geographical location of Portuguese focus regions



Source: Own construction

4.1.1 Case study *BIOP-Douro*

In the Portuguese case was considered important to select an innovation related to farming practices within the selection focus of AgriLink in integrated ecological farming. This was related with the weight of permanent crops, both in cultivated area and economic value generated by the Portuguese agriculture, and their importance and growing contribution to the agricultural exports. Different crops were considered, namely grapevine, fresh fruits and chestnuts due to their vulnerability to sustainability challenges encompassed by climate change and to an increasing incidence of novel pervasive pests and diseases. Innovative agro-ecological farming practices were investigated for these crops across the country (Portugal Continental) during the period of inventorying potential case studies for WP2. The ecological infrastructures enhancement in the Douro vineyards revealed a very interesting innovation to study in the context of AgriLink research questions, given the advisory challenges involved by an innovation which builds on scientific knowledge but requires in-field trial and error experimenting and active learning from the farmers. Another challenge related to this innovation is its assessment, given it has to be done through implementation and requires long term in-field experimentation to render evidence on the benefits and costs and the respective balance.

This innovation is being developed in Douro due to a particular constellation of three major events occurring simultaneously in the 1990s: a) the food safety concerns and incentives that led to the popularisation of environmental beneficial farming practices; b) the vineyards landscape classification by the UNESCO; and, c) the global dynamics in the wine sector. The regional integration of these external

changes leveraged the Douro winescape singularity and explain why such a sophisticated innovation as the EEI became possible and is becoming popular.

The dissemination of the integrate protection and integrate production in region initiated in the 1990s, incentivised by the Council Directive 91/414/EEC of 15 July 1991 concerning the placing of plant protection products on the market. It was quite successful in this region dominated by vineyards and other permanent crops, such as olive-yards and the apple orchards in the Southeast part of the region. In this decade the pressures from consumers, society and the EU legislator regarding food safety were acknowledged by the producers of the region that were at the time investing in a quality differentiation strategy of their products. The legal requirement of technical support from qualified advisors created room for the development of dedicated services in existing FBO and the creation of new agricultural organisations focused on offering technical support to the integrate protection in the vineyards and other crops. Universities and other higher education institutions, like superior Agrarian Schools, included integrate protection in their curricula for the students in the agrarian field, and a significant number of them had dedicate advanced training in-field to plant integrate protection, hence contributing to the accumulation of a relevant scientific-based applied empirical knowledge on this subject along with the development of skills and expertise at the sectorial and local level (Amaro, 2013). The evolution to the integrate production and to a certification framework moved the support to the certification services. This change was evaluated as negative from in-depth interviewed AKIS key actors in relation to the innovation, and their opinion is probably generalised, given that the Portuguese RDP 2014-2020 had introduced a 15% premium to the baseline support when farmers applying for adds to the integrate protection and production contract technical support. However, in spite of the withdraw of incentives to the technical support, the continuation along the time of the adds to these farming practices, alternative to the conventional agrochemical control, allowed for the accumulation and dissemination of important knowledge on plant protection by advisors and farmers, leveraged by a large informal knowledge network on this subject, involving advisors, farmers and researchers along with input suppliers and farm products clients. The introduction in 2015, through the RDP 2014-2020, of an agri-environmental measure (Measure 7.4.2) to provide financial compensation to the green cover of permanent crops stimulated the adoption of these type of agro-ecological practices in accumulation with integrated production. The Douro region represents almost 25% of the area under this measure in the total of the country (IFAP, 2015), and it's mostly adopted for the vineyards as show by their concentration in the parishes where this crop represents more than 85% of the area of permanent crops, known as "Alto Douro Vinhateiro (ADV)".

The ADV is the core area of the Douro Designated Controlled Origin (DOC) region which boundaries roughly overlap the NUTS 3 Douro. The Douro DOC is one of the oldest regulated winemaking regions in the world, settled in the year of 1756 aiming at protecting Porto wine. The vineyards were installed in the sloppy hills of the Douro river valley supported by loose stone schist walls handmade in the 18th century. The phylloxera pest decimated the vineyards in the decade of 1860s and around 10 years after its recover has been initiated with the installation of new vineyards in a new type of stone schist walls, robust and larger. The landscape recovering accentuated its previous patchwork configuration, in particular in the ADV: a patchwork landscape were the vineyards, surrounded by olive trees and fruit trees, olive-yards, stand up, but were other elements, such as the Mediterranean bushes (remains autochthonous cover of this area) and the "mortuaries", the remains of the older vineyards decimated by the phylloxera, are important biodiversity pools" (Aguiar et al., 2001). The heritage value of this landscape was acknowledged in 2001 by the UNESCO. The process leading to the landscape classification was launched in the late 1990s as a way to bring visibility to its unique landscape and to reinforce the Douro territorial brand competitiveness within a highly competitive market due to the entrance of the new world players.

The landscape classification end up to be a powerful tool to prevent the loss of its character, that was in motion since the 1980s through a process of large scale vineyards reconversion. The Douro vineyards modernisation aimed at enhancing its mechanisation to cope with massive labour scarcity formerly available to cultivate the vines using animal traction. It was initially funded by the World Bank before Portugal entered the EEC, and then by the EEC programmes to support the Portuguese agriculture modernisation. The reconversion consisted largely on replacing schist walls by land terraces and by planting new vineyards upright to the terrain level contours, eliminating surrounding tress and live hedgerows, and planting new vineyards in areas occupied by the Mediterranean bushes and the "mortuaries". Hence, the launching of the process towards the landscape classification was itself a contextual trigger that had raised awareness for the need of environmentally friendlier farming practices in the region. The UNESCO world heritage classification brought international visibility to the region and an increasingly rise in tourism, in particular in wine-tourism, and henceforth opportunities to create and capture added value from the wine by associating it to the landscape cultural and environmental value. Gradually the region experienced an inversion of the local social norm defending the reconversion towards a mechanised vineyards monoculture by a nowadays consensual rejection of the "lunar landscape" that vine-growers were creating in the 1980s. It's has been replaced by a narrative highlighting the importance of a landscape "full of life" build on recovering, maintaining and reinforcing its eco-functionality.

The third event that has strongly contributed to emergence of the EEI innovation by levering the launching of the UNESCO classification, was the global dynamics in the wine sector. In the begin of the 1990s the entrance of New World Countries (NWC) in the quality wine market created a huge pressure over the traditional European wine producers (France, Italy, Spain and Portugal) that were forced to invest strongly on their wines differentiation and reputation (Rebelo and Muhr, 2005). The NWC by lacking the value of tradition and cultural heritage invested heavily on oenological quality and sustainability inducing a strong dynamic for the aestheticization of wine production and consumption (Beckert et al., 2017; Negrin, 2015), build on marketing strategies based on the "terroir" singularity and on values comprising authenticity and sustainability.

Hence, in the later 1990s this particular constellation of events created room for the introduction of the selected biodiversity-based innovation known as enhancement of ecological infrastructures (EEI) in the vineyards. This isn't an innovation with a straightforward definition, as will be shown by the data collected. The EIs comprise the ecologic network made of green cover of vineyards, live hedgerows, schist walls, bushes, grassy vegetation in the slopes of land terraces, which enhance the habitat of auxiliary fauna (arthropods, birds and reptiles) to increase the effectiveness of natural enemies of grapevine pests (Carlos et al., 2010 and 2011). It entails recovering, maintaining and improving these IEs in the vineyards. And by comprising soil coverage both of vineyards and the slopes it is as well a soil improving cropping system type of innovation, protecting the soil and the land terraces from severe erosion risk due to the high slope defining the vineyards in this hilly region.

Figure 4: Ecological infrastructures in Douro vineyards

Source: Photo took by the UTAD team

The innovation was introduced and developed in the region by a sectorial FBO, a vine growers association (ADVID) that is an advisory organisation focused on R&D and network activities, although it supplies technical support to members in particular in the area of integrate protection and protection. The technical support to EEIs is also delivered by request but requires an extra payment. However the association has conducted advice group actions to disseminate and to support the implementation of the EEI among its associates.

To develop the innovation, the ADVID[2] built on EU funded research and demonstration projects, implemented by multi-actor partnerships involving researchers and vine growers. The organisation integrates the R-FAS but is exceptional respecting its business model, leadership and main activities. Hence, this innovation is led by an innovative organisation which members are medium to large grapevine growers, and is headed by wine estates owned by wine companies operating in the global market. The regional FAS, in particular the sectorial organisations, comprising a significant number of cooperatives and some grapevine producers associations, while involved in integrate protection and production, aren't so far supporting this innovation, as shown by data collected.

4.1.2 Case study *DMAR-Tâmega*

The food short supply chains became popular across the world given they allow farmers to capture more added value from their productions and hence contribute to the development of rural areas (Renting et al., 2003). They are of particular importance to small-scale farming due to the difficulties small-scale farmers experience with the selling of their products, including lack of buyers and very low prices at the farm gate. An interesting and awarded programme to promote direct selling in Portugal was the PROVE[3,4]. The programme PROVE developed its own framework to facilitate the farmers direct supply to consumers of the "PROVE baskets" that has to be managed by the farmers themselves after a training period.

Figure 5: Horticultural crops and PROVE baskets

[2] ADVID (Associação para o Desenvolvimento da Viticultura Duriense).

[3] PROVE – Promoting and Selling. More information available at http://www.prove.com.pt/www/english.T9.php

[4] PROVE received the 1st prize in the category "Support for the development of ecological markets and resource efficiency" at the 10th edition of the European Awards for Business Promotion awarded by the (European Enterprise Promotion Awards – EEPA). PROVE was also acknowledged as an European good practice by the DG-AGRI in the Cork 2.0 European Conference on Rural Development held in Cork, Ireland in 5-6 September, 2016.

Source: Photos of ADER-Sousa

The PROVE methodology bases on the creation of small groups of famers, 3 to 5 small-scale farmers, that collectively prepare the baskets combining their different seasonal products addressing the consumers demand for vegetables and small fruits, and that have to organise the logistics to weekly deliver the baskets directly to the consumers in predefined delivery points in the consumer's residence area. PROVE developed a specific software to support the on-line orders management by the farmers. The programme was launched at pilot scale in 2006 by a LDA in two municipalities close to the Lisbon conurbation, funded by the EQUAL programme. Later, in 2008, as part of the dissemination phase, more four LDA across the country, including ADER-SOUSA[5] in the Northwest of Portugal, in the NUTS 3 Tâmega e Sousa (named Tâmega until the 2015 NUTS 3 revision). The programme PROVE benefited from funding from the Portuguese RDP 2007-2013 (PRODER[6]) and spread across the country (Portugal Continental) supported by 16 regional LDAs, including another one from the focus region, the DOLMEN[7], which operated (an still does) in the Eastern part of the region. In 2012, the focus region was a nationwide successful case by having 45% of the PROVE producers and 30% of the PROVE groups of producers, a total of 6 groups and 26 producers (Baptista et al., 2012).

The focus region Tâmega e Sousa is an intermediate consumption countryside region, comprising two areas, the Sousa river valley, in the Western side, close to Porto conurbation, and a more inland Eastern area known as Low-Tâmega. The proximity of Sousa Valley to the Porto conurbation was envisaged as good location to promote the PROVE initiative in this region. Hence, given this is one of the pioneer regions implementing the programme PROVE as it's simultaneously a region with a large number of small-scale farmers, 84% of the farms have less than 5 hectares (GPP, 2017), full and part-time farmers, it was selected to study the direct marketing innovation.

The R-FAS is similar to the other regions in Portugal, dominated by the FBO, comprising cooperatives and sectorial and regional farmers associations. Its role in the launching and implementation of the PROVE baskets innovation was limited to some facilitation, for instances opening their facilities to dissemination and training actions organised by the LDAs. The LDAs led this innovation supported by a multi-actors partnership along its different stages from dissemination and support to implementation build on the

[5] ADER-SOUSA (Associação de Desenvolvimento Rural das Terras do Sousa).
[6] PRODER – Programa de Desenvolvimento Rural
[7] DOLMEN – Desenvolvimento Local e Regional, C.R.L (https://www.dolmen.co.pt/).

programme framework, offered through a published and on-line booklet with guidelines and additional learning materials, as well as the ICT tools. The regional FBO were involved in these partnerships along with local governments with a facilitation function. This is a case study allowing for the analysis of the role of new advisory actors popping out outside of the agricultural field, like the LDA. However, LDAs are focused on the territorial development and held competences for designing and implementing strategies and programmes at the meso region-scale, hence showing a limited scope and poor competences to help farmers in consolidating their direct selling strategies at a micro-level scale.

4.1.3 Case study *TECH Lezíria*

The NUTS 3 Tagus flatlands (Lezíria do Tejo) is a region with a strong agrarian vocation due to its soils fertility resulting from its location in the Tejo river valley floodplain. It is an agrarian predominantly rural area close to city. It comprises medium sizes cities and is nearby the Lisbon conurbation.

The Lezíria do Tejo was the Portuguese region that most beneficiated from the CAP until its first reform in 1992, due to the dominance of irrigated cereals in the cultivated area, in particular the maize in the Northern part of the region. Hence, after the Portugal entrance in the EEC the area of irrigated maize grown substantially followed by an increasingly productivity. The CAP reform in 1992 that transferred part of the direct support to indirect support decreased the producer's income but not significantly and didn't impact the cultivated area. However, the CAP reform of 2003 by eliminating completely the direct support had a huge impact on the producers income (according to Costa, 2017, the aid reduced from around 37 €/ha to 6 €/ha). Since then the region experienced a decline in the cultivated area of maize, that more than halved between 1986 and 2017, being mostly replaced by the growing of fresh vegetables. The dominance of profitable industrial crops, the maize in the Northern subregion, and the rice and the tomato in the Southern, shaped a strong agricultural sector in this region which explains its AKIS vitality. The regional AKIS builds on the FBOs similarly to other regions in the country, although with a strong presence of the private agro-industry and upstream industry (suppliers of inputs, equipment's and technologies), and in Southern subregion the R-FAS comprise also the FBOs managing collective irrigation infrastructures.

Figure 6: Maize and horticultural crops in Lezíria do Tejo

Source: Photo maize, milhoamarelo.pt; Photo horticultural took by the UTAD team

The success of maize in the region is largely associated to a group of farmers that view the opportunities brought by the CAP and founded the AGROTEJO[8] in 1986, which is a large FBO, initially with 600 associated farmers (individual and enterprises), and counting currently more than 1000 members, including

[8] AGROTEJO (União Agrícola do Norte do Vale do Tejo).

also collective organisations outside the farming sector, such as an environmental NGO, local governments, and social non-profit organisations. AGROTEJO developed an innovative business model by creating in 1987 the AGROMAIS[9] that is a cooperative own by it. The cooperative was created to agglomerate, pre-process (maize drying) and store the maize and other cereals, and later on to ensure similar type of operations for the new crops, adding the packaging of fresh vegetables. AGROMAIS had initially 400 associates and counts currently with 1200. It is since then the major agro-industrial operator in the sector of cereals at the national level. AGROMAIS agglomerates and uses its large scale to gain bargain power in the negotiation with the regional agricultural large buyers, comprising the powerful national and international agro-industry and the large distribution. A third organisation was created in 1998, the AGROMAIS PLUS[10], which is a private company fully owned by AGROMAIS, and that is an input supplier, including the supply of irrigation equipment. Hence, this is a case of a fully integrated FBO able to supply not directly paid farmer-to-farmers advice, along with paid technical advice services, by supplying faming inputs and irrigation equipment. The risk of advice bias due to coupling supplying inputs and equipment's together with technical advice is in this case minimised given that the company is owned by the farmers and depends on their economical sustainability.

The fact this FBO being created by a group of innovative farmers probably explains its permanent focus on knowledge and innovation. Hence, Lezíria do Tejo is a pioneer region in the introduction of precision farming and the smart farming in general, largely headed by AGROMAIS. Given the importance of irrigation in this region this FBO also pioneered the introduction of soil moisture probes (intelligent irrigation sensors) along with other technologies to increase water use efficiency and to optimise the crops irrigation. The first "probes" were introduced around 1998 and were manually-handled, hence requiring a lot of human effort and provided limited results. The FBO tested this equipment for around 4 years, basically with learning and demonstration purposes. The appearance of the intelligent irrigation sensors, known as soil moistures probes, in 2008 launched an ICT innovation dynamic focused on irrigation optimisation headed by the organisation that had since then worked closely with high technology developers, start-ups and companies developing software to the probes. Hence this a case where "conventional" advisors played a key role in the introduction and development of the innovation, by working with the hi-tech sector in the design and supply of the technology, aiming at best-adjusting it to the farmers' needs, considering their agro-ecological conditions (soils and climate), crops, and irrigation systems.

What do the soil moisture probes do? They are installed in the soil and monitor in real-time parameters such as humidity, temperature and salinity at different soil depths. Hence they measure soil water availability by communicating the monitoring data to computers, mobile phones and other mobile devices, through software developed in an app format that stores, manages and integrates data from other devices, namely from field meteorological stations. These intelligent humidity sensors allow farmers to know when and how much water is needed to irrigate their fields in an eco-efficient manner. Data can be directly used by farmers installing the app in their mobile phones or other electronic devices. However, most of the adopters, as shown by the farmers' survey data, rely on the weekly report and alerts, the information "ready-made" prepared by AGROMAIS that analyses and interprets continuously the data from the probes together with the meteorological information.

The introduction of an agro-environmental measure (Measure 7.5) in 2015 paying farmers for efficient irrigation water use incentivised the use of the probes by the farmers, although the design of the measure

[9] AGROMAIS – Entreposto Comercial Agrícola, C.R.L.
[10] AGROMAIS PLUS Produção Agrícola, S.A.

wasn't initially interesting for farmers according to the view of the interviewees, and some, including large farmers, choose not joining the measure.

4.2 Group of farmers target and sampling strategy

The group of famers has been already identified in the previous subsection, hence they are summed up in the following bullets.

- Case study *BIOP-Douro* targeted the Douro commercial grapevine and wine growers, comprising adopters and non-adopters respecting the selected innovation, the enhancement of ecological infrastructures (EEI) in the respective vineyards. This group concentrates on the municipalities of the ADV area of the vast and heterogeneous Douro region (13 of 19 municipalities), and comprises small to medium scale grapevine growers, and medium to large[11] grapevine and winegrowers, with own wine brands. Hence along with diverse farm structures, there is a relevant difference, to the innovation uptake, that is the grapevine growers' business model concerning: 1) the level of integration in the value chain; 2) the value capture strategy; and, 3) the presence of diversification strategies by coupling winegrowing with the wine tourism.
- Case study *DMAR-Tâmega* addressed mostly small-scale familiar famers, fresh fruits, vegetables and legumes growers in small areas, including kitchen gardens, comprising adopters, non-adopters and droppers. The later were identified as being relevant during the exploratory interviews conducted to the key AKIS actors.
- Case study *TECH-Lezíria* focused on commercial medium and large farmers growing maize and vegetables, and tomato for industry (in the Southern part of the region), related with the intelligent irrigation sensors, comprising adopters and non-adopters. Droppers also show up in the fieldwork, but weren't initially identified as a relevant category. In this case the farmer business model is relatively similar in the Northern subregion: producing and delivering their production to large assemblers, such as the FBO AGROMAIS and other cooperatives; In the Southern subregion the farms tend to be larger, and some farmers trade directly with the private agro-industry and the large distribution.

Sampling procedure relied on the snowball techniques. The support of FBO was fundamental to identify some famers allowing to putting snowballing procedure in motion.

Table 2 depicts the total of farmers surveyed in each case study and their distribution according to the three categories respecting their relation to the innovation: adopters, non-adopters and droppers.

Table 2: Farmers surveyed per case study

Innovation case study	Adopters	%	Non-adopters	%	Droppers	%	Total
BIOP-Douro	23	54.8	17	40.5	2	4.8	42
DMAR-Tâmega	14	37.8	9	24.3	14	37.8	37
TECH-Lezíria	21	55.3	10	26.3	7	18.4	38
TOTAL	58	49.6	36	30.8	23	19.7	117

Source: Own construction

[11] It's adopted here the INE (2017) classification that defines three classes of size farms according the respective agricultural cultivated area: small when size is >0 and < 5 ha, medium when size is from 5 to less than 50 ha, and large when size is 50 or more ha.

Farmers for in-depth interview for case study narratives were selected in order to cover adoption and non-adoption or dropping the innovation and to include cases enabling for the description of the farmer decision-making path across the three stages of the trigger cycle model. Hence were selected farmers that have a good record on own path and show able to talk about it in a reflexive manner.

4.3 AKIS experts and advisory organisations

The advisory landscape in each of the three selected case studies was described in the subsection 4.1. FBOs are predominant and comprise farmers associations, both regional and sectorial, cooperatives and groups of farmers. New players relevant as advice suppliers can be only found in the *DMAR-Tâmega* case study given that the direct marketing was introduced and disseminated by the LDAs that are not typical agricultural advisors. In the other two case studies, FBO are central, although they underline two exceptional FBO, in particular in the *BIOP-Douro* case study. The R-FAS in general doesn't appear to have a relevant role regarding the innovation, with the exception of *TECH-Lezíria*, in spite of leadership of AGROTEJO.

The strategy to identify the advice suppliers to be interviewed in the advisory organisations survey relied upon the identification done by farmers, which were asked in the farmers' survey to identify the relevant actors and organisations in their social support network across the three stages of trigger cycle under analysis, awareness, assessment and implementation. These stages can resume only to the first in the case of non-adopters. In addition farmers were requested to describe their farm management general micro-AKIS, by identifying the type of advisors supporting them in different aspects. The advisory suppliers' identification was also supported by the information gathered through exploratory interviews and conversations with AKIS key actors and the Portuguese RMAG (Regional Multi-Actor Group), and the information collected during the fieldwork through the farmers' interviews, given that it entailed numerous contacts and conversations with a diversity of AKIS actors.

The selection of the key AKIS actors for in-depth interviewing was driven by the concern of fieldwork information triangulation, and hence actors from different AKIS areas were selected.

In the *BIOP-Douro* case study four actors were selected, including an advisor, a farm manager (a pioneer from a pioneer wine estate), a researcher, and the leader of the proposal for the Douro application to the UNESCO world heritage list (a professor and researcher at the time also leader of the ADVID). The first three actors had worked together in the pioneering stages of the introduction, assessment and implementation of the enhancement of ecological infrastructure in the vineyards in Douro region.

In *DMAR-Tâmega* case study the procedure was similar and the selection encompassed actors involved in the introduction and that supported the implementation of PROVE baskets. These actors were: 1) an advisor, a technician from the LDA ADER-SOUSA, although other technicians have been involved; 2) a small-scale farmer that was leader of one of the initial and more dynamic PROVE baskets groups in the region, and that has consolidated his own strategy of direct marketing; 3) a researcher that supported the LDA with the programme dissemination and that was later on responsible, with other researchers, for monitoring and evaluation the PROVE programme (in the years of 2012-2014).

In the *TECH-Lezíria* case study four actors were selected and interviewed. These actors were: 1) the pioneer farmer regarding the innovation, the probes as well as precision farming and other digital technologies, that was also involved in the creation of AGROTEJO and AGROMAIS, being largely responsible for the organisation openness to innovation and networking; 2) an advisor, a technician of the referred FBO that was hired in the late 1990s to support the introduction, development and

implementation of the irrigation probes, and more generally to support farmers with irrigation systems, working on this subject since then, together with the farmers and the hi-tech developers of software to the probes; 3) the technical director of the hi-tech company currently more involved with AGROMAIS, responsible for the software used by the FBO to manage the probes data; 4) and a forth interviewed, a technician from a FBO responsible for the planning and managing of collective irrigation infrastructures in the South part of the region where flood irrigation is still used for rice production, and where farms, mostly of large dimension are in general less related to AGROMAIS, being the interviewed FBO the main responsible by the introduction and dissemination of the intelligent irrigation sensors in the this subregion of large growers of tomato for processing industry and vegetables that use irrigation systems.

In addition, the questionnaire addressing advisory organisations was administrated in the three case studies, although to a limited number of actors given the weak involvement of the respective R-FAS with the innovation, with the exception of the *TECH-Lezíria* case study, although in this case the questionnaire only fitted to the FBO involved with the innovation. Hence, in the *BIOP-Douro* case study in addition to the FBO ADVID, two wine cooperatives (FBO) were interviewed, although they weren't involved in the innovation. In the *DMAR-Tâmega* case study, in addition to the two relevant advisory suppliers, the LDA, a cooperative was also interviewed. In the *TECH-Lezíria* case study three FBO were interviewed, whereas other not dedicated advice suppliers (such as private up and downstream companies) were impossible to interview in spite of the team insistence.

5 Results

This section presents the main results of the fieldwork, comprising the farmers' survey, the advisory organisations survey and the in-depth interviews to the key AKIS actors. It is replicated for each of three case studies. The results presentation is organised in two main subsections, one devoted to the findings from the farmers' surveys and a second to interviews to the advisory organisations and AKIS actors.

5.1 Case 1: the role of farm advice in innovation case study *BIOP-Douro*

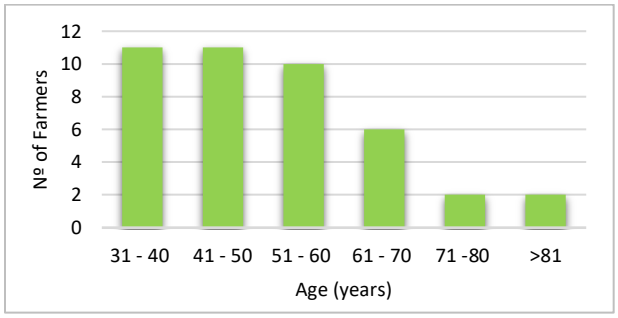
5.1.1 Findings related to the Farmers' survey

The findings gathered with the famers interviewing are presented into four main subsections. First is presented the farmer profile and the respective farm structure, distinguishing adopters, non-adopters and droppers. Secondly is described the farmers' attitude toward innovation and change. Thirdly the trigger cycle change and the farmer path is described. And finally the farmers' micro-AKIS are presented.

5.1.1.1 Farmers' profile and farm structure

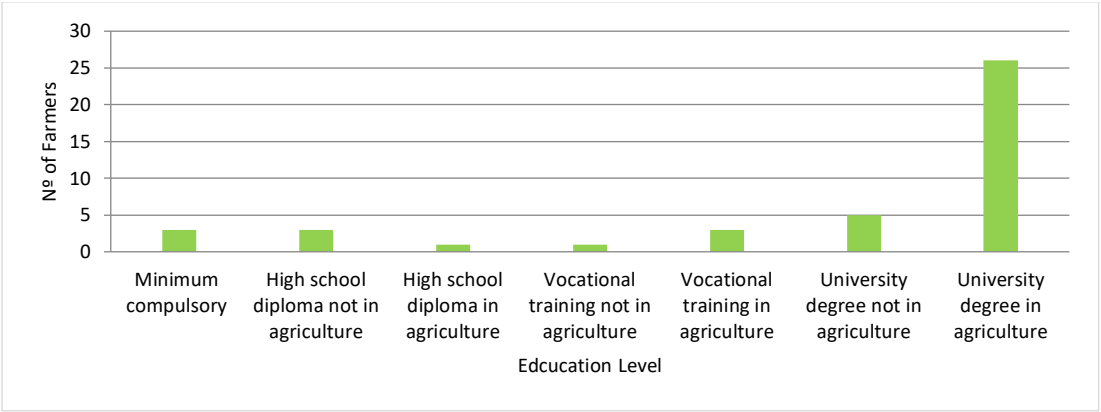
The interviewed farmers tend to be relatively young (***Figure 7***), although non-adopters tend to be relatively older, more than 40% have more than 60 years old. The majority of the interviewed has higher education, mostly in agricultural field, and there are farmers holding vocational educational level also in agriculture (***Figure 8***).

Figure 7: Interviewed farmers according respective age classes



Source: Own construction

Figure 8: Interviewed farmers according education level



Source: Own construction

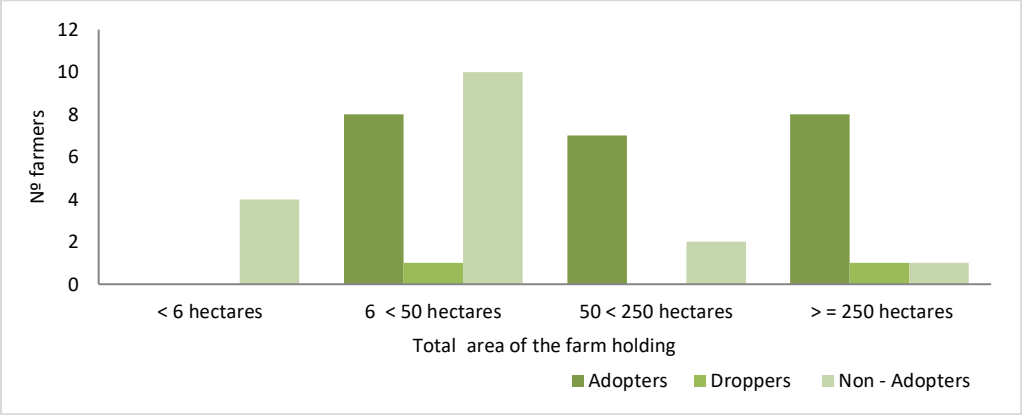
Although high education level defines also non-adopters, the less educated (also older) interviewed are mostly non-adopters.

Farm succession issues didn't show relevant in this case study, probably due to the fact of interviewees being relatively young and part of them be farm hired managers (14 respondents), whereas other seven are farm managers of familiar farm holdings, already resulting from successful familiar succession strategies. Only older small-scale farm owners show concern regarding the farm succession.

Most of the respondents have experience in the agricultural field, which is correlated with respective age. Respondents appear to have good access to internet and at least one quarter of the respondents uses ICT to support decision-making related to farm management. Less than half of the respondents (17) attended training events in the 12 months previous to the interview, in a quite diversified set of subjects, although there was a prevalence of attendance to training workshops/sessions on professional application of plant protection agrochemical products (resulting from the Portuguese law of 2013 that implemented the Directive 2009/128/EC, establishing a framework for Community action to achieve the sustainable use of pesticides).

The distribution of the respondents according to the total area of the farm evidences that adopters tend to hold medium to large farms. Non-adopters tend to have smaller farms, and comprise the full presence of small-scale farms in the sample. Large farms hold substantial area of forest and Mediterranean bushes.

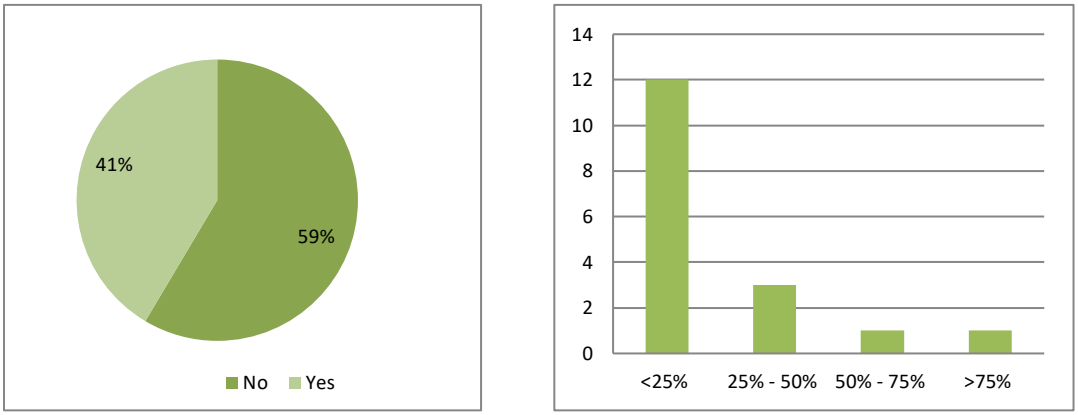
Figure 9: Interviewed farmers according to farm total area



Source: Own construction

Regarding the business model, smaller and some medium size farmers produce only grapevine, while medium to large produce wine, mostly Porto wine and quality DOC wines, often with own brands, addressing foreign markets. In addition, there is a significant number of farms that have wine tourism, comprising 16 of the 17 respondents referring to have other gainful activities related with the farm holding (***Figure 10***).

Figure 10: Existence of other gainful activities in the farm and their share (%) in the farm sales revenues



Source: Own construction

The share of other gainful activities, in particular the wine tourism in this case, shows to be quite relevant in two cases, although it represents in general less than 25% of the farm sales revenues.

Agricultural subsidies benefit most of the farms, whereas they represent in general less than 25% of the farm revenues (***Figure 11***).

Figure 11: Agricultural subsidies and % they represent to the total income generated by the farm

Source: Own construction

Adopters' farms are mostly non-family and have used permanent hired labour in the previous year to the interview: three of the interviewees employed more than 50 permanent hired workers, while 11 hired between 10 and 50 workers, and eight hired less than 10 workers. The non-adopters include two farms using only familiar labour, while the other 14 responding to the question resorted to hired labour by employing less than 10 workers in 13 of the cases, and more than 50 workers in a single case (which is a large farm). Only one of the droppers provided information for this section of the questionnaire, and it's a familiar farm resorting to two additional permanent workers.

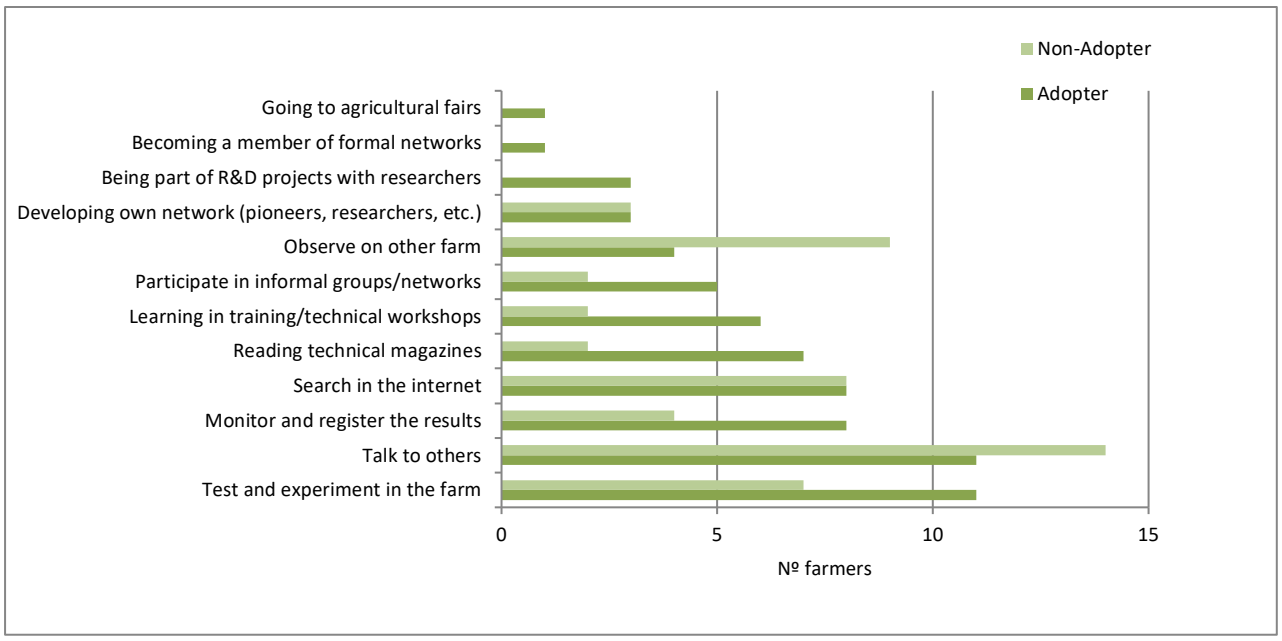
In the case of *BIOP-Douro* there is a significant heterogeneity regarding the total farm area and the holding of a significant area of forest and bushes in the very large farms. Adopters tend to be relatively young and have in average a high education level. Heterogeneity influencing innovation up-taking, along with the farm size and vineyards area, includes the weight of hired labour that is significantly higher among adopters, and

the farm business model, with the farmers producing and bottling own brand DOC wines and /or exploring wine tourism in their farm holding to be the ones to potentially benefit more with the EEI innovation.

5.1.1.2 Farmers' attitude towards innovation and change

The general micro-AKIS, referring to the knowledge assemblage for the farm management not specifically focused in the innovation, highlights interesting differences between adopters and non-adopters, as shown in ***Figure 12***. When asked to identify the three most important activities to obtain knowledge and skills to support the farm planning and management, adopters evidence a different behaviour towards innovation compared to the non-adopters. Adopters assign more importance to activities entailing knowledge creation, self-learning and skills development, such as testing and experimenting, monitoring and registering results, participating in informal and formal groups and networks for knowledge exchange, and learning through attending to technical training sessions and workshops, complemented in some cases with the reading technical magazines. Non-adopters tend to highlight more passive leaning activities, such as talk to others and observe on other farms.

Figure 12: Most important activities to obtain knowledge and skills to manage the farm



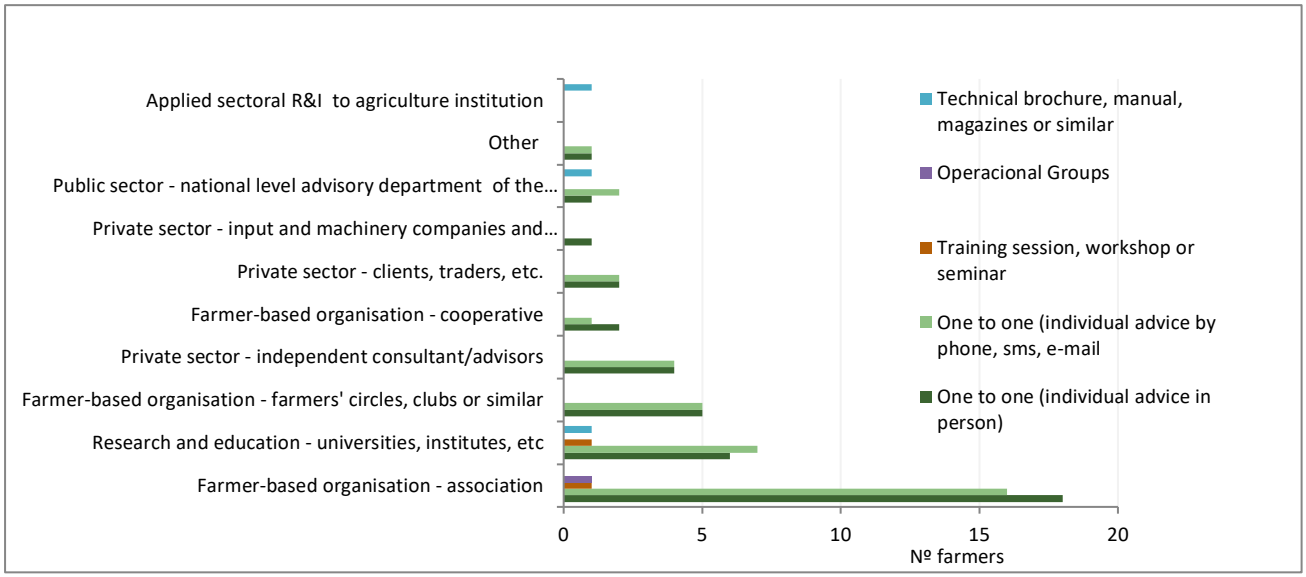
Source: Own construction

The FBO are the main organisations regarding the supply of advice to farmers both the adopters and non-adopters (see ***Figure 13*** and ***Figure 14***) and clearly one-to-one advice is far more used regarding other advisory methods. However, as the figures underline (**Figure 13** and ***Figure 14***) the adopter micro-AKIS tend to be far richer than the one of non-adopters. Adopters have a larger and diverse micro-AKIS, comprising in part of the cases research institutions, private consultants and other types of FBO like farmers' circles and groups. A little number is involved with operational groups.

The non-adopters micro-AKIS relies upon farmer associations and cooperatives (see ***Figure 14***). They also reveal some importance of family members, probably related to aged farmers, and some support from agricultural public services. It's important to recall that a significant part of the non-adopters are familiar small-scale farmers, with labour shortage and less land available to engage into time-consuming and risk

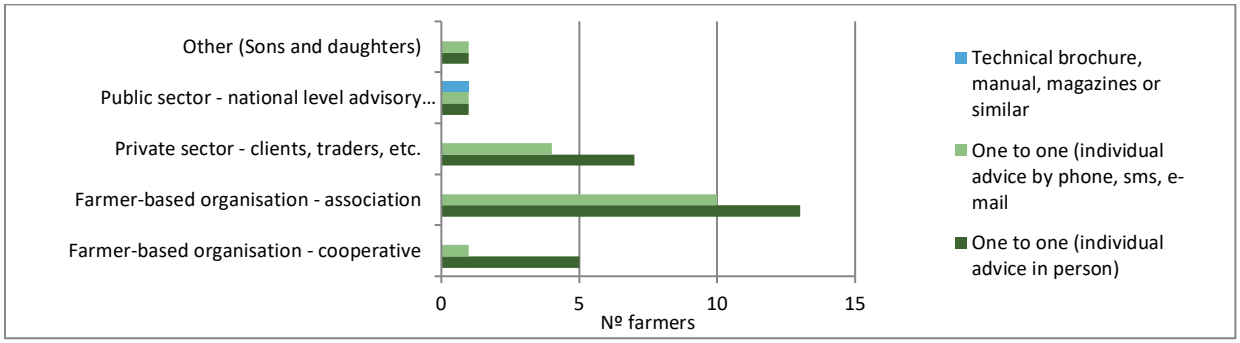
involving EEI (enhancement of ecological infrastructures in vineyards) innovation due to the need for in-field long-term testing, experimenting and monitoring activities involving labour and land allocation.

Figure 13: Who provides farm advice and how (adopter case)



Source: Own construction

Figure 14: Who provides farm advice and how (non-adopter case)



Source: Own construction

Non-adopters become aware of the EEI innovation between 2010 and 2017. However, some of them doesn't seem to be fully aware of what this innovation is, probably due to its complexity and their little involvement with the knowledge holders in this innovation, which are researchers, farm managers and advisors from the FBO ADVID. The innovation-related regional AKIS is basically limited to medium-large grapevine and wine growers, excluding the vast majority of small-scale grapevine growers.

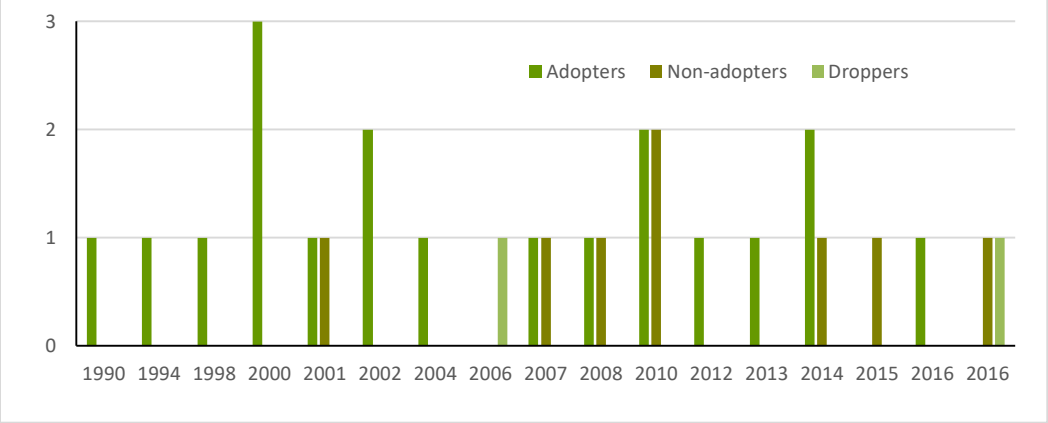
5.1.1.3 Farmers' innovation paths and trigger cycle change model

The 'official' introduction of the EEI innovation in the Douro region is established around the late 1990s. However, there is a few adopters reporting to be aware of it in the early 1990s. This uncertainty respecting the timeline of awareness on the innovation in the region is likely a result of its complex nature. It consists partially on enhancing the patchwork landscape inherited from post-phylloxera crisis in the late 1980s, although build on new agro-ecological scientific-based knowledge in particular related with plant protection,

derived from the introduction of integrate plant protection and soil green cover farming practices in the early 1990s, and its successful dissemination and consolidation in the region. But on the other hand, due to the large-scale landscape restructuration occurred in the 1980s and 1990s that eliminated at large extent the landscape patchwork pattern, EI needed to be reintroduced and restored, entailing the adoption of new farming practices such as the soil and slopes green cover. This process was launched after 2001, and experienced a boost in the current decade due to the multi-actors R&D projects led by ADVID, and the introduction of the agri-environmental measure compensating soil green cover in permanent extensive crops. Hence, the innovation awareness has happened along the time according to the referred timeline (see ***Figure 15***). Non-adopters became aware later than the adopters, only since 2000, and in particular since 2010. One of the droppers became aware in 2006, but the other only very recently (2016) and probably the rush to implement it was the reason for failing to be successful.

Hence, this is a case where, in spite of extensive no adoption amongst small-scale grapevine growers, the majority of large successful winegrowers has adopted. This probably explains why it's disseminated across the region a positive idea of the innovation and are observable mimic strategies of the smaller grapevine grower's which are neighbours and /or grapevine suppliers of large wine estates.

Figure 15: Year when farmer gained awareness of the innovation



Source: Own construction

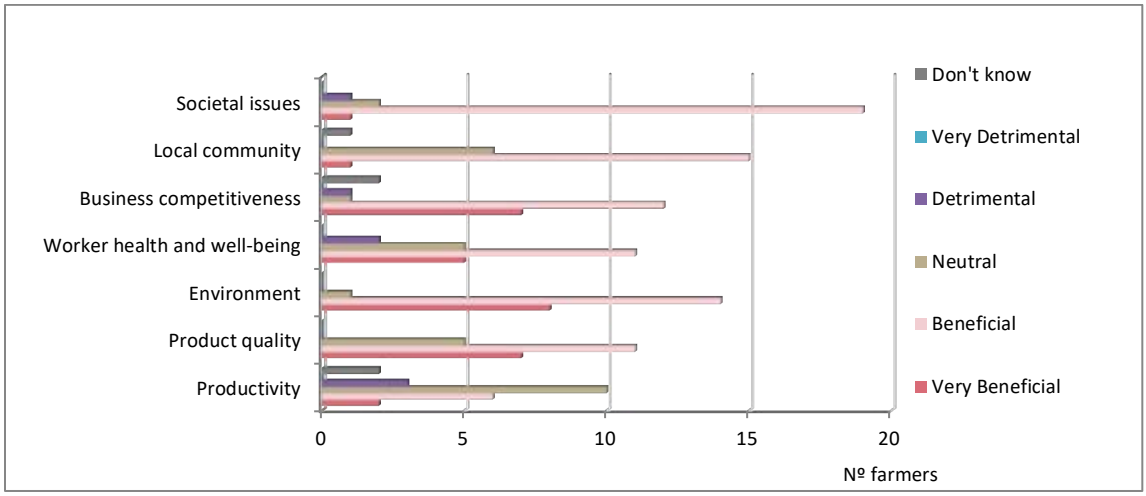
Adopters, as well as other actors involved in this region AKIS related to the innovation are aware of the limited dissemination of the innovation amongst the small-scale farmers and also that the R-FAS hasn't so far showed interest in actively involving in the disseminating the innovation. The fact that there isn't a specific aid to support it, probably hinders R-FAS to actually be able to support grapevine growers with the innovation implementation. Current agri-environmental measures address only the soil green cover maintenance (with seeded or spontaneous vegetation) in permanent crops, hence are not well-fitted to promote this complex and knowledge-demanding innovation. In addition, the need to put "land aside" to proceed with the innovation development and assessment, largely done largely in-field experimentation, plus the competition for labour scarcity in small-scale familiar farms hinders the later to involve with it.

Triggers that took the adopters, droppers, and some non-adopters to assess the innovation, while expressed with diverse formulations, can be grouped into three major subjects: a) responding to the expectations of market and consumers, and as well as to the visitors of the region since 2001; b) expressing a focus on caring about the environment, the biodiversity and being aware of the ecosystems limits, etc.;

c) having a personal identification with these biodiversity-based farming practices, related with the ecological focus, and also with the training path of the farmer or farm manager (e.g. have studied the topic or a related one during internship or master thesis, what evidences the role of university professors /researchers as influencers).

The adopters' evaluation of the innovation (see ***Figure 16***) highlights the benefits both to the environment and to business competitiveness. Hence, in spite of most of them associate the innovation adoption with a cost increase, that seems to be compensated by higher product (wine) quality and the diffuse marketing and reputation gains related with society acknowledgement.

Figure 16: Adopter evaluation of impacts of the innovation

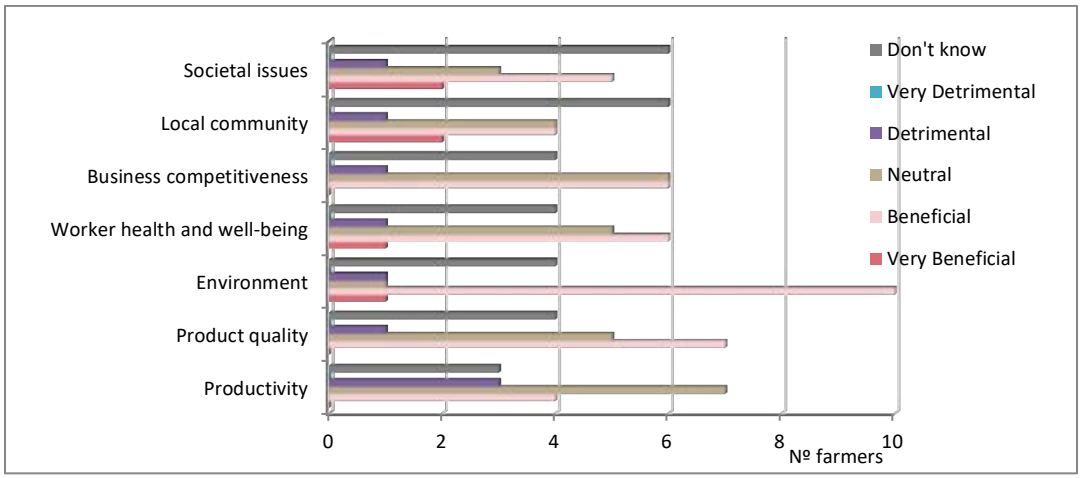


Source: Own construction

The innovation is generally evaluated as very beneficial regarding society issues (such as reducing agrochemicals use) and as being beneficial or neutral to the local community. Detrimental impacts are pointed by some adopters for productivity and worker well-being (probably because the innovation is labour-physical effort demanding, by entailing the use of man carried out mowers). Impacts on productivity are not consensual, what is probably explained by the diversity of agro-ecological conditions of the vineyards (in the different farms and even in different plots of the same). For instances higher soil dryness might potentiate water competition between the vines and the soil cover vegetation. Maybe surprising are the benefits perceived on the grapevines and wines quality, which reinforce perceived competitiveness positive effects. However, recent scientific research carried out to compare tillage with different cover crops has been focused on this issue, and results tend to confirm it, whereas there is contradictory evidence regarding the best cover crop alternative (e.g. Bouzas-Cid et al., 2016).

The evaluation of the innovation by the non-adopters (***Figure 17***) underlines a larger uncertainty on its impacts, with more neutral impact classification along with "no answers". Detrimental effects are perceived across all the aspects, with a focus on productivity.

Figure 17: Non-Adopter evaluation of impacts of the innovation



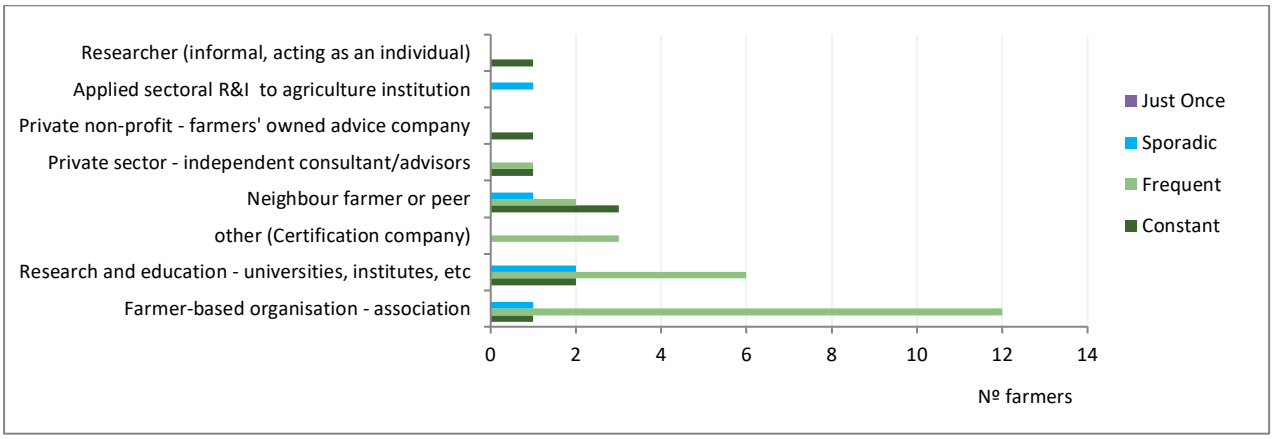
Source: Own construction

5.1.1.4 Farmers' innovation micro-AKIS

The micro AKIS supporting the adopter in the assessment stage is basically the same of awareness and partial implantation, so is not surprisingly the micro-AKIS 'continuity' (see ***Figure 18*** to ***Figure 20***) along the trigger cycle change, reflecting the cycle 'continuity' associated to this innovation, that in general is spread gradually across the vineyards area and deepened along the time build on accumulated knowledge by the farmer or farm manager.

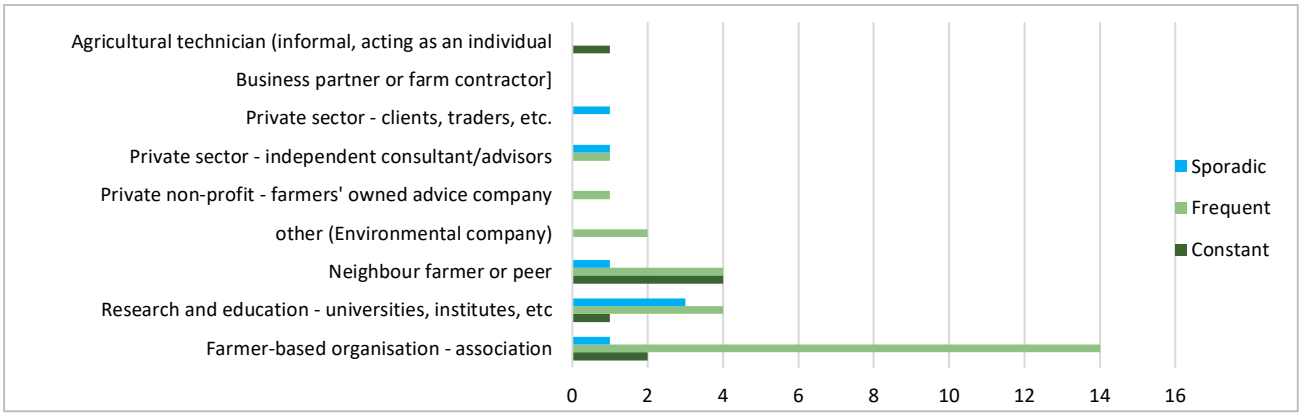
The comparison of adopters' micro-AKIS along the three stages show the reinforcement of a triple-helix based AKIS at the implementation stage, build on the FBO sectorial association (ADVID), the R&D sector, through formal and informal interaction, and the peers, the group of farm managers and farm owners involved with the innovation. The importance of interacting with the other farmers and farm managers increases during implementation phase, when R&D became the third players loosing importance in comparison with the former phases of trigger cycle change model. A likely surprising result is the cooperation established among competitors wine growers, highlighting the organisational and governance dimension of the innovation and the innovators perception that the innovation success depends on their implementation at the landscape scale (and not solely at the farm scale).

Figure 18: Adopter's awareness stage micro-AKIS



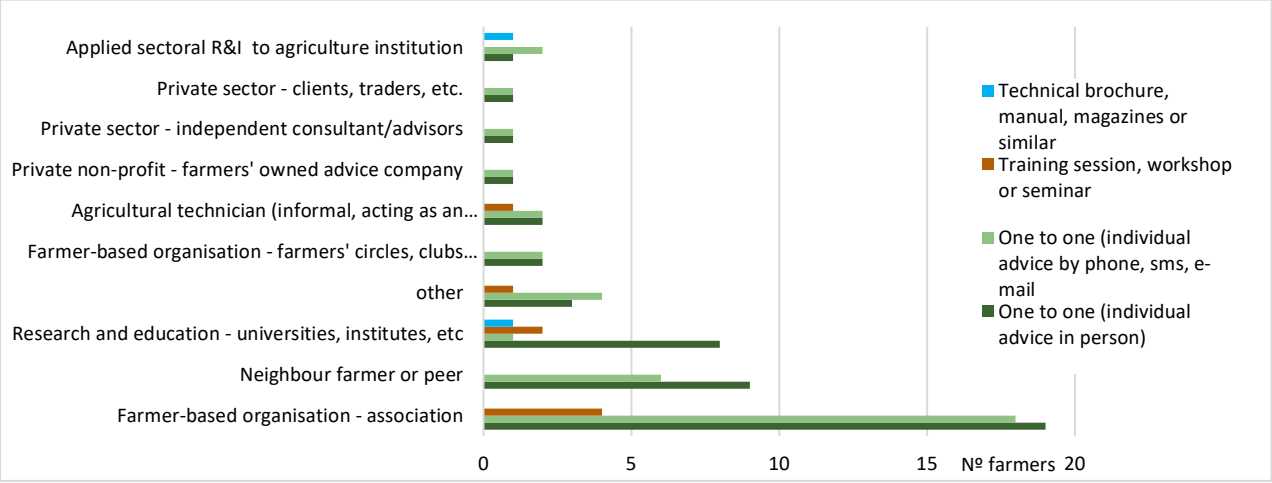
Source: Own construction

Figure 19: Adopters' assessment stage micro-AKIS



Source: Own construction

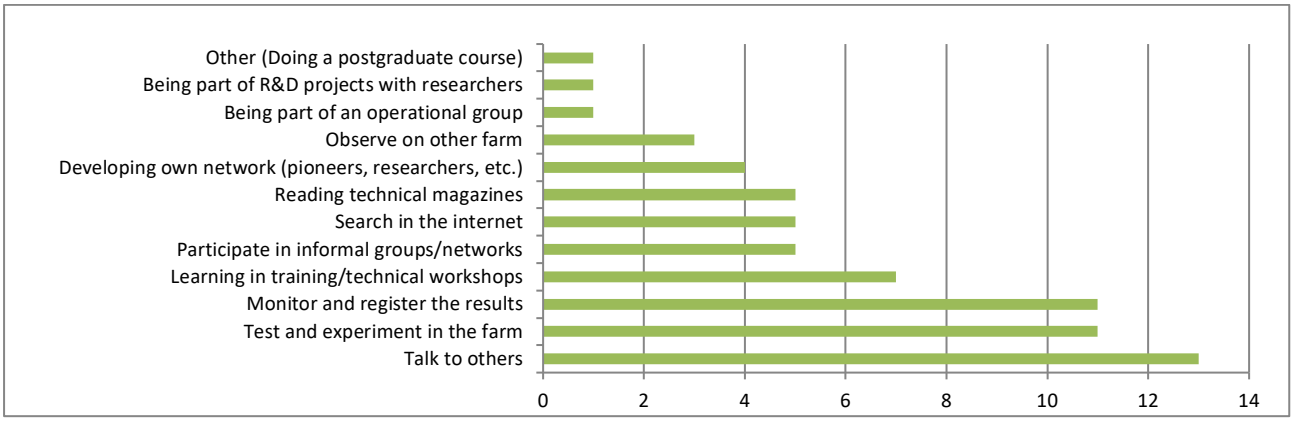
Figure 20: Adopters' implementation stage micro-AKIS



Source: Own construction

The importance of interaction among 'peers' to exchange knowledge and experiences is underlined by adopters when asked to indicate the three most important knowledge and skills development activities to be successful at the innovation implementation stage (***Figure 21***).

Figure 21: Most important activities to obtain knowledge and skills implement the innovation



Source: Own construction

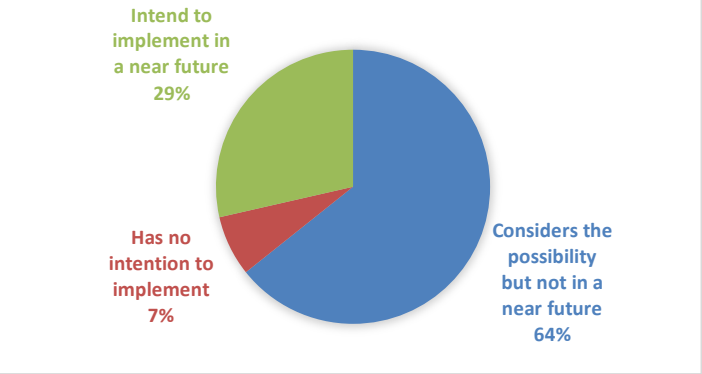
The interaction between the three main players of adopters' micro-AKIS is intense, rated as frequent, and even constant in more limited number of cases. The interactions are defined for most of adopters as entailing reciprocity.

Respecting new actors it matters to highlight the appearance of certification organisations at the awareness stage, as positive influencers, and the presence of environmental NGOs in the assessment stage, related to group advisory supply in the context of training actions and workshops. Unconventional advisors at the assessment stage are the clients and traders, which highlight the importance of the markets and consumers within this innovation uptake. Private consultants are as well present similarly to what happens in the farmer 'general' AKIS, which presents (see ***Figure 12***) a similar pattern to the innovation micro-AKIS, although in the innovation micro-AKIS peers appear to play a major role. One-to-one advice, in-person and mediated by communication means (e.g. phone, SMS) appear to be the predominant advisory method at all stages in particular with the FBO advisors.

In the *BIOP-Douro* case study it's possible to distinguish the awareness stage from the assessment, likely because the assessment entails active testing and experimentation through implementation, preferable in a vineyards plot, pilot scale. Important contextual triggers can be found related with Douro vineyards landscape classification by UNESCO in 2001, the increasingly concerns of society, consumers and the legislator with the effects of agrochemical products used in plant protection both to the environmental and to the public health, and a third one that were the EU funded R&D multi-actor projects implemented in the early 2000s. The impact of these projects approach was limited by the number and type of FBO and farmers involved and its time discontinuity, hence the testing, experimenting, monitoring and knowledge storage was left at the expenses of the farmers, and only a few can accomplish such demanding tasks.

The absence of an extensive and inclusive AKIS related with the innovation explains generalised non-adoption amongst the grapevine growers, delivering their grapes to the cooperatives or increasingly selling it to the large winegrowers. They face costs and difficulties to access the knowledge and don't experience the business competitiveness advantages related with marketing and higher wine quality. In fact the reasons for non-adoption among the interviewed farmers relate to high costs perceived, given that a transition period is necessary involving risk-taking respecting eventual losses in productivity and grapevine production. Difficulties that are reinforced by labour scarcity and limited access to knowledge and support to the innovation assessment in own vineyards. Yet, the majority of non-adopters state intending to adopt at some point the innovation, as shown by ***Figure 22***.

Figure 22: Non-adopters plans to implement the innovation



Source: Own construction

The two droppers identified and interviewed consist of two particular cases, where dropping triggers are of more personal nature. Both intend to re-introduce the innovation. One of these droppers is a newcomer to grapevine and wine growing, part-time and professionally very busy that become in charge of the farm due to an unplanned farm succession. This situation is relatively common in the case of medium-large grapevine growers that inherit the wine estate due to parent decease and need some time to gain experience in the activity. There are no-adopters that are as well in this situation, explaining why they intend to adopt the innovation in near future. The second case of innovation dropping reflects labour restrictions and appears to involve also a particular reorientation in business model.

To sum up, attitudes towards change and innovation appear to be related with farmer age, and when older the likely of having a successor, and the costs perceived with the innovation. The costs perception might be related in the case of complex innovations like the 'enhancement of ecological infrastructure in vineyards' to the uncertainty respecting costs and benefits and the need to conduct the innovation assessment through an in-field experimental implementation for a relatively long period of time.

5.1.2 Findings from the AKIS experts interviews and advisory organisations survey

This subsection presents the data and information gathered through the advisory organisations survey and the in-depth interviews to key AKIS actor, identified by the farmers and by the research team based on the previous exploratory work and the side information collected along the period of farmers' survey implementation.

5.1.2.1 Advisory landscape in the focus region

The advisory landscape of Douro focus region was shaped by the weight of the vineyards and winegrowing in this region, which is the major wine-region in Portugal, and represents around of half of the wine exportations of Portugal. In the past, the region produced Porto wine (fortified wine) and table wine, the later with grapevines from the vineyards not allowed to be Porto wine. Regulatory bodies were created along the time to regulate production, bottling and exportation of Porto wine. In the 1990s the explosion of DOC table wines, along with declining value captured with Porto wine, originated new business models of in-farm bottling and branding of wines, directly marketed by the producers without the mediation of the Porto and Douro wine exportation association. These major transformations in the wine business reshaped the traditional advisory landscape in Douro.

Traditional R-FAS build on the wine cooperatives coupled with regional public advisory services. The presence of a large number of small-scale grapevine producers led to the creation of a large number of wine-cooperatives in the 1950s, which are currently 23, at last one cooperative per municipality, characterised by having a large number of associates from 250 up to 1000. The cooperatives were created to agglomerate the grapevines and to transform it into the wine, mostly sold in the wholesale market. They never were actually focused on supply in-person technical advice, and basically supplied it as input sellers, to farmers that went to their stores to buy inputs. After the Portugal entrance in the EEC most of them, in particular in 1990s when the regional agricultural public extension services were replaced by the FBO, aggregated the provision of support to agricultural subsidies application. With the explosion of DOC wines and the tough global competition on its markets, high skills on grapevine cultivation and on wine making (oenological) became fundamental to ensure business competitiveness. Hence in the 1990s, most of the cooperatives entered into a crisis due to low prices they got in wholesale which translated into very low prices paid to grapevine growers. A few cooperatives managed to create relatively successful own brands, although a large number kept struggling along the years with financial problems, that led small-scale growers to prefer selling their grapevines to large wine growers build on informal but often trustful relationships.

Hence, most of the cooperatives remain important by supporting farmers with the agricultural subsidies applications, selling inputs, and in some cases by supplying advice on plant integrate protection and production.

The introduction and further dissemination of integrated plant protection in the 1990s introduced some vitality in the advisory regional landscape. Given that in the first phase of the agricultural policy support to these farming practices technical advice was required, existent and new FBO come out to provide it. These include the cooperatives, but either new farmers' sectorial and regional associations and the regional farm management support centres, created in the 1990s to support farmers in accountancy and to develop farm business plans.

During this period the advisory landscape was also defined by a larger interaction with the regional agricultural (an oenological sciences) high education system, that trained professionals with the skills required by the legislation to provide technical support to plant integrated protection. The agricultural public services were, and still are, relevant by supporting technicians and farmers with the supplying of a plant pest and disease alert system, designed and maintained with the support of the public regional R&D system which is part of the high education institutions (universities and polytechnic colleges).

Input sellers from private companies are another important source (while not independent) source of supply to grapevine growers. Other actors supplying advice, although being not advisory organisations, comprise the certification associations and related consultancy organisations (integrated protection and protection, organic farming, Global GAP, among other), and the regulatory bodies, in particular the one regulating Porto and Douro DOC wines production (the IVDP).

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

The innovation selected in this case study, the EEI, as already explained mobilises a triangular advisory system, comprising the FBO ADVID, a group of winegrowers, mostly farm managers, and the R&D system, mostly the North region based.

The FBO ADVID had a pioneering role by introducing the innovation backed up by the R&D system and involving a few emblematic wine growers in R&D projects entailing testing and experimenting in those wine growers vineyards. The innovative character of this advisory organisation which business model builds on strong back-office R&D, advisors high qualification (in a group of five, two hold a PhD and the other two a MSc degree, supported by the FBO) and international networking, created room for the development of the EEI innovation. The lining up of this FBO[12] vision, mission and values with the wine growing sustainability promotion, raised by a virtuous constellation of events, already described in section 4, made possible the pioneering and consolidation of a set of agro-ecological farming practices defining a biodiversity-based plant protection model enhancing the eco-functionality of cultivated vineyards not expected in a commercial mainstream farming activity.

The FBO ADVID backed-up by the R&D system, represented by a small group of researchers, played a fundamental role in the awareness stage for pioneers and early adopters of the innovation. Its success in the assessment stage, by designing successful applications to R&D projects public with competitive calls, and by mobilising emblematic wine growers, launched the innovation to the implementation stage.

[12] The FBO ADVID was awarded by the Gulbenkian Foundation (the most important private foundation in Portugal) the sustainability prize in 2017, and was one of the four nominated also in 2017 for the Innovation/Research award of the wine magazine (Revista dos Vinhos).

The implementation and consolidation stage of pioneers and early adopters has worked as an awareness trigger to other larger to medium wine growers that were also ADVID members and that were conquered by the success of the EEI implementing by their peers. Hence there is an informal network of farm managers that actively and intensively exchanges knowledge and experience about the innovation and that has created a positive vision of it among the majority of grapevine and winegrowers in the region.

The more relevant public policies for this innovation emergence were the funding of multi-actors R&D projects, whereas the agri-environmental aids along with other agriculture subsidies, showed fundamental to spread and to sustain it, according to the interviewed advisors and key AKIS actors. In the Douro region the grapevines are grown in mountainous vineyards what rises production costs and diminishes productivity in comparison to the majority of competitor wine-regions, hence the agricultural and agro-environmental payments are critical to the activity survival.

5.1.2.3 Transformation of advisory landscape

The contextual triggers identified as responsible for the emergence of the EEI innovation are the ones that are reshaping the advisory landscape. The changes in the global wine markets created a huge pressure for each wine unique quality and differentiation, which by its turn entailed the demand for high qualified advice at the different levels of the business, comprising the grapevine production. High quality grapes are a major concern of winemakers, what has leveraged the demand for qualified professionals in this domain and boosted the practice of creating and accumulating knowledge through testing and experimenting activities developed in the vineyards. Grapevine growers in this group, which includes the large and some medium sized, felt in the late 1980s the need for an innovative FBO able to support them to thrive in the competitiveness challenge they were involved. This dynamic led to the creation of ADVID as already described. More recently, in 2015, they have created the grapevine professional growers association the ProDouro[13], which groups 66 associates and focus on disseminating information among the associates and on promoting initiatives to discuss and to raise attention to the major challenges faced by the mountainous grapevine growing in Douro. These comprise: a) the market competitiveness challenges; b) the climate change which is already affecting severely this region due to its Mediterranean climate with very hot and dry summers, and, c) the dramatic labour scarcity in the region. These challenges and the responses to them will shape the near future of advisory landscape in the region.

The EEI evidences the current duality in the grapevine growing regional advisory landscape and respective socio-technical regimes. The EEI has reinforced a more elitist R-FAS, created, managed and largely funded by the professional grapevine growers, which rely mostly on in-house advice by hiring and investing in high qualified technicians and in the engagement of high skilled farm managers. In-house advice is supported by their own FBO ADVID which focus on R&D and international networking to bring to them constantly updated knowledge and innovation. The R&D and innovation focus of ADVID and as well as of the majority of the high qualified farm managers and technicians of wine estates favours a strong and intense interaction with the R&D system, namely the universities were many of these professionals were trained.

The major weakness of this "triple helix" (Etzkowitz and Leydesdorff, 1995) type innovation-driven advisory system is its limited inclusiveness. The weakness regarding the dissemination of the EEI is acknowledged by the farm managers of large grapevine growers. Some of them are already supplying advice to small-scale vine growers that are their grapevine suppliers. By doing this, they emerge in the region as a novel advice actor related with this innovation. However, they are aware of their limitations in disseminating the innovation due to the barriers small-scale grapevine growers face to assess and to

[13] The Associação ProDouro, more info is available on http://www.prodouro.pt/.

implement the innovation. Collective action would be needed to conduct in-farm testing and experimenting activities in small-scale grapevine growers. In addition to a novel advisory model at the assessment stage, public financial support would be needed to the implementation stage given the costs of the transition to this type of farming practices which are not affordable to the small-scale grapevine growers that only indirectly can benefit from the IIE positive impacts in the grapes quality.

A more difficult barrier to surmount in the case of small-scale, and more and more in the near future by the medium sized grapevine growers, is the labour scarcity. The IIEs entail the use of more labour what is a critical issue in a region that is experiencing a dramatic labour shortage for a crop that is still quite labour intensive.

Hence, the small-scale R-FAS, still dominated by the cooperatives and some farm associations, including the farm management centres, didn't show so far interested in disseminating the EEI. Yet, the dynamic created by the large winegrowers in supplying advice to their supplier small-scale grapevines might help to trigger the change among the more dynamic advisory organisations of the small-scale R-FAS, which comprise a few cooperatives and farmers associations related to the integrated protection and production.

5.2 Case 2: the role of farm advice in innovation case study *DMAR-Tâmega*

5.2.1 Findings related to the Farmers' survey

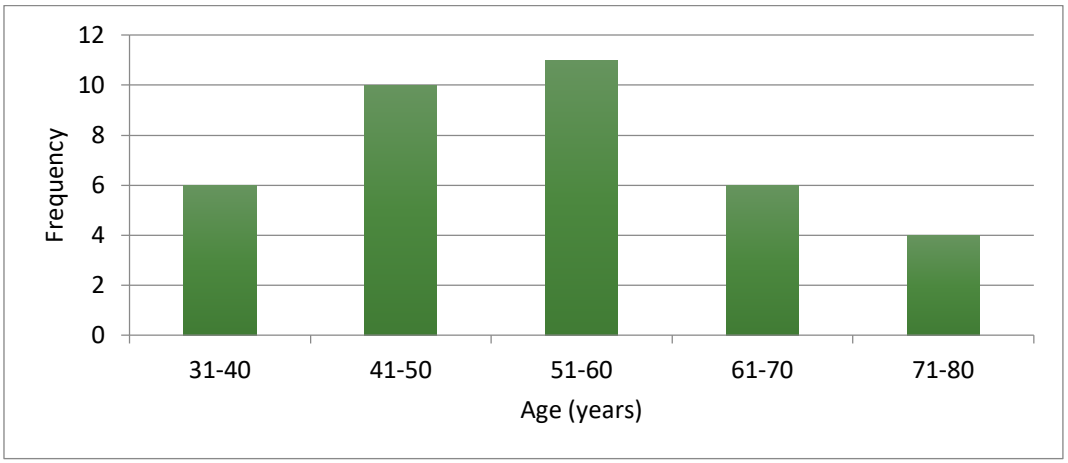
The findings gathered from the farmers' survey are presented into four main subsections. First is presented the farmer profile and the respective farm structure, distinguishing adopters, droppers and non-adopters. Secondly is described the farmers' attitude towards innovation and change. Thirdly the trigger cycle change and the farmer path are described. And finally the farmers' micro-AKIS are presented.

The farmers' survey in *DMAR-Tâmega* case study included 37 farmers, 14 adopters, 14 droppers and 9 non-adopters. Droppers are a relevant analysis category in this case study.

5.2.1.1 Farmers' profile and farm structure

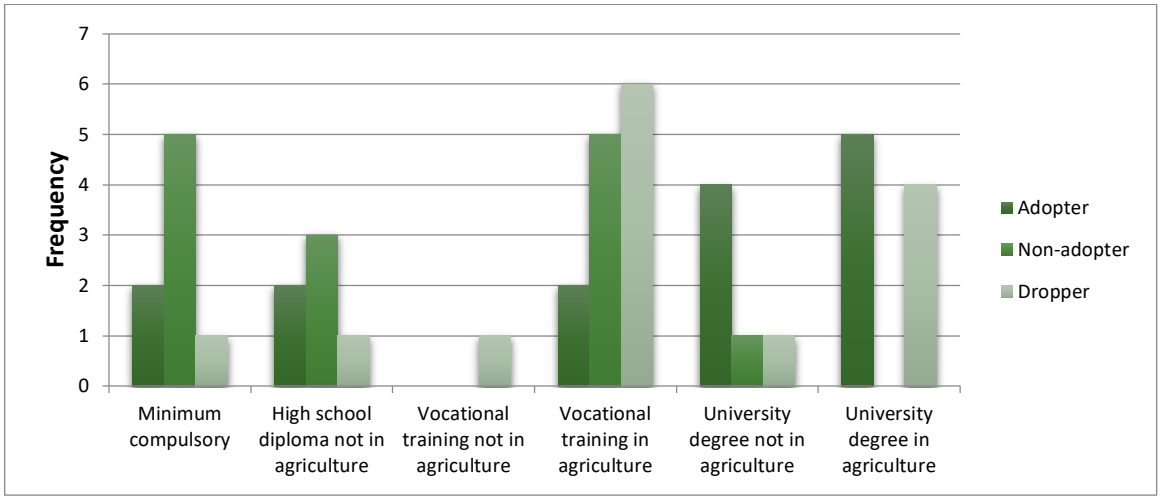
The interviewed farmers tend to be middle aged (***Figure 23***), although non-adopters tend to be older, more than 40% have more than 60 years old. The majority of the interviewed have vocational training in agriculture. However, adopters hold more often a high education level than non-adopters, while non-adopters show a higher number of respondents with only the basic education level (***Figure 24***).

Figure 23: Interviewed farmers according respective age classes



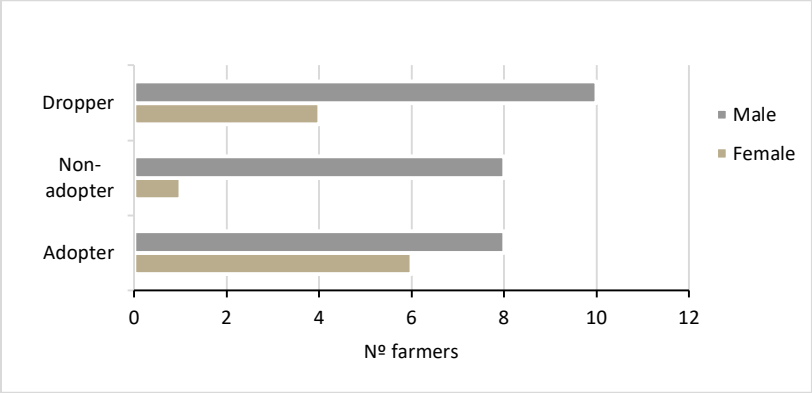
Source: Own construction

Figure 24: Interviewed farmers according education level



Source: Own construction

Figure 25: Interviewed farmers according to gender



Source: Own construction

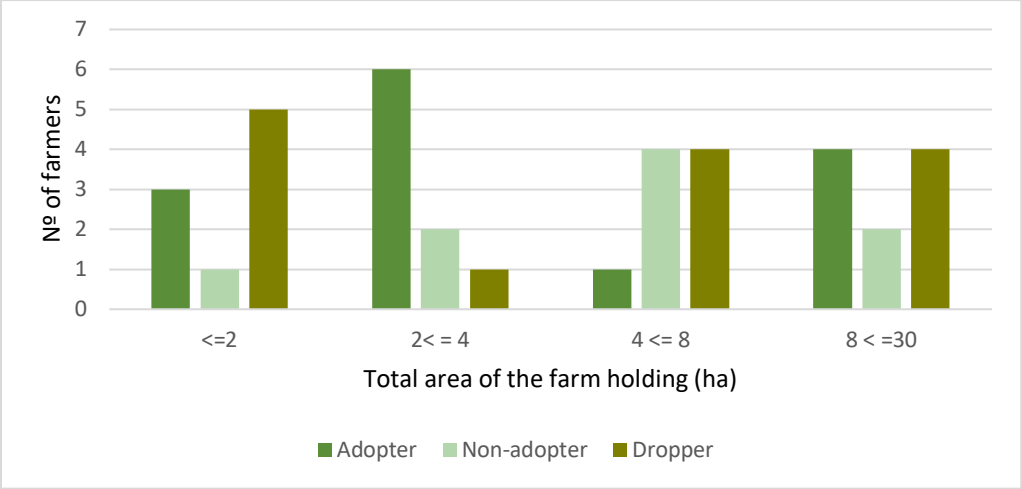
Direct marketing innovation tends to involve a significant number of females. And apparently they tend to persist more than men within this business model, given the proportion of males among the droppers (***Figure 25***). The reason for that might be related with the fact of females to me more prone to interact and to socialise with consumers. The establishment of bonds with the consumers is key to the success of this innovation, given consumers need to be conquered and spoiled to become involved with the innovation.

About 50% of the interviewed farmers have been working on farm business for more than 30 years and 20% have a successor.

About 30% do not have internet access, and more than 70% do not use ICT to support decision-making related to farm management. About 40% (15) attended training events in the 12 months previous to the interview, whereas in a quite diversified set of subjects.

The distribution of the respondents according to the total area of the farm evidences that adopters tend to hold smaller farms than non-adopters and droppers (***Figure 26***).

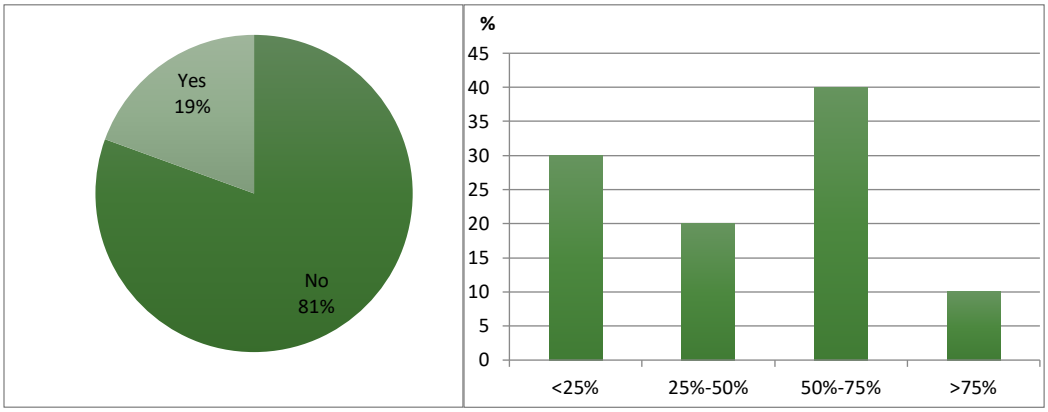
Figure 26: Interviewed farmers according to farm total area



Source: Own construction

Regarding the business model, most farmers (81%) do not have other gainful activity. But those who have (7), the activities are related to agro-tourism and processing agricultural products (***Figure 27***).

Figure 27: Existence of other gainful activities in the farm and their share in the farm sales revenues



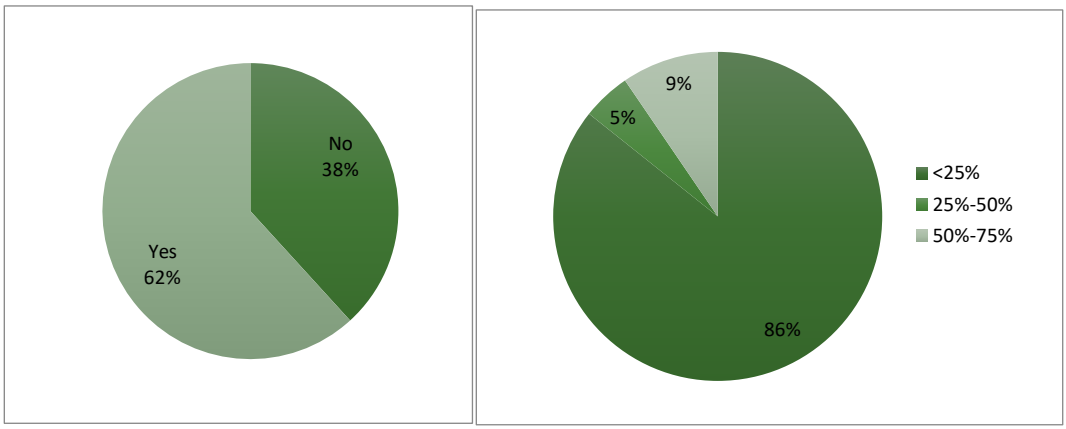
Source: Own construction

The share of other gainful activities, in particular processing agricultural products shows to be relevant in 2 cases, because it represents more than 50% of the farm revenues from sales.

The predominant type of technical-economic orientation is the production of vegetables, legumes and fruits, whereas most of the farms have a similar or even larger area of vineyards. There are a few specialised producers in new crops, in general young and high educated, such as aromatics, berries, kiwis, asparagus, and shiitake mushrooms. Most of direct marketing is done under the PROVE approach, whereas there are few farmers that also complement it with informal direct selling and supplying restaurants. The direct marketing addressing restaurants seem to be growing and is particularly attractive to young producers that are more specialised in new crops like mushrooms, asparagus or melons from a traditional Portuguese variety fitting restaurants gourmet trends. Berries and aromatics are also trying to go through direct marketing but only show able to do it partially. The ones that joined the PROVE groups end up dropping because they were not able to supply the products variety the baskets require. Actually, the specialisation in a particular crop doesn't fit into basket PROVE approach, that entails to combine a variety of fresh vegetables and fruits, hence enhancing polyculture and the introduction of new crops in small quantities.

Agricultural subsidies benefit most of the farms, whereas they represent in general less than 25% of the farm revenues (***Figure 28***). Adopters due to small size of their farms are amongst the ones that benefited lesser from agricultural subsidies.

Figure 28: Agricultural subsidies and % they represent to the total income generated by the farm



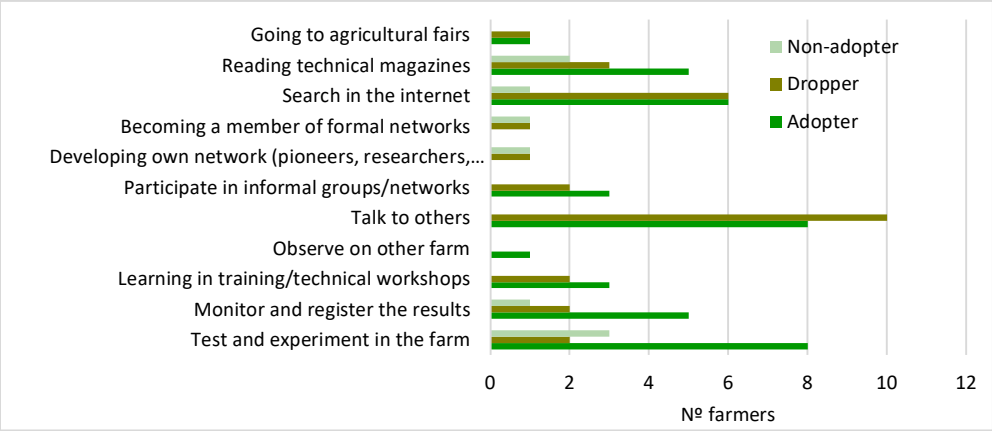
Source: Own construction

In the case of the adopters 6 are legal entity holdings, whereas 8 are singular producers. They are, in general, familiar holdings using non-familiar permanent workers (8 respondents employed 1 to 8 persons permanently) and temporary (6 respondents employed 1 to 8 temporary workers) hired labour in the previous year to the interview. Concerning non-adopters, 6 respondents employed 1 or 2 permanent workers and one respondent employed 15 temporary workers. About familiar workers 3 adopters employed 1 to 4 familiars and 5 droppers employed one familiar.

5.2.1.2 Farmers' attitude towards innovation and change

The comparison of the general micro-AKIS (referring to the knowledge assemblage for the farm management not specially focused on the innovation) of the various categories of farmers regarding the innovation, highlights similar differences to the *BIOP-Douro* case between adopters and non-adopters, showing droppers to be also different from adopters regarding the activities highlighted by farmers as important to obtain knowledge and skills (***Figure 29***).

Figure 29: Most important activities to obtain knowledge and skills to manage the farm

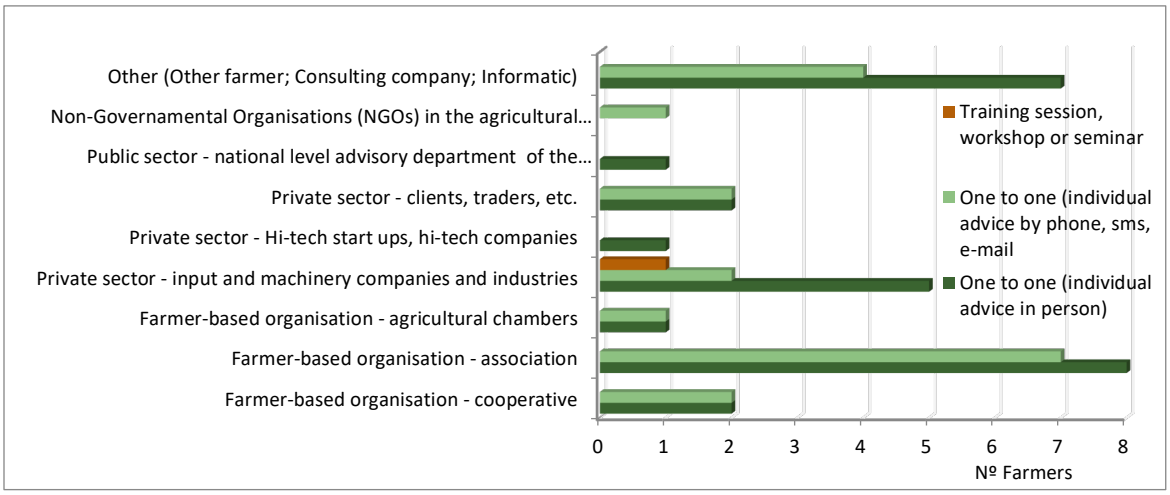


Source: Own construction

Adopters highlighted testing and experimenting along with monitoring and registering activities, which are not so relevant to droppers that clearly prefer more interactive and cognitive less demanding activities such as "talk to others" and internet search, although some reported the reading of technical magazines. This later activity is also important, and it's in a large extend to the adopters, what suggests the reading of written materials, namely manuals and flyers produced and disseminated by the PROVE programme. Learning by participating in workshops and similar events along with the participation in informal groups and networks is valued by both categories. Non-adopters value either activities such as testing, experimenting, monitoring and recording, likely due to their agricultural training background. However, they don't rely much on talking to others or on internet search. Non-adopters show a professional farmer profile with a significant agricultural training indicating the importance and success of agricultural training in this region associated to the programme of young farmers' installation, in the years following the Portugal entrance in the EEC. This success was related with the expansion of profitable agricultural activities at that time in this region, namely the milking cows raising and the greenhouse flowers cultivation.

The adopters are mainly small-scale familiar farms and their "general" micro-AKIS is very much related with the innovation, hence probably explaining the weight of FBO association where they place the LDA supporting them with PROVE baskets direct selling (***Figure 30***). Most of them refer to be also supported by private input providers and freelancer private consultants and technicians from other fields, like informatics and accountancy, likely related to their need to deal with legal and fiscal matters, like issuing invoices and transportation permits.

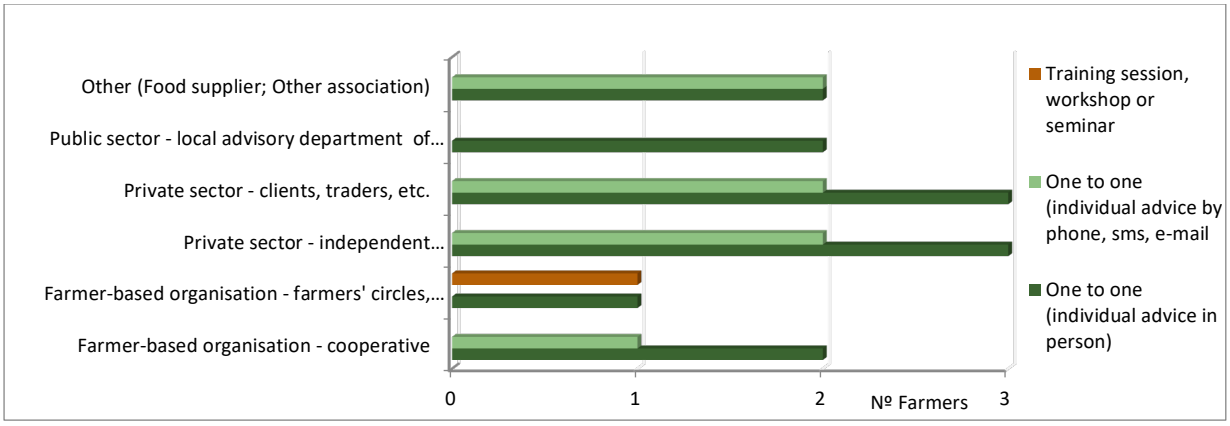
Figure 30: Who provides farm advice and how (adopters)



Source: Own construction

Droppers depict diverse micro-AKIS regarding their general farm management (***Figure 31***). This is related with the fact of some of them, as the case of the elder are also in a process of declining farming activity. Others, younger, invested on specialisation in new crops, what might explain the diversity of advisors, including private consultants and the private downstream sector, namely the traders and clients.

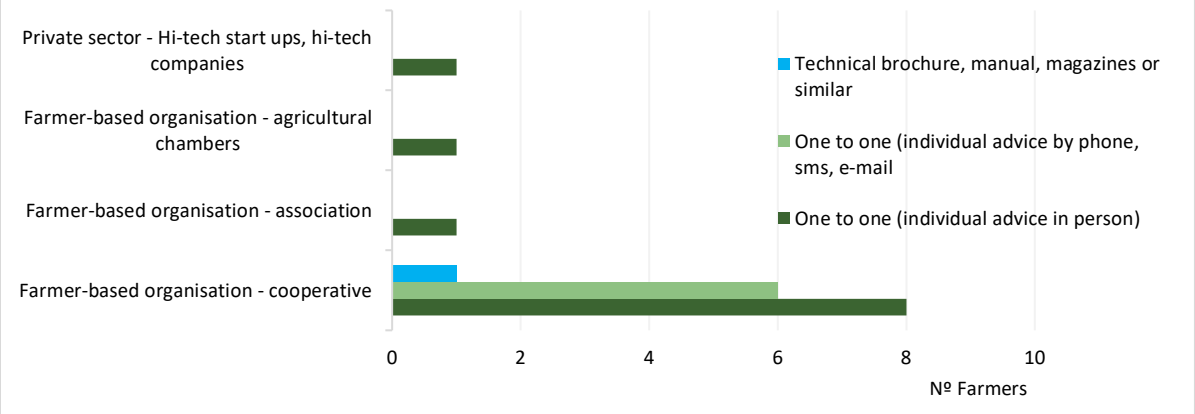
Figure 31: Who provides farm advice and how (droppers)



Source: Own construction

Non-adopters show a conventional micro-AKIS depending on the local cooperatives, who appear to be able to deliver them technical support (***Figure 32***). The professional agricultural profile and larger areas of this group probably explains the role of cooperatives.

Figure 32: Who provides farm advice and how (non-adopters)

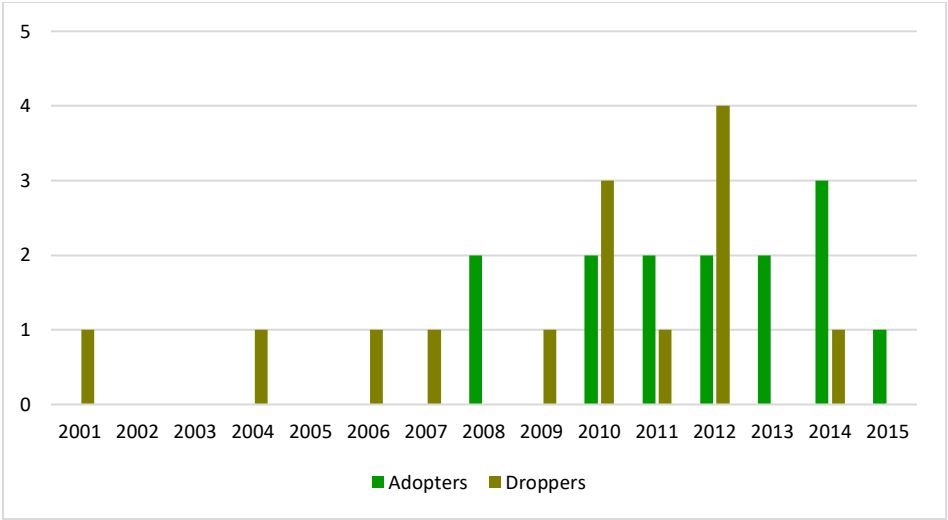


Source: Own construction

5.2.1.3 Farmers' innovation paths and trigger cycle change model

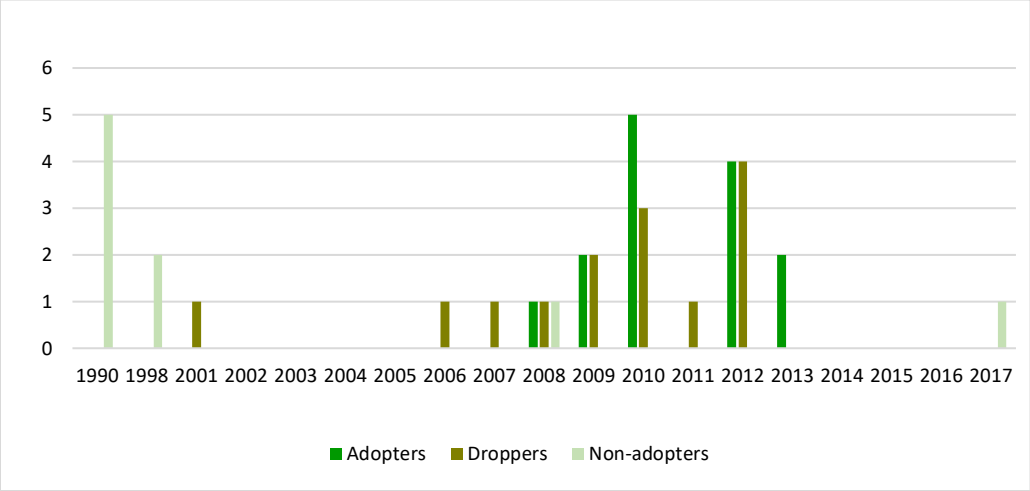
The direct sell through the PROVE programme has been introduced, as abovementioned, in the focus region by the LDA ADER-SOUSA in 2008, when the association was involved in the dissemination stage of the programme still under the EQUAL funding. However, since that year and until 2013-2014 the programme benefited from the support of PRODER through the ADLs joining it. The programme enlargement allowed for the entrance of another LDA of the region the DOLMEN, which influence area is the Eastern part of the region, the Low Tâmega valley. Both associations were very dynamic, according to the interviewees, and the PROVE nationwide evaluation conducted in 2013 (Baptista et al., 2013). In fact, was during the period 2010 to 2014 that the adoption of direct selling flourished in the region (***Figure 33***). Before 2008 only currently droppers have implemented direct selling within other business models such as local markets and informal direct selling to consumers and to groceries. That situation probably explains why some droppers, along with non-adopters, were aware of the direct selling years before the adopters (***Figure 34***), and might also be a reason why some droppers, namely the oldest, didn't fitted to the PROVE basket approach, given they were used to work alone and in a more informal way.

Figure 33: Year when farmer implemented the innovation



Source: Own construction

Figure 34: Year when farmer gained awareness of the innovation



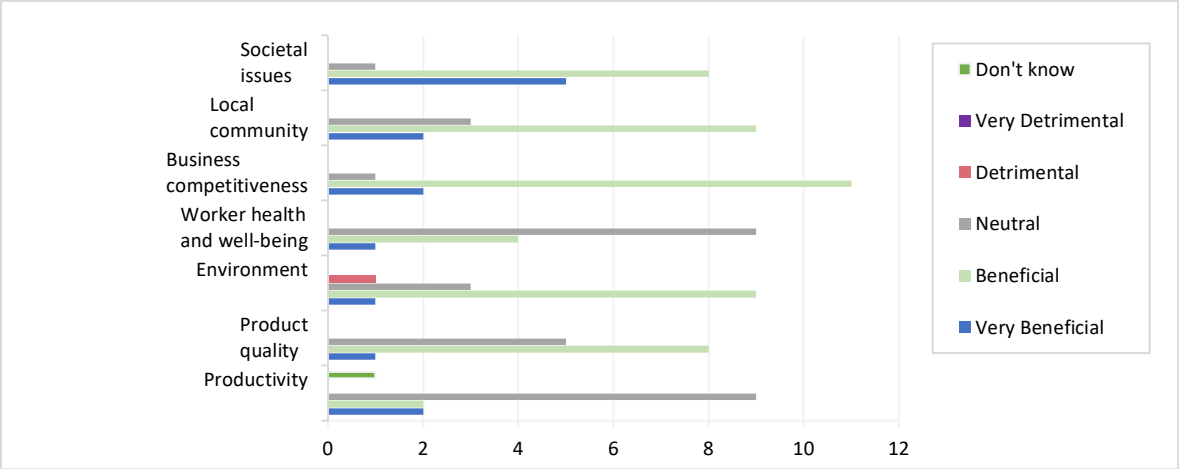
Source: Own construction

The assessment stage in the case of adoption of PROVE baskets approach took only a short time, around 3 to 6 months, with the early adopters being convinced as a result of a visit they made to the producers of the PROVE pilot case in the South of the country. The assessment was mostly a passive process, differently from what occurred in the *BIOP-Douro* case study, what probably explains that the actual assessment has been also done through the implementation and resulted in a high rate of innovation abandonment.

The main triggers leading to adoption were the opportunity to sell spare production and to generate additional income to the household. However, a few droppers mentioned as main motivation the opportunity of being part of a group and the opportunity to interact with the customers.

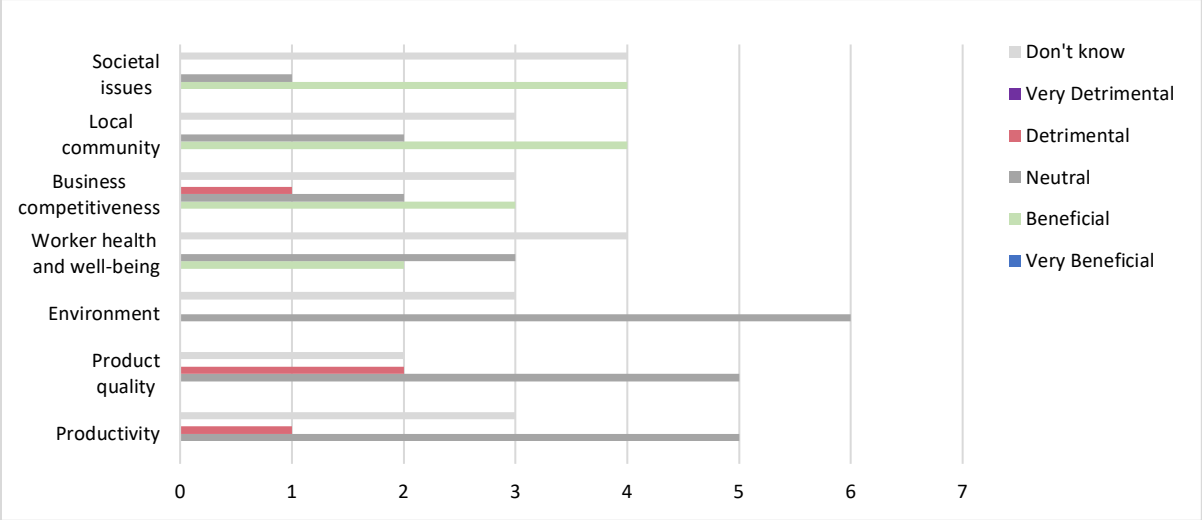
Adopters evaluated the innovation as beneficial respecting the business competitiveness, and underlined positive effects to the environment, the local community and the society issues. Effects on productivity are envisaged by the majority as being neutral. Respecting the quality of the products the evaluation varies from very beneficial to being beneficial or neutral. Non-adopters have mixed evaluations regarding business competitiveness of the innovation, some of them envisaged negative effects on products quality and productivity. Regarding the effects on local community and societal issues their evaluation expresses uncertainty, whereas some classified the effects to be positive.

Figure 35: Adopter evaluation of impacts of the innovation



Source: Own construction

Figure 36: Non-adopter evaluation of impacts of the innovation

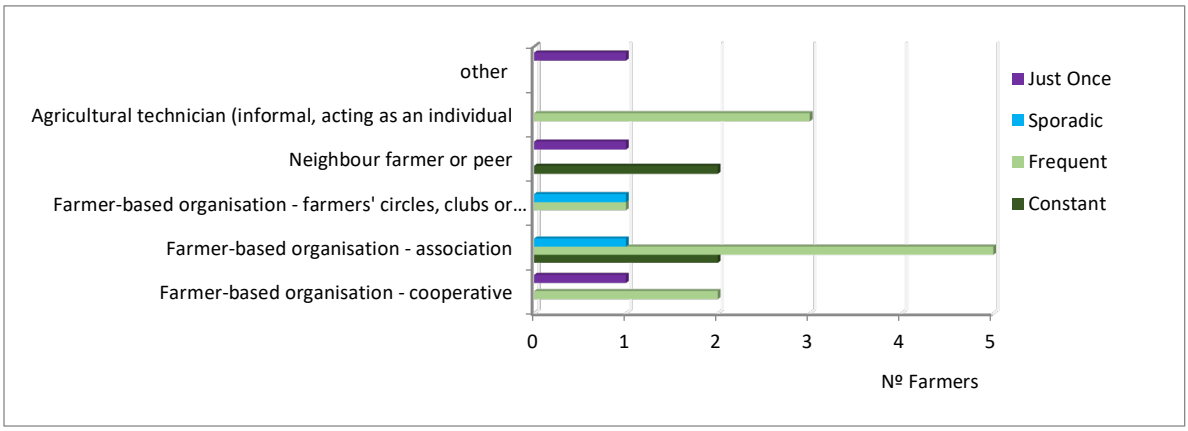


Source: Own construction

5.2.1.4 Farmers' innovation micro-AKIS

The direct marketing adopters' micro-AKIS in the awareness stage, which shows rough similar to the assessment stage micro-AKIS underline the role of LDAs, identified as farmer based associations, along with the intense interaction with other farmers, the "peers", and frequent contacts with a diversity of advice suppliers, with emphasise in the more conventional, the cooperatives and the independent advisory suppliers (see ***Figure 37***).

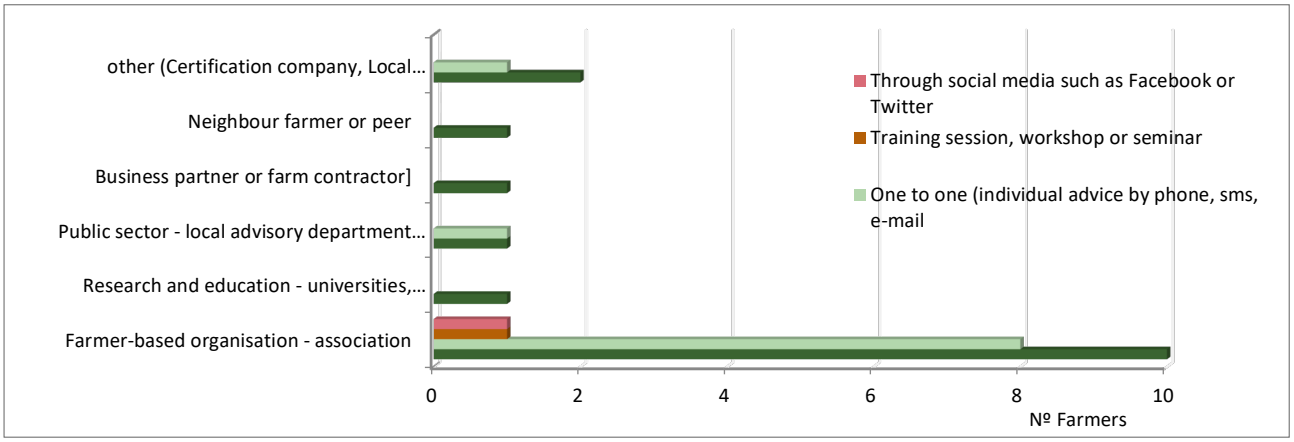
Figure 37: Adopter's awareness stage micro-AKIS, advice suppliers and frequency of contacts



Source: Own construction

Droppers awareness micro-AKIS presents a similar pattern to the adopters, although depict more diversity in a few cases, comprising the R&D, the local governments and a NGO (often mentioned) and the resort to a more diversified pattern of advice methods in the interaction with the LDA (see ***Figure 38***). This micro-AKIS, given the concentration of droppers in the Tâmega Eastern sub-region more rural and distant from Porto conurbation underlines the region effort to disseminate and to support the PROVE programme.

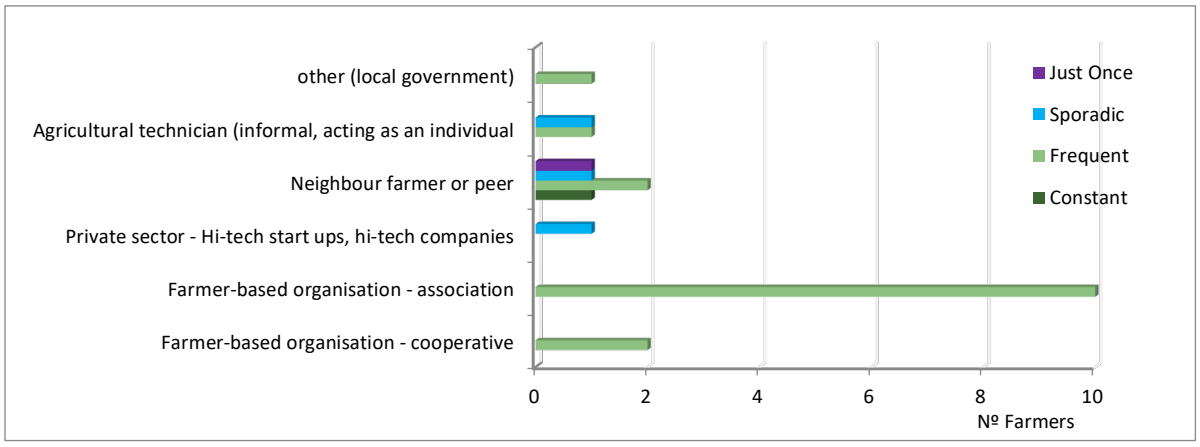
Figure 38: Droppers' awareness micro-AKIS, advice suppliers and methods



Source: Own construction

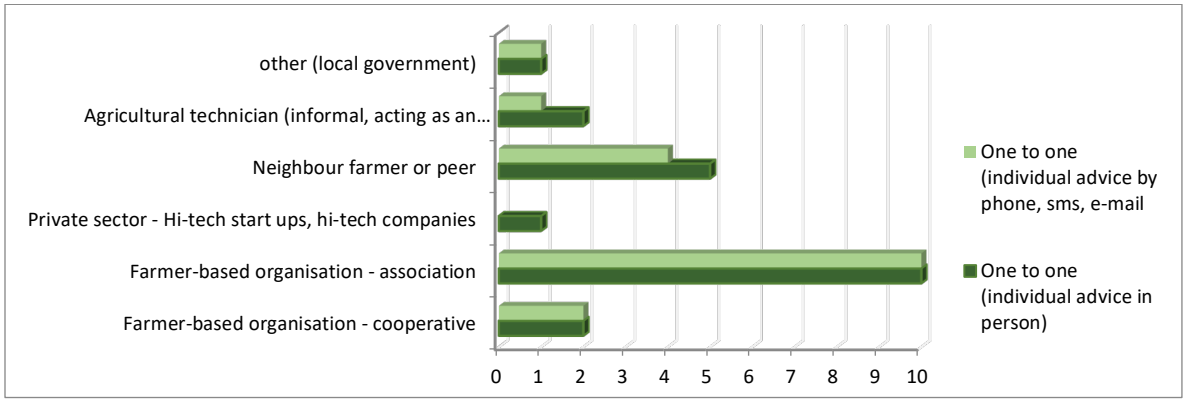
The adopters' micro-AKIS of implementation phase (***Figure 39***) highlights a more intense interaction with the LDA. A small number of farmers depicts a larger micro-AKIS, comprising other farmers, cooperatives, independent advisors, local governments, and technician from other sectors (informatics mostly).

Figure 39: Adopters' implementation stage micro-AKIS, advice suppliers and frequency of contacts



Source: Own construction

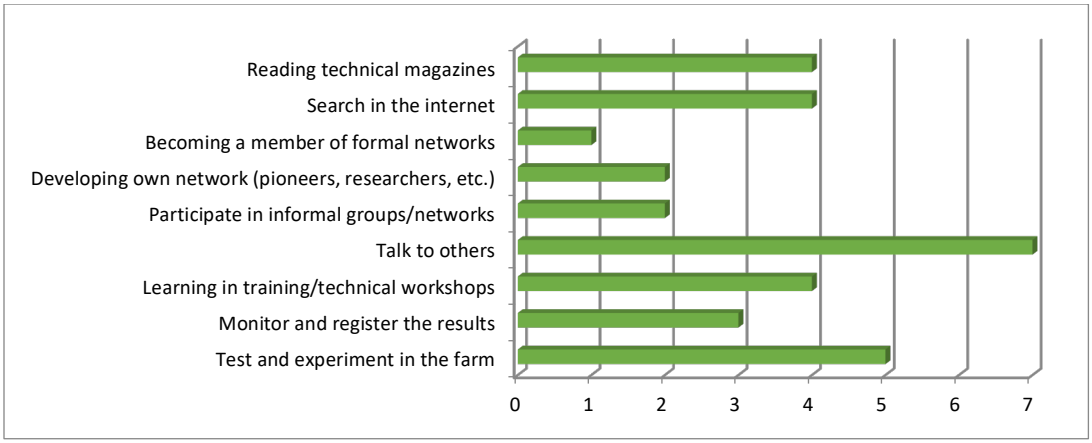
Figure 40: Adopters' implementation stage micro-AKIS, advice suppliers and method



Source: Own construction

The predominant advisory method is the one-to-one in-person (see **Figure 40**). This finding is probably related to the importance assigned by adopters to activity "talk to others" to gather knowledge and skills to implement the innovation (see **Figure 41**), differently from what has been observed for their general micro-AKIS.

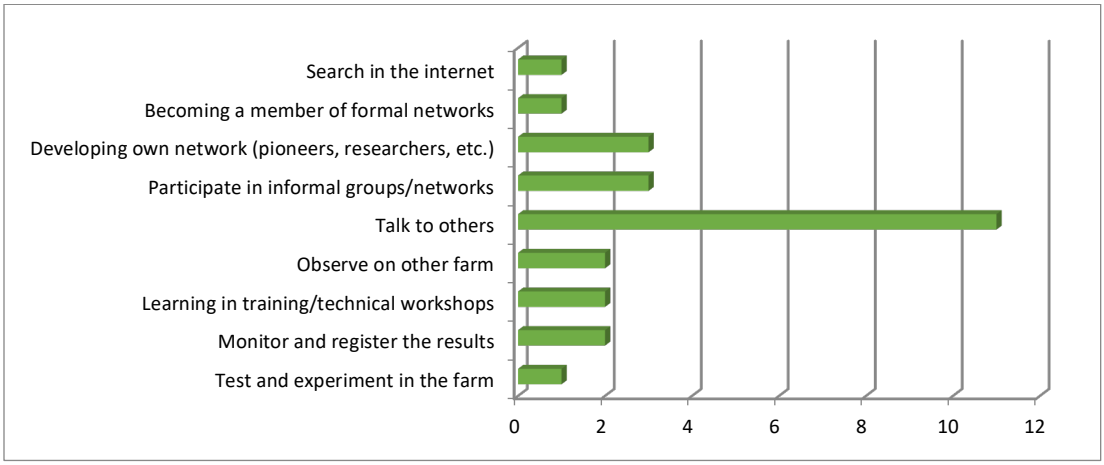
Figure 41: Most important activities to obtain knowledge and skills to implement innovation by adopters



Source: Own construction

The activity "talk to others" shows even more important in the case of the innovation droppers at their implementation stage (see **Figure 42**).

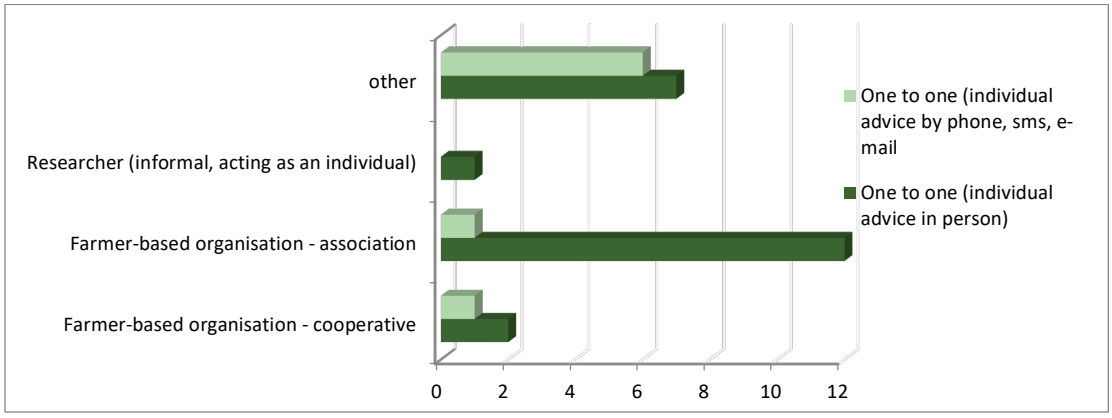
Figure 42: Most important activities to obtain knowledge and skills to implement innovation by droppers



Source: Own construction

Droppers' micro-AKIS for the implementation of the innovation exhibits a larger diversity of advisors in comparison with adopters, revealing a high role of "other", non-conventional advisory suppliers, already mentioned such as the local governments and an ONG involved in this process, and the presence although residual of the R&D sector (see **Figure 43**).

Figure 43: Droppers' implementation stage micro-AKIS, advice suppliers and method



Source: Own construction

Micro-AKIS related to the innovation adoption in both cases of adopters and droppers are according to the interviewed farmers characterised by reciprocal interactions in most of the cases, when the advice suppliers are the LDAs and others farmers with whom they have interacted more intensively.

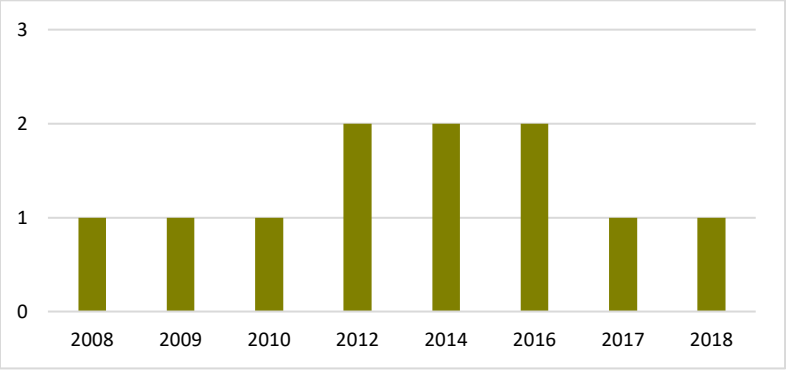
Regarding the assessment underpinning innovation uptake decision-making, around half the adopters didn't envisaged additional costs with it, whereas others weighted additional costs related with the production and marketing of the products. Only one farmer mentioned the need for extra labour and the additional cost. The cost assessment at the decision-making level was similar in the case of droppers. Both groups identified risks with the innovation uptake comprising the risk of lacking clients, often related by the farmers with risk of not being able to provide the variety and quality consumers demand (showing implicitly an insufficient ability of assessing the innovation), the competition and conflicts between producers, and at

less extent the climate conditions. Uncertainties identified included the loss of customers, the competition among producers, the prices volatility and the climate conditions. Negative side effects associated to the innovation include the conflicts between farmers within the groups, detailed in the conversations as comprising situations such as: a) the uneven share burden with the effort and time consumed entailed by the transportation and interaction with the consumers; b) the fact groups being too big to ensure profit to all; c) the fact direct selling with the baskets approach entailing too much effort and being too time consuming; e) the need of farmers to enrol as fiscal entities and have to pay VAT over products and not over baskets, making the group management complicate and often entailing paying taxes without being sure they would sell all the production.

Non-adopters that have considered to adopt the innovation (6 from the 9 interviewed) point out the bureaucracy involved as major issue along with the difficulty to have the variety and quality demanded by the customers, they anticipated as being demanding, hence being more easy for them to keep delivering their production at the cooperatives.

The support of the LDAs is very much highlighted and the end of funding to the programme in 2014 is referred as a turning point in particular for the groups supported by the DOLMEN association in the Eastern part of the focus region, that by being more rural and far from Porto conurbation make the direct sell more costly. Hence, all adopters in this sub-region abandoned the PROVE baskets. A few, the ones with larger and specialised productions of new crops, continued at least partially with the direct marketing by selling to restaurants. The direct marketing within the PROVE approach continued in the Western part of the focus region, the Vale do Sousa, after the end of the funding to the programme, but with a total different group dynamics. There were droppers and groups fragmentation. The current groups, including new ones (e.g. one selling only organic products) have at maximum two persons, and often these persons are associated with different farmers in different groups. Basically an individual dynamic has been established. This new dynamic highlights that initial groups were likely too large for the available customers and that without the support from the LDA, in particular in the Tâmega subregion, which comprised the lending of a van, the support to bureaucracy requirements and the group tensions mediation, farmers' couldn't bear the burden. Hence, some dropped out, whilst others created their our own dynamic by grouping with another individual producer they knew and trust, when that was felt as advantageous, or choose to work alone otherwise. The direct marketing innovation dropping out appears to have two phases, as shown by **Figure 44**. Initial droppers are the specialised producers that soon realised that their business model didn't fit the PROVE baskets approach, and a second phase triggered by the withdrawn of the LDAs, what was foreseen in the programme methodology of supporting only the launching of the groups.

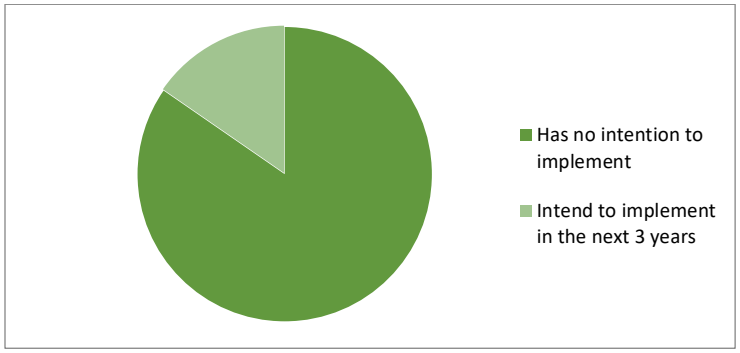
Figure 44: Year droppers abandoned the *DMAR* innovation



Source: Own construction

The reasons evoked for abandoning the innovation concerning the PROVE approach, when not related with moving to a different direct marketing business model, highlighted this innovation to be a tough one. Hence, in spite of its profitability when farmers are able to establish a stable customers portfolio, it presents a number of difficulties respecting the logistics costs (in money, time, bureaucracy, and personal effort), soft skills are required to maintain and conquer new customers, what showed not so easy as initially though when the programme was launched. Actually some of the currently adopters interviewed refer to the need for home delivering and that consumers get bothered with the baskets and they need to constantly think on new crops to satisfy them. Hence, **Figure 45** shows without surprise that only a few droppers have the intention to reintroduce the innovation in their business model.

Figure 45: Droppers plans to re-implement the innovation



Source: Own construction

To sum up this case study highlights the importance of contextual factors for innovation success, and that relate with regional heterogeneity. The Eastern part of the focus region, the Vale do Tâmega, evidences that in spite of the subregion effort to set up an AKIS purposely to disseminate and to support the innovation (the PROVE baskets approach), the more rural character of the area along with the larger distance to the Porto conurbation, didn't allow the sustaining of the programme after the LDA withdraw. Hence, highlighting that its implementation was basically an assessment to the innovation. Similarly in the other subregion, the Vale do Sousa, the programme was able to sustain itself although with a major reconfiguration led by the farmers themselves.

5.2.2 Findings form the AKIS experts interviews and advisory suppliers survey

This subsection presents the data and information gathered through the advisory organisations survey and the in-depth interviews to key AKIS actor, identified by the farmers and by the research team based on the previous exploratory work and the side information collected along the period of farmers' survey implementation.

5.2.2.1 Advisory landscape in the focus region

The NUTS 3 Tâmega e Sousa is part of the Northeast region of Portugal, corresponding roughly to the agrarian region of the Entre Douro e Minho (EDM), historically characterised by small-scale farming. Currently 84% of the farms have less than 5 ha of cultivated area and only 0.5% have more than 50ha (GPP, 2017). The regional agrarian landscape was shaped by the maize production, in the past used massively for human consumption and currently mostly for animal feed, although as part of a polyculture pattern together with the growing of vineyards, vegetables and fruits, and cattle breeding. The entrance of Portugal in the EEC in 1986 has boosted the dairy farming in this region. A large network of 44 dairy cooperatives has formally established, in 1989, as a union of cooperatives of the entire North region of Portugal,

following a process of agglomeration led by a dynamic dairy cooperative which origin goes back to the year of 1949. The problems faced by the dairy sector as a result of the reforms of the CAP, along with the decline of familiar labour, created room for new dynamics in the regional agrarian landscape in the last 20 years. The grapevine and wine growing expanded and become attractive due to the competitiveness gained by the quality DOC wines of this region (EDM). The focus region Tâmega and Sousa is currently the sub-region that contributes more to this DOC wine production (wine Verde). The importance of wine growing, along with cattle breeding, shaped the advisory landscape in the focus region. Similarly to the Douro region cooperatives were founded in 1950s in most of the region municipalities, aiming at agglomerating and transforming the grapevines, and to agglomerate milk and supply inputs to the famers. This was at the time a nationwide agricultural policy of the dictatorship that has governed Portugal until 1975. With the 1975 revolution and installation of the democracy a few new cooperatives were established in the focus region focused on representing the small-scale farmers and with a broad scope of products and services. The supply of agricultural training in the format of courses for young farmers and shorter training sessions was a new activity cooperatives embraced in 1980s. Meanwhile the advisory landscape has diversified with the emergence of farmers regional and sectorial associations, and the agrarian management centres, when the public services of the Ministry of Agricultural and its regional Directorships withdraw from the subsidies application, in the 1980s, and a FBO FAS has been established both at the national and regional level.

However, in current times with a few exceptions, cooperatives face financial difficulties and are focused on the agricultural subsidies application and the selling of inputs, experiencing difficulties in supplying technical support due to human resources shortage. And farmers associations are as well concentrated in the subsidies application, while some of them, along with some cooperatives, have also became involved in the support to the integrated production, very important in this region associated to the grow of grapevines for high quality wines.

One of these successful cooperatives located in the Vale do Sousa is a major exporter of DOC wine and of kiwi fruit highlighting the success dynamics in the regional agricultural in the last 15 years: the consolidation of DOC wine growing for high quality global markets, and the investing on new crops, namely the kiwis (since the 1990s). The kiwis are nowadays an important crop in the focus region and comprise a substantial number of specialised producers that have created their own sectorial associations.

Hence, the R-FAS is not focused on the innovation of direct marketing, although it has shown to be part of the innovation micro-AKIS, although in a relatively marginal manner, by their support function to the launching of PROVE programme as partners of the LDAs together with the local governments. Nonetheless, they are part of the adopter's micro-AKIS as well as the other farmer by selling input and delivering related technical advice and by supporting farmers with the agricultural subsidies. Personal proximity relations of some farmers with cooperatives technicians were reported in same cases as helpful to the innovation.

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

DMAR-Tâmega illustrates an innovation being developed outside the conventional R-FAS. That happened because it addresses small-scale farmers and an organisational / marketing innovation both not addressed by the R-FAS. The PROVE approach by building on group dynamics and designed to be sustained through the action of farmers and their groups following an individual and collective initial learning process can be envisaged as a social innovation (e.g., Mumford, 2002; Neumeier, 2017). Hence, a novel AKIS has been set up, led by the two LDA working in the region: the DOLMEN which influence area is the Eastern side of the focus region, the Vale do Tâmega, and the ADER-SOUSA, acting at the Western side at the Vale do Sousa. The innovation was launched through the programme PROVE, already described in section 4.1.2,

as well as along the section 5.2. This was a programme initially funded by the EQUAL and later by the rural development programme, hence focused on the facilitation actions and not associated to an agricultural development programme. PROVE aimed at increasing the income of small-scale farmers by involved them in short food supply chains business model, and to contribute to local development by empowering these farmers to be able to develop and strength these short food supply chains. The LDAs mobilised their best fitted partners to support them with the innovation dissemination and implementation, comprising the local governments, the local FBO, in particular the cooperatives, the NGOs focused on social entrepreneurship, like the CAERUS[14], and the R&D sector, that was also mobilised at the national level for the programme evaluation.

Hence, the key players were the two LDA, along with the PORVE programme nationwide methodology and support materials and tools. The other actors have been mobilised and contributed to the innovation dissemination and implementation. However, with the ending of funding to the programme this innovation-related AKIS collapsed and the farmers stayed basically on their own, aggravated by the fact that the PROVE groups dissolved and the interaction between "peers" was also substantially reduced to a few that still collaborate with each other but led by own dynamics. This failure underlines the limitations of the traditional division between the agricultural and rural development actions with the RDP, which hinders the development and the consolidation of innovations that are transversal, such as the direct marketing involving small-scale familiar farmers.

5.2.2.3 Transformation of advisory landscape

As described in the previous section in this case the transformation of the advisory landscape didn't occurred in a sustained way, likely due to the programme PROVE weren't designed to account for the fact that farmers needed to be supported by a permanent R-AKIS that wasn't actually developed. It raises some questions on the self-sustainability of programme-based initiatives assuming the individual actors, in this case the farmers, can proceed without a support system, and the importance of foreseeing the development of these systems as part of the programmes. *DMAR-Tâmega* illustrates also the conventional R-FAS inability to support organisational and marketing innovation, what hinders direct marketing in different formats, such as the direct sell to gourmet restaurants and groceries, to be properly developed and expanded given these are business models enabling to increase farm-based business sustainability, comprising as well as new crops specialised producers that also lack support to be successful.

5.3 Case 3: the role of farm advice in innovation case study *TECH-Lezíria*

5.3.1 Findings related to the Farmers' survey

The case study *TECH-Lezíria* focused on commercial farmers of irrigated crops, mainly maize, vegetables and tomato for industry, covering the group diversity regarding adopting and non-adopting the smart irrigation sensors, along with the regional heterogeneity on farm structures and farmers profile. The farmers' survey comprised a sample of 38 valid interviews, including 21 adopters (55.2% of the total interviewees), 10 non-adopters and 7 droppers respecting the innovation, the adoption of smart irrigation sensors.

[14] CAERUS is a NGO associated to a local government established as a Social Contract for Local Development of Third Generation (CLDS3G of the municipality of Marco de Canaveses). More info on http://www.caerus.pt/

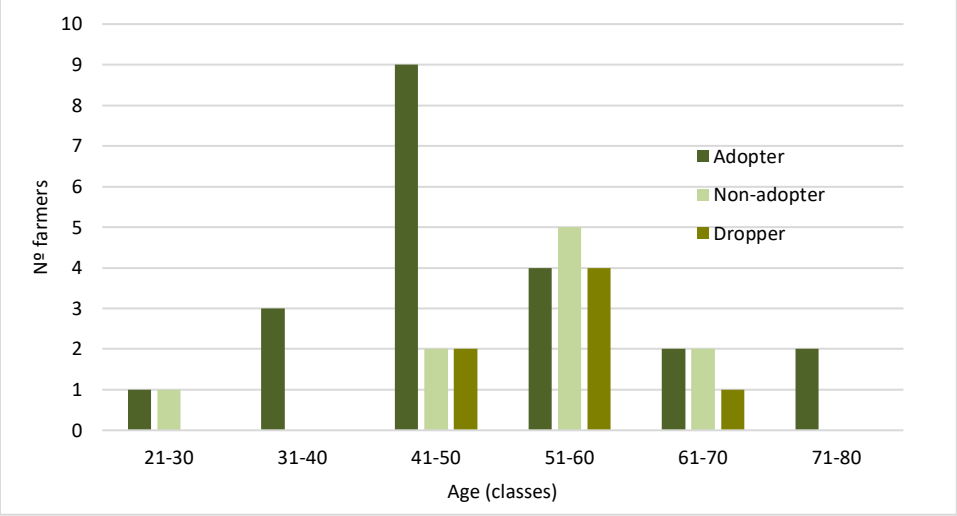
5.3.1.1 Farmers' profile and farm structure

The interviewed farmers tend to be more than 40's aged, whereas they are relatively young. There are adopters of all ages, in spite of adopters being younger in comparison to non-adopters and droppers that tend to be older than 50's (Fig. 43).

As already introduced in Section 4 this focus region, NUTS 3 Lezíria do Tejo, is a region characterised by a strong agricultural sector which has experienced a boost after the Portugal entrance in the EEC (in 1986). A significant role in that boost can be assigned to the group of visionary farmers that had created the AGROTEJO and headed the regional agricultural transition from rain-fed maize cultivation to the irrigated intensive maize cultivation, allowing farmers strongly benefit from direct support to the cereals production paid at the time by the CAP. Irrigation systems became indispensable, and intensive investments were done in irrigation infrastructures and equipment's largely supported by aids to the farm mechanisation until the end of the nineties. The survey has focused mainly on the farms in the Northern subregion, given the Southern has a large part of the agricultural area devoted to the rice growing with flood irrigation. Farmers in the Northern Lezíria do Tejo rely mostly on groundwater they extract from wells using irrigation pumping systems, currently using mostly electricity as energy source. Common irrigation systems in the region are sprinklers and central pivot irrigation, although drip irrigation is rising related with the rise in the vegetables growing. These crops are replacing the maize, due to the declining profitability of this crop since the 2003 CAP reform, aggravated by the world market low price for maize (mainly for animal feed) enhanced by the worldwide generalised cultivation of genetically modified (GM) maize outside of the EU.

There are a large proportion of farms established as legal entities (53% of interviewed farms), the majority resulting from familiar farm succession strategies. The sole holders are more common among non-adopters and droppers and are related with small size of respective farms.

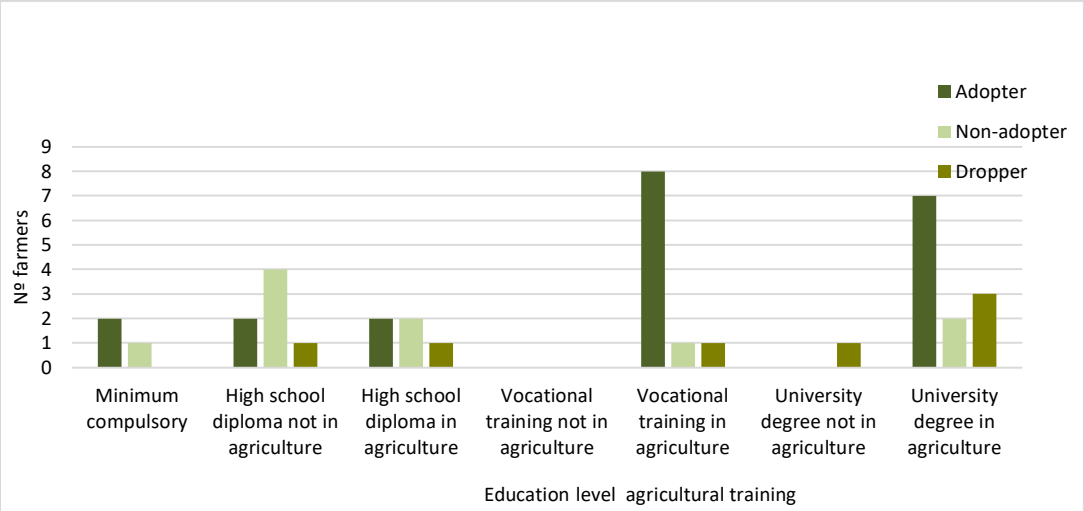
Figure 46: Interviewed farmers according respective age classes



Source: Own construction

The strong agrarian feature of this region along with the great and positive influence of CAP until 2003 explains that the majority of the interviewed have vocational training in agriculture (***Figure 47***).

Figure 47: Interviewed farmers according education level



Source: Own construction

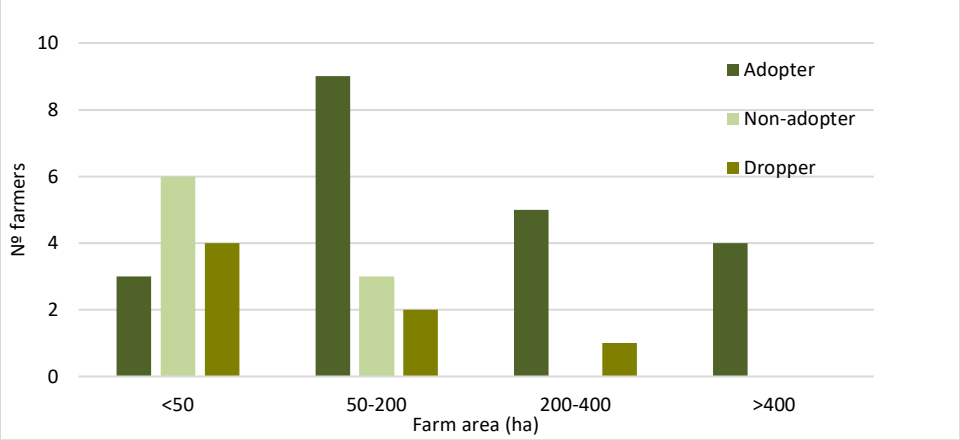
There are adopters from all education classes, however their majority has vocational training in agriculture or even a university degree on the subject. Non-adopters have in comparison to adopters a lower level of education, whereas droppers tend to do not differ substantially from adopters regarding this variable.

About 60% has been working on farm business for more than 30 years, droppers tend to have large experience in agriculture, whilst the group of the non-adopters has less experienced farmers (or farm managers), three of 10, have less than 15 years of experience in agriculture. Given most of the farmers are relatively young, the farm succession isn't still an actual issue, although only 10% of the interviewees stated to have a successor, the majority thinks that sons and daughters likely will be not interested in continuing the activity. Most of the farmers are pessimist respecting the future of the activity due to the low prices currently being paid to their productions, above the levels they received 30 years ago, while inputs price kept rising along the years.

All respondents have internet access, and more than 40% use some ICT to support decision-making related to farm management. About 42% (16) attended training events in the 12 months previous to the interview, mostly related to agriculture.

The distribution of the respondents according to the total area of the farm evidences that adopters tend to hold larger farms than non-adopters and droppers (***Figure 48***).

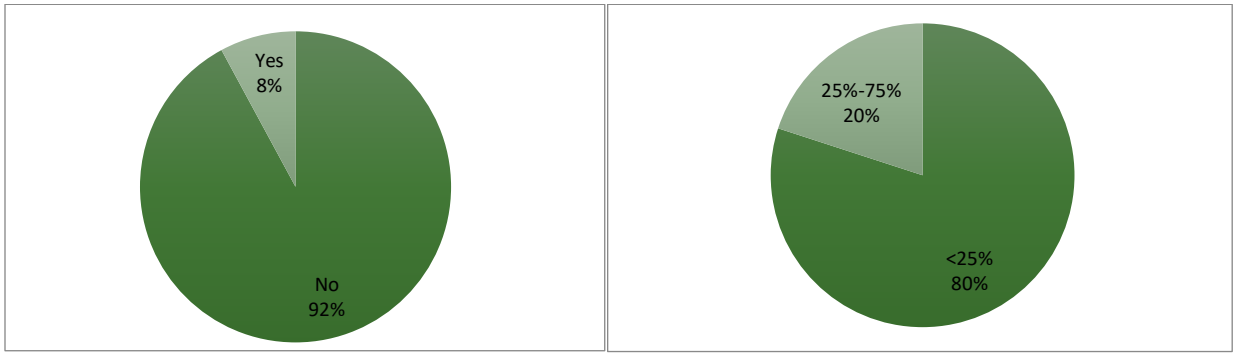
Figure 48: Interviewed farmers according to farm total area



Source: Own construction

Regarding the business model, most farmers (92%) do not have other gainful activity. But one of those who have (3), revealed the activity is related to the production of electricity (solar panels) (**Figure 49**).

Figure 49: Existence of other gainful activities in the farm and their share in the farm sales revenues



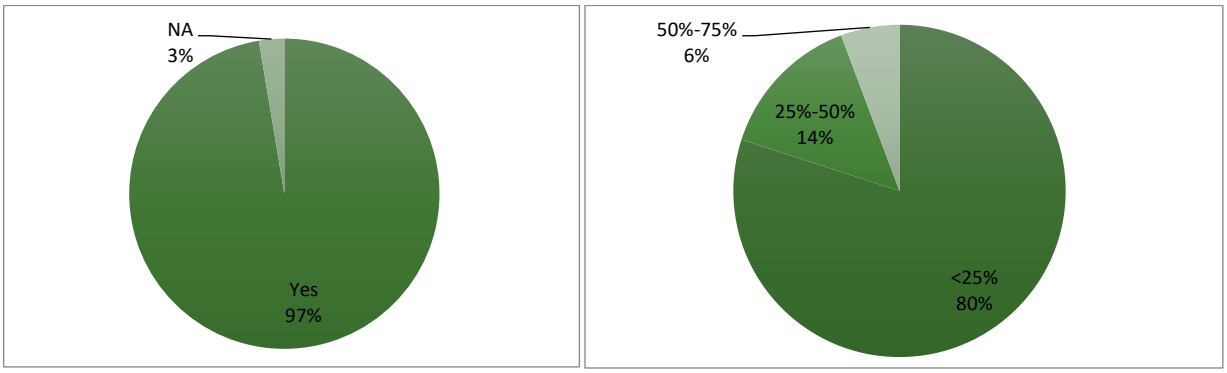
Source: Own construction

The share of other gainful activities represents less than 25% of the total revenues of the farm. In addition the business model of the majority of the farmers is similar: they do bulk sell to AGROMAIS in the case of maize mostly destined to feed production.; the vegetables are also sold in bulk at farm gate prices but to different buyers: some deliver their production also to AGROMAIS, other to other cooperatives in the region. Large producers of the Southern subregion also do bulk sell, mainly of tomato and other vegetables, but often do it directly to private agroindustry companies operating in the region, with locally-based procurement and processing facilities. Direct selling is residual, and only a few, innovation non-adopters and droppers, sell part of their vegetables, usually associated with fruit production, in the Lisbon wholesale fruits and vegetables market or directly in agricultural fairs. Hence, the replacing of the maize in the cultivated area, due to low prices of this commodity, by the growing of vegetables keeps being done through a similar business model, with bulk selling to large agglomerates or directly to the agroindustry when farmers have enough scale to get better prices in comparison to the former option. The major change happened in this focus region (in particular in the Northern subregion) during the 15 years after Portuguese entrance in the EEC, with the farmer's technical-productive reorientation from the maize commodity monoculture is that they left a market stable production system to an instable one. The demand for vegetables varies a lot from year to year, according to the market demands and prices, introducing

uncertainty in the farm planning and business profitability in comparison to the previous stable and profitable business model based on the growing of maize supported by the CAP.

Agricultural subsidies benefit all farmers (one farmer choose do not answer), whereas they represent in general less than 25% of the farm revenues (***Figure 50***), whereas in 6 cases represent more than 25% of the farm revenues.

Figure 50: Agricultural subsidies and % they represent to the total income generated by the farm



Source: Own construction

Most of the farms resort to no-familiar permanent labour, what is related to the relevance of farms established as legal entities (agricultural firms). In the case of adopters using hired permanent labour, more than 50% have employed less than 5 permanent workers in the previous year, and only 4 interviewees hired more than 5 permanent workers. Permanent workers are mainly operators of tractors and other farm machinery. Non-adopters, given the prevalence of sole familiar holdings and the small size of the farms, used hired labour at much less extent, an average of two workers, only 4 respondents reported having less than 10 permanent workers.

Respecting the use of familiar labour: seven adopters reported 1 to 4 familiars in full-time, three adopters employ one familiar on a part-time basis; three droppers employed one familiar in full-time, while five droppers employed 1-3 familiars in part-time; one non-adopter employed 2 persons in full-time and three non-adopters employed 1-2 familiars in part-time.

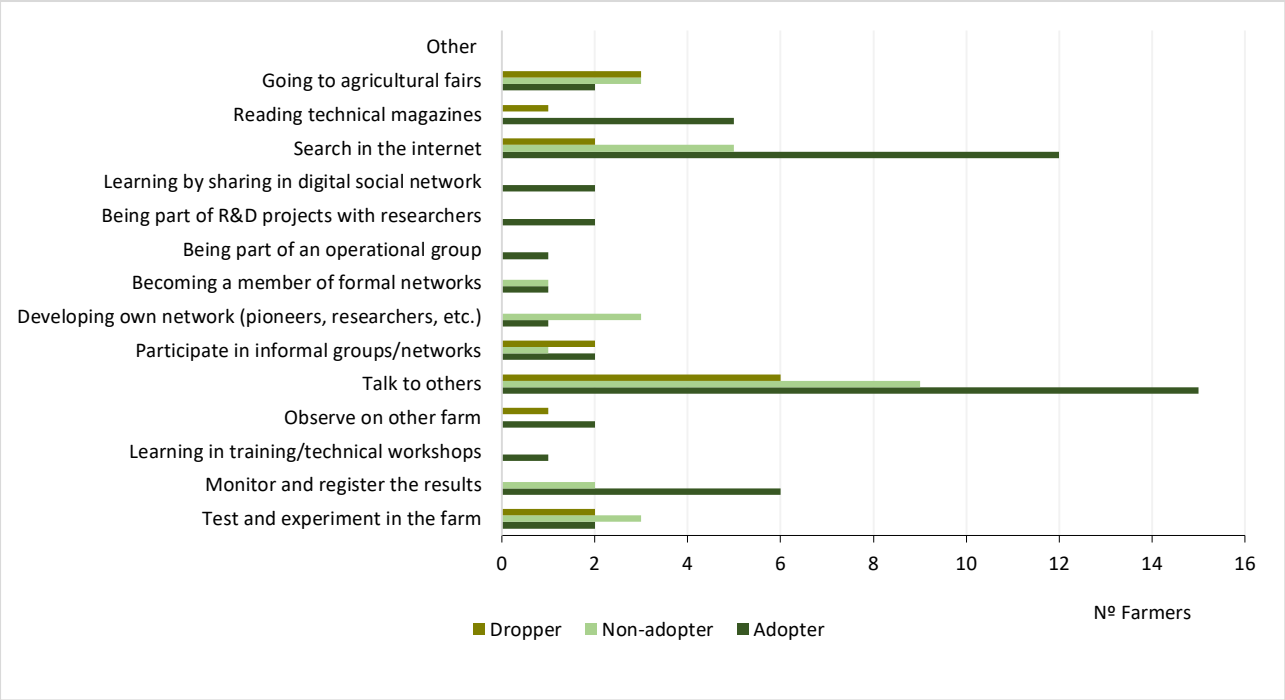
Farmers of all categories resort to some temporary labour depending on the farm size and in particular the area of vegetables they grow. Labour scarcity for agricultural is a problem in the region similarly to what happen in most of the Portuguese agrarian regions. Hence farmers resort as much as possible to mechanisation, and often are the smaller the more dependent on temporary labour. The fact of vegetables grown be more labour demanding explains partially why farmers resist to abandon the maize and other cereals cultivation.

5.3.1.2 Farmers' attitude towards innovation and change

The comparison of the general micro-AKIS (referring to the knowledge assemblage for the farm management not specially focused on the innovation) of the various categories of farmers regarding the innovation, shows that the three most important activities to obtain knowledge and skills to manage their farms in the case of adopters are 'talking to others', 'searching in internet' and 'monitoring and registering results', closely followed by reading technical magazines (***Figure 51***). These results suggest they use in comparison to non-adopters and droppers more often activities that are cognitive demanding, by mobilising codified and synthetic knowledge, and hence they are more prone to use smart ICT devices,

such as the smart irrigation sensors. Adopters group comprises the farmers, while only a few, learning through the participation in digital social networks, being part of R&D projects and /or operational groups, and learning in training or technical workshops.

Figure 51: Most important activities to obtain knowledge and skills to manage the farm



Source: Own construction

The comparison of general micro-AKIS of adopters (***Figure 52***), non-adopters (***Figure 53***), and droppers (***Figure 54***) highlights the importance of farmers associations, which includes with few exceptions to the AGROTEJO, in all cases respecting the relation to the innovation. The importance of private sector is also evident in all the three situations, although adopters depict a richer and diverse type of private advisory system, comprising not only the upstream and downstream industry, respectively suppliers of inputs, machinery and equipment and the buyers, but also independent advisors and hi-tech companies. On the other hand, the downstream sector, encompassing the food industry, agroindustry, traders and the large distribution play a major role and appear as the second most important player following the FBO association.

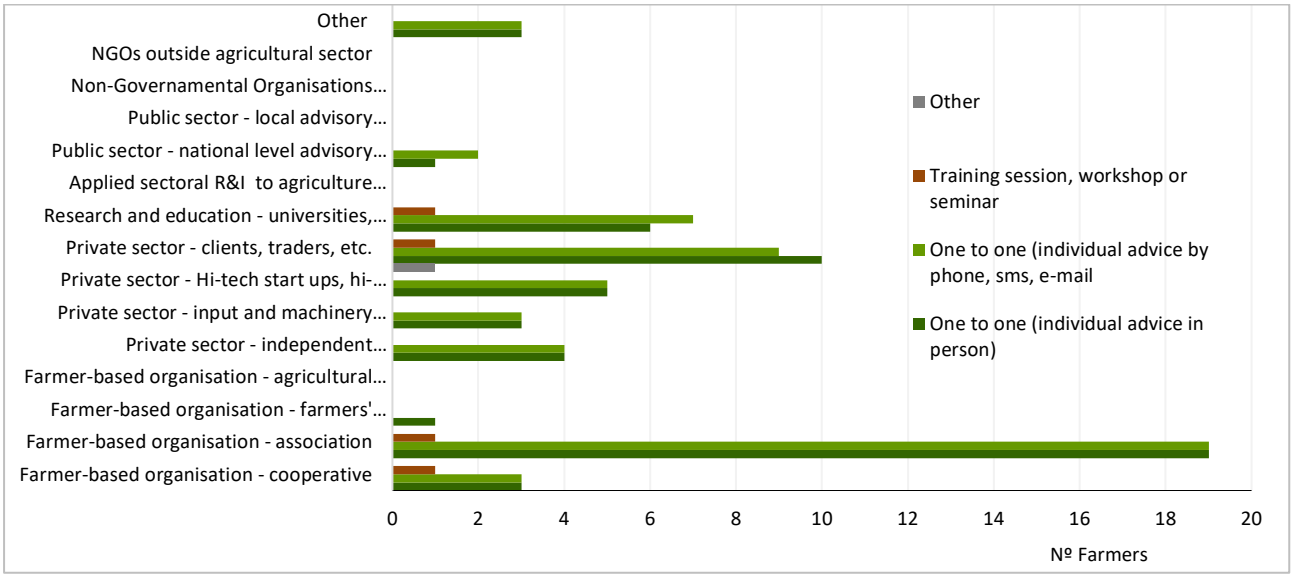
The hi-tech companies while most important in the case of adopters are also reported by one non-adopter, likely related to other technologies related to the irrigation and precision farming. Cooperatives are reported by adopters and droppers as advice suppliers.

Adopters present a richer and diverse micro-AKIS including R&D sector and advice from public sector, the services of local agriculture ministry.

Predominant advisory method, similarly to what has been observed in the other case studies is one-to-one individual advice in-person, closely followed by one-to-one not in person, by phone, SMS or e-mail, whereas in the case of adopters the later method is equivalent to the first and even more used regarding advice supplied by the R&D and public sector. However, collective advice delivered through training session, workshops, seminars and similar events, show more relevance in comparison to the other case

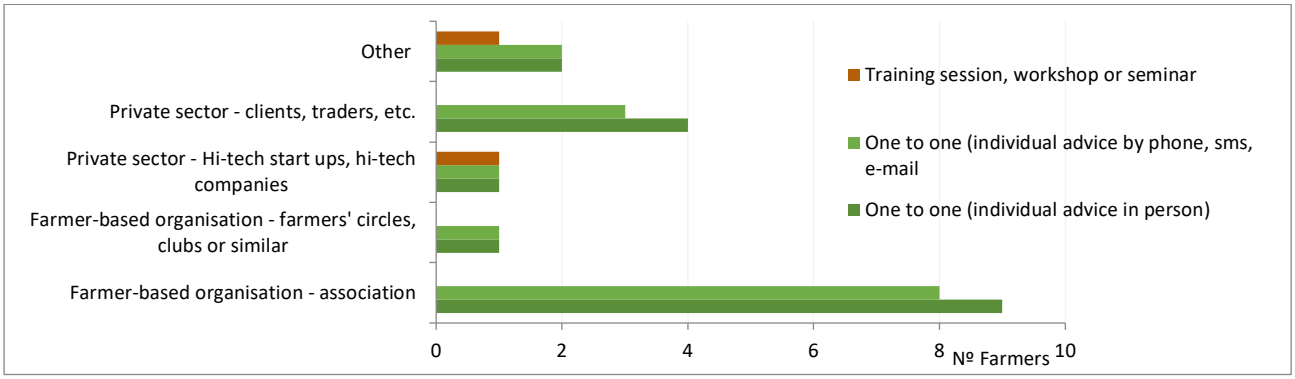
studies and appear associated to different types of advice suppliers, likely reflecting a more structured regional AKIS and the quality standards required by the large assemblers and buyers. In the case of adopters this method is mentioned in relation to the FBO association and cooperative, the downstream sector and the R&D institutions. Non-adopters and droppers also refer it for advice supplied by the downstream sector and hi-tech companies.

Figure 52: Who provides farm advice and how (adopter)



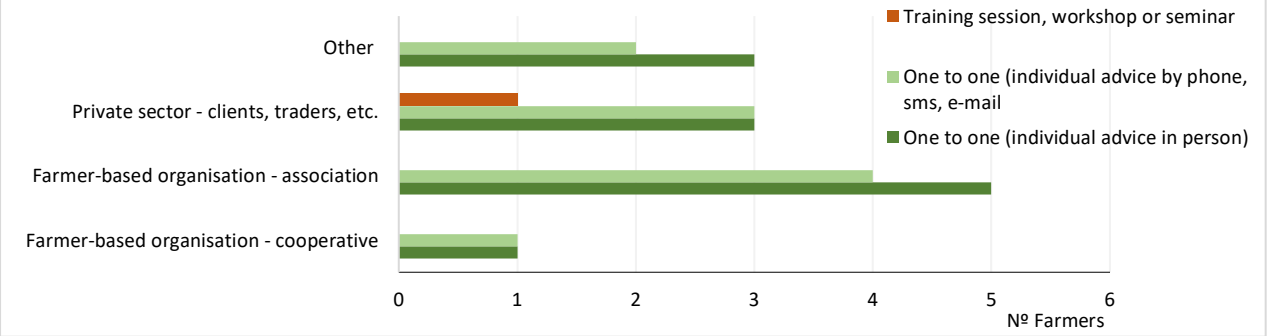
Source: Own construction

Figure 53: Who provides farm advice and how (non-adopter)



Source: Own construction

Figure 54: Who provides farm advice and how (dropper)



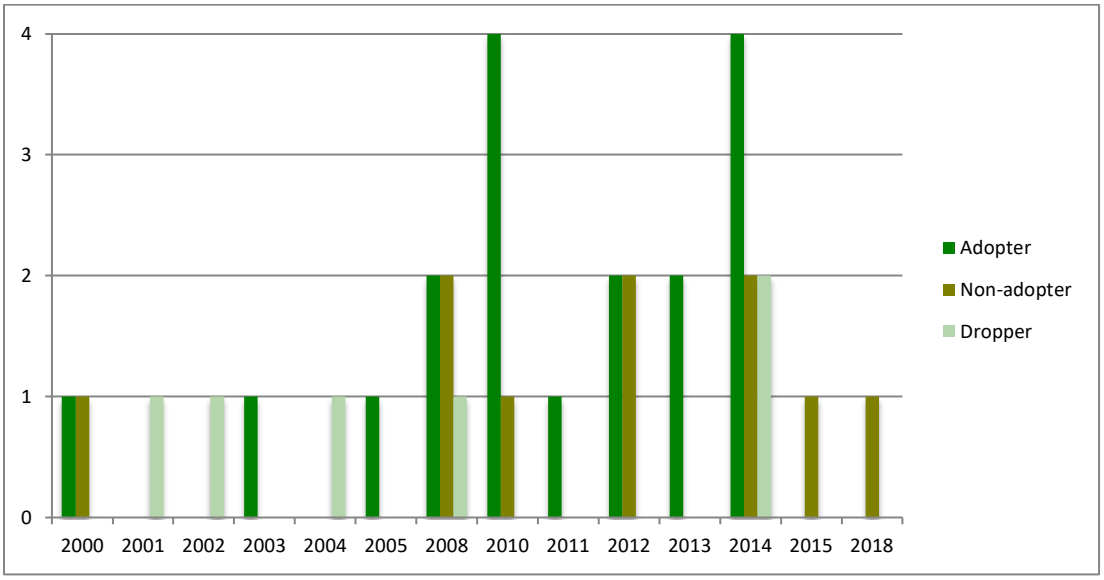
Source: Own construction

The FBO associations are the main providers of technical advice, whereas the inputs suppliers and private consultants and in particular the downstream sector are also mentioned. Support to subsidies and project applications is mostly requested to the FBO associations, and in a few case to independent advisors and centres of farm management. Advice on marketing is requested only by a few farmers and to a diversity of advisory supply, including the farmers' association, the private downstream sector and the hi-tech companies.

5.3.1.3 Farmers' innovation paths and trigger cycle change model

There are two periods were awareness about the innovation has peaked (as shown by ***Figure 55***), between 2008 and 2010, and a second period around 2014. The first period coincided with the AGROMAIS campaign to disseminate the innovation by inviting farmers to adopt it at reduced costs, supported by a demonstration project. Second peak corresponds to the introduction of the agro-environmental measure incentivising more efficient irrigation.

Figure 55: Year when farmer gained awareness of the innovation

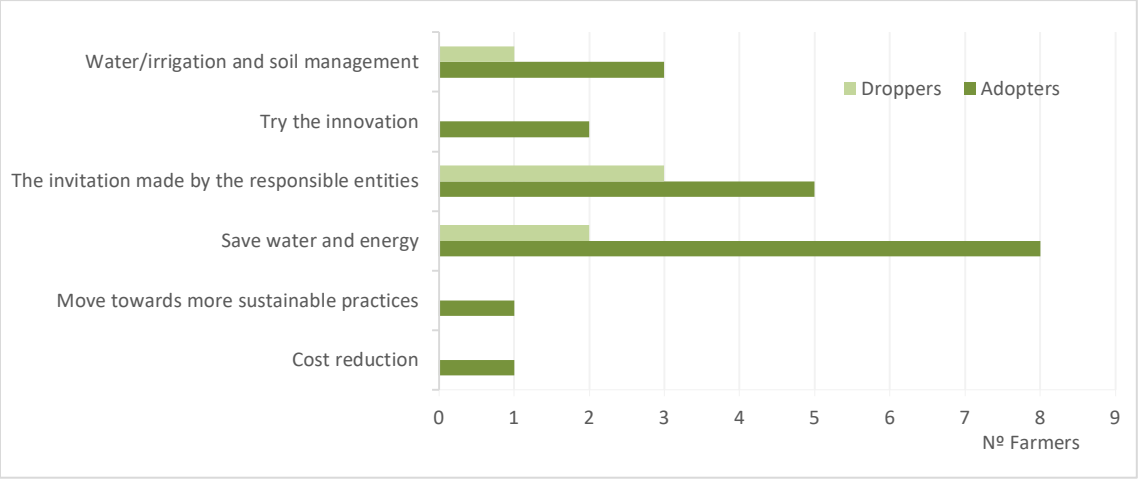


Source: Own construction

The innovation assessment period tends to be short, less than year in average. Shorter assessment periods are probably in part due to the fact of external triggers motivated the innovation uptake in the two periods pointed out. Both adopters and droppers are amongst the farmers that firstly become aware of the innovation, whereas non-adopters tend to be aware later on, including the more recent years, suggesting that in spite of FBO dissemination efforts there are still farmers not aware of it.

The motivations for assessing the innovation (***Figure 56***) comprise the response to the FBO invitation and the expectation of saving water and energy, along with a better management of irrigation Nonetheless is possible to identify a more prone innovation behaviour in the case of adopters in comparison to droppers given their motivations for the assessment comprise either the interest for more sustainable practices and the idea of experimenting the innovation.

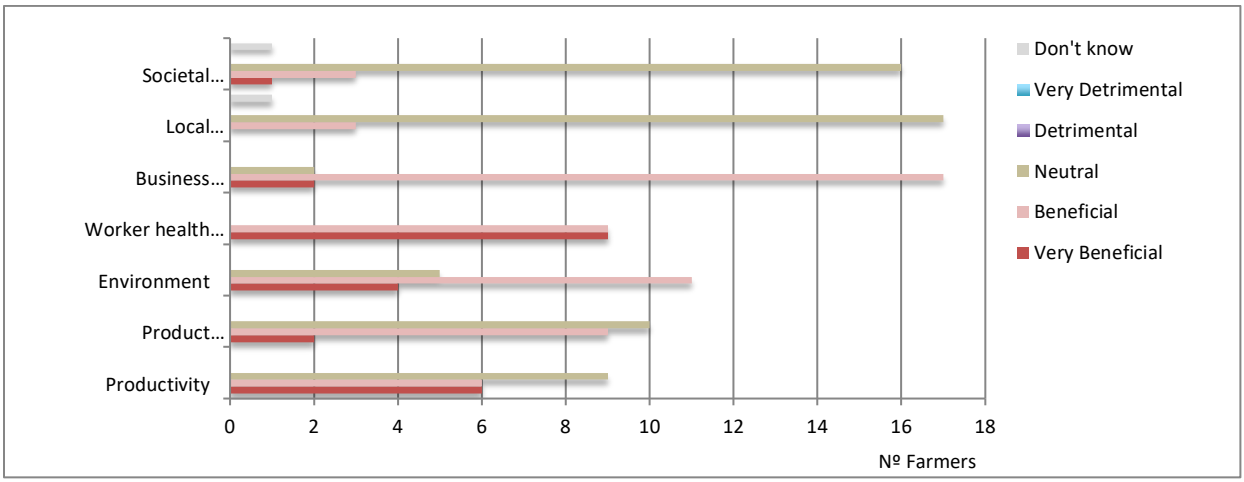
Figure 56: Motivation for assessing the innovation



Source: Own construction

The adopters' evaluation of the innovation (see ***Figure 57***) show their consensual believe in benefits on to the business competitiveness. Beneficial and very beneficial effects assigned to the workers' health and well-being are likely associated to work and effort saving by using the smart irrigation sensors. Effects on the environment are evaluated as beneficial and at less extent as neutral and very beneficial. Regarding productivity and product quality, neutral effects dominate beneficial effects evaluations. Adopter's don't see relevant effects on the community by using the smart irrigation sensors. No detrimental effects were pointed out to the innovation.

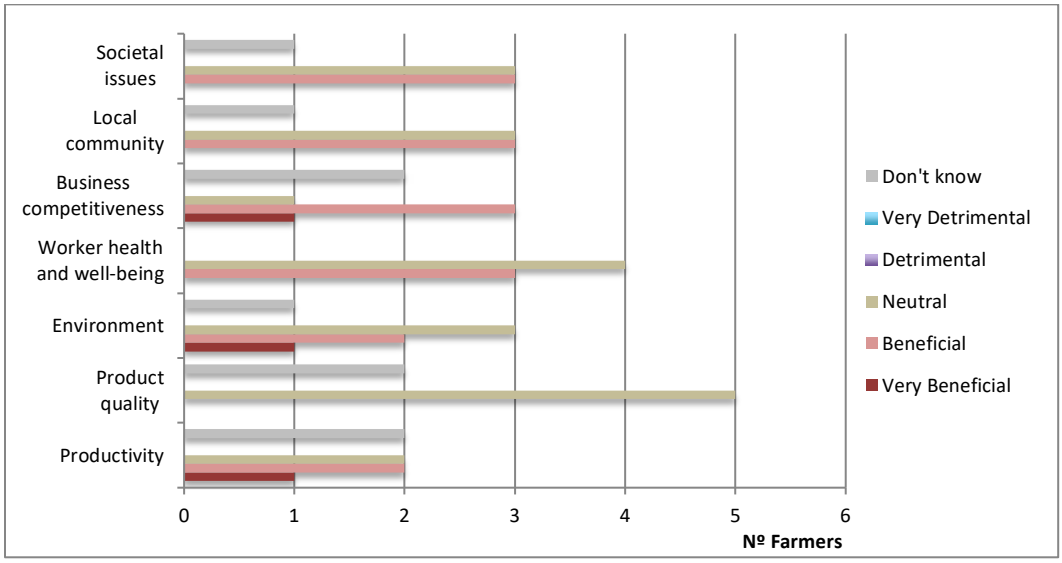
Figure 57: Adopter evaluation of impacts of the innovation



Source: Own construction

Droppers show less enthusiasm and more uncertainty regarding the innovation evaluation, while acknowledge, as well as the adopters, benefits on the business competitiveness, the environment and at some extent on productivity, as shown by ***Figure 58***. Differently from adopters, droppers appear to believe more on benefits to the community and society. No detrimental effects were reported, similarly to the adopters.

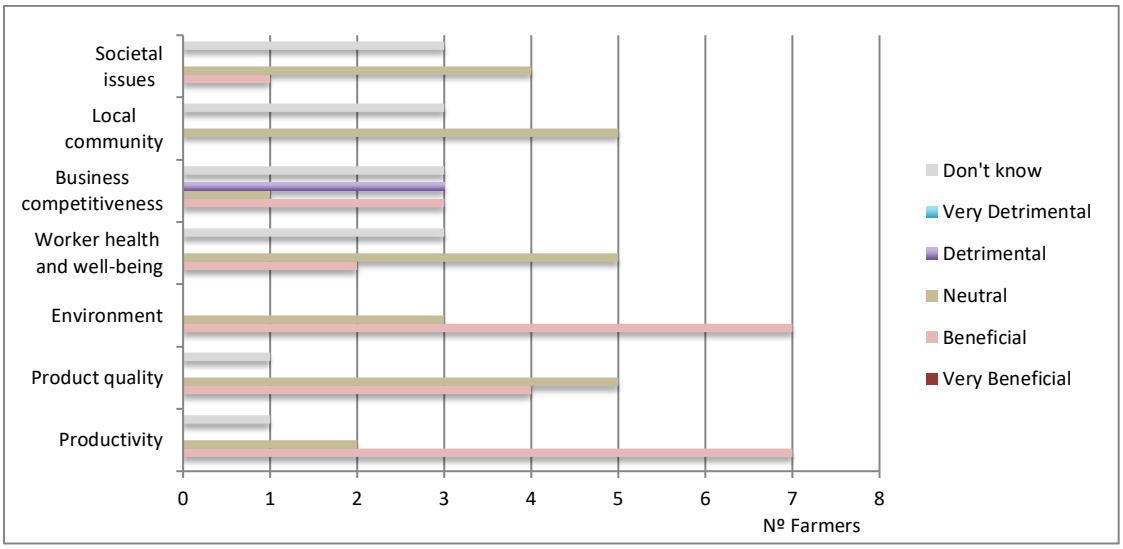
Figure 58: Dropper evaluation of impacts of the innovation



Source: Own construction

Non-adopters evaluation on the innovation effects highlights neutral benefits along with some uncertainty (see ***Figure 59***). Benefits are assigned by the majority of non-adopters to environment and productivity dimensions. Detrimental effects on business competitiveness are reported by 3 non-adopters.

Figure 59: Non-adopter evaluation of impacts of the innovation



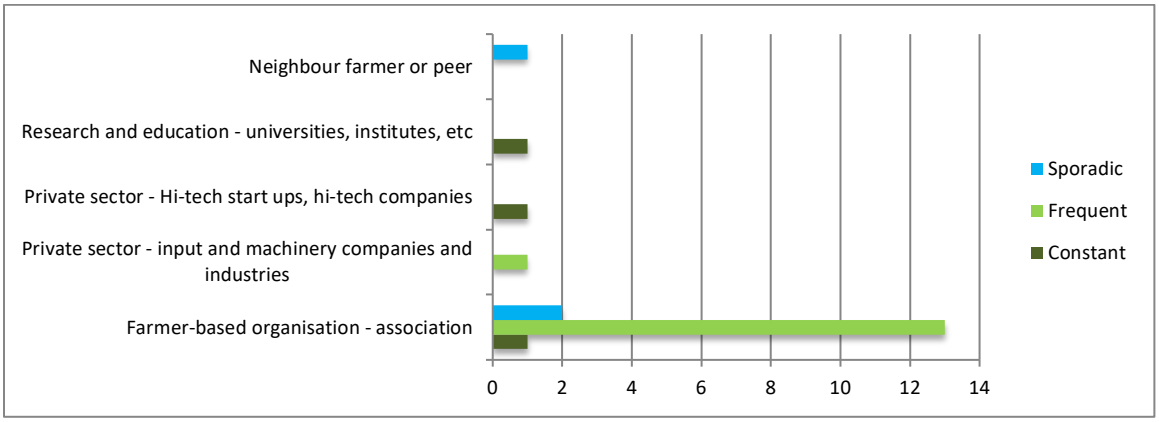
Source: Own construction

Regarding the cost-benefit analysis farmers conducted in the assessment stage there are no significant differences between adopters and droppers, while non-adopters tend to mention more the risk of data reliability from the probes. Main cost identify by all the farmers is the high cost of renting the probes, whereas main benefit would be the water and energy saving along with the enhancement of irrigation process. Among the risks that were identified by very few respondents are the probes stole or damaging by animals or farm machinery, and the farmers inability to take advantage of the technologies due to lacking him skills for that.

5.3.1.4 Farmers' innovation micro-AKIS

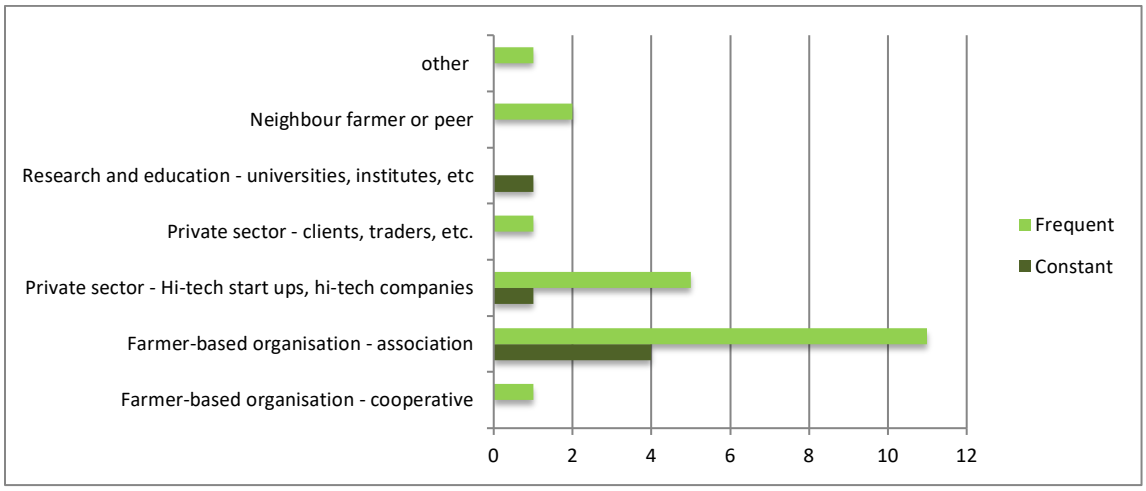
Adopter's micro-AKIS along the stages of trigger cycle model are showed in ***Figure 60*** to ***Figure 62***, and evidence a distinction of awareness and assessment micro-AKIS stages. In the first stage FBO associations (in particular the AGROMAIS) are the dominant relevant actor. Assessment stage shows the broadening of the adopters micro-AKIS, namely by the presence and the contacts intensity with the private sector, namely the hi-tech companies and the interaction with other farmers.

Figure 60: Adopters' awareness stage micro-AKIS, advice suppliers and frequency of contacts



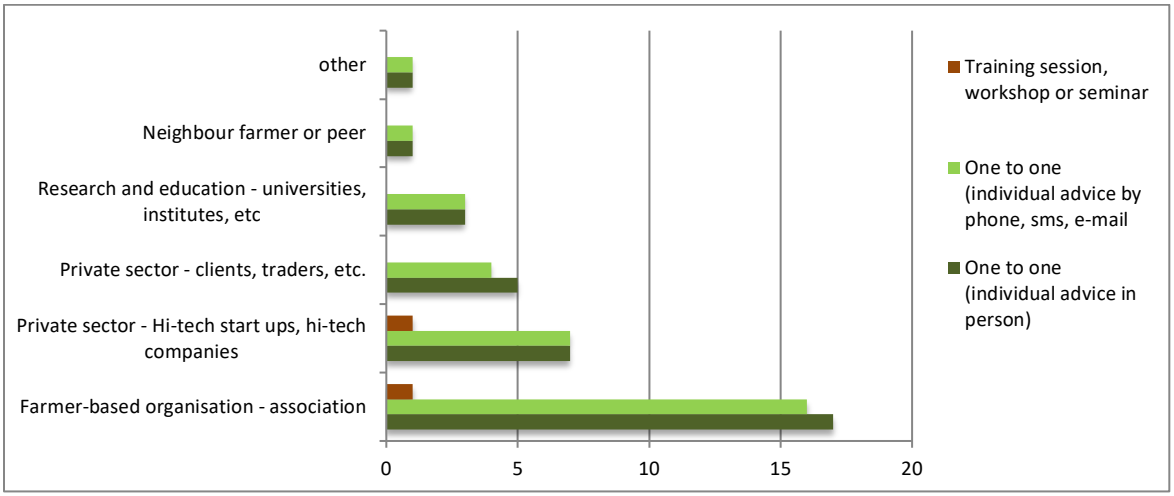
Source: Own construction

Figure 61: Adopter's assessment stage micro-AKIS, advice suppliers and frequency of contacts



Source: Own construction

Figure 62: Adopter's implementation stage micro-AKIS



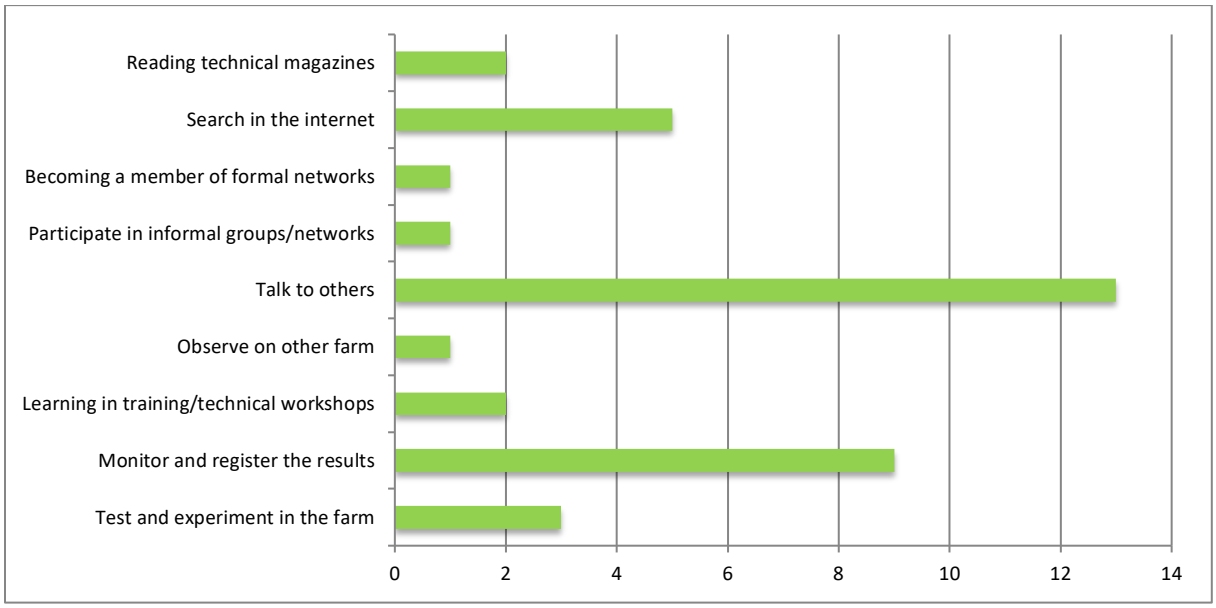
Source: Own construction

In the implementation stage the downstream sector actors emerge as relevant advice suppliers to adopters of smart irrigation sensors in the focus region. This is likely due to the fact they more recently directly incentivise mostly large farmers to install sensors often by supplying them for free in order to help farmers to become acquainted with this smart technology which will brings benefits in the quality of vegetables they buy from these farmers.

Adopters inquired about the three most important knowledge and skills to implement the innovation underline "talking to others", what confirms the advisors information that most of them are passive innovation up-takers. Advisors from FBO associations, and in a lesser extent the hi-tech companies and downstream agroindustry companies install the probes, manage and store the data, and monitor irrigation needs by sending farmers alerts by SMS to their smartphones. There is a group of adopters whom are active learners and monitor directly the data and the information released by the software managing the data registered by the probes, evidencing abilities to cope with synthetic knowledge, by understand it and

being able to contribute to its co-creation, by in-field monitoring and experimenting the best placement for the probes in their plots.

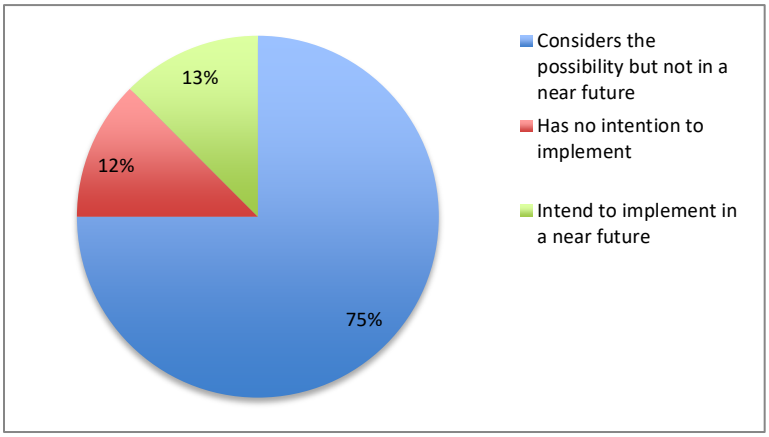
Figure 63: Most important activities to obtain knowledge and skills implement the innovation



Source: Own construction

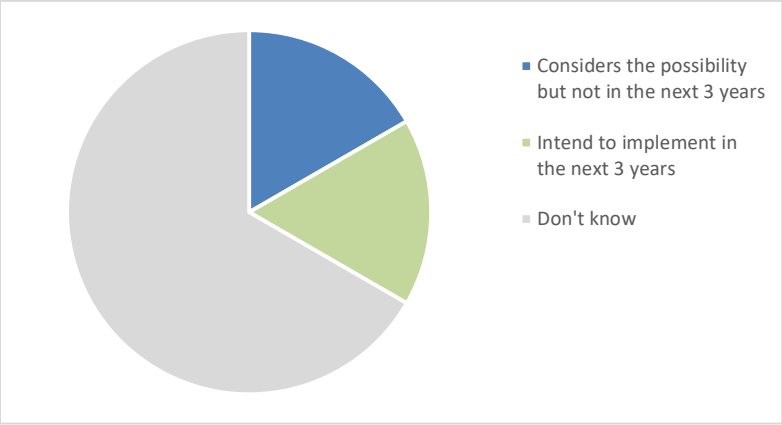
The overall positive evaluation of the innovation by the droppers, and at lesser extent by non-adopters, probably explains why the majority of non-adopters stated the intention to introduce the innovation in their farms and that mostly of droppers responded they don't know (see ***Figure 64*** and ***Figure 65***). The major issue for most of the droppers is the fact they have a cultivated area fragmented by many small plots that entails the use of a huge number of probes, number that could be increased by the heterogeneity of soil conditions within the plots. Hence, they seem to be aware that to make a proper use of the probes farmers need to have a small number of large area plots, otherwise the costs are impeditive. Hence, there "don't" answer is probably related to their uncertainty that the probes rental cost decreases substantially in the future and that they are able to manage their land rentals and purchases to enlarge the plots area.

Figure 64: Non-adopters plans to implement the innovation



Source: Own construction

Figure 65: Droppers plans to implement the innovation



Source: Own construction

5.3.2 Findings form the AKIS experts interviews and advisory suppliers survey

This subsection presents the data and information gathered through the advisory organisations survey and the in-depth interviews to key AKIS actor, identified by the farmers and by the research team based on the previous exploratory work and the side information collected along the period of farmers' survey implementation.

5.3.2.1 Advisory landscape in the focus region

Lezíria do Tejo is characterised as abovementioned by being a region with a strong agricultural sector that have been boosted with the Portugal entrance in the EEC in 1986. A strong R-FAS, in comparison to the majority of Portuguese regions, was established in the 1980s. The advisory landscape of the Northern subregion (at the North of Tagus river), that has been the principal object of this case study, is largely shaped by the AGROTEJO and AGROMAIS FBOs already introduced. These FBO are a major advisory supplier to the farmers with irrigated cereals, namely the maize, which are increasingly also vegetables producers, resulting from their crop diversification strategies dictated by the end of direct payments to cereals by the CAP in 2003. Other major cooperatives and producers groups operate in the region usually with a focus in particular crops producers important in the region, besides the maize and the vegetables. These comprise the grapevine and wine growers, olive and olive oil growers, and melons and other fruits grown as annual crops. In the Southern subregion the agricultural sector is dominated by the tomato for industry, rice and similar crops to the Northern counterpart while the later are minority in comparison to the former industrial crops. In the Southern subregion the irrigators associations responsible by managing large collective irrigation systems are another source of independent technical advisory supply related with irrigation issues. Large FBO and the irrigators associations are well networked with the R&D system and hi-tech companies developing software for precision farming and smart agriculture. Suppliers of equipment's for precision and smart farming are another relevant source of technical advice in the region, although not independent. FBO deliver technical advice along with support to agricultural subsidies application, such as the single payment and agri-environmental measures, and to farm modernisation projects.

Up and downstream industry are very important in this region, given the large scale bulk production. Input sellers, along with farming machinery and irrigation equipment's sellers, are an important source of

technical advice for farmers, although not independent advisory. Agroindustry related with fresh and frozen packing of vegetables and the transformation of tomato and rice have a relevant presence in the region and often offer technical advice supply to large producers. Others actors supplying advice, whistle not being advisory organisations are certification associations and related consultancy organisations and companies (integrated protection and production, Global GAP, among others).

Independent advisors, both companies and freelancers have also some expression in this region, while mostly located in the Southwest municipality which is already part of the Lisbon conurbation, and some of them are located in Lisbon. These are demanded in general for more specific advice, such as project design or business and financial plans.

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

TECH-Lezíria is a case study showing how a FBO was key to the introduction, dissemination and the implementation of a hi-tech innovation making possible is adoption by farmers who aren't actually ICT active users. The FBO AGROMAIS was (and is) clearly the main player regarding the intelligent irrigation sensors. It was able to develop a fruitful informal partnership with the technological companies (originally small start-up's) that develop software for smart sensors, and to engage with the public R&D conducting research in relevant areas related with the innovation (such as soils, irrigation, and plant protection).

Other FBO, private up and downstream companies, and even the hi-tech companies are currently incentivising and supporting farmers with the sensors adoption, but they do it in more selective way, by choosing farmers they work with it, particularly large producers, often to test and develop the technology or their effects on productivity and products quality.

Again, as already noticed in the *BIOP-Douro* case study, the key role of the FBO was a result of strong investment on back-office activities: advisors training, networking and leading /involving in R&D projects. However, in this case front-office activities were also very relevant due to direct contact of advisors with the farmers and the fact they seem to trust them. The FBO was responsible for a major external trigger to the innovation adoption by launching the campaign of reduced fare for intelligent sensors to allow farmers to test them, and to assess the innovation, for two years. This FBO has a strategy that includes concrete actions, like this campaign and the annual award of the producer with higher potential, according to increase in productivity and gains, addressing the improvement of farmers' knowledge and skills and their attitudes towards new technologies, such as smart farming. A corporate best in-class culture underpins these efforts, motivated by keep being an agricultural leading area in the country and by acknowledging that entails to take all, or at least the larger number as possible of famers "on board" respecting the new technologies. However, low prices of products at farm gate, with withdraw of direct payments, made most of the farmer's pessimist respecting the future of the activity and hence less prone to invest and to innovate.

5.3.2.3 Transformation of advisory landscape

The major transformation of advisory landscape in this region occurred with the Portugal entrance in the EEC in 1986, which created room for the creation of large and strong FBO such as AGROTEJO. The withdraw of direct payments to the cereals with the 2003 CAP reform reinforced the previous crop diversification pattern of the region, and led to the R-FAS diversification comprising larger and smaller FBO advisory organisations well networked with up and downstream industry, including the ICT developers and suppliers.

The trends for the near future according to the interviewees will be the surviving of large farmers and a significant enlargement of the average cultivated is foreseen. Low prices paid to farmers and increasingly production costs, let to small and medium-sized farmers little room to invest and to innovate by up-taking new technologies. They are aware of their low competitiveness and keep in business due low opportunity cost of moving out, given their agricultural professionalization and investments often associated with bank loans they are still paying. Hence, future advisory landscape can change substantially, given that medium to large competitive professional farmers are more directly related to private sector and more prone to pay for specialised advice and a more elitist regional AKIS can emerge in the future.

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?

BIOP-Douro case study highlights the role of an innovative advisory organisation, which is a FBO, as the holder of the leading role in the region transition path towards a more eco-functional farming landscape, by implementing the innovation "enhancement of ecological infrastructures" (EEI) in the Douro vineyards. This fact is largely due to the reasons motivating the creation of this FBO. It was founded by leading and innovative winegrowers aware of market trends, society demands and funding opportunities. Hence winegrowers collectively engaged in a vision of creating an innovative advisory organisation with strong back-office skills and competences, particularly respecting R&D and network with regional and worldwide researchers and experts. Hence, the FBO basically led a "triple helix" type regional AKIS, by involving the R&D sector and the medium and large grapevine and winegrowers, underpinned by its ultimately mission of keeping the region (regional brands Porto and Douro) in pace with their value chain worldwide best players.

Its central role is evident along the three stages of the trigger cycle change model, although in this case study the assessment stage substantially overlaps with the implementation. In general, farmers implement the innovation gradually learning-by-doing, given this is a pretty much local-specific innovation and the available scientific knowledge is scarce given research efforts are basically limited to the cover crops practices currently a generalised worldwide farming practice in the case of the vineyards addressing high quality wines for global markets. In this case study the innovation involves a broader and deepen effort in getting knowledge on how the enhancing of agro-ecological features in the landscape, such as the old schist walls, the maintenance of the Mediterranean bushes and the old vines mortuaries, and new ecological infrastructures such as the covering of the vineyards slopes actually interacts with the vineyards. This knowledge scarcity evidences the need for a stronger involvement of the R&D to make the innovation assessment easier and less dependent on the vine grower's efforts. Actually pioneers and early-adopter play a key role in the assessment of the innovation, and as well as in the awareness stage, given they are envisaged as role models in the region. Nevertheless this vine growers association has been very active in capturing R&D funding, when available, to support farmer's knowledge co-creation with researchers in the context of R&D and demonstration projects. In addition, they incentivise and support the involving of their own advisors in scientific research by conducting PhDs and MSc thesis aiming at contributing to the scientific knowledge about the EEI innovation. Open day in-field are also organised by the FBO to show the best players practices and to incentivise the innovation dissemination.

However, the R-FAS related with vine growing and wine sector, with the exception of the former FBO appears to be distant of this innovation. This situation is likely related with the fact of it being costly in labour and knowledge and don´t benefit the small and medium vine growers. Many of them are curious about the innovation but an incentive would be needed to raise the R-FAS adherence to the innovation.

TECH- Lezíria is a case study were advisory organisations were (and are) fundamental to trigger the innovation (the adoption of smart irrigation sensors) and they actually support adopters along the trigger cycle change model. There is a leading FBO, with similarities to the one refer to in the former case study,

by being created and led by best and innovative farmers, that had anticipated the importance of back-office advisory activities to enhance and support the innovation. This FBO was determinant for triggering the adoption of intelligent irrigation sensors innovation in the region, in particular in the Northern subregion where it's more influent, by having the initiative of launching a campaign of reduced fares for the sensors rental and inviting a relatively large group of famers to test it. It shows also a fundamental actor supporting farmers with the implementation of the innovation, both by supporting farmers with front-office activities, as well as by its strong back-office activities of R&D, training and networking. By investing in their advisors qualification and training enables them to cooperate with the high technology companies, which are developing and updating the software for the irrigation sensors, in order to bias the technology development in favour of farmer's needs.

Currently in this case study other larger FBO, including the irrigators associations, are involved with the innovation. They are also active along the different stages of the TCM, given they are suppliers of irrigation equipment and /or receive pressure from the large vegetables buyers to increase quality standards, often involving Global GAP certification and other sustainability requirements.

Hi-tech companies and agroindustry start to play role by directly contacting and interacting with large farmers which in some cases are able to deal with massive information flow generated by the sensors software. The ones that aren't able rapidly abandon the trials. On the other hand, the ICT skilled farmers that grab all the opportunities to have more sensors in order to optimise irrigation in all parcels they held, start also to emerge as relevant actors in the innovation disseminating and support of its assessment by the knowledge they are creating by testing and experimenting the technology in their farms.

The *DMAR-Tâmega* case study evidences the difficulties of conventional R-FAS in promoting and supporting marketing and organisational innovations. Local Development Action (LDA) groups emerged as well placed to do it but in the funded programmes context. In this case the two LDAs have shown very effective in triggering and disseminating the innovation and to support its implementation in an early stage. Again, and similarly to the former two cases the innovation assessment was done through its implementation. The fact of this case being populated by innovation droppers makes evident that the quick assessment made by farmers' wasn't actually an innovation assessment and that assessment was actually achieved through implementation and by the farmers themselves. This highlights advisory gap in the innovation assessment.

The LDAs build on the programme (PROVE) guiding farmers on how to directly deliver the baskets of vegetables and fruits to the consumers, but assuming the need of collective action for the innovation success. Hence, the PROVE methodology stated the need for the establishment of producers groups. These groups should encompass 5 to 6 farmers in order to ensure the baskets variability required by the consumers and provide the opportunity for farmers to sell different products. However, this configuration show to be inadequate given farmers produce similar products and the food safety legislation hinders the baskets diversification required by the consumers, that would like to have poultry or eggs, among other products.

The LDAs shown effective to support early stage implementation stage by being part of the process, and helping farmers to find consumers and promising delivery points, to pack the baskets and sharing with them critical resources such as vans, along with the training and some coaching actions. These dynamics were enhanced by the LDAs ability to network and to mobilise other partners such as the local governments and NGOs supporting entrepreneurship and own business creation. However, their withdrawing from the process, as foreseen by the PROVE programme methodology, relying on the approach of the initiative sustainability beyond the funded pilot stage has shown disastrous. Farmers'

couldn't handle multi-tasks burden involved by direct selling, along with annoying bureaucracy, and simultaneously organise themselves as a group due to insufficient customers and lack of leadership skills to cope with difficulties and problems and no one to help them.

The conventional R-FAS although have shown supportive of the initial LDA network effort had not vocation neither resources to support this type of innovation.

6.2 Farmers diversity and role of advisory in innovation uptake processes

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

BIOP-Douro case study underlines simultaneously an advisory organisation which is a best-fitted example, the abovementioned vine growers led FBO, and, the limitations of the general R-FAS to get involved with the EEI innovation. In this case the R-FAS comprises the advisory organisations related with the advice supply to grapevine growers doing bulk sell or producing undifferentiated wines, which are the large majority in the region dominated by small and medium grapevine producers. It encompasses wine-cooperatives, farmer associations and other organisations, such as the centres of support to farm management and accountancy, which had involved with the support to integrate plant protection and to integrate production in vineyards and some of them also on other crops. The innovation in this case study has uneven distributed benefits, benefiting only the grapevine and wine growers producing branded and highly differentiated wines. This situation hinders "conventional" R-FAS interest in disseminating the innovation giving the lack of benefits to the large majority of grapevine growers they support.

Hence, in the *BIOP-Douro* case study the innovation highlights the duality of socio-technical farming systems and also innovation regimes shaping the vineyards landscape and regional wine sector. EEI innovation adoption by medium-large winegrowers with own or being part of collective brands reinforces their competitiveness by contributing to wines differentiation both through marketing and enhancing oenological quality (the later not consensual as being a benefit). Hence, they have an incentive to cope with the costs and risks of implementing EEI innovation, and have also more resources, namely land and labour, which are critical to implement the innovation. Small to medium grapevine growers are constrained by limited land and particularly by labour availability, which is a major problem in the region affecting all grapevine growers. Nevertheless, there are also some large winegrowers, while being a minority from its group, not involving with the innovation by evaluating its costs as not being compensated by the benefits. In fact benefits are not easily quantifiable, and there aren't actual monetary estimates for it. This evidences gaps in the innovation assessment, which are as well as advisory support gaps, given farmers implementing the innovation have no support on how to record and to store the data that some of them are collecting by own initiative.

In *TECH-Lezíria* case study the farmers' heterogeneity is determinant in dropping and non-adopting. Small to medium farmers with their cultivated land fragmented by a large number of plots perceive higher costs than benefits by adopting the sensors. They would need a large number of sensors to have at least one in each plot, and even that, according to them, could not be the optimal due to the heterogeneous soil conditions in the Northern subregion of Lezíria do Tejo. In this case farmers assess easily the costs of the innovation because they have to pay their rental. Droppers had the opportunity to assess the benefits that, in general, evaluate as insufficient namely respecting the energy saving. Even larger farmers are not clearly

aware of the innovation benefits in saving energy costs and water extraction. The variability in the climate conditions and an increasingly incidence of atypical years in climate conditions make it harder to assess the cost-benefit ratio of the innovation. Gaps in innovation assessment are evident and although couldn´t be completely covered, they could be reduced by more research on the innovation effects and the modelling of the complex interactions affecting the assessment of the sensors actual performance.

Moreover, the innovation itself might be creating a divide between the farmers with digital skills or ability to develop them and the other that are passive users of the technology. The former group is smaller, in general younger and with large areas and a large number of sensors, along with other smart farming devices. This group tends to become autonomous respecting the use of the technology and is able to relate directly with the hi-tech companies and to take advantage of trial offers from downstream industry as a way to increase the number of sensors. They are also in a position of creating useful knowledge for the technology development by monitoring and recording data, similarly to what does the FBO that firstly introduced the sensors in the region. The other FBOs tend to incentivise and to support the sensors implementation but don't have in general the back-office activities of AGROMAIS, which comprise the monitoring and recording of information of sensors as well as the potential effects on crops productivity and the energy costs. Data management is a tool developed and intensively used by this FBO to assess costs and benefits of innovation introduced by their associates. However, they aren't able to disentangle the water and energy potential savings that can actually be assigned to the sensors use, given the complexity of variables involved.

The *DMAR-Tâmega* case study evidenced how the regional characteristics impact the innovation. Proximity to Porto conurbation in the Western subregion, the Sousa Valley, was determinant to the survival of direct sell by the ability of a few individual farmers directly delivering the baskets to the groups of consumers they had conquered. In the Eastern subregion, the Tâmega Valley, more peripheral to the Porto conurbation, this model of direct selling didn't thrive. The PROVE initiative has proven a best-fit direct sell business model for small-scale farmers, with soft skills to interact with customers and abilities to satisfy them. According to the interviewed producers the consumers constantly demand for novelties and "gourmet products" introduced by social networks and cooking programmes in the television, what entailed (and entails) a permanent effort of farmers that need to be continuously introducing and testing new crops in very small plots, having none or very little technical support on how to cultivate some of these new crops.

PROVE baskets approach demands a business model built on a fair work division, that can be done by coupling differentiated competencies of a couple or of two partners trusting each other. Specialised farmers, namely in new crops that are an important group in the region had to experiment other direct selling models, such as selling to gourmet groceries and restaurants. The case study emphasise also the abilities of small to medium scale farmers non-adopters to better assess the difficulties associated with direct selling, comprising logistics, legal and fiscal burden, and the consumers volatility. Difficulties that adopters realised by implementing and that led most of them to abandon the innovation, because they were exhausted and obtained limited gains to compensate the logistics costs. Only a few were able, in general due to particular circumstances and good skills to interact with the consumers were able to keep implementing the innovation, although by their own initiative and with advisory support.

This regional experience also show that informal features of traditional direct selling are key for its success. Farmers by working along are able to work more informally and satisfy consumers with delicacies that couldn't be possible in a formal standardised manner.

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 spite of the inclusiveness shortcoming of the EEI, the *BIO-Douro* case study shows that the innovation is positively viewed by the majority of the grapevine growers, evidencing an inversion in social norm defining a "good famer" as one with their crops well-tilled and free of weeds and also the idea of a competitive grapevine grower as one having a "lunar landscape" type vineyards, shaped to maximise mechanic traction use and to minimise its costs. The implementation of the EEI reintroduces the need for human labour in particular to control the vegetation in the vineyards cover crop and in the slopes of land terraces using manual mowers. The change in social norm favours innovation, especially because EEI is implemented by successful winegrowers. There is an increasingly number of small grapevine grower's curious and even already mimicking the former by essaying the EEI implementation in their vineyards. This happen mostly when respective vineyards confine and small farmers can observe the innovation implementation and its results, and /or when they are suppliers of large winegrowers.

Actually large winegrowers depending on grapevine supply from small-scale producers are emerging as advice suppliers respecting the innovation. Some of them are increasingly aware of the advantages of bring-in on board small-scale grapevine growers, not solely due to the potential benefits of wine quality and differentiation, but mostly for the sake of the landscape. They are aware of the benefits of expanding the EEI at the broad landscape scale because that would increase its eco-functionality benefiting their vineyards, but mostly because they are aware that tourism, and that some tourists often are "undercovered" wine major buyers, acknowledge the difference in the landscape with and without EEI, and comparatively dislikes the second. According to these winegrowers to broaden the innovation cope at the region level other actors need to be involved and incentives to small-scale grapevine growers need to be introduced.

In this case the transformation of the advisory landscape is happening due to the difficulties of the traditional FBO, the wine cooperatives, in survive to the globalisation of wine markets and the prices decline, along with the reinforcement of the winegrowing business model that allows income to have quality paid advice. The withdrawing of mandatory technical support initially required to the farmers accessing public support to the integrate plant protection had as well as negative effect on advisory landscape, forcing some small dynamic FBO to devote only to the support to the agricultural subsidies.

In the case of *TECH-Lezíria* what the sensors innovation underlines is that only a few farmers actually uptake the innovation in the sense of a smart technology enhancing active learning to optimise irrigation and farm management in general. For the vast majority of farmers that adopted the innovation, dropped it, and / or would adopt it if its costs were lower, it is just a technology that they passively use with the support of front-office activities of FBOs. The technicians come to the farm and install the probes, manage the data collected by the probes and send farmers' weekly reports and SMS alerting them on climate conditions and soil water availability indicating when irrigation should be done. They improved their ability to understand synthetically knowledge and talk comfortably using water millimetres referring to irrigation management, however, they are still quite far to understand the amount and complexity of synthetic knowledge they would need to fully benefit from smart technology. Hence, they will continue to depend on the FBOs front-office activities to support them with the innovation implementation and consolidation. And that applies to smart technology in general and not merely to the intelligent irrigation sensors.

On the other hand, in the region the autonomous users of the smart tech devices are emerging as key actors given they can directly interact with the technology developers and become independent of advisory mediators. Given they tend to be the younger and more qualified farmers with large areas and focused on efficient farm managing market-oriented, FBO may lose its key role in the future, respecting the support to the sensors and to the smart technology adoption in general.

The *DMAR-Tâmega* shows that innovative programmes can enhance new visions for business models, such as the specialised producers of new crops reorientation towards other type of clients, gourmet restaurants and groceries. It is also an example of how a multi-actor build AKIS, involving no conventional actors of R-FAS, can be set up through intra and inter-regional networking. However, it shows also how rural development, such it is promoted by the LDA at the regional meso-scale can diverge from farming micro-scale innovation. This situation underlines the lack of advisory for small-scale farmers' innovation and that attempts to set it up by the LDA approach, such as the PROVE, fail by misunderstanding farmers difficulties and the nature of the market-oriented innovation, that isn't just a punctual change, on the opposite, entails a continuous effort through incremental improvements and adjustments, that show too demanding to be done by small-scale farmers alone. This case also illustrates that digital technologies, involving sophisticated apps and logistics software, might be overvalued, given the farmers end up using simple communication strategies such as the phone, SMS or Facebook messenger to interact with the customers, stressing the importance of informal dimension of direct selling to consumers. Paraphrasing a DMAR successful adopter "digital helps, but keep it simple for simple things, and we can add delicacies to the consumers benefiting from some informality".

7 Case study narratives

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8 Conclusions: Insights & Highlights

INSIGHTS

The Portuguese (Portugal continental) R-FAS builds on a large number of regional and sectoral FBO, where the cooperatives and the farmers associations are dominant. As whole it configures a weak and fragmented FAS, although the case studies evidenced that innovative FBO have emerged along the time, in particular after the Portugal entrance in the EEC, build by innovative farmers able to envisage opportunities both on agricultural policy, namely the CAP, and on novel market trends. These FBO focused on investing in back-office activities in particular in R&D through intense networking activities. For these FBO introducing and disseminating innovation is part of its mission of continuously enhancing innovation within the sectors and the regions they are involved with. The *BIOP-Douro* and the *TECH-Lezíria* case studies evidence the presence of such dynamic and professional advisory organisations leading innovations which require a strong involvement with scientific research in the first case and with the high technology sector in the second one. The case study of *DMAR-Tâmega*, on the other, highlights that the conventional R-FAS is not directed neither prepared to support non-technological innovations, such as marketing, organisational and social innovation which imply going beyond the agricultural sphere.

The reported findings also evidence the importance of public policies and funding to cooperation between advisors, the research sector and the farmers direct involvement in R&D and demonstration projects and actions. The problem with them are the systematic discontinuities in the funding availability as well as in the goals they pursue.

The selected case studies underline a third important fact which is the heterogeneity of the Portuguese agriculture across regions and diversity of farmers in each region and /or sector. Hence, the conventional sectoral approach to the innovation in agriculture creates inevitability inclusiveness problems. In addition, the case studies tend to evidence that young, more educated and larger farmers are in better position to innovate, what would be expected but that calls attention for the numerous small to medium and less educated farmers that are the ones more needed of support to innovate.

In the following paragraphs we add more insights in the format of "good and failure stories" along with main "gaps and surprises".

- **Good stories**

The presence of pioneering and innovative farmers that envisaged market, societal or political opportunities and risks and launched novel and innovative advisory organisations strongly build on back-office activities, R&D-oriented, including advisors qualification and training, and local and international networking. These FBO proved to be able to launch and to support the development of both smart technology and agro-ecological farming strategies innovation at the regional level, respectively in the *TECH-Lezíria* and *BIOP-Douro* case studies.

- **Failure stories**

DMAR-Tâmega case study provides an example of an innovation successfully triggered by non-conventional R-FAS actors, the LDAs, but also that they didn´t encounter an R-FAS able to support farmers with the successful implementation of the direct selling innovation.

- **Gaps**

Advisory gaps in innovation assessment are transversal to all the three case studies, although the reasons for that vary. In the *TECH-Lezíria* the gaps come from the limitation on merging scientific and synthetic knowledge enabling to measure water and cost savings, which is critical to prove the eco-efficiency purpose of the intelligent irrigation sensors and to establish fair financial support by the agri-environmental measures. *BIOP-Douro* emphasises the importance of public institutions to support, monitor and store new knowledge and to create knowledge on actual costs and benefits along with risk assessment for complex agro-ecological innovations, such the "enhancing of ecological infrastructures" (EEI) in the Douro vineyards. *DMAR-Tâmega* showed as an awarded programme wasn't able to develop an effective assessment methodology and how that led farmers to create enthusiastic expectations that turned into frustration and disappointment. It also highlights that supporting farmers at the micro-scale require resources and skills at this scale.

- **Surprises**

The leading FBO in *TECH-Lezíria* case study that was able to act effectively both in back and front-office serving the diversity of farmers in the region, including small-scale commercial farmers, by developing an integrated business model from up to downstream logistic chain, both for cereals and vegetables. The innovative large-scale winegrowers, through their farm manager's action, supplying advice for awareness and implementation of the EEI to the small-scale grapevine growers, by being aware of these numerous farmers role in the landscape character that cannot be shaped only by their innovative strategies and practices. The "peer-to-peer" support evidenced by *BIOP-Douro*, and as well in the case of *DMAR-Tâmega*, in line with the value adopters assign to "talk to others" learning activities, what is somehow in contradiction with an increasingly digitalised world.

HIGHLIGHTS

From the three case studies numerous insights and highlights could be underlined. Only a few are let here.

- Mainstream agriculture, here illustrated by the *BIOP-Douro* and *TECH-Lezíria*, comprise pioneering and innovative farmers able to cooperate and to developed effective advisory FBO locally strong rooted, close to and trusted by farmers, but simultaneously well-networked with other key AKIS actors at the meso-regional and the global scale.
- These FBO, due their strong back-office activities, high qualified human resources, and good governance models, are able to identify relevant contextual triggers at different levels and dimensions and to trigger innovation to cope with them at the local and the regional scales, by being able to act at the farmers' micro-scale.
- Organisations, such as the LDA or the local governments, although are gaining an increasing role in enhancing organisational and social innovations, evidence difficulties in dealing with the farmer micro-scales and farming systems and business models specificities, showing insufficient knowledge on agriculture and limitations to enhance innovation in this sector, in spite of showing effective in triggering and raising awareness about potentially interesting innovations at the meso-regional scale.
- Other institutions, in particular the governmental ones are fundamental to support the knowledge creation demanded by innovation assessment. Innovation adoption could be speed up and broaden if

assessment information on costs, benefits and risks were available, and it could be generated through monitoring of innovation implementation and the continuously data collection, storage and analysis to be converted in usable knowledge.

- The dynamic nature of innovation needs to be understood by advisory organisations, as well as by the public sector and by the politicians at different levels, and when it is as shown by the case of the two leading FBO in the case studies of *BIOP-Douro* and *TECH-Lezíria*; Innovation is not merely a static event but a dynamic social process incrementally developed by farmers together with their micro-AKIS and other actors acting at different scales.
- The former highlights the importance of farmers' skills of learning-by-doing, by testing and experimenting, but as well as sharing what they are doing among peers and with other actors, comprising researchers, hi-tech companies or even the consumers, given its potential to boost innovation.
- Selected case studies also show that innovation can have uneven distributed costs and benefits (and risks) reflecting different farm structures and farm business models and the innovation inclusiveness is an issue to be taken as policy matter, by acknowledging that coping with global sustainability challenges calls for more innovation inclusiveness; Otherwise there is an actual risk of accentuate or even created new dualities in socio-technical farming system regimes, elitist AKIS, and to contribute to intra-regionally divides.

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