Tuning up a Method for an Appropriate Introduction of the New Paradigm of Sustainable Agriculture Management Inducted by the Innovative High Technology Farming.

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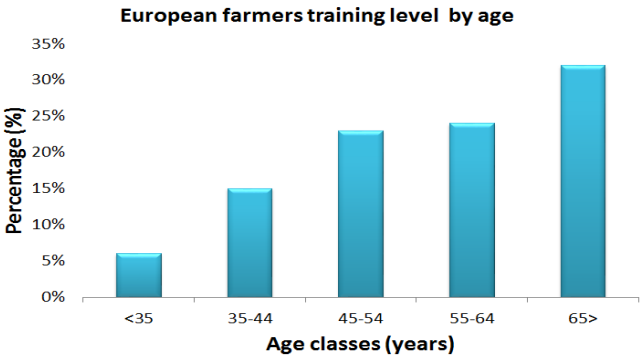
Abstract: Innovation has already arrived profitably in urban and industrial settings and is in part due to the spread of social innovation practices and collaborative spaces diffusion. In rural contest, this could mean more competitiveness, sustainability and productivity. It is a frenzy period for technology innovations, so it is important to understand what kind of innovation is useful and which are not useful for the development of precision agriculture in marginal areas. Consequently, Tuscany region is collaborating on a smart specialization platform (S3) on precision agriculture. The proposed scope should be a starting point to manage the current confusion between actors on precision agriculture. The checking of Technology Readiness Level allows understanding of whom, what types of innovation and when it happens. One of the goals is to understand if technology transfer, knowledge and innovation will be for all actors - old and new farmers - and if it could be a chance of more consciousness in better managing agriculture to achieve profitability, increase their competitiveness, sustainability and productivity especially for marginal areas. Spreading innovation through communities and actors in farming, with more consciousness and sharing, means also easier hydro-geological managing and water regulation because where there are active communities and innovative technologies, that facilitate the direct selling from farm to consumers. As a result, there is land control and value generation for those areas. The aim of the study is to understand why there is a lack of digitization, technology transfer and knowledge in farming and how to overcome this difficulty in rural contexts.

Key words: Regional CAP policy, knowledge transfer, multilevel approach, smart specialization strategies, high technology farming, precision farming

Introduction

The EU's publication "Precision agriculture and the future of farming in Europe" tell us that by digitization we can improve efficiency and have less environmental impact but on the other hand there are problems about level of farmer's training, knowledge and technology transfer about digitalization and precision farming in Europe.



Graph 1

Graph 1 point out that the basic level of education is below 35% in all age groups and in younger age groups (under 35 to 44) the gap is higher (EC, 2016a). These data point out the gap between agriculture and the access to innovation in the agricultural sector and therefore reflects on what methods can be put in place to bridge this gap.

In 2016, proposals were made at rural level, in Cork's declaration (Cork 2.0 Conference on Rural Development) entitled "Better Life in Rural Areas". This document highlights the need for an innovative, integrated and inclusive agricultural rural policy in the European Union, inspired by ten policy guidelines, including the emphasis on the subject of strengthening the rural value chains, Rural environment, and stimulate knowledge and innovation through rural communities that have to participate in the knowledge economy.

Rural enterprises, in all types and sizes, including farmers and foresters, must have access to appropriate technologies, advanced connection to find solutions and new management tools to generate business, social and environmental benefits. In order to develop the skills, it is essential that policies have more focus on social innovation, learning, education, advisor system and professional training. To all of that it should be added the peer-to-peer exchanges, networking and cooperation among farmers and rural entrepreneurs. The EU research agenda should reflect the needs and the contributions of rural areas. Industry, researchers, professionals, knowledge providers, civil society and public authorities need cooperate closely to make better and share the arising opportunities from scientific and technological progress. " (EC, 2016b). Within this framework of European policies, Tuscany Region clarify how these indications are accepted in the framework of the European Union, it is important to introduce the concept of smart specialization that traces its origin back to the debate on the transatlantic productivity gap (Corpakis D., 2013). Concept of smart specialisation is central to economic development and growth policy; it is a central pillar of Europe 2020 Strategy and a central element in the development of a reformed European Cohesion Policy. In fact it is based on the principles of 'smart', 'green', and 'inclusive growth'. In this framework, Regions (Tuscany) are required to identify sectors and technological necessity, where they seem to have competitive advantages, and then to focus their regional development policies to promote innovation. This development would then be rooted on knowledge assets (Markkula M., 2013).

The Eu's guidelines on precision farming and how to spread technological innovation, in agriculture, are developing fast. In Italy, Tuscany Region is collaborating for its smart specialization platform (S3) on precision agriculture. The applied methodology to better understand the state of art of this field is developing trough the European project (S3) and in the scoping note on how choose modern technologies and services on precision agriculture, has been presented on the 6th-7th of December in Florence - Italy during the S3 platform Kick-off meeting, the meeting was managed by Tuscany Region which is carrying on high tech farming in agriculture (S3HTF) its smart specialization strategy. The objectives of the smart specialization strategies are stimulating innovation through entrepreneurship, modernisation, and adaptation; These dare to introduce innovative governance solutions; think about strategic technological diversification on areas of relative strength and potential; increase diversification – promote new linkages, synergies and spill overs (McCann and Ortega-Argilés, 2013). In order to implement precision agriculture in all business dimension and in almost all the value chain in agriculture it is important to have a define clarity in the process and in the product. It will be the base to develop a method that promotes the professional training (awareness) and an useful interaction among actors in the agricultural sector. This will be possible to be done by developing gradual ways of acquiring technologies

to better introduce the new agrarian paradigm, starting from a sector that has large differences between companies in terms of profits and technology acquisition since ten-year. These data are confirmed by the last general agriculture census, which is a picture to be improved from Tuscany, especially on digitization. In fact, only in Tuscany, 94.78% of companies are not computerized. In this framework the statistical data on the Tuscany Region and the data of the 2007-2013 RDP policies of the Tuscany Region confirm the trend towards the need to guide the choices made in agriculture on technological transfer for the next seven years. At regional level, the guidelines for dissemination and growth of knowledge and research are provided mainly by the Regional Development Plan (PRS 2016-2020), which, as far as the guidelines for regional interventions on these topics in line with Europa2020, the Region recall to a regional specialization strategy (RIS3). The S3HTF is a multilevel policy that could give new results in the light of previous experiences with the 2007-2013 PSR.

Materials and Methods

In the choice of tools, to develop a method for the successful introduction of sustainable precision agriculture, is necessary to choose a methodology to clear out and understand how to define both subjects and objects in the processes and services. Set to rights is a mental and formative process before being a concrete act. To define how organizations create value is basic in respect of a new economic, technological and social paradigm (Corvo, 2015). Starting from the development of the manufacturing sector, before the advent of Industry 4.0, companies have grown up with the "Lean production" method, eliminating waste and doing the right things at the right time (doing more with less). This approach, with regard to small-medium farms, is lacking for a number of reasons. In order to maintain a productive, profitable and competitive agricultural enterprises, it is necessary to acquire new specialized technology, but the lack of steps important to acquire technologies becomes an obstacle to the full realization of sustainability and production-oriented business development. For this reason, the agricultural sector, in order to successfully acquire technology, has to set on such steps. There are five benchmarks (5S): Separate (identify) by starting the organization process, Settle down (setting order), Clearing (Clean and tidy Spaces), Standardizing (Analysis, Procedures and Structures), Supporting (Consolidating and Improving). (Wikipedia, 2017).

Figure 1- 5S Lean manufacturing methodology

Figure 1- shows a scheme of the 5S that represents the heart of the "lean manufacturing" system that develops into the *assembly-line*, developed in the west from "Toyota production system" in a shortage of resources as an alternative to the *assembly-line* production model. If, therefore, the objective is to develop a method for the successful introduction of sustainable precision agriculture within companies it is necessary to apply a method such as “lean manufacturing” by adjusting it according to the underway paradigm (Wikipedia, 2017). In order to successfully introduce innovation, it is necessary to activate and create functional relationships between three main actors, such as Universities/Research Bodies, Enterprises and Institutional Entity (in this case the Tuscany Region), defining the triple helix model.

Regarding to this , in Tuscany, the S3HTF platform (using the 5S of “the lean manufacturing” method) is developing an approach through a simple and intuitive method for organizing technological innovation to identify the different types of technologies present in the Agricultural system, diversified technologies and services to agriculture.

The technology oriented includes:

1. EYES & TOUCH to monitor the single element on wide area (sensors and digital layer) and recognise the effects in each element treated (on board, proximal and remote sensors)

2. MIND to be aware of what, where and when to act in each single productive step (Modelling and Decision Support Systems)

3. INTELLIGENT ARMS to do huge and precise tasks (automation, robot)

The service oriented includes:

1. INTELLIGENCE (Data Management & Prescriptions)

2. MEMORY to be aware on what has been done (telemetrics, traceability, data store)

3. IDENTITY of agricultural resources and sustainable use at Local & Regional level (territorial complexity, TRL of tools & services, Know-how, CoPs).

Each of these approaches reflects the range of technologies available. To identify the technological level at which different actors have access it is possible to use the Technology Readiness Level (TRL) based on a range value from 1 to 9, where 1 is the lowest value (Basic principles definition) and 9 the highest one (system already used in the operating environment) (Table 1). Knowing the TRL of a technology is important in order to know whether it is a mature technology or under development and consequently who has the tools to use it.

TRL Level:	**Score**
Basic principle observed	1
Technology concept formulated	2
Experimental proof of concept	3
Technology validated in lab	4
Technology validated in relevant environment	5
Technology demonstrated in relevant environment	6
System prototype demonstration in operational environment	7
System complete and qualified	8
Actual system proven in operational environment	9

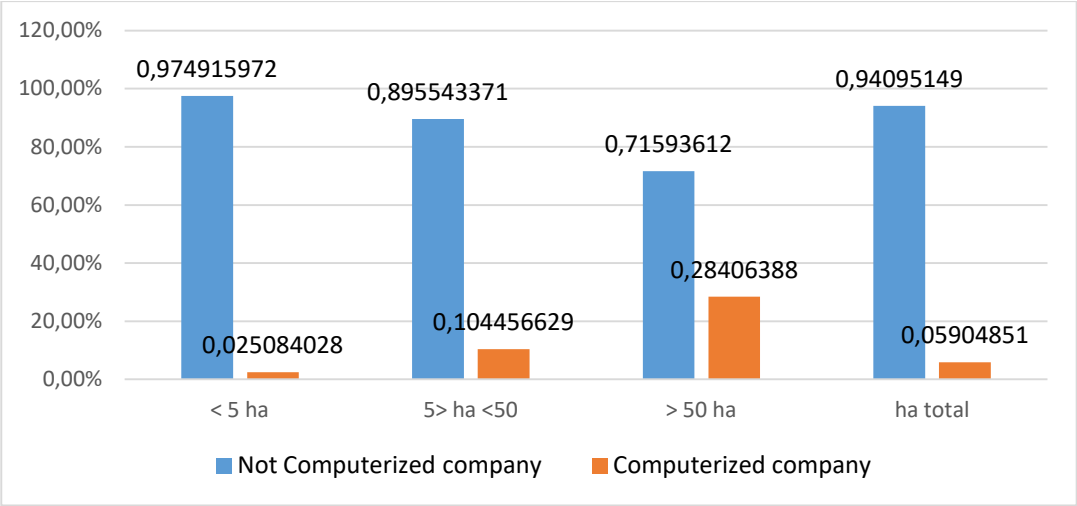
Table 1 – Reference table of TRL

Results & Discussion

Technology and innovation transfer are mainly factors to improve the competitiveness and sustainability in agriculture. In the previous regional programming (2007-2013) these themes were not specifically addressed, it was focused more on the analysis of the value chains.

In the ex-post analysis of RDP (2007-2013) programme, in order to develop innovation was applied the measure 124 "Cooperation for the Development of New Products, Processes and Technologies in the Agricultural, Food and Forestry Areas". This measure achieved as much as it could be possible to get important results, ie it has directly promoted cooperation between the world of the production and the scientific world by testing "in the field" the validity, and the transfer of innovations from the results of previously activated research in the sector of agricultural and forestry such as the partnership created on the VIS project between the University and Pistoia nurseries, with which a project on the benefits of recovery of nursery waste (Recchia L. et al., 2013) has been carried out, or IMVITO projects (Vieri M. et al., 2013) and TRA.PRE.VIT (Sarri, D. et al., 2015), the latest opened the way for the introduction of vineyard management with precision farming. Measure 124 was also included within another tool “PIF” (integrated chain project), but the time lag, the lack of precise selection criteria, that would not have the investment at the same time of the experiments and without specific actions of transfer. within the partnership, did not always guaranteed the best implementation into the company. Measure 124 was also put in place under LEADER programming through LAGs, the overall impact ended funding 69 projects with 281 beneficiaries for a total amount of € 15.7 million. In the 2014-2020 programming period, the co-operation measure (Art.35 of Reg. UE 1305/2013) has been further developed with some sub-measures, although Tuscany did not activate the 16.7 one, the planned financial resources amount to 35 M €, particular attention is being paid to sub-measure 16.2 (Tuscany Region, 2017).

As mention in the introduction of this article, in the Tuscany Region the level of computerization of companies is low, and is also one of the factors on which the Region is trying to intervene in time to fill the digital divide. The following chart shows the ISTAT 2010 census data for the percentage of computerized companies in the Tuscany Region according to the utilized agricultural area (UAA) (ISTAT, 2010). The graph shows a high gap between the total percentage of computerized and non-computerized companies. This gap (both in percentage and numerically) grows when decrease the cultivated area (SAU) to be 97.49% for companies with size less than 5 ha (Histogram 1). Data analysed and divided by computer typology divided between computerized management for administrative services, computerized farm for crop management, computerized management of breedings, show that, regardless of the size of the company, the relationship between the use of these three technologies generally show an increase in the size of the company's surface. The other information emerging from the analysis is a wider acquisition by companies (> 50 hectares) of IT tools supporting administrative management (24.67%) against a progressively lower acquisition for IT crop services (12.74%) and breeding (5.20%).



Histogram 1 - Agricultural companies ICT level by agricultural surface used (SAU)/ha in Tuscany

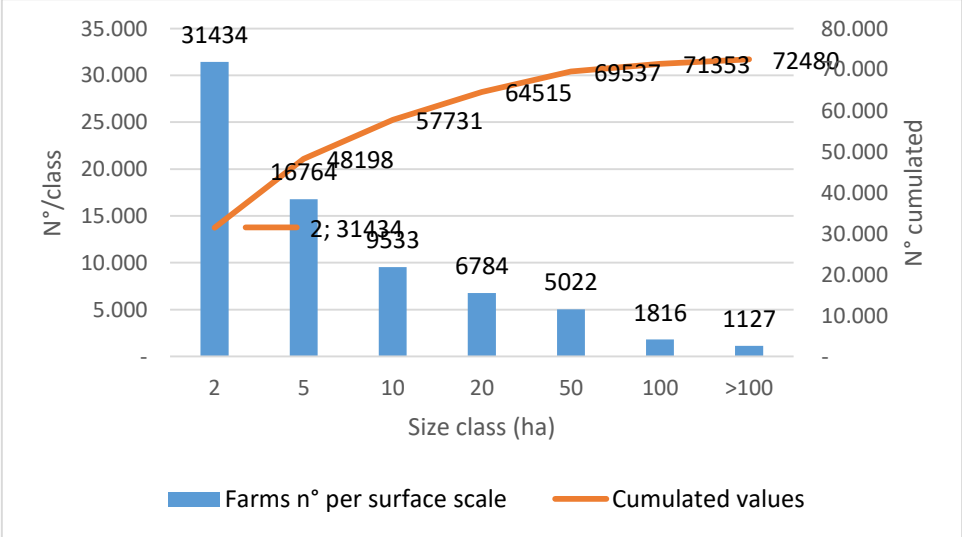
It can be deduced that larger companies are more easily computerized and that small companies have difficulty of accessing this technology. This data is influenced by the average age of business leaders, which, as in Europe, is generally high (> 65). If the objective of the S3HTF platform is to realize and identify a competitive advantage and how to guide future development of policies to promote innovation in the agricultural sector, the analysis of the introduction of innovation in agriculture can be developed according to the observation of the following aspects:

1. Identification (of beneficiaries)
2. Necessity (expressed by beneficiaries)
3. Applicability (of the transferred technologies)
4. Actions (of value chain actors)

These points can then be explained as follows.

1. Identification

In relation to the Tuscany reality showeded in Histogram 2 (No. SME vs ha / SME).



Histogram 2 - Farm size distribution and cumulated values

Half of the farms have an area of two hectares and in generally, the following primary subjects can be identified by the analysis of the graph (Histogram 2):

a) Farmers with companies under 5 hectares (subject a)
   i. these represent the most important part numerically, territorially and socially, and are the target of the agriculture of Tuscany
   ii. have a critical production structure for structural essentials and low investment opportunities
   iii. need absolutely reliable solutions of TRLs already mature (9)
   iv. do not have R & D capability and implement their production on 3 bases: their own evaluations, b) imitation, c) requirements from consultants or input provider
b) Large enterprises (> 100 ha) (subjects b) are the ones that first adopt the technology and through which it is spread. They have constitutionally the production process a physiological activity of R & D, they allow the experimentation of non-mature technologies (TRL <5) and therefore allow investments in high-risk actions (for example, they may be able to try technical choices that may prove to be wrong by testing them on processes Or on significant areas but lower percentage than general production). It is very important to emphasize that digital and mechatronic innovation is born out of agriculture; it is typical of the industrial sector. So we must establish the necessity and constraints of this actor who represents the "innovative technology provider" (subject c). (See industry report 4.0 in S3 HTF)

1. Needs
   a. Clarity of the agricultural production process according to the principles of sustainable agriculture (both for "a" and "b")
   b. Clarity of product / service offered by subject "c".
   c. In the industry sector “INDUSTRIA 4.0”, has been preceded by a decade of “lean manufacturing” that, by simplifying, is based on the 5S: Separate (Identify), Settle (Place), Clear (Clean and Tidy Space), Standardize (Analysis, Structures), Support (verify and consolidate).

3. Applicability

   a. to. "a" subjects need to absorb mature and reliable technologies from a differentiated diffusion process of the various individual technologies.

   b. Subjects "b" acquire innovation within their R & D budget chapter, they have access to innovative products and services at national and international level. The technologies are also eligible for R & D at low maturity levels (TRL <5)

4. Actions
   a. Training and Demo Day (timing and dissemination)
   b. Demo Farm / European Demo Hubs
   c. Induction of Territorial Service Platforms with Actors a, b, c

Conclusion

In this new economic and social paradigm, the process of introducing technologies is evolving, especially in a sector, such as agriculture, with structural difficulties on innovation. At the first approach to the predisposition of a method for the profitable introduction of precision agriculture switch by combined action of several factors. There are therefore issues that can no longer be referred to and, on which seems necessary to act for the innovative technology system, needs to be acquired in order to maintain the level of competitiveness of

the companies, Tuscany Region has been committed (at the Regional Agriculture and Food Conference of rural development) to complete by intervening with the future programming:

- overcoming the digital divide in rural areas to enable anyone to access products and services
- foster the approach and interaction of very different realities in size and business model.
- Insist on the training aspects of farmers regardless of the age factor.
- Encourage multidisciplinarity in agriculture through training courses that help to develop digital and soft skills at the same time.

All the projects financed by the Tuscany Region and the S3HTF platform are examples of how to start investing and gaining roles and awareness among the various actors in the agricultural reality. For this reason, use past experience, in order to monitor on-going projects, to avoid mistakes and to achieve more easily goals. The data analysed and the policies implemented in the previous ones clearly indicate that the way to implement a profitable technology transfer is through the interaction between actors of the third helix (Universities, Enterprises, Government).

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