Innovation in the Mediterranean Agrifood Sector
Concepts, experiences and actors in a developing ecosystem

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Contents

Foreword

After several decades during which the agrifood sector in Italy and the Mediterranean has essentially been based on the dynamic reinvention of tradition, today it is innovation that appears to be the recurrent and increasingly central issue in the general debate regarding the sector.

This book aims to contribute to the ferment of ideas in two ways: by embracing the theoretical framework supporting the most recent analyses and political decisions regarding innovation, and by indicating several practical proposals resulting from the work done by CIHEAM, in order to convert the demand for agrifood innovation into a concrete stimulus for economic and social development in territories that are not only in the Mediterranean area.

Given that this issue is now of interest to public opinion, and that the demand for innovation comes mostly from younger people, the most obvious and urgent task is to recompose the various pieces of a critically fragmented system. The most accredited theories state that research bodies, Universities, businesses, institutions, farmers, their representative bodies, and even brokers and extension services in our territory, should be included in an active and functional innovation system in the agrifood sector and in other sectors, in a way that allows the sharing and transfer of knowledge.

However, something is not working properly. The current systems for creating and transferring knowledge are often involved in projects whose results either fail to reach those operating in the sector, or else are too far-removed from their real needs, and therefore cannot be used.

This process inevitably means that knowledge is wasted; this is one of the three types of wastefulness that CIHEAM aims to combat, together with food waste (which involves all stages of the production system), and the waste involved in the misuse of natural resources.

Wastefulness can be tackled with actions at different levels, starting with awareness of the limits inherent in the present linear approach to innovation.

The "Networks" are the typical organisational structure of our society and provide a great opportunity for re-considering the knowledge transfer model; its limits are increasingly evident and it often lacks vitality, since it only allows knowledge transmission essentially from the top down, from the centre to the periphery, from theory to practice. This approach should be completely reversed by placing businesses and society at the centre, and by giving more importance to the practices – the good practices – that can indicate areas and directions for research work.

This development was foreseen in 1996 by philosopher Pierre Lévy, who wrote that "individuals can be a kind of living encyclopaedia for each other, establishing friendships and cooperation activities [...], and this new dimension of communication should allow us to share our knowledge and inform each other ".

Thinking about knowledge sharing and the "Network" enables detachment from the technical and practical developments that often fail to take its sustainability into account. Technology tends to change and evolve continually, and since it is often based on more universal criteria, it fails to consider social, cultural and traditional issues.

This situation must be completely overturned; this requires a capacity to hear and interpret the needs of the territory that is, for the most part, still waiting to be developed.

This book describes how CIHEAM has attempted to create a system for gathering these needs. This is a first attempt, and it must be shared in order to make improvements and adapt it to different contexts, where necessary. In order to achieve this, there is a need for open collaborative platforms that can collect, share and co-generate innovations by involving the market, society, institutions and bodies in the knowledge system.

The present book is one of the countless concrete elements of CIHEAM's strategy for the Post-2015 Development Agenda centered on several principles, including the campaign against the "triple waste" (of knowledge, natural resources and food) already mentioned, on the enhancement of good practices and a systematic approach to food security (sustainable processes, product quality, promotion of healthy nutrition), on the central role of young people and territories considered to be "on the fringes" (therefore inclusive growth and development), and on prevention and management of the risks related to the political economy and geopolitics of food.

Concerning its methods, CIHEAM is committed to transforming these principles into training activities to support research and innovation by creating open and collaborative platforms and networks and by sharing knowledge and practices.

It is a challenge, especially for cooperation policies, to favour an "interactive" model of the knowledge system that involves all actors, research organisations, businesses and individuals working to develop new products, processes and forms of organisation. The geographical and cultural barriers have always been the greatest obstacle preventing the creation of transnational projects with concrete, sustainable and lasting outcomes . The 21st century also forces cooperation policies to tackle and overcome other barriers, particularly in the Mediterranean, e.g. the barrier preventing direct communication between farmers and researchers. We need to climb over the "wall" that still appears to separate technological innovation from its cultural, anthropological and social components.

The following pages illustrate a first attempt by CIHEAM, specifically the Bari Institute, to provide articulated support for the ideas and principles mentioned above.

Cosimo Lacirignola
Secretary general of CIHEAM

Introduction

In the agrifood sector, the 1990s witnessed the rediscovery, and in some cases the "reinvention" of tradition. Now innovation has once again become a central issue, especially in the agrifood sector. Expo 2015 was a showcase highlighting the importance of food safety at the global level, giving visibility above all to innovation and good practices guided by consumer needs, and defining development areas which have been the focus of much effort, especially start-ups. In other cases, as in the Feeding Knowledge project (www.feedingknowledge.net), the focus has been on good practices and on innovations proposed by farmers. Feeding Knowledge has been like the creation of a great catalogue, creating a system for exchanging experience, a showcase for the ideas and practices which agrifood businesses and territories use to resolve their great and small daily problems. This experience lies behind the present work.

To talk about innovation in the Mediterranean agrifood sector is to be like the first cartographers: there are just not enough landmarks or, by extension, concepts and models. The problem is not the lack of theoretical references, but is that of defining an area that is essentially still developing. Liveliness is the most important characteristic of a context which sees young innovators engaged in flourishing activities in Italy, Greece and the Mediterranean, with the beginnings of a system to optimize these activities, which consists of accelerators, investors, research and political institutions. This ferment of activity is in contrast with the traditionally static nature of Mediterranean agrifood businesses.

The best approach to defining this developing sector is to investigate the territories involved. The second part of the report describes the incubator created by CIHEAM Bari as part of the Italy-Greece territorial cooperation project, and is a valuable contribution in this sense. This book also aims to provide a kind of "navigational chart", identifying the reference points and highlighting the relationships between the various subjects whose priority objectives are innovation in the agrifood system. The development of this system must also be taken into account.

Innovation in agrifood is the result of a production chain consisting of different players, regulations and approaches developed over time. The linear production chain, with research and innovation originating from research bodies in a top-down process, has given way to an "interactive" or systemic production chain where innovation originates from interaction between the chain's different components. EU policies have accepted this change, which involves repositioning the agrifood business and its needs at the centre of the system. Not only does this involve redesigning approaches and information flows, but it also involves redesigning the role of the individual actors in the production chain, from research bodies, to business consultancies and businesses, to the institutions and the policies which influence the way in which the different players interact, share, access, exchange and use their know-how.

The authors of this book are actors in the production chain of innovation, and want to share their ideas in order to contribute to the development of this system.

The authors belong to inter-governmental bodies (CIHEAM Bari), research institutes (ENEA, Milan Polytechnic, Alma Mater University of Bologna, Ionian University of Corfu), and the business community (Agrifood District).

Innovation in the Mediterranean agrifood sector has certain specific features which cannot be assimilated to the economics of innovation in other sectors. The process is just starting and the navigational charts have yet to be plotted. This book will attempt to carry out the task.

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Part One

The scenario and models

Specificities of agriculture, innovation and development in the Mediterranean region

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Abstract. Mediterranean agriculture and food production now have to face the great challenges of ensuring sufficient healthy and nutritious food to feed the population. Overcoming these challenges requires a great effort to transfer knowledge and accelerate innovation. The Mediterranean is a kind of microcosm representing many of the current challenges to agrifood production and consumption models. Some of these are particularly urgent: declining biodiversity, climate change, the shift towards new and not always sustainable food consumption habits, dependence on supplies, are all unknown factors that may be revealed and managed only with a strong input of technological and organisational innovation. Although the specificities of agriculture mean that models imported from other sectors cannot function, it would be a mistake to refuse the opportunity of networking with players outside the traditional innovation ecosystem. Farming involves dealing with many unprecedented risks because, in addition to the traditional risk posed by the climate, there are now also political and market variables. The agricultural innovation ecosystem should begin to reorganise itself from within, seizing the opportunity offered by a phase of transition towards open innovation models.

Keywords. Risk management – Mediterranean – Food security – Local and global – Climate change – ICTs.

Spécificités de l'agriculture, innovation et développement en Mediterranee

Résumé. *En Méditerranée, l'agriculture et la production alimentaire doivent répondre à des défis importants pour garantir à la population une nourriture suffisante, saine et nutritive. A cette fin, il est nécessaire d'intensifier les efforts visant le transfert de la connaissance et l'accélération de l'innovation. La région méditerranéenne forme un véritable microcosme qui reflète en grande partie les défis encore ouverts autour des modèles de production et de consommation agroalimentaire. En particulier, l'érosion de la biodiversité, le changement climatique, la transition vers de nouvelles habitudes de consommation alimentaire pas toujours durables, la dépendance des approvisionnements sont des enjeux majeurs mais méconnus, qui peuvent être appréhendés et abordés seulement à travers une forte innovation sur le plan technologique et de l'organisation. Si, en raison des spécificités de l'agriculture, l'importation de modèles issus d'autres secteurs ne peut pas réussir, refuser la mise en réseau avec des acteurs en dehors du cadre traditionnel des écosystèmes de l'innovation agricole serait néanmoins une erreur. Parce que pratiquer l'agriculture signifie prendre des risques, le plus souvent inédits, d'autant plus que des variables liées à la politique et au marché s'ajoutent au risque climatique traditionnel. L'écosystème de l'innovation agricole devrait entreprendre une réorganisation interne, en saisissant l'opportunité d'une transition vers des modèles d'innovation ouverte.*

Mots-clés. *Gestion des risques – Méditerranée – Sécurité alimentaire – Local et global – Changement climatique – TIC.*

I – Old certainties and new risks

Farming is a risky enterprise from an economic point of view.

This is mainly due to the close relationship between farming activities and life cycles, growing seasons, weather conditions and the ways in which they interact with the climate and the quantity and quality of the main asset: the land. The key factors affecting farming production worldwide are the surface area for agricultural use and the soil type, along with climate conditions and water availability.

The relation between agriculture and ecosystems significantly affects the nature of the enterprise, because managing a farm business is not the same as managing a factory that makes bolts or ball bearings. After all, the fact that in many languages the equivalent of the Italian word "impresa" (enterprise) is seldom used when speaking of farming says a lot about the peculiarities of this sector. *Exploitation agricole* in French, *farm* in English, *granja* in Spanish and *Bauernhof* in German. In Italy, where farms are *businesses,* the "'*imprenditore agricolo*" is a professional farm entrepreneur (*IAP),* whose activity is covered by specific laws recognizing the special features of business risk in the primary sector.

The land is a capital (the land capital) which requires appropriate management techniques. The predominance of biological factors and the management of production assets that mostly include living matter (plants and animals) imply, in general, a high incidence of fixed costs on productions costs and a certain degree of supply rigidity. Dairy cows do not have a tap that we can just turn off and on at will, and trees do not bear fruit on request. Products spoil and hence, proper solutions are needed for post-harvest handling, transport and storage. Therefore, farm businesses adapt more slowly to market signals compared to businesses in other sectors.

Even the timing of cash inflow and outflow, meaning the financial resources used for production and revenues, has its peculiarities. Farmers buy seeds, use machines and employ labour in a given period of the year, and if all goes well, they will earn money after a few months. It may be difficult to predict accurately the yield and quality of harvest or production. Climate and weather are a source of additional uncertainty and increase the investment risks. In agriculture, "breaking down" the production activity is harder than in other sectors.

Farming systems are the outcome of different combinations of markets, ecosystems, land, labour, capitals and other inputs. But they are also made up of interwoven identities, social behaviours and cultures. They are closely related to the local context and territory, which means not only an area characterised by specific bio-physical features but also a social space embracing consumption, production and trade models. Different farming systems can coexist within the same territory, quite near to each other. Life cycles, territories, historical and social factors also affect farming organization.

In the Mediterranean region, the natural and social environments have led to the establishment of farms that are generally family owned, with a certain level of fragmentation of the productive fabric and an endemic difficulty of integration into other realities, even within the same territory. Various forms of cooperation in the region may constitute an exception, but in general we may say that in the countries around the Mediterranean Sea the achievement of economies of scale in agriculture is limited by the sector's specificities.

Farming not only means an enterprise with its own levels and types of risk, but is also a fairly sophisticated activity in management terms. Today even more than before, a farmer should be knowledgeable about biology, ecology, legislation, veterinary and medicine, economics, marketing, finance and even about trade policies, and should master at least one foreign language, namely English.

The specificities of farming activities affect the implementation, development and dissemination of sector innovation. Without this awareness, there is a risk of not going far. The experience of Calgene, regarded in the 1990s as a kind of Apple in the field of biotechnologies, teaches us a lesson. The small Californian firm, with audacious ideas and a creative team, has been a David versus the Monsanto Goliath, seen by many as the Microsoft of biotech, with an analogy drawn between seeds and software and between the intellectual property policies of the Saint Louis based multinational and those of the company created by Bill Gates. The story is told in great detail by Daniel Charles in his *Lords of the Harvest* (2001). With a very different marketing strategy from that of its rival, based on transparency of experimental data, public debate, and a continual attempt at open exchange with the opponents of agricultural biotechnology, Calgene intended "merely" to revolutionise agriculture by marketing the Flavr Savr tomato, which was genetically engineered to lengthen its ripening period. However, it had reckoned without... agriculture. And also without weather conditions and weeds, pest attacks, the need to graft the revolutionary gene into several varieties, the long time-scale required by traditional breeding, storage, logistics and transport technology. While the millions of dollars invested by Calgene in Flavr Savr failed to generate the expected results, a tomato with similar characteristics, grown by Mexican farmers, entered the American market. It had been obtained by traditional breeding techniques and patented in the 1980s by the Israeli Nahum Kedar. The tomato's name was LSL, an acronym for Long Shelf Life, and it shattered the dreams of glory of Calgene, which was then swallowed up by Monsanto in two distinct phases, in 1996 and in 1997.

Stories like this demonstrate the distance between this sector and the innovation model developed in other contexts. When we say "start-up" in agriculture, especially if we mean a business involved in strictly primary production, we cannot refer to the Silicon Valley pattern, where the main goal of an innovative start-up is to grow big enough and fast enough to aim at being listed on the stock exchange within five years or else to die in the same period of time, and then be absorbed by larger companies. An innovative start-up in agriculture must consider that it has to come into existence to live a long life. As long as possible.

In contrast, the innovation economy model, which has characterised the Web 2.0 boom, is clearly mirrored by the development of businesses specialising in technologies related to farming activities that, above all in the US, are mobilising private resources in the form of venture capital. From 2010 to 2015, investments in "AgTech" and "FoodTech" have increased from less than 500 million to more than 4 billion dollars per year (Rabobank, 2015).

The specificities of farming, combined with its function of fulfilling the population's primary needs, provide the historical justification for public intervention in this sector, which has shaped the innovation systems traditionally characterised by a strong presence of the State. All over the world, despite some differences in scope and a few exceptions (Australia and New Zealand), agricultural policies are typically intended to support the viability of farms, by reducing entrepreneurial risk, developing regulatory frameworks, and laying down specific measures to protect the sector, including innovation systems. For this reason, the agrifood industry is by definition considered to be an economically stable sector.

Nevertheless, in the globalized world there are a number of risk factors which may not be strictly economic. Like border closure. When Russia closed its borders in 2014 to European agrifood products in retaliation for sanctions imposed by the EU and the US over Ukraine, European businesses were denied an important outlet. From one day to the next, and for reasons unconnected with the weather or economic conditions. Disturbances in the normal activity of agricultural markets can also be caused by health problems. In 2011, during a dramatic health crisis brought about by the propagation of a killer strain of *Escherichia coli,* the spread of inaccurate news about the source of infection caused the fruit and vegetable market across Europe to collapse in just a few days.

In this context, climate risk is a source of additional uncertainty, given the increased frequency of extreme weather and the rise in global average temperature. Agriculture is already paying a hefty price for climate change in terms of water availability (drought *versus* floods), soil quality, the spread of new pest species and plant diseases, modification of growing cycles, huge yield variations and impact on agroecosystems in general.

As we will see later in more detail, agriculture is today at the intersection point of an increasingly complex social demand, which coincides with an increasingly broader and overarching concept of food quality and an expansion of supply to a number of sectors like energy and biomaterials, besides the usual supply of food and feeds with a high health standard.

Faced with an increasingly stratified demand and with new risks related to climate conditions, geopolitical situations and information management in the case of health and veterinary emergencies, traditional agricultural policies designed to support the development of markets impervious to external tensions demonstrate many limits. At least in Europe, a thorough overhaul of the sector policy has begun, not only to enhance crisis management measures, but also to promote innovation.

Despite the peculiarities of agriculture as an economic sector, the facts demonstrate that it no longer makes any sense to use this as a defensive position. Redefining relationships with the farmers and the other players of the chain (in both production and innovation), interconnecting, exchanging and "networking" with players outside the traditional agricultural innovation system now appears to be the only choice, given that the business challenges and risks are no longer those strictly confined to agriculture.

The reduction of transaction and management costs, made possible by the use of ICTs (Shirky, 2008), is a big opportunity for strengthening the integration of farms in the local area and in the global village, for increasing trade and exchange with other productive sectors and with consumers, thus paving the way for new solutions to everyday problems. That is to say, for generating innovation.

At present, agriculture is living through a paradox: the advent of the service economy has led, particularly in the Northern Hemisphere, to the perception of agriculture as a "traditional" and "natural" activity, although for thousands of years it has been the most significant of all man's actions to modify "nature", to the point that it even incubated the industrial revolution.

Apples or peaches, or even the livestock we know today, seem to be "natural". But they are man-made, the culmination of tens of thousands of years of human innovation in trade and cultural exchanges, in species selection, production of food and feedstuffs, cultural practices and storage and transport technology (Ashton, 2015).

Through the centuries, the Mediterranean has been the chosen place bringing all these connections and fusions together. The Mediterranean diet is the result: a tradition which is actually a series of very successful innovations.

II – The world and *Mare nostrum*

Due to its primary function of producing food and its close relationship with ecosystems, farming takes centre stage in the challenges facing humanity nowadays. According to FAO estimates (2012), in order to meet the demand of a burgeoning world population, with an increasing per capita income, above all in emerging and developing countries, in 2050 the global agricultural production will rise by 60% compared to the period 2005/07. This means being confronted with some constraints like the scarcity of natural resources i.e. land and water, which are essential for food production, and the impact of climate change, requiring adaptation to new conditions and shared efforts with other economic sectors to mitigate the effect of the expected rise in global average temperatures.

The change in food consumption patterns has demonstrated that complementarities exist between nutrition quality and access to food, generally measured as calorie intake. The Food Security challenge has become greater, and besides working to reduce the number of undernourished people, approximately 800 million today, this also entails fighting the nutrient deficit that affects over 2 billion people, and facing issues like obesity, traditionally a problem of wealthy countries but now increasing in developing countries (IFPRI, 2014).

The extreme volatility of the main agricultural raw material prices between 2007 and 2012, and the historically associated social unrest that broke out in 2008 and in 2010, drew attention to the primary role that food supply stability plays in ensuring social stability in general.

In short, agriculture is a nexus, a node, a critical activity expressing the interdependence of only ostensibly separate domains: water, energy, food, land, ecosystems and their social use, all contribute to the “meta-challenge” of ensuring enough healthy and nutritious food for mankind, in a sustainable way.

The Mediterranean area as a whole – the southern and south-eastern EU Members and the MENA region (Middle East and North Africa) – is a place where all these challenges are particularly prominent. Access to food and the related social issues, the food trade balance, management of ecosystem resources, food safety and nutritional quality, climate change mitigation and adaptation, maintenance of biodiversity levels: the Mediterranean area reflects, as in a microcosm, all the unsolved questions of global development.

As regards the sustainable management of resources, the Mediterranean is one of the “hot-spots” of the world’s biodiversity. At the crossroads of the Euro-Asian continental block and African block, it features a vast array of geographical and topographical environments and is home to 10% of the endemic plants on only 1.6% of the world surface area (Médail and Meyers, 2004). This biodiversity is threatened by urbanisation and inefficient use of land and water.

According to the estimates of the United Nations’ Intergovernmental Panel on Climate Change (IPCC, 2007), the effects of climate change on the region will be very strong. The last simulations (Gualdi *et al.*, 2013) of the Euro-Mediterranean Centre for Climate Change (CMCC) for the period 1951-2050, demonstrate that in this area, already particularly vulnerable to stress, the climate will tend to become drier and warmer, which means lower rainfall (-5%), higher temperatures (+1.5°-2°C) and a rising sea level (+7-12 cm). These conditions are very likely to affect water availability and crop productivity, soil degradation and the increasing demand for water in agriculture, levels of biodiversity and the spread of new pests and plant diseases.

The Mediterranean region is also going through a “nutritional transition” (CIHEAM, FAO 2015), where under-nutrition coexists with overweight, obesity and diet-related chronic diseases like diabetes.

The geopolitical earthquake known as the “Arab Spring” has demonstrated once more how food supply disruption may create social conflict with unpredictable results. In North African countries, the high level of food insecurity caused by the world markets’ “hyper-dependence” (Abis, 2015) on the supply of staple foods such as wheat, has created an explosive mix with persistent components like social inequality and the “youth bulge”: millions of people under the age of thirty, with a high level of education and poor job prospects– according to the International Labour Organization (ILO) unemployed young people in the Mediterranean coastal countries account on average for 30% of the total labour force – and the wish to extend the scope of individual freedoms.

Instability caused by the Arab Spring uprisings, combined with other geopolitical factors, has driven some countries like Libya into a condition of permanent crisis, and others such as Syria and Iraq into a conflict on an unprecedented scale, which does not show signs of ending soon and poses the threat of global destabilisation. The destruction of physical and social infrastructure exacerbates disparities, health risks, food insecurity and the degradation of natural resources, thus encouraging massive migration flows. Based on data from the International Organisation for Migration (IOM), in 2015 alone, approximately one million people have entered Europe by land and sea through Spain, Greece and Italy.

The recovery of agrifood production enabling a harmonious social, economic and environmental development and the revitalization of food consumption patterns like the Mediterranean Diet will be valuable assets once the Mediterranean trouble spots are stabilised.

Given its close links with life cycles, agriculture could be a permanent research and innovation laboratory for improving the relationship between man and the natural environment (De Castro, 2015), and this would be especially true for the Mediterranean. The creation and launch of open knowledge and innovation exchange and sharing systems could become a driving force in this sense, at least in two ways. Firstly, in the "Mediterranean laboratory" food and agriculture are particularly important in terms of social identity and the economy; secondly, because innovation policies are now an integral part of cooperation and development policies.

III – Innovation for development

Innovation-driven economic growth is not, or at least is no longer, the prerogative of developed countries. China, India, Malaysia, Vietnam, Kenya and Uganda are examples of medium or low income economies where the creation of innovation systems is a major development driver. Agriculture and food production play a pivotal role in most of these countries.

The National science, technology and innovation plan launched in Uganda in 2012 emphasises the need for a multi-sectoral approach to innovation across all sectors of the national economy, including agriculture, energy, services and information technologies. Ghana has introduced the Farmer Field Fora, an approach to agricultural extension, using the participation of farmers and players of the food chain and of other economic sectors to increase crop efficiency and quality. In Kenya, the city of Konza is about to become a hub for the development of innovative technologies and start-up incubation in a number of sectors ranging from agriculture to mobile banking and ICTs (Global Innovation Index, 2015). In China, food security is a major concern; ensuring enough food to the population has been high on the national development agenda for decades, and the country's main agriculture universities now lead the world in patenting many of the new agricultural technologies (see Figure 1).

After a decade of stagnation during the 1990s, public investments in research and innovation in agriculture between 2000 and 2008 increased by 22% worldwide. The average annual growth rate is 2.4%, and this is mainly due to the efforts of emerging economies, with China, India and Brazil in the forefront. In contrast, investments are at a standstill or in decline in the developed countries (IFPRI, 2012).

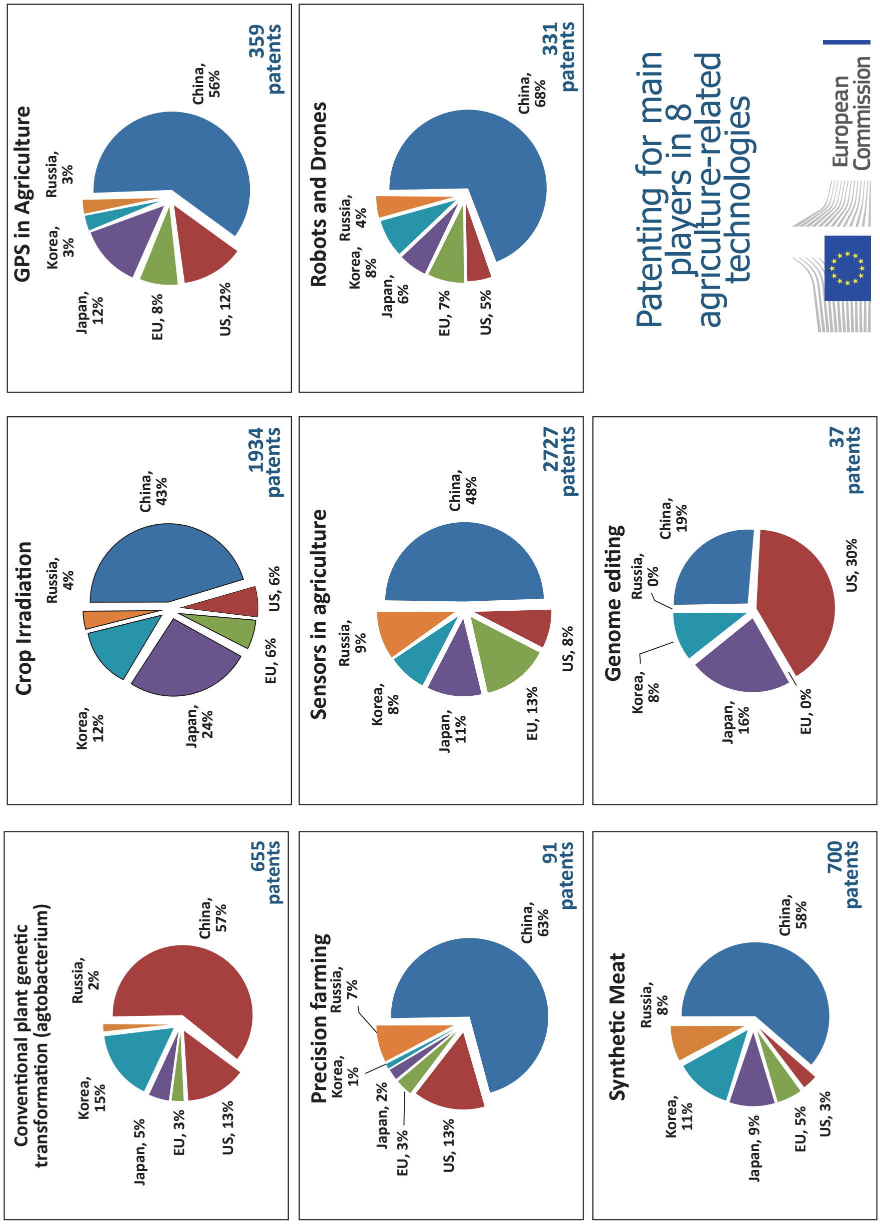
Based on the number of patents registered over the last fifteen years in eight key areas for the development of agriculture-related technologies, the European Commission's Joint Research Centre has provided the following overview:

Agricultural productivity has increased throughout history, and its impact on the environment has been modified only with the development of innovative solutions and their widespread use by farmers. Owing to the specificities of farms, this process has generally been driven by the State and the public authorities. More recently, private sector investment has partially replaced public sector intervention in the advanced economies, above all in the US.

However, without a broad-based revival of investment in innovation also involving the public sector in countries with a high per capita income, and without a redefinition of the existing systems to enhance the sharing of research results with the production chain, we can hardly imagine achieving the levels of productivity and of ecosystem management required by the current scenario.

IV – Edmond's gesture

Edmond is the name of the slave who revolutionised the cultivation of vanilla, the most used aroma in the food and industrial sector. In 1841, twelve-year-old Edmond, an orphan born in slavery in one of the world's outposts (Reunion Island, near Madagascar) and ignorant of botany as codified science, surpassed European experts by discovering how to pollinate the vanilla flower, aiding fertilisation by means of a toothpick-sized sliver of bamboo and a simple gesture.



Source: JRC cumulative graphs, data based on Patstat. 2000 to 2014

Figure 1 . Patenting in 8 agriculture-related technologies

Le geste d'Edmond (Ashton, 2015), as the French colonists called it, is still used today and marked a major breakthrough.

Vanilla was in great demand among the wealthy classes in Europe, but it was rare because its reproduction was considered mysterious. After 1841, plantations began to develop anywhere in the world with suitable climatic conditions, and demand grew together with supply, as often occurs when rare resources become abundant thanks to innovation. Prices started to fall and vanilla became more accessible.

The knowledge transfer involved in teaching Edmond's gesture, first to the growers in the island's plantations and then increasingly further afield, made it possible to increase production from a few thousand to 5 million vanilla pods between 1841 and 2010. Nowadays, countries like Indonesia, China and Kenya are great players in the supply of vanilla to many sectors ranging from the food industry to cosmetics.

Rather than being the invention of a genius, vanilla was the result of a "chain reaction" (Ashton, 2015). Edmond was not totally unaware of the science of plant organisms. His master, Ferréol Bellier Beaumont, had told him about the work of the late 18th century German naturalist Konrad Sprengel on the sexual reproduction of plants, and had demonstrated this principle by manually fertilising water melons. Not only did Bellier Beaumont free Edmond from slavery and insist that the boy be recognised as the inventor of the method, but he also worked hard to transfer this method to other growers. This dissemination activity, which would be called today innovation brokerage, is after all just one example out of many that can be diffused around the world.

Despite the enormity of its consequences, Edmond's gesture was a typical incremental innovation, a small step and not the mythological "great leap" forward which common sense attributes to invention. Of utmost importance is that Edmond's gesture was purely practical, a cost-free and easily replicable innovation. Rather than the gesture *per se*, what really counted were the information and the knowledge transfer, alongside a great social demand.

This story tells us that innovation is primarily a collective and social process, based on learning and interaction. Like the apples and the livestock cited earlier in this chapter, which are regarded as "natural" although they could not exist without human creative effort, innovation in agriculture and in other sectors is a collective work mostly done by anonymous players and requiring continuous adjustment, dictated by a dynamic relationship between needs and creativity, and by the exchange of knowledge for mutual learning.

Precisely to facilitate the exchange of views, at least from the 16th and the 17th centuries onwards, after the successful establishment of botanical gardens and the development of modern science in Europe, innovation in agriculture has been codified in knowledge transfer systems and models. Each period has had its own prevailing organisational model, its "paradigm" (Kuhn, 1962), to support the participation of farmers and scientists in innovative processes. The phase we are now experiencing has all the features of a transition between models, with many possible directions.

During this transition stage it is possible to compare, try and adapt different general approaches to different real situations.

The coexistence, comparison and fusion of a vast array of models and solutions could favour the alignment of agricultural innovation systems with the great challenges of the present, enabling them to find the best ways of adapting to local needs.

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Innovation in the agricultural and food sector: Divergences and complementarities

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Abstract. Innovation is a particularly complex concept, and offers a great many levels of interpretation. This chapter focuses on three different approaches to innovation: economic, technological and managerial. The dissemination of innovation in agriculture is as necessary as it is complex, but it is not always easy to convince a large number of farms to adopt new technologies. The main obstacles lie in the structural characteristics of Mediterranean agriculture, with a large number of small or very small family-run farms scattered across the territory, and farmers who are often old and poorly educated. While the main source of farm innovation remains external, the food sector tends to generate internal innovation. Today's food industry seems increasingly less "supplier-dominated", and more of a sector in which companies must be able to maintain a balance between technology-push and demand-pull innovations. Using the results of an analytical study at the local level, the chapter considers the differences in the propensity to innovation of two kinds of business: farming and food processing. Solutions are offered for aligning the two innovation systems and making them more efficient.

Keywords. Food business – Farms – AKIS – Local – Southern Italy – Agricultural extension services.

L'innovation dans le secteur agricole et alimentaire : Divergences et Complémentarités

***Résumé**. Le concept d'innovation est particulièrement complexe et il se prête à différentes interprétations. Ce chapitre met l'accent sur trois approches différentes : économique, technologique et managériale. La promotion de la diffusion des innovations en agriculture est une activité à la fois nécessaire et complexe, mais il n'est pas toujours facile de convaincre un grand nombre d'exploitations agricoles à adopter les nouvelles technologies. Et ce principalement à cause des spécificités structurelles de l'agriculture méditerranéenne qui caractérisent les exploitations agricoles (d'un nombre assez élevé, réparties sur tout le territoire, souvent de petite ou très petite dimension, et familiales) et les agriculteurs (souvent âgés et de faible niveau d'études). Alors que dans l'exploitation agricole la principale source de l'innovation reste exogène, dans le secteur alimentaire c'est la tendance à produire de l'innovation à l'intérieur des entreprises qui prévaut. Aujourd'hui, l'industrie alimentaire apparaît de moins en moins un secteur "dominé par les fournisseurs" et il est un milieu où les entreprises doivent être capables de maintenir un équilibre entre l'innovation du technology-push et du demand-pull. Se basant sur les résultats d'une analyse menée au niveau local, ce chapitre examine les différences de propension à l'innovation des deux types d'entreprise: de l'exploitation agricole et de l'entreprise alimentaire. Il propose des solutions visant à harmoniser les systèmes d'innovation de l'une et de l'autre.*

***Mots-clés.** Entreprises alimentaires – Exploitations agricoles – AKIS – Local – Italie méridionale – Service de vulgarisation agricole.*

I – Foreword

Throughout history, human development has mostly been connected with innovations in agriculture. Today, faced with a forecast world population of over 9 billion by the year 2050, society poses a new challenge to the farmers of the twenty-first century: the need to increase productivity while reducing the use of natural resources. Once again, human creativity is called on to contradict Malthusian theories and to improve on the green revolution of the last century by maintaining production processes at acceptable levels of social and environmental sustainability.

Among the many implications of this challenge, one should analyse not only agriculture but also the agrifood system as a whole. This analysis includes all the production sectors involved in food production and distribution, and has become successful in these last fifty years, alongside and sometimes replacing the traditional approach to the study of agriculture[1]. The success of the systemic approach is linked to the process of "primary sector outsourcing" i.e. the progressive transfer of activities typically performed on-farm (e.g., production of technical inputs or product processing) to other economic organizations. The effects of outsourcing become evident with the progressive reduction in the contribution of agriculture to national income and employment and also with the increasing importance of the industrial segments downstream and upstream of the agricultural production process (Malassis and Ghersi, 1995).

The agrifood system is a particularly important component of the economic system in developed countries. Following Say's law, the importance of an agrifood system can be measured by starting with its effects on the market. In 2014, Italian families dedicated 14.5% of their total spending to food products. The economic value of domestic agrifood products represents 17% of Italy's GNP, and generates about € 266 billion. The distribution sector (retail plus Ho.Re.Ca.) contributes the largest share, accounting for almost half the added value created, while smaller shares are produced by the agriculture (11%), technical inputs (9%) and food (10%) sectors (Inea, 2015).

The importance of the agrifood system for the domestic economy makes it necessary to focus attention on its innovative capacity. Methodological rigour requires that agrifood innovation should be explained by emphasising the organizational characteristics differentiating the behaviour of its operators from those in other sectors. In fact, although it consists of different components, a system is defined as such when it represents something more and different from the sum of its single parts (Von Bertalannfy, 1971). Nevertheless, this paper will maintain a sector-based approach, focusing only on the two components of agriculture and the food industry, so as to underline their exclusive characteristics and dynamics, and then highlight the affinities and differences in their innovative strategies[2].

II – Innovation (and technological transfer)

The concept of innovation is currently an important subject of public and scientific debate, and is frequent in technical documents, press articles or economic essays. It is therefore taken for granted that the reader is familiar with this subject. However, the concept of innovation is quite complex and is open to multiple interpretations. This chapter focuses on three different approaches to the subject: economic, technological and managerial. These are three perspectives that do not entirely cover the complexity of the concept, but they are useful in understanding its implications for the agrifood sector.

The concept of innovation probably owes its current fortune to the (macro)economic approach that interprets it as the increase in input productivity, and consequently as the driving force of economic growth. The best-known formulation of this approach is probably Robert Solow's equation, which introduces the concept of technological change into the growth of economic systems, defining it as the increase in the quality of inputs used at the aggregate level (Solow, 1957). Based on this seminal work, various scientists analysed the magnitude of innovation in agriculture over time and space, and have achieved a detailed understanding of sources and determinants (Alston *et al.*, 2010).

Researchers have a different perspective, especially in the field of "hard" science, and innovation coincides with invention. In this sense, innovation is any new combination of scientific knowledge applied to methods, materials and instruments in order to solve technical problems. The most effective operational translation of this "technological" approach is the patent. In other words, the intellectual copyright and exclusive right to economic exploitation of an invention, guaranteed to the inventor who applies for a patent. Alternatively, the innovative capacity of a system is interpreted by the quantity and quality of the scientific publications it can produce. This point of view is also the origin of one of the main sources of confusion in the debate, i.e. the tendency to consider the concepts of innovation and scientific research as being the same (and more dangerously, that the concepts of research policy and innovation policy are the same)[3].

A third point of view is offered by the managerial approach. In this spirit, innovation becomes so only when it faces the market and is positively judged by it. The best description of this approach is the standard definition in the OECD Oslo Manual, stating that innovation is the capacity to manage knowledge in order to generate competitive advantages through the production of new goods, processes and organizational systems (OECD, 2005). This meaning refers back to Schumpeter's view of the characteristics of the entrepreneur, the nature of competition and the countless efforts firms must make in order to conquer markets[4].

So-called managerial innovation naturally implies technological innovation, in the sense that economic exploitation of new knowledge inevitably requires that the latter be created[5]. It may happen that the two processes take place within the same organization. More often, however, they occur separately. In fact, the growing complexity of the contemporary world favours specialization processes that concentrate the creation of scientific-technological knowledge in research centres, while commercial businesses carry out the corresponding market exploitation. In these contexts, the process connecting the two phases, that is to say technology transfer, becomes increasingly important.

The concept of technology transfer originated in the academia to describe the process of protecting (patenting) and marketing technologies derived from their own research and development projects. Over the years, this activity has become so important that it has led to the creation of different specialist bodies like the Industrial Liaison Offices (ILO), the Technology Transfer Offices (TTO) and the Technology Districts. As is often the case, the concept has been extended over time to a series of processes that are quite different from the original meaning. In brief, technology transfer must not be confused with simple training, dissemination and/or consultancy, but is something more substantial, which brings about a real change in technological knowledge when it is transferred for adaptation to economic use (Azzone and Bertelè, 2000; Amehesse and Cohendet, 2001).

These three perspectives do not entirely deal with the complexity of this topic. Each of these approaches implies further specifications. In particular, when describing agrifood innovation in its entirety it would also be appropriate to focus on other attributes, including[6]:

– process: linear model or pipeline or chain model;
– nature: land or labour saving, capital or knowledge intensive;
– object: technological, organizational, commercial; reified or immaterial;
– results: impacting on the product or exclusively on the process;
– motive: demand pull or technology push;
– sources: self-produced or purchased externally;
– degree of novelty: based on consolidating the knowledge base (incremental innovation) or envisages the creation of a new knowledge base (radical innovation)

III – Innovation in agriculture

In the last 150 years, technical progress in agriculture has been impressive. This can be seen by the capacity of our planet to support increasing numbers of inhabitants; the human population increased from approximately 1.26 billion in 1850 to 1.65 in 1900, and then from 2.52 billion in 1950 to 5.97 in 2000 (United Nations, 1999). Agricultural production has been able to satisfy the food requirements of a continuously growing world population thanks to the diffusion of induced innovations, i.e. they were generated by changes in the price of inputs. This is how innovations aimed at cutting down the most expensive inputs have spread. Until the 1930s, abundant land and a lack of workers meant that labour-saving innovations (machinery, equipment, etc.) were introduced, but the subsequent land scarcity and increasing demographic pressure meant that land-saving innovations (improved seeds, fertilisers, insecticides, irrigation, etc.) prevailed[7].

The following Figure shows the yearly increase in productivity for the last 50 years, starting in 1960 (Fuglie, 2010). It can be noted that productivity has grown 50-150 fold from 1960, slowing down in the last ten years. A greater injection of capital was responsible for 25% of the general increase in productivity, but the most important effect on productivity was the adoption of chemical and genetic technologies (44%).

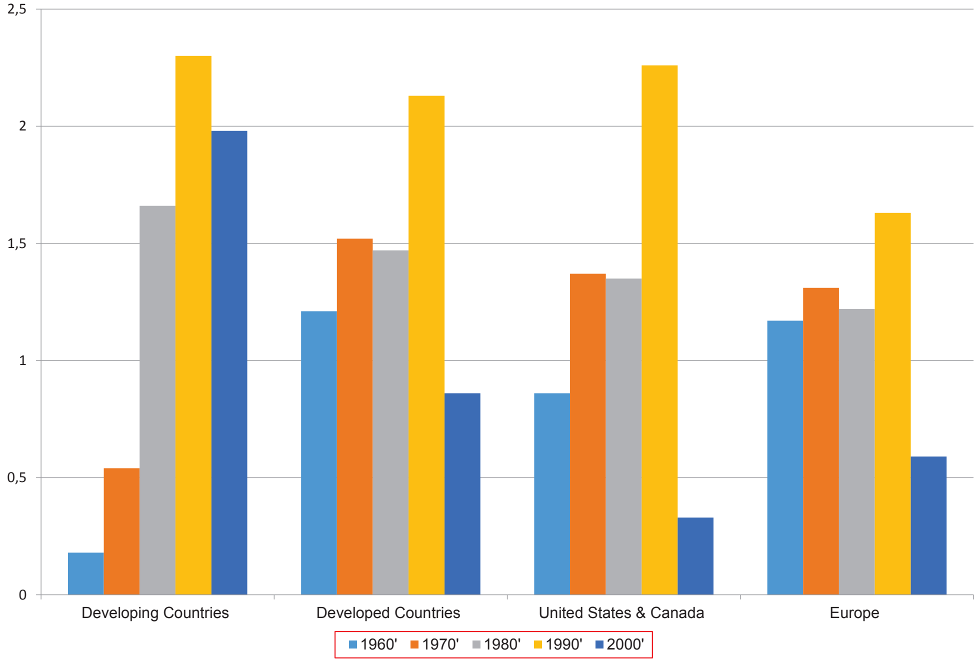

Figure 1. Average yearly increase in productivity in agriculture

The innovations introduced in agriculture have various origins. In general terms, six types of institutions have been identified which generate and spread innovations in agriculture in different ways (Possas *et al.*, 1996):

– private sector firms operating in pharmaceutical, chemical, mechanical, genetic (e.g. producers of pesticides, machines and tools, seeds, veterinary products, animal feed, etc.) industries;

– research institutions like universities, public research bodies and private research centres;

– firms processing farm products e.g. the food and the paper industries;

– private sources organised as non-profit and collective enterprises, whose objective is to develop and transfer new technologies e.g. new seed varieties and agricultural techniques;

– private sources specialized in providing services e.g. technical support for product use, crop treatments and animal feed;

– farm businesses that develop new knowledge and education through learning by doing.

Although accurate quantification of the importance of each group is not possible, given the nature of the "green revolution" it is certainly possible to conclude that the prevailing sources of innovation are external to the agricultural sector, and that they belong in particular to the first two groups. It is no coincidence that agriculture is classified as a supplier-dominated sector (Pavitt, 1984).

A further element in common with the innovations introduced during the last century is the tendency to development following a linear model: beginning with scientific research, progressing through applications and industrial prototyping before arriving on the market. However, this model starts showing some difficulties in interpreting contemporary reality. In particular, there is an increasing need for theoretical models to explain both the dominant role of knowledge over research, and also the increasing influence of the food industry and market demand in demanding that more attention be given to product innovation (Boccaletti, 2001; Knickel *et al.*, 2008).

Even if it were confirmed that innovation in agriculture is progressively changing character, shifting from a model driven by factors external to real agricultural activity towards a model driven by demand from inside the supply chain, the basic social objective remains unchanged: to favour the adoption of innovative solutions, not by individual entrepreneurs but by all farmers.

Promoting the dissemination of innovations in agriculture is a necessary and complex activity. In fact, it is not always an easy task to convince a great number of farms to adopt new technologies. The main obstacles lie in the structural characteristics of Mediterranean agriculture: a particularly large number of small or sometimes very small family-run farms that are scattered over the whole territory, and farmers who tend to be old and poorly educated. The result is that agricultural innovation tends to spread in the same way as an infectious disease. It is a slow start because only few "pioneers" approach innovation after overcoming suspicion and mistrust. Over time, the process advances in a typical logistic or sigmoidal path, gradually gaining momentum and involving an increasing number of farms (in order: *Early Adopters*, *Early and Late Majority*, and finally *Laggards*), which are stimulated by contact with those who have already introduced innovation, or else by contact with sources providing information about innovation (Rogers, 1962)[8].

Various factors play a significant role in the adoption and dissemination of innovation[9]. Of course, the economic factors are the ones that mostly play a role. The cost of resources and the price of products are always the main factors driving the action of economic subjects. However, there is also a contribution from policies supporting the agricultural knowledge system, especially extension services (Jones and Garforth, 1997).

Since the late nineteenth century, policy has focused particularly on the measures to favour technological change in agriculture. In fact, agriculture is a strategic sector for two reasons: it drives the growth of traditional economies and supplies food. Therefore, over time there has been strong support for the processes of knowledge creation and transfer in this sector.

Consistently with the linear model, the intervention model has focused on the fundamental role of Universities and Research Centres, supporting them through services for business development (agricultural extension) by involving public consultancy networks, information agencies, vocational schools and training centres. This approach probably started with the establishment of the US *land-grant universities* in 1863 and has become a support model largely implemented by the European Commission, the FAO, the World Bank and other international organizations. Over time, this model has been subject to relatively small additions and amendments, and subsequent elaboration in the concepts of *Agricultural Knowledge and Information System* or AKIS (Roling, 1988) and *Agricultural Innovation Systems* or AIS (Hall *et al*., 2006)[10]. The flagship initiative supported by the current regulations for rural development is part of this approach. It aims to favour formation of Operational Groups of European Innovation Partnerships and the creation of innovation brokers.

IV – Innovation in the food industry

The figures show that the European food industry is the most important sector of the European manufacturing industry. FoodDrinkEurope statistics report 289,000 active businesses in 2013, with 4.2 million employees and a turnover of €1,244 billion. The structural characteristics of this sector are the high number of SMEs, employing 63% of sector workers and producing 50% of turnover, and good propensity to export. The European food balance is particularly positive, with a surplus of € 27 billion in 2013. In particular, food businesses export goods worth €92 billion, accounting for 18% of total European exports (FoodDrinkEurope, 2015).

As in the case of agriculture, the history of the food industry is full of innovations. This can be seen in the attached table showing the major twentieth century innovations, and by the interesting paper it comes from (Welch and Mitchell, 2000). Moreover, the food sector is also traditionally included in the taxonomic category of agriculture; it also contains a significant number of SMEs and is science-driven, with a predominantly external innovation source ("supplier-driven") and objectives mostly aimed at reducing costs and with scarcely appropriable results.

ISTAT highlights additional elements the two sectors share, concerning the type of innovative activity and the rate of spending on research and development.

Regarding the type of innovation, Table 1 shows that "reified" innovation prevails in the food industry, as in agriculture, since it tends to consist of buying capital goods that entrepreneurs have encountered at trade fairs, in the trade media or through manufacturers' commercial intermediaries[11].

Table 1. Importance of the different types of innovative activities in the food industry.

TYPE OF INNOVATIVE ACTIVITY	% OUT OF INNOVATIVE EXPENDITURE
Internal R&D	16.9
Purchase of R&D services	7.6
Purchase of innovative machinery and equipment	60.1
Purchase of technology not embedded in capital goods	2.3
Design and other activities prior to production	5.4
Other expenses	7.8
TOTAL	100.0

Source: Istat, 2010

Similarities are observed also relative to the reduced intensity of research and development of the sector. The food sector is low-tech when compared to high research intensity sectors like the electronic, pharmaceutical, chemical and automotive sectors. However, this should not imply that innovation is very infrequent in this sector. Not at all. In fact, it is recognised that although the food sector spends relatively little on research, it successfully introduces innovations by enhancing internal resources (Le Bars *et al.* 1998).

Table 2. Research and development expenditure, in absolute value and per worker in various manufacturing sectors.

SECTOR	EXPENDITURE K€/worker	K€	SECTOR	EXPENDITURE K€/worker	K€
Electronics	17.3	1,704,241	Oil	8.0	90,773
Pharmaceutical	15.7	892,153	Food	6.7	1,114,719
Paper	12.6	544,490	Furniture	6.3	491,022
Chemical	10.8	994,461	Clothing	6.1	470,392
Automotive	10.5	1,679,405	Minerals	5.8	693,948
Audio-press	9.7	444,669	Rubber and plastics	5.7	663,949
Metallurgy	8.7	843,830	Metal	5.6	1,424,854
Wood	8.0	327,181	Textile	4.7	364,909

Source: ISTAT, 2008

Given these data, it must be considered that the approach to innovation in this sector has developed due to changes in consumer habits. This is especially true for specific aspects like the reason and objective of innovation, sources, appropriability and the nature of the innovative process.

One first remark is that food businesses do not now innovate only to become more competitive regarding costs. In the past this behaviour was consistent with consumers' particular unwillingness to change their food habits (Padberg and Westgren, 1979). Following this interpretation, in order to adapt to a demand that was particularly reluctant to accept innovative products, the food industry introduced process innovations, or incremental innovations to products, instead of radical changes. Essentially, new products did not diverge too much from better-known products.

An additional consequence is that a feature of the system was "redundant technology", meaning that the market could not take advantage of all the opportunities science and technology offered for acting on food characteristics, such as taste, convenience foods and nutritional content (Galizzi and Venturini, 1996).

In the current context, generational turnover and an acceptance of novelties encouraged by growing globalization mean that food demand has changed considerably, requiring businesses to move towards preparing foods with a high innovation content (Wilkinson, 2002). This increases the demand-pull approach, creating a greater inclination to product innovation, with thousands of new products launched on the market every year (Hermann, 1998; Lord, 2000; Menrad, 2004; Costa and Jongen, 2006).

The generation of innovation is probably the aspect that most distances the food industry from agriculture. The main source of innovation on the farm is still external, whereas in the food sector there is increasing internationalization of innovation within businesses. Today, the food industry seems to be increasingly less "supplier-dominated", and more an environment where businesses need to maintain a balance between technology-push and demand-pull (Grunert *et al.*, 1997)[12]. In other words, businesses need combine the exploitation of scientific advances and their incorporation into business processes with satisfying the needs of their potential customers (Traill and Mulemberg, 2002).

The increasing appropriability and endogeneity of the innovative processes in the food industry make the "chain" model a better explanation than the linear model (Mendrad, 2004). This means that the innovative business is at the centre of the model, and interacts continuously with the knowledge and research system. Innovation stems from the business's capacity to identify a potential market, intended as a need to be met, and its subsequent combination of in-business and off-business knowledge in order to determine an analytical design for development and testing (Kline and Rosenberg, 1986).

The most delicate phase is that of combining existing knowledge with collective learning. In fact, the food sector, especially in the Mediterranean basin, has a wealth of deep-rooted knowledge that is inherent in the typically family-based management of food businesses and handed down over time. On the other hand, businesses need to internalize structured knowledge (originating from research) in order to make the best use of the technological opportunities that science makes available to the real demand for innovation[13].

Based on this condition, although food businesses are constrained by structural deficits, they evidently feel the need to collaborate with research bodies. In addition, the vast literature on this subject shows that collaboration between businesses and research bodies increases the possibility of introducing innovations, consequently increasing the chances of success for new products[14]. In this sense, rather than speaking of the diffusion of innovations, the term co-creation or open innovation means that businesses' tend to avoid self-sufficiency, and adopt an open approach based on closer interaction with the external environment (Chesbrough, 2003).

Considering the specificity of the food industry, it has been proven that technological transfer brokers are one of the factors that most affect the capacity to establish relations with businesses. Brokers are especially useful in the complicated phase of needs analysis, which contributes to the knowledge sourcing that is a determining factor in bringing two very distant spheres closer to each other (Muscio and Nardone, 2011; Bonesso and Comacchio, 2008). In addition, although there has been a proliferation of abbreviations and models like Science and Technology Parks, Competence Centres, Technology Districts, *Liaison Offices*, and Innovation Clusters in recent years, no best practice has emerged to bridge the gap between research and business. Without entering into this discussion, the best way to encourage the two sides to become closer – probably also for the food industry - is by relying on the typical light and low-technology extension services that agriculture offers businesses for solving their specific problems (Martin and Scott, 2000)15.

V – Conclusions

There are similarities between innovation in agriculture and in the food industry, but there are also some aspects that are quite different. Of all the aspects described above, what emerges in different ways is the importance of the relationship between businesses and research bodies.

In the case of agriculture, external innovation ensures high economic returns to subjects who are outside the sector but responsible for the generation of new knowledge, processes and products (not necessarily research bodies but also businesses providing inputs). Fewer benefits are obtained by the early adopters, namely the first farmers who innovation, and they progressively extend to the others although to a lesser extent. In this context, research bodies should always play a fundamental role, especially as tools of public utility, since they contribute to the process of knowledge creation and dissemination, and ultimately to increasing agricultural productivity.

This takes on a completely different importance in the food industry, where there is an increasing tendency to internalize the innovation process, making it increasingly appropriable. As previously described, the relationship of businesses with research bodies leads to increased opportunities for introducing business-owned innovations and for the success of new products. Hence, research bodies are useful partners for increasing business profitability. Also in this case there may be a social return if industrial innovation policies increasingly favour relations between the parties through direct funding (cooperative research funding models such as research and development partnership programs) or indirect funding (cooperative contractual models such as tax credits).

In both agriculture and the food industry, there are similar obstacles to overcome in order to create a good relationship between business and research. Business has to contend with the small size of firms, an aversion to risk and the ability to recognize opportunities, while research often has little understanding of the entrepreneurial mind-set, and tends to remain isolated in an “ivory tower”. This often adds up to a generalized mutual lack of trust between the two sides.

The specific elements of innovation in the agrifood system and its limits in defining adequate innovative patterns must be held in due consideration when dedicated innovation policies are promoted. In particular, legislators should allocate resources to the brokering phase of the relationship between businesses and research bodies, in order both to disseminate innovative practices in agriculture and to encourage open innovation in the food industry.

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Major innovations introduced in the food industry in 1900

1900

First flour bleaching agent

Milk pasteurisation

Drum dryers

Sanitized tin cans

Pre-cooked tinned beans

1910

Oil hydrogenation

Higher yield in flour extraction

Post-harvest mechanization

1920

A and D vitamins added to margarine

Plate heat exchanger

Tubular blancher

Juice extractors

1930

Slaughter-house mechanisation

Lining of cans

Technology of injection of curing solution

Blast freezing technology

Soluble coffee atomiser

Sliced and packed bread

Milk in cardboard container

Refrigerated counter at the point of sale

1940

Fortified bread (rickets)

Preservatives in meats

Mass production of chocolate

Lyophilisation of vegetables

Additives for flour processing characteristic

HTST pasteurisation

1950

Preservatives in bakery products

Controlled atmosphere preservation

Aseptic canning

Tetra Pak

Frozen food (fish sticks)

Tea bags

1960

Chorleywood bread process

Instant mashed potato

Polyunsaturated margarine

Enzymes for meat maturation

UHT method for milk

Aseptic Tetra Pak packaging

1970

Growth in services content

Automation and computerization

Slimming foods

Granary bread

Aseptic bag packaging

1980

new plastic material for packaging

Single cell proteins (SCP) - Quorn

Low-calorie ingredients

Nutritional labelling

Chilled ready meals

Mono-unsaturated margarine

Modified atmosphere packaging

Aseptic packaging of liquid foods (Particulate Food)

1990s

Increasing specialization of businesses

Fat replacers - Simplesse

Use of irradiation (limited)

Minimal processing

Functional foods

Growth of organic foods

Genetically modified foods

Source: Welch and Mitchell, 2000

Notes

1 The original codification of the agrifood concept might date back to Davis and Goldberg, 1958. Further distinctions may refer to the concept of the agri-industrial system, but we refer back to it in other sessions.

2 For analysis of system organization and its consequences on innovation refer to Nardone and Pilone, 2009.

3 For interesting material on this subject, see Dosi *et al.*, 2006.

4 *It is not [price] competition which counts but competition from the new commodity, the new technology, the new source of supply, the new type of organization … competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and output of existing firms but at their foundations and very lives* (Schumpeter, 1942).

5 Schumpeter carefully separated the concept of innovation from the concept of invention.

6 For further explanation of each single aspect see Malerba, 2000.

7 Hayami and Ruttan (1985) introduced the first theories of induced innovation. More recently, a challenging analysis of this process is found in Sunding and Zilberman, 2001.

8 A classical representation of this theory is the adoption of hybrid maize in various American states masterfully described by Griliches, 1960.

9 See Feder and Umali, 1993 for a review.

10 Although it is not possible to explore this subject in detail here, it should be noted that the shift from the traditional approach to the current more popular approaches is the direct consequence of at least two simultaneous factors. One is that governments invest fewer economic resources to support innovation in agriculture, and the other is the progressive reduction in the interpretational capacities of the linear model, so that the focus has shifted from the role of research centres to that of networking and collective learning.

11 Additional evidence that food industries often innovate through new machinery or new ingredients is also found in Christensen *et al.*, 1996, and Martinez and Briz, 2000.

12 The innovative model implemented by food businesses (especially large businesses) is conventionally defined as “phase and gate”, intended as a map of sequential operations accompanying a product or an innovation from its design through to its launch. The process develops through steps separated by barriers or “gates”; these are phases in which each design idea is reviewed before it is considered adequate to move on to the next step. Steps and criteria for the advancement of a project are established by *ad hoc* teams and are highly formalized. The main steps are usually generation of the idea, development of the concept and marketing strategy, economic feasibility analysis, product development, and market testing.

13 The ability of a firm to recognize the opportunities resulting from technology and adapt them to its demand for innovation is defined absorptive capacity (Cohen and Levinthal, 1990). For further details on the demand for innovation in the food industry see Muscio *et al.*, 2010.

14 For a more detailed analysis of the relation between research bodies and food businesses refer to Nardone and Pecorino, 2013.

15 The proposed model envisages the construction of bridging institutions that are not directly involved in research activities but which produce, preserve and enhance a database of technical solutions to real business problems. The establishment and operations of the Puglia Regional Agrifood District (*Distretto Agroalimentare Regionale* (D.A.Re) is inspired by this philosophy.

New knowledge transfer practices

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Abstract. In sectors like the agrifood industry, the complexity of the problems needing to be tackled often requires solutions that integrate expertise from very different disciplinary areas. From this point of view, the proposal made several years ago by economist Richard Normann to allow the development of a "value chain" towards the "value constellation" takes on a new meaning, not only for production processes, but also for the formulation of new strategies for the development of innovation. In order to enable the formation of the constellation in the innovation ecosystem, it becomes necessary to train those able to act as real "brokers" – or intermediaries – in the networks, connecting stakeholders who are not traditionally connected, but who create "new combinations" of technological solutions, essential for generating innovations. Following this, the chapter explores the instruments provided by digital technologies and cyber networks for improving interaction and consolidating an open and collaborative approach between different actors in the innovation systems. The vast range of new instruments/environments provided by the Web can contribute to the creation of an "ecosystem" in which the innovation brokers are supported in all the key processes connected with their work.

Keywords. Digital technologies – ICT– Web – MOOCs – Global – Innovation broker.

Nouvelles pratiques de transfert de la connaissance

Résumé. *La complexité des questions qui caractérisent des secteurs comme le secteur alimentaire exige souvent des solutions qui intègrent des expertises provenant d'un large éventail de disciplines. Dans cette perspective, la proposition faite par l'économiste Richard Norman il y a quelques années, consistant à faire évoluer le concept de "chaîne de valeur" vers le concept de "constellation de valeur", revêt une nouvelle signification non seulement dans les processus de production, mais aussi pour la formulation de nouvelles stratégies de développement de l'innovation. Afin de faciliter la formation de la constellation dans l'écosystème de l'innovation agroalimentaire, il apparaît nécessaire de former des sujets capables d'agir en tant que véritables "broker" - ou intermédiaires - dans les réseaux, en reliant les parties prenantes qui ne sont pas traditionnellement connectées mais qui peuvent donner lieu à "de nouvelles combinaisons" entre les solutions technologiques, ce qui est essentiel pour générer de l'innovation. Successivement, l'on examine les instruments que les technologies numériques et les cyber-réseaux rendent disponibles à ceux qui souhaitent améliorer l'interaction et renforcer une approche collaborative et ouverte entre différents acteurs des systèmes de l'innovation. La vaste gamme de nouveaux instruments/environnements mis à la disposition par le Web peuvent contribuer à créer un "écosystème" dans lequel l'innovation broker est soutenu dans tous les processus clés liés à son rôle.*

Mots-clés. *Technologies numériques – TIC – Web – MOOC – Global – Broker de l'innovation.*

In 1876 Menlo Park was simply a small village in New Jersey, but a few years later Charlie Street in Menlo Park was the first street in the world with electric lighting. The credit belongs to Thomas Alva Edison, the "Wizard of Menlo Park", who directed one of the most creative laboratories in history for over ten years at Menlo Park, birthplace of the phonograph and the commercial version of the incandescent light bulb.

Menlo Park produced more than 400 patents in six years. The key to this incredible output was that Edison firmly believed in the innovative power of recombining previously existent knowledge with a new operational outlook. Menlo Park was a success due to cooperation between scientists from different backgrounds, designers, and mechanics with experience of industrial machinery, who all worked together to design, develop and produce new technology. At the time, the connections between technological know-how in different sectors were extremely weak, and Edison was the first to recognize that catalysing a horizontal integration process (between different fields of theoretical knowledge) and a vertical integration process (technical knowledge with operational knowledge of design and production) would have great potential to create new solutions.

In almost 150 years since the success of Menlo Park, the relationship between research, innovation and production has become much more complex, but the difficulty of devising new and more effective strategies to connect research and the world of production persists.

Compared with Edison's time, it is even more evident now that the business strategies with the greatest short-term impact potentials are no longer those aimed at encouraging new "inventions", but rather those based on developing the capacity to recombine existing know-how in order to create operationally usable products/services that meet the real needs of businesses and citizens. This is even more the case of sectors like the agrifood sector, where complex problems often require solutions that combine expertise from very different disciplines. In this perspective, the proposal made some years ago by economist Richard Norman (2002) to develop the "value chain" concept towards the "value constellation" concept takes on a new meaning, not only for production processes, but also for the formulation of new strategies for the development of innovation. The impact of Norman's image was that, unlike a chain with links arranged and linked to each other in a fixed way, a constellation is a creative and modifiable conjunction between several fixed points - the stars - that contribute to create value added above and beyond their purely consecutive positions. The idea is that the system of subjects, processes and flows that generates the value is the result of a dense web of relations to be continuously and dynamically re-defined by creating new forms of fusion and integration in order to solve problems by finding new solutions. However, the limit of these dynamic processes is that they do not easily work autonomously and inertially, but require a smart active engine that not only systematically enriches the system of potential nodes, but also creatively stimulates the connections. They thus need a key figure having specific skills who may support animation.

Already a few years ago, many studies (Burt, 2004; Obstfeld, 2005) stressed that there was a need for individuals capable of acting as true brokers in networks to link stakeholders that are not traditionally connected, but from which it is possible to develop "new combinations" between technological solutions essential for generating innovations. In the agrifood sector, the fundamental role of the Innovation Broker is to collect, mediate and support the transformation of research into real value added for businesses and, as highlighted by Klerkx and Gildemacher (2012), this may take very different forms.

The simplest form is the "Innovation consultants" who mainly deal with single farmers, or farmers' associations and groups of Small and Medium Enterprises (SME). Their role is to connect farmers with innovative service and product providers, and to link farmers and SMEs that share the same interests, to facilitate access to innovative solutions and sources of funding for experimentation and implementation.

On the contrary, the "Peer network brokers" play a more structured role, bringing farmers together to exchange knowledge and experience at the interpersonal and group level in order to facilitate business development through "peer-to-peer learning", which includes extending network relations by inviting entrepreneurs from other regions or sectors, or specialists.

Quite interesting is the figure of the "Education broker" aimed at curricular innovation in support of innovative processes and at facilitating access to them.

Alongside these professional figures, Klerkx and Gildemacher identify more complex profiles, like institutions which may act as "systemic intermediaries" to support innovation at a higher systemic level (like an entire production chain), or research councils whose operational agencies can act as innovation leaders at the political-institutional level.

I – A digital ecosystem for the innovation broker

All the ways in which Klerkx defines the Innovation Broker in the agrifood context, describe a new and modern proactive figure that must be capable of acting in a complex context and needs specific support in order to develop adequately. What are then the conditions that may sustain the role of the innovation broker?[1] The discussion about the enabling conditions has highlighted many aspects requiring action: from the institutional aspect (political-regulatory context where the innovation broker acts), to procedure (operational modes to access funding, etc.), to the accessibility of information about innovations that have already reached the right level of applicability.

On the contrary, not a great deal has been said about the technological aspect, that is to say how the wide range of new tools/environments available on the Network may contribute to creating an ecosystem where the innovation broker is supported in all key processes related to the role:

- emergence of needs and their transformation into project challenges;
- real access to products and technological solutions;
- cross-fertilization between different fields in order to design products/services that meet needs;
- creation of an appropriate context for the use of a product/service;
- transfer of the successful practice and its diffusion.

What these processes all have in common is that they are based on the iterative collaboration between individuals of different origins and objectives, and are based in geographically distributed contexts: these are exactly the conditions in which the operational modalities of what is known as "e-Collaboration" can develop. By e-Collaboration[2] we mean the integrated system of recursive processes where several individuals interact online to achieve a common objective, using the collaborative tools available from the complex set of innovative solutions, known from an operational point of view as "Web 2.0", and from a technological point of view as "Cloud Computing".

But in what types of activities can e-Collaboration be especially advantageous to the Innovation broker? Let's start listening to the needs. The Innovation Broker must be capable of developing sophisticated **listening to the needs** of farmers and territories, which cannot be limited to superficial interactions bringing out only needs already openly expressed. To maximize the role as a development promoter, the Innovation Broker has to succeed in intercepting the wide range of territorial needs that intersect with the agrifood sector. E-Collaboration tools can support it in different ways. In this perspective, quite interesting is the possibility of participating in the informal networks set up by professional operators and citizens in social networks. If we explore the most popular social networks like Facebook, we realize that the idea that using these tools is still alien to the agrifood sector is mostly a prejudice. On the most popular social networks there are already many groups dealing with these themes, and some in Italy have several thousand members (see the Facebook group "*Gruppo trasversale agricoltori*" with over 1,700 members or the "*Gruppo Coltivare Condividendo*", with over 3,800 members), who discuss and share news and thoughts related to the agrifood chain and rural areas. Participation in existent groups or the creation of new thematic groups can be an interesting way to recognize problems and needs as the starting point for developing the work of the Innovation Broker. Web listening could also be one of the useful support tools to monitor the major issues and timely grasp emerging problems. These tools have various levels of sophistication and range from the simple and free-of-charge systems (like *Social Mention*[3], or *Talkwalker Alerts*[4]) to the more sophisticated paid systems (like *Radian 6*[5]), but they all make it possible to monitor the level of interest in a topic broadcast on a specific set of web channels worldwide or in a given geographical context. Web listening systems not only automatically signal the publication of new contents, via e-mail alerts, but also monitor various parameters related to the topic of our interest. These include the number of users who have created contents related to the topic of our choice, the probability that this subject is discussed on the web, and what is known as “sentiment”, meaning the rate of positive quotes about our topic out of the total. In short, they are a kind of “barometer” of the Network that may help identify the issues for which a certain interest is developing.

Other e-Collaboration tools can be useful for needs identification: from the oldest tool useful for this purpose, the forum, to those for designing and easily managing online questionnaires even complex ones, which can be sent out by email, or quick surveys that can be created on the social networks.

E-Collaboration strategies make it easier to reach individuals with the most disparate experiences and professional backgrounds, independently of their geographical or organizational position. Therefore, they can also be useful to the Innovation Broker in **constructing the networks** required to identify useful technologies and integrate them into solutions that satisfy needs.

For this purpose, general research-oriented (*ResearchGate*[6], *Academia.edu*[7], etc.) or specific subject-oriented (*Feeding Knowledge*[8], a food security network) social networks, where researchers worldwide share their results, can be useful. Professional-oriented networks (*Linkedin*[9]) can be useful for identifying the right players to stimulate for transforming innovations into operational services.

Other possibilities that e-Collaboration offers to the innovation brokering process consist of managing **communication** easily and rapidly and of making communication with whoever is to be involved in our processes economically sustainable, independently of their geographical position. For a while, systems like *Skype*, *Messenger*, and *Twitter* have been providing rapid contact with our interlocutors, either individually or in a group. In addition, the communication functions of the social networks can be used to send messages or chat in real-time with individuals or groups.

Finally, e-Collaboration can also be useful to the innovation brokering processes in **constructing and sharing contents with the subjects involved in the process.** This means all forms of content: from the most “traditional” (e.g. texts, spread sheets, presentations, logical maps), to the more complex (e.g. videos, animations), to lighter and **extemporary** forms (e.g. posts, messages, comments, reviews, personal profiles). Web 2.0 has made it considerably simpler to create media contents, even complex ones (e.g., videos can be produced and edited on YouTube), by allowing real-time collaboration with others (Google Drive[10], for instance, allows online collaboration to create texts, presentations, spread sheets and so on) and the results can be made available immediately to anyone with access to the Web.

All these possibilities certainly have very interesting potentials, but the Network environments where all these possibilities come together to achieve a specific objective of innovation processes are even more interesting.

II – The case of OpenIDEO: from problem formulation to collaborative construction of an innovative solution

When dealing with supports to innovation processes, the potentials of e-Collaboration can yield quite interesting results when they are aggregated in consistent contexts capable of supporting complex processes, ranging from establishing the problem to the identification of possible solutions.

OpenIDEO[11] is a very interesting case from this point of view, because it is a web-based innovation platform where everyone can work together to develop innovative solutions for societal challenges. Launched in 2010 by British design company IDEO (famous for its methodologies modelled on "human centred collaborative design"), the platform is open to anyone (individuals, no-profit organizations, etc.) wishing to submit a challenge related to a social problem. OpenIDEO staff evaluate the importance of the issue, and if they judge it to be significant, they formulate it in terms of a "Challenge" and publish it on the site. Then, three successive steps are developed:

- *inspiration*, the community logged on to the site is invited to upload and share any useful references to products, services, initiatives - even developed in other sectors - which may give others ideas for solving the problem that is the "challenge";
- *concepting*, developing and sharing of project concepts by any member of the community;
- *evaluation*, multiple-step selection by the community of the most interesting solutions.

Users of the platform participate in each of the three steps through a kind of collective brainstorming session and receive points that increase their DQ - Design Quotient - a kind of indicator of the reputation gained in the field as "Designer of innovative solutions". At the end of the process, which usually takes place over about three months, the community assesses the most interesting solutions. The winning projects can be used by anyone: all concepts developed are generated under a Creative Commons licence that authorises sharing, recombination and reusability.

It is interesting to note that the first challenge launched by the portal concerned precisely the agrifood sector: well-known English chef Jamie Oliver launched the topic "How can we make kids aware of the importance of consuming fresh food?"

After a ten-week session involving hundreds of people of all kinds (designers, nutrition experts, teachers, entrepreneurs, citizens), 180 proposals emerged, and from these the community selected 17 winning concepts.

The selected concepts proposed very different types of solutions: supermarket organisation strategies to attract children's attention to fresh food; *Apps* mid-way between socialization tools and online games encouraging children to express their opinions of a wide range of fresh foods; proposals for a policy to regulate automatic snack machines to keep a number of slots for fresh foods; "smart" shopping trolleys that encourage customers to buy fresh foods.

With over 20,000 members in more than 170 countries, OpenIDEO has successfully created a community of "creative thinkers", willing to contribute to social innovation processes by sharing inspiration, proposed solutions, selection and assessment skills. In some cases, OpenIDEO even goes beyond the simple creative challenge and supports the search for sponsors to turn the idea produced by the community into reality.

The potential of open innovation social networks like OpenIDEO is still to be discovered, but can easily be recognized for contexts like innovation in the agrifood sector, where cross-fertilization and sharing between all active territory-based players are the indispensable ingredients for design and implementation of sustainable situations.

III – Massive Online Open Courses: a working space for Education Brokers

Continuing our exploration of the Network's contribution towards Innovation Brokering, it is quite interesting to consider one of the many profiles identified by Klerkx and Gildemacher for innovation in the agrifood sector: the "Education broker" involved in training who supports innovative processes and facilitates access to them.

From this point of view, we can think of an additional interesting process that could be explored to enrich the online ecosystem supporting Innovation Brokers: it includes all the new ways of sharing online know-how, which means first of all the MOOCs (Massive Online Open Courses) which are revolutionising free (or low-cost) training available online.

These were launched in spring 2012 (the best known are Coursera[12], EdX[13] and Udacity[14]) with the support of top-level university institutions (MIT, Harvard, Princeton, Stanford, etc.), which propose online courses free of charge, and mostly held by teachers with international standing. The number of participants in each course is on average equal to several thousands (that's why the word "massive" is present in the acronym). The key point for the birth of MOOC philosophy was Stanford in September 2011, when a free online course on artificial intelligence held by Peter Norvig and Sebastian Thurn attracted more than 160,000 students from all over the world, suggesting the launch of Coursera, the most aggressive MOOC start-up.

At present, the two leading American MOOC start-ups - Coursera and edX - are having outstanding worldwide success. Coursera has over 13 million members and edX has more than 5 million, but there are also many European MOOCs (iVersity15, FUN[16], Futurelearn17, ECO[18]). Any institution can propose its own MOOCs and find a platform to host them, provided the course quality is high. It will be up to the users to decide to what extent this is successful.

Unlike "traditional" e-learning courses, MOOCs are the result of true "knowledge sharing" strategies, by which institutions make their knowledge available to all those interested via quick and highly communicative formats. This is a huge phenomenon: just three years after the first MOOCs were launched, in January 2015 the European Commission's Open Education Europe initiative counted over 3800 MOOCs worldwide, and this figure is expected to increase on average by more than 50% between 2013 and 2018. Of course, such a wide system offering high-level training brings new opportunities in the configuration of the learning processes that must accompany the development and application of an innovation.

MOOCs are generally based on a set of ad hoc materials (mostly high-quality short videos) by teachers selected not only for their reputations but also for their excellent communication skills, and the videos are often produced using the most innovative video and animation techniques. Generally, the contents are supplemented with exercises where peer-to-peer exchanges are very important (for instance, it is the core of evaluation exercises) and this ensures the sustainability of a learning context with a high rate of social interaction and a very large number of users. An attendance certificate is issued at the end of the course, free of charge in most cases, although some Universities are now experimenting with issuing recognized University credits for a fee (a few dozen dollars), and in some cases they ask students to supplement the course with specific assessed assignments.

Although the offer in French, Spanish and Italian is steadily growing, for the moment MOOCs are mostly in English. Course contents are mainly in STEM areas (Science-Technologies-Engineering-Math), but the agrifood sector now has an increasing number of MOOCs.

The National Virtual Academy for Indian agriculture (NVAforIA) promotes a very interesting course on the IT BombayX platform, a platform belonging to the big family generated by OpenedX (the open source platform for MOOCs developed by MIT). This is entitled "Diseases of Horticultural Crops and their Management",[19] and is a training course funded by the government to encourage young people to study agronomy.

OSU (Oklahoma State University) pursues a similar objective. With "Farm to Fork: A Panoramic View of Agriculture",[20] it aims to encourage students to look at the agrifood sector proactively by taking part in debates on controversial themes, and this is also the case with the "Agriculture and the world we live in" MOOC developed by Massey University in New Zeeland.

Copenhagen Business School offers a MOOC called “Social Entrepreneurship”[21] on the Coursera platform, which looks at the issues involved in the relationship between innovative entrepreneurs and social innovation. Among other things, it also focuses on issues related to the agrifood sector and the rural context. Agreenium, the French consortium for economic and veterinary research and education, proposes “Agroécologie”[22], a MOOC in French, aimed at stimulating an active approach to understanding the complexity of the agrifood sector and its relationships with the environment.

MOOCs focus especially on topics related to food security and sustainability in a global perspective. Lancaster University has launched “Global Food Security: Addressing the Challenge” on the platform of MOOC Britannica FutureLearn;[23] this MOOC deals with food security in its various technological, economic and social terms. The University of Reading proposes “Our Hungry Planet: Agriculture, People and Food Security”[24] that deals with food security with a special focus on the role of family farming.

Wageningen University (The Netherlands), known for its advanced studies on innovation in the agrifood sector, offers a MOOC called “Growing our Future Food: Crops”[25] on the edX platform (promoted by MIT and Harvard); it examines the relationship between sustainable approaches to farm production and food security.

An increasing number of MOOCs cover subjects not strictly related to the agrifood sector, but essential in any innovation project: from methodologies for the adoption and implementation of start-ups, to significant contents for the rural context like social innovation and sustainability. This area is growing continuously, and every institution can contribute by creating alliances with the managers of large international platforms and by making contents available that are useful for the prospects of innovation to be promoted together with local entrepreneurs.

IV – Conclusions

A quick exploration of the web-based tools that can support the process of Innovation Brokering, shows that Innovation Brokers can benefit from using web-based tools in all the steps of the process. This means starting from context analysis, in order to recognize needs and opportunities (available technologies, funding, training opportunities, specific policies), and following on with the construction of partnership networks (by selecting those with complementary knowledge, technology and funding resources) to arrive at the formulation of innovative solutions and the creation of the cultural and operational context for their integration. However, the challenge is to integrate all the opportunities offered by the web into a real ecosystem aimed at specific needs of broker innovation in the agrifood sector. This means that the tools for listening to needs, for networking, training and the collaborative construction of solutions must be developed synergically around a new professional profile, that integrates e-Collaboration skills with innovation process skills and specific sector-based knowledge in support of a new Innovation e-Broker for the agrifood sector.

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Notes

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The role of research bodies, from leaders of the system to responsible partners

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Abstract. They were once the central element in state-funded research, but now the research bodies need to redefine their role as partners in the innovation process, responding more efficiently to the needs of society and businesses. In agriculture, the concept of innovation was dominated in the past by linear knowledge transfer in the form of new technologies that were essentially generated by public research (research institutes or universities), transferred to the agricultural extension services, and hence to the farmers for adoption. Therefore, the knowledge generated was transferred between the actors by means of mechanisms that were mostly one-directional (conferences, articles in scientific journals or technical publications etc.). This model has achieved successes, but it is equally undeniable that the innovation context in agriculture has changed radically in three ways. The challenges are increasingly complex, many new actors have burst onto the innovation stage in agriculture, e.g. the third sector organisations and producers' associations, and the general public is also demanding a more active role in the decision-making processes related to the adoption of technological innovations. The chapter offers an outlook for renewal of the agricultural innovation systems based on the Responsible Research and Innovation pillars (RRI).

Keywords. Research – Social responsibility – AKIS and AIS approach – Responsible research and innovation (RRI).

Le rôle des organismes de recherche: de pivot du système à partenaires responsables

***Résumé**. Autrefois élément central de la recherche financée par le secteur public, les instituts de recherche sont appelés à redéfinir leur propre rôle comme partenaires du processus d'innovation, pour répondre d'une manière plus efficace aux besoins de la société et des entreprises. Traditionnellement, le concept d'innovation en agriculture a été centré sur le modèle de transfert linéaire de connaissances, sous forme de nouvelles technologies issues pour la plupart de la recherche publique (instituts de recherche ou universités), transférées aux organisations de vulgarisation agricole et transmises ensuite aux agriculteurs pour leur adoption. Le transfert des connaissances générées au niveau des acteurs s'appuyait sur des mécanismes de communication le plus souvent unidirectionnels (conférences, articles dans des journaux scientifiques ou revues techniques, etc.). Ce modèle a connu un grand succès, mais il est tout à fait évident que le contexte de l'innovation agricole a changé radicalement, en particulier en ce qui concerne trois aspects. Les défis sont de plus en plus complexes, beaucoup de nouveaux acteurs ont fait irruption sur la scène de l'innovation agricole, comme par exemple les organisations du tiers secteur et les associations de producteurs, en plus de la demande croissante de participation active du grand public au processus décisionnel en matière d'adoption d'innovations technologiques. Ce chapitre propose une perspective de renouvellement des systèmes de l'innovation agricole reposant sur les piliers de la « recherche et innovation responsables » (RIR).*

***Mots-clés:** Recherche – Responsabilité sociale – Approche AKIS et SIA – Recherche et innovation responsables.*

I – Introduction

In recent years, new technologies have enabled significant progress to be made in understanding where, how, when and why certain occurrences take place, and society has never felt such a need to be less of a spectator and more of a leader in decisions about the future (Sykes and MacNaghten, 2013). In a world where information can reach every corner of the world in real time, it becomes crucial to reflect on the actual quality of the information shared, to enable society to make the right decisions. This is also true for the scientific community, which has an extra responsibility towards society, since it possesses complex information that is not promptly and easily understandable, but which has a great potential impact, at various levels.

Scientific knowledge and the technology derived from it should be considered the most evident product of a society that is becoming highly complex. This complexity is also demonstrated by secondary occurrences, often devastating in the impact of human activities on the environment. Predicting these impacts and minimising them without jeopardising development needs is one of the most difficult challenges human society has ever faced in its entire history. The scientific community is playing a leading role in this challenge, as a possessor of knowledge and essential information for promoting environmentally sound and socially sustainable development. However, the changes that occurred during the last century are challenging the driving role of science, often seen as an opponent and unable to withstand the weight of society's growing demand for participation. The scientific community has begun to ask itself questions about a series of aspects that concern not only its relationship with society but also the dynamics within the research community.

In the agricultural sector, the concept of innovation was dominated in the past by an approach based on the linear transfer of knowledge. This meant that new technological developments were mostly generated by public research bodies (research institutes or universities), and then transferred to the agricultural extension services that transmit them to farmers for adoption. This model was based on the contract between science and society in force for much of the 20th century: in exchange for public funds, research bodies produced new knowledge and ensured its reliability via internal quality guarantee mechanisms (Gibbons, 1999). Hence research bodies, state administration, intermediate organisations (for agricultural systems, extension services and private firms producing and distributing fertilisers, plant protection products and agricultural machinery) developed quite independently, in a relationship based on mutual trust. The knowledge generated was thus transferred between actors using traditional, mostly one-directional, communication mechanisms (conferences, articles in scientific or technical journals, etc.)

It is undeniable that this model achieved notable successes, enabling the constant growth of agricultural productivity (Esposti, 2014). Between 1961 and 2011, agricultural production actually increased proportionately more than the world's population, thus satisfying the dramatic rise in demand for food, and this increase in production was largely obtained thanks to the technical and organisational innovations adopted by the world agricultural production system (Sonnino, 2014).

It is however equally undeniable that the agricultural innovation context has profoundly changed because of at least three kinds of closely related factors. First of all, agricultural research is currently confronted with increasingly complex challenges, such as the need to further increase food production to deal with population growth and urbanisation and the subsequent increase in food demand, and the need to reduce pressure on the natural resources that are the basis of agricultural production in order to ensure long-term sustainability (Sonnino, 2015). The existing challenges are then aggravated by the need to reduce agriculture's contribution to greenhouse gas emissions and to adapt production systems to climate changes, as well as by the growing importance of adapting production systems to the rapid evolution of global market needs.

Secondly, many new players have burst onto the scene of agricultural innovation, such third sector organisations and producers' associations, while others have greatly increased their roles, like private companies producing seeds and other means of production. In any case, the new and existent actors in agricultural innovation processes have shifted their roles and importance: agricultural and industrial businesses in the agrifood system express a strong and more explicit demand for innovation, which has become a major driver to scientific research and innovation. This reduces the weight of new available knowledge in triggering innovation (Viaggi, 2015), and emphasizes the importance of participatory and multidirectional communication mechanisms (Ekong *et al*., 2015).

Thirdly, today's general public demands more active participation in decision-making related to the adoption of technological and social innovations, and urges for a shift from procedural (or representative) to deliberative (or participatory) democracy models (Sonnino and Sharry, 2015). A recent work by MacNaughten *et al*. (2015) analyses the public's responses to emerging technologies by studying its acceptance of nanotechnology. The concerns expressed are related to five basic categories:

1. *Be careful what you wish for* (fear of wasting opportunities under conditions of scarcity of resources);
2. *Pandora's box* (fear of unexpected and irreversible negative consequences);
3. *Going against nature* (fear that artificial elements prevail over natural elements);
4. *Left in the dark* (fear of not being able to exercise control over technological changes);
5. *The rich get richer* (fear that private interests damage social equity).

Whatever the public's concerns are, it is evident that the social contract between science and society requires that the new knowledge generated by the research system be not only scientifically sound, but also aligned with the dominant social values, i.e. it must be socially sound (Gibbons, 1999). Research and demonstration projects have demonstrated that it is possible to achieve significant results through direct involvement of the social players concerned (see, for example, Carrabba *et al*., 2012). Again in this case, traditional communication mechanisms become rapidly obsolete and need to be integrated with new multidirectional tools.

II – Responsible Research and Innovation (RRI) and its six pillars

In Europe the problem of how innovation processes should meet the expectations of civil society has been discussed since the definition of EUROPA 2020 contents (European Commission, 2010) within the EU research and innovation Framework Programme *Horizon 2020* (European Union, 2013). In 2013, the European Commission published a report by a group of experts on Europe's state of the art regarding responsible research and innovation (*Responsible Research and Innovation* – RRI), in order to promote and further support the debate on these issues (European Commission, 2013). Based on the work done within initiatives promoted by some member States and the Commission, it has emerged that alignment of research with society's needs requires a more comprehensive approach to research, targeted at innovation but also responsible, in the etymological sense of this term (*responsum abilis* or able to respond to the explicit or tacit needs of society). Responsibility lies, for example, in the capacity to involve stakeholders from the early stages of research, so as to make them fully aware of the consequences of outcomes and of the potential opportunities, and to allow them to assess (and choose responsibly) different options according to the needs and the moral values expressed by society. This consciousness of choice becomes crucial when society is reorganised, as is the case now, in order to find new forms and new paths towards development. The wish to create a *smarter* and greener economy, combining growth with a healthier environment and a more equitable society, necessitates tools involving primarily the leaders of growth, i.e. the research and technological innovation bodies that have always acted as drivers of development. In 2012, the European Commission indicated Responsible Research and Innovation (RRI) to the scientific community as a strategy for bridging the gap with society (European Commission, 2012). Responsible Research and Innovation (RRI) is defined as "*a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper scientific and technological advances to permeate our society appropriately)*" (von Schomberg, 2013).

The principles of RRI were officially relaunched by the Rome Declaration (Italian Presidency of the Council of the European Union, 2014). The suggested pathway is clear and consists of six priority areas for action, aimed at incorporating the theme of responsibility into research and innovation. Applying the RRI approach means enabling different societal actors to work together during the entire research and innovation process, so that results are attuned to the values, needs and expectations expressed by society. The six areas for action, called "pillars", may be summarised as follows:

1. Taking responsibility (*Engagement* – "Choosing together") of all societal stakeholders. As the problems to be addressed become increasingly complex, it becomes more difficult to take decisions. If this is combined with poor knowledge of the problem, the decision becomes nearly impossible. Thus, "*information, communication and citizens' involvement cannot happen (…) by chance, but must be part of the decision-making process"* (Valentini *et al*., 2015). This is also true for the process of identifying the objectives of research and technological innovation. Allowing society to actively participate in choosing the objectives and technological solutions is the only way to promote the realisation of collective responsibility that will make individual technological choices actually applicable. This will make the process of moving towards a more sustainable development model easier and more feasible.

2. Gender equality (*Gender equality* – "Fully exploiting the potential") means making sure that important resources for societal development do not remain unused or else used "below their potentials". This is intended not only as a traditional gender concern (for example, the establishment of female quotas) but it involves recognising that different components of society can make original contributions to development processes (hence to science and innovation) that could otherwise be recovered only through the direct and full involvement of human resources. Equity means recognising all merits and contributions related to gender, age, culture and the capacity of accepting and integrating these contributions for a more general development of an increasingly complex society.

A specific aspect of equity related to research and innovation is that they can make available technological solutions that can free entire groups of people from toil and enable them to express their potential for greater societal development. This is the case, for example, of the technologies that over the years have freed people from the heaviest work in agriculture, while giving an increased agricultural income, and so enabling farmers' children to have access to better education. Another example is the technologies that have relieved women of the heaviest housework, giving them more time to work outside the home, a higher income, and a potential of ideas directed at societal development.

3. Science education (*Science education* – "Creative learning, fresh ideas"). Science education means instilling a passion for research and innovation in young people, thus preparing the new generations of scientists to look at the development of new knowledge as an uncharted and fascinating future. Science education should also improve the level of future research by improving the current level of student preparation, supplying them with better knowledge and learning tools, and creating a close link between primary and secondary education institutions and the scientific community. This is obviously linked to the attractiveness of the scientific careers proposed to young people, as explicitly mentioned in the previous item. Scientific preparation is actually worth nothing if the economic and career difficulties of scientific contexts prove discouraging to young people. However, science education should not be directed only at future scientists and researchers, but at all society's *stakeholders*, who may thus become more actively involved in the challenges of shared governance, thanks to their improved scientific and technological understanding.

4. Open access to the outcomes of research ("Complete transparency and sharing of outcomes to boost growth and confidence") Sharing scientific data and having open access to the outcomes of research is a long-standing issue. The cost of research and the possible commercial use of its outcomes has always encouraged data protection. Promoting a responsible vision of research and technological innovation towards society requires transparency and accessibility, in order to allow stakeholder involvement in decision-making related to development (governance). Open access to data and outcomes should be fully guaranteed, at least to publicly funded research, by removing all obstacles preventing or limiting knowledge diffusion. It is expected that the sharing of scientific data can give a decisive boost to the stakeholder use of the information and technological results, and allow growing awareness of the value of science and of the opportunities it offers. This would also align with the need to educate society about science and increase confidence in the institutions.

5. Ethics ("Doing the right thing and doing it right"). The ethical aspects of this discussion are obviously essential and concern the context of values and rules enabling the achievement of concrete results in terms of responsibility in research and technological innovation. But who decides what is the right thing to do? Europe shares a common cultural root (identity), whose society has co-evolved over hundreds of years. This gives a language and legacy that are not exactly identical, but are very similar or familiar. These aspects can represent a starting point for the development of a new set of shared rules in a profoundly changing society. The fundamental aspect is however "doing it together", considering differences an asset rather than an obstacle. This may be considerably aided by science education and by open access to data and outcomes. Being able to rely on a common culture can further help to enhance the richness and the development potentials offered by differences. In addition, a clear idea of the accepted areas and limits ethically shared by society can enable the scientific community to choose research directions more effectively, to obtain results actually usable for development. A strong mandate in this sense makes it possible to overcome doubts and reserves that civil society often has about innovations in areas that are considered to be on the border between what is largely perceived as lawful and what is not.

6. Governance ("Designing science with and for society"). Governance represents the prerequisite of the whole process described so far. How to achieve the desired outcomes in the involvement of citizens, the achievement of equity and science education, in allowing free access to data and outcomes, in achieving an ethically shared vision? It is important to envisage and implement a process made up of rules, directed at achieving a strong and shared objective. This last item is of particular importance, as it indicates that it is not possible to achieve any kind of result without a process involving the careful evaluation of the policies to be implemented and a strong commitment to them. Although the start-up and management of governance initiatives are the responsibility of-government, it is evident that such a new "extended" process aimed at identifying a vision and a new way to development, should necessarily include the wishes and tacit and explicit needs of society as a whole. It is the responsibility of political decision-makers not to exclude anyone from this inevitable process that will hopefully be as virtuous as possible.

The six themes identified are not separated from each other, but should be considered as different parts of a single strategy, aimed at identifying the best way to ensure the continuity of society's general development, despite the exponential increase in its complexity.

The interdependence of the six RRI pillars may also be seen indicating the complexity of the problem. The fact that it is possible to describe even a complex evolutionary pattern of governance means that our society is probably ready to achieve this transition towards a more sustainable development.

III – Innovating the notion of innovation in agriculture (including agricultural players)

Innovation in general, and innovation in agriculture in particular, has many definitions. The FAO defines agricultural innovation as "a system of individuals, organizations, and enterprises focused on bringing new products, processes and forms of organization into social and economic use (to improve efficacy, efficiency, competitiveness, resilience or environmental sustainability), in order to achieve food and nutrition security, economic development, and sustainable natural resource management" (FAO, 2014). In other words, innovation is the complex creative process by which social entities transform knowledge into economic, social or environmental value. As pointed out in the Strategic Plan for Innovation and Research in Agriculture, Food and Forestry (MIPAAF, 2014), innovation does not only concern technology, but all phases of the production process as well as the context where it takes place. The FAO definition, like other widely accepted definitions, does not refer to research as a source of innovation; this does not its importance is overlooked (Vagnozzi, 2013), but underlines the multiple possible origins of creative ideas (scientific knowledge, traditional knowledge, tacit knowledge, and business knowledge, etc.)

Table 1 summarises the evolution of the agricultural innovation interpretation models applied over recent decades and compares the four successive approaches that were not always mutually exclusive, with long overlaps and periods of coexistence. In fact, although the model of linear technology transfer has proven unsuitable for new contexts, it is still applied by some scientists, while subsequent approaches have never fully replaced the previous ones. The two first approaches (linear and circular transfer) prioritise the supply of technologies, whereas the two last emphasise, the demand for innovation (Ekong *et al*., 2015).

Both the AKIS (Agricultural Knowledge and Information Systems) approach and the AIS model (Agricultural Innovation Systems)[1] recognise the complexity of innovation processes and promote the collective creation of knowledge. The AKIS model considers as actors only research, education and extension service organisations, and focuses on spreading knowledge and information, via the analysis of knowledge flows (Spielman and Birner, 2008). The AIS approach also includes farmers and their organisations, agrifood businesses involved in the distribution and international trade of fresh or processed food, producers and distributors of means of production, the public administration, certification and inspection agencies, and third sector organisations (Fig. 1). The result is a much more complex framework, not restricted to merely rural areas but also including the market and the general context (Klerkx *et al*., 2012). AIS are actually defined as "networks of single organisations to use in order to bring about social, economic, or environmental effects, together with the regulations and policies affecting the system's behaviour and performance" (World Bank, 2006). Hence, the AIS analytical approach recognises the important role of research bodies in creating and transferring knowledge, but also attempts to understand the contribution of each single actor involved in the agricultural innovation process and, above all, the dynamics of their interactions.

Table 2 shows the tasks of the most important players in the AIS. In this framework, the role of research bodies must be fully re-considered: from being the initiators and leaders of innovation, whose task was mainly to create new knowledge and new inventions and to find suitable channels to spread knowledge among final users, to being partners in complex processes involving collective learning and the transformation of rules and pre-existing behaviours to adjust agricultural production systems to environmental, social and market changes. This role is no less important, but has a different nature and requires different professional skills, such as the ability to communicate, mediate and facilitate, and to carry out systemic analysis and inter-disciplinary work. It is worth mentioning that the innovation process is an engine fuelled by different kinds of knowledge (Bessant, 2013) and that research bodies are in any case called on to keep feeding the sources of scientific and technological knowledge.

Table 1. Main features of agricultural innovation interpretation models (translated and modified by: Klerkx *et al.*, 2012).

	Technology transfer	Farming System Approach	Agricultural Knowledge and Information System (AKIS)	Agricultural Innovation Systems(AIS)
Period	‘1960s	‘1970s and ‘1980s	Since ‘1990s	Since ‘2000s
Purpose	Transferring innovative technologies	Supplying solutions to farmers’ problems	Collaborating in research and extension service projects	Developing research jointly
Research agenda	Defined centrally	Defined centrally based on surveys	Defined based on consultancy	Defined by a participatory approach
Objective	Increase in production per Ha	Increase in production per input unit	Improved living standard, product quality	Agriculture sustainability
Model	Linear transfer	Circular transfer (Farmers to Farmers)	Knowledge triangle	Network
Communication channel	Top-down, One-directional	Bi-directional	Multi-directional	Documentation and knowledge management, facilitation
Innovators	Researchers	Researchers and agricultural technicians	Farmers, researchers and agricultural technicians	Multiple
Role of farmers	Adoption of technologies	Supply information and adopt technologies	Test technologies	Are partners; express innovation demand
Role of researchers	Innovators	Experts	Collaborators	Partners
Changes caused	Adoption of technologies by farmers	Solution to farmers’ problems	Promotion of the role of farmers	Innovation
Area	Farm	Farm	Farm; rural area	Supply chain, production system, territory
Integration in the market	None	None	Low	High

Figure 1. AIS Diagramme

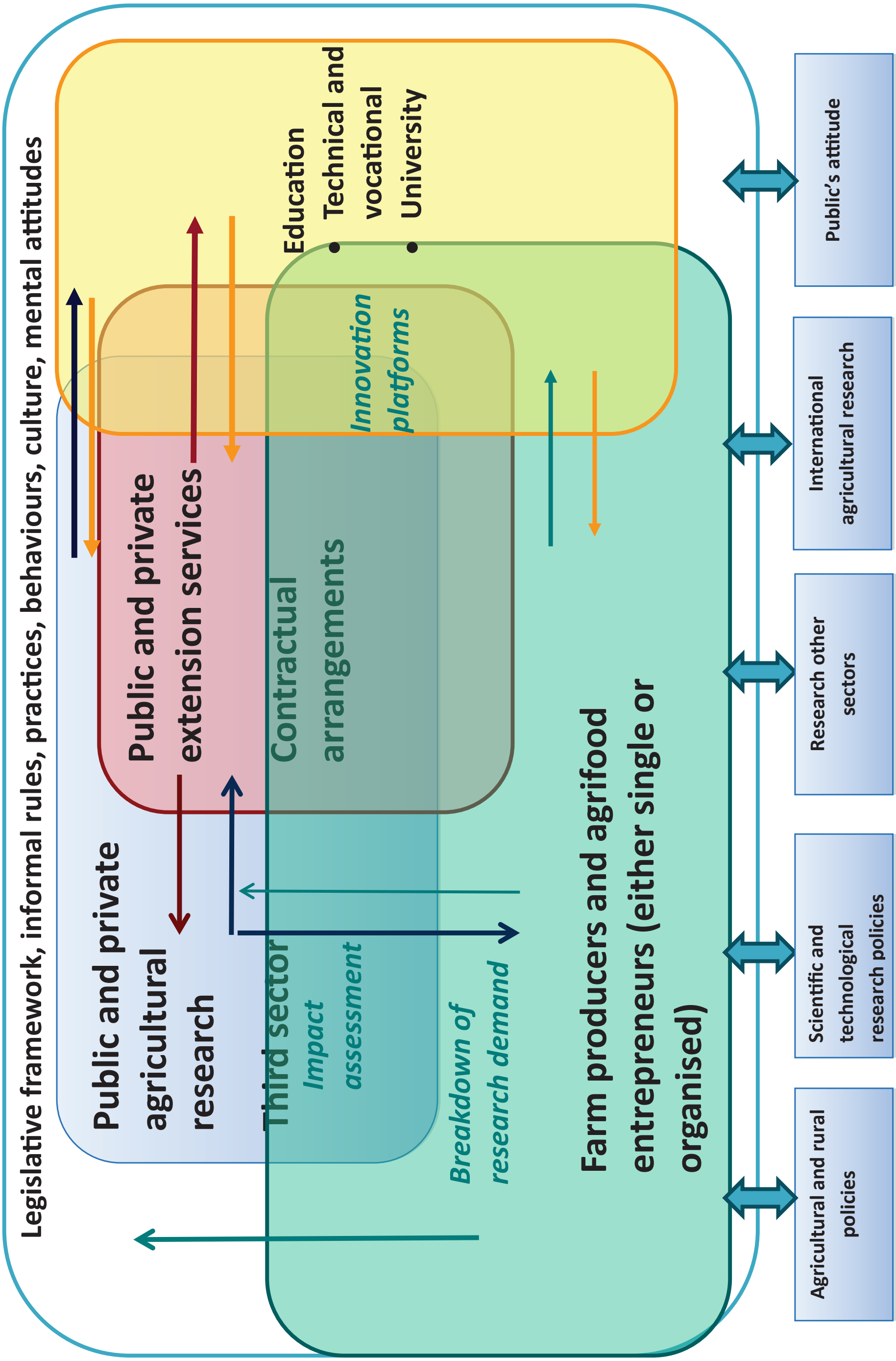

Table 2. Tasks of the most important players in the AIS (Translated and modified by Gildemacher and Wongtschowski, 2015).

Actor	Role in the AIS
Farmers	• Creation, testing and adaptation of new practices • Adoption of new practices and management of the related risks • Expression of innovation demand
Farmers' and producers' organisations and cooperatives	• Meeting innovation demand • Mediation of knowledge sharing among farmers and the other actors • Facilitation of the access to information, technology, means of production, credit and the market • Identification and implementation of new marketing practices • Representation of farmers in political institutions and in research and extension service management bodies
Extension services (involving the public, private and third sectors)	• Mediation of knowledge sharing among farmers and the other actors • Transfer ofknowledge to farmers and the other actors • Facilitation of access to information, technology, means of production, credit and the market • Promotion of gender equality • Mediation for conflict resolution (for access to resources)
Distributors of means of production (fertilisers, mechanisation, plant protection products, etc.).	• Distribution of innovative means of production • Provision of technical assistance
Wholesalers, processing industry (and their professional organisations)	• Identification and opening of new market opportunities • Search for new markets • Definition of quality standards for agricultural products • Development and application of new technology (for storage, cooling, packaging, logistics, processing, etc.)
Research bodies	• Identification and understanding of farmers' needs and priorities • Identification of innovation opportunities • Development, testing and adaptation of new technologies • Bringing the new promising technologies to production scale (via a participatory approach) • Sharing results obtained (even if negative) • Assessment and recording the socio-economic and environmental impacts of innovation
Institutes of technical, vocational and tertiary education	• Education and training of agricultural technicians at various levels
Public administrators	• Development of research and innovation policies • Formulation and implementation of rural development plans • Creation and implementation of a favourable legislative and regulatory framework for innovation • Provision of incentives for innovation

In particular, besides conducting their traditional scientific and technological research activities, research bodies are asked to involve final users in designing research and to incorporate their values, needs and priorities. They are also required to identify innovation opportunities directed at satisfying these needs, to share the results obtained, to make practices developed applicable, and to assess the socio-economic and environmental impacts of the innovations introduced, in addition to using participatory methods.

Until now, the concept of AIS has mostly been applied as a tool for describing agricultural innovation processes, especially following the introduction of a specific innovation (Spielman and Birner, 2008). There has been a recent proposal to use the AIS approach in the projects aimed at strengthening the innovation capabilities of developing countries (Ekong *et al*., 2015).

IV – Conclusions

The RRI approach is adressed to the general public, and responds to the needs analysed by MacNaughten *et al.* (2015) that were mentioned in the introduction to this article; it builds the bases for a renewed relationship of trust between science, technology and society. The AIS approach considers a more limited group of stakeholders, and is the strategy for promoting the adoption of technological, social and organizational innovation in a complex system like that of agrifood production. Both RRI and AIS approaches can and must be integrated into a new innovation paradigm, and they agree on the need for a profound cultural change summarised in Table 3. In other words, it is the social contract between science and society that must be modified, shifting from a relationship involving the supply of knowledge and technology to a partnership in processes of collective reflection aimed at giving collective responses to social, economic and environmental needs.

Table 3. Cultural changes made necessary by the new context of agricultural innovation.

	From	To
Ultimate aim of research	Creation of knowledge	Social, economic and environmental change
Social contract	Science for society	Science with and for society
Scientific approach	Reductionist (understanding the system's components)	Systemic (understanding the relations between the system's components)
Knowledge created	Scientifically sound	Scientifically and socially sound
Assessment	Indicators of result (publications, patents)	Impact indicators (social, economic and environmental change)
Relationship with society	Consultation with potential beneficiaries	Direct involvement of the parties concerned in decision-making processes
Type of communication	One-directional	Participatory
Communication tools	Scientific communication (conferences, scientific and technical papers)	Facilitation, recording, management and sharing of knowledge
Area of innovation	Farm	Territory
Type of training	Education	Collective learning
Work organisation	Individual merit and competition between research institutes	Teamwork and collaboration within and between research institutes and between research institutes and society

Lastly, it should be recalled that the previously mentioned needs for change reflect not only a mere social or ethical need but also specific economic requirements. In a period like the present, in which a generalised recession makes the allocation of economic resources a particularly critical process, it is essential to choose research guidelines that respond effectively to societal needs and whose results, once ac hieved, can actually be utilised for the positive general development of society.

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Notes

1 Some Authors refer to AKIS as Agricultural Knowledge and Innovation System, with a similar meaning to Agricultural Innovation System, and use the term AKS as Agricultural Knowledge System (EU SCAR, 2012). For the purposes of this article we prefer the terms AIS and AKIS, as suggested by the World Bank, the FAO, the IICA and other international organisations.

Policies and actors in the agriculture innovation system

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Abstract. There is a long tradition of State intervention to support agriculture, and this has to do as much with national security issues (*food security*) as with the need to respond to market failures caused by the specificities of agricultural systems, especially in very recent times. The justification for public action aimed at supporting the innovation system in agriculture is that the results and implications of agricultural research are often a “public asset”, that the actors in the agrifood system - particularly those in the primary sector – are often fragmented, and that long time lapses frequently occur between the creation of an innovation and its adoption. Nowadays, active involvement of the final users of innovation is the key point, and this contributes to definitively overturning the view of agricultural innovation as a “supply driven” process. The chapter documents this transition at the European level, as reflected in the tools provided by the agricultural innovation policies. Within the initiatives promoted for the 2014-2020 programming period, it mentions the European Innovation Partnerships (EIPs) as the tool that most favours the new approach.

Keywords. European Union – State – AKIS approach – Innovation broker – Mission-oriented innovation.

Les politiques et les acteurs dans le système d’innovation agricole

Résumé. *L’intervention des Etats en faveur du secteur agricole s’inscrit dans une longue tradition liée à des objectifs de sécurité alimentaire ainsi que, plus récemment, à la nécessité de remédier aux échecs du marché causés par les spécificités des systèmes agricoles. Dans le cas des initiatives publiques visant à soutenir le système de l’innovation agricole, la justification relève de la nature de “bien public” qui caractérise souvent les résultats de la recherche agricole et leurs implications, de la fragmentation qui marque souvent les acteurs du système agroalimentaire – en particulier ceux de la phase primaire – et des temps assez longs qui séparent la création de l’innovation de son adoption. Aujourd’hui, la participation active des utilisateurs finals de l’innovation devient un élément clé et contribue à renverser définitivement la vision de l’innovation agricole comme un processus axé sur l’offre. Le chapitre documente ce changement au niveau européen, qui se reflète dans les instruments mis en œuvre par les politiques pour l’innovation agricole. Parmi les initiatives promues pour la période de programmation 2014-2020, il est fait mention des partenariats européens d’innovation (PEI) comme de l’instrument qui favorise le plus cette approche.*

Mots-clés. *Union européenne – Etat – Approche AKIS – Intermédiaire de l’innovation – Innovation investie d’une mission.*

I – Introduction

Innovation has traditionally been the main driver of productivity growth in all economic sectors, and there is plenty of evidence to support the theory that public expenditure on agricultural research and development (R&D) has significant impacts on the total productivity of its factors (Fuglie, 2007; Alston *et al*., 2010). At present, it is also the main stimulus towards combining the growth of economic performances with the growth of positive externalities generated by the agricultural sector and - to a larger extent - by the agrifood system (De Castro *et al*., 2011).

The actors and organisations involved in the system of knowledge creation and transfer may be classified in three main groups according to their functions: researchers together with private businesses and farmers who create innovation; input and service providers who contribute to its diffusion; and the actors at the end of the chain who stimulate demand.

In the case of the first group, one of the main aspects that has been changing over the last few years is the recognition of farmers as co-creators of innovation. This vision identifying the farm as a source of demand and also as innovation producer, supports a more traditional approach, in which farmers are essentially beneficiaries of the products developed by industry and research. Among the actors in the second group, a very dynamic process of disintermediation and re-mediation is under way, regarding players and innovation transfer protocols. Within the last group, special attention has been directed over the last few years at consumers, who are increasingly called on to certify the effectiveness of innovation (Grunert *et al*., 2008). Consumers were quite reluctant to change their food and buying habits at least until the 1980s, but are increasingly considered as proactive parties in the innovation process. The members of these groups constitute a dynamic system based on actions and interactions around which innovation is produced and activated and which are the heart of innovation systems (Hall, 2012).

This is the framework within which state action defines the objectives of innovation and directs its efforts by providing specific financial resources and policies that influence the evolution of the economy and of the tangible and intangible infrastructures available to the innovation system.

There is a long-standing tradition of government action to support the agricultural sector in connection with food security objectives and more recently with the need to respond to the market failures caused by the specificities of agricultural systems. In the case of public initiatives aimed at supporting the innovation system in agriculture, these may be justified by the "public good" that is often a characteristic of research outcomes in agriculture and their implications (OECD, 2013), by the fragmentation that is often a characteristic of the actors in the agrifood system, especially those in the primary phase, and by the consequent time lapses occurring between the creation and adoption of innovation.

II – Public support for innovation in agriculture

Knowledge-based systems in agriculture are very diversified, not only due to the level of economic development achieved by different nations, but also to the existing differences in institutional frameworks. The structural and organisational polymorphism found even in advanced economies is the result of multiple approaches that have had to tackle and are still tackling widely differing economic policies and production scenarios. To summarise and simplify, we can say that different contexts produce different approaches and "paradigms". Despite these differences, it is possible to indicate trends common to nearly all national innovation systems that have mostly emerged in the last twenty years.

The first trend concerns the strengthening of supranational cooperation mechanisms, which have been particularly boosted in the years following the 2007/2008 recession and the recommendations on this theme formalised in the G8 and G20 statement[1].

The second trend relates to the general trend towards decentralisation of services for the transfer of innovation in agriculture and the subsequent emergence of new actors and new knowledge brokers. The last trend concerns the progressive increase in resources and initiatives directed at developing public/private partnerships for the solution of specific problems.

It is generally thought that all of this has improved the flows along the knowledge chain, and widespread application of methodologies to assess the results achieved has provided increased opportunities to analyse and correct criticalities.

In all countries for which relevant statistical data are available, public sector commitment to agricultural research and development measured in terms of expenditure is massive. Once again, however, the dynamics are diversified: the amount of public investment in R&D for agriculture ranges from 45% of the total in the United States, to about 90% in New Zealand, Poland, Argentine and Turkey. Based on the data of the "OECD R&D database"[2] public expenditure in agricultural R&D grew between 1985 and 2005 in over two-thirds of the countries examined. However, in the second half of the last decade, due also to the economic recession, expenditure has fallen in over half of OECD countries. In the case of private investments, the agroindustrial system is lagging behind other sectors in terms of R&D intensity (traditionally quantified as the ratio between R&D expenditure and turnover). The European food industry has an index of 1.9%, compared with 6.4% for the leisure industry, 2.7% for the chemical industry and 10.6% for the IT sector.[3]

Public expenditure is not the only measure of state commitment to supporting innovation in the agrifood system. There are actually many other elements to consider, starting from context macroelements. Long-term macroeconomic policies combined with strong institutional capacities actually promote the conditions for high growth levels; they favour low and stable inflation rates and consequently support the growth and adoption of innovation (OECD, 2010).

More specifically, institutional capabilities affect the quality of *governance* systems and their capacity to respond to market failures (Haisey *et al*., 2010). The main areas in which this capacity is expressed include regulations, fiscal policies, strategies for competitiveness, financial market operation and trade integration.

Measures regarding taxation and competitiveness, for instance, can encourage the growth of investments in R&D and direct them towards particular objectives (environmental, social, etc.), facilitate collaboration between different stakeholders and different elements of the complex knowledge chain, and improve infrastructures for the creation and exchange of knowledge.

Financial markets and commercial exchanges can also provide an extraordinary stimulus to support innovation; by helping to mobilise capitals, goods and human resources, they also support the sharing of knowledge.

Lastly the role of agricultural policies. These exist in different forms and at different levels all over the world, and are aimed at supporting farmers' incomes. On the one hand, this may positively affect farmers' capacity to invest also in R&D; on the other, it may hamper competitive dynamics and slow down structural adjustments (Fanfani, 1996). For these reasons, a transition is taking place especially in developed countries from a protectionist approach not centred on specific market failures to a more focused approach which is attuned to the profile of public assets connected with agricultural production.

III – The justification of public intervention to support innovation

The theory of market failures and the justification of state intervention are viewed from different positions which have created two main schools of thought: the neo-Keynesian school concentrates on the means of correcting market failures, such as imperfect information (Stiglitz and Weiss, 1981), while the public choice theory (Buchanan, 2003) prioritises the role of the market in efficient allocation of resources.

Moreover, it is worth noting that the discussion about market failures does not cover the entire issue of state intervention in the specific field of innovation. One of the main limitations to the explanation of public intervention by the theory of market failures is its basic assumption that once the reasons for failure are resolved, market forces will be able to drive growth and development processes efficiently. However, allowing the market alone to drive the change may actually lead to sub-optimal social results (Nelson and Winter, 1982), and this explains the importance of state initiative, particularly in managing big changes, including the transition from old to new technical and economic paradigms (Perez, 2002). The example of the so-called information revolution explains this importance well: state action and resources have been important not only in the achievement of specific technological objectives, but also and above all in allowing the benefits of the results achieved (the innovations generated and their applications) to fully express their potential in all components of the economy and society (Perez, 2002; Block and Keller, 2011). This is related to the aim of state action, defined by Keynes (1926) as “to do those things which at present are not done at all” [4], and to the so-called innovative role of the State, which has sufficient resources and an overall view enabling it to invest in areas that would be too risky for the business community, and to manage the process of change via medium to long-term strategies that clash with the shorter “return periods” usually required by private capitals (Mazzuccato, 2013).

Two main visions of innovation policies have developed through history, i.e. the macroeconomic theory and the theory of innovation systems.

The former considers innovation as a linear process, which starts from basic research and reaches the user (businesses) passing through all the different steps involved in research and development. Market failures justify the state action that involves research-oriented policies as the major tool.

According to the second theory, the policy of innovation systems is based on the interaction between different stakeholders involved in the innovation process, and on solving the systemic problems that affect knowledge production and transfer processes in a given context (Smits *et al*., 2010).

While the macroeconomic vision is centred on the economic notion of balance, the systemic vision is more oriented to examining phenomena in relation to the notion of imbalance. This latter vision, which stems from Schumpeterian creative destruction (1911, 1942), has gained a foothold over the last decades. The OECD has long embraced this approach, and in 2005 it issued a set of recommendations aimed to promote its diffusion.

IV – Establishment of the systemic vision and the frontier of the European partnerships for innovation in agriculture

Criticism of the linear vision of innovation transfer urges a more complex and systemic approach even in agricultural and rural systems, where the social aspects related to innovation production and development have a special importance. The family/business overlap that often characterises agrifood operators, and the special link between agriculture and territories actually produce cause and effect relationships in innovation systems that involve not only technological and scientific aspects but also significantly involve social issues.

The active involvement of innovation’s final users becomes the key element that helps to overturn the vision of a “supply driven” innovation creation process in the agricultural sector (Oudshoorn and Pinch, 2003). In this framework, the role of information and communication takes on even greater importance in facilitating the interaction between all different components of the knowledge-based system. This focus on the knowledge creation process and on the role of quality and organisation of information flows has actually been a key element in the conceptual shift from the AKS (Agricultural Knowledge System) to the AKIS (Agricultural Knowledge and Information Systems) and to the consequent inclusion of actors outside the research, education and technical assistance system. In this sense, the role of communication in innovation transfer processes is constantly changing, going beyond the traditional areas of information and dissemination (Sulaiman, 2012) to become a more complex tool of connection, mediation and brokering between the relations and processes within which innovation and the technical and institutional adjustments it requires can grow.

Europe has long embraced this vision, advocating within the framework of its innovation policies inhe agricultural sector the mobilisation of existing knowledge via a bottom-up approach aimed at strengthening the interactions between the different actors in the AKIS. A long series of initiatives launched in the early 1990s has progressively strengthened the importance of participatory approaches to innovation. The terms “co-production” and “co-generation” have thus become common in rural development policies.

Within the initiatives promoted for the 2014-2020 programming period, the European Innovation Partnerships (EIPs) are the tool that most facilitates the systemic approach. Designed to facilitate flows between the production and utilisation of research, EIPSs involve all components of the AKIS, promote a multi-disciplinary vision, and strengthen opportunities for exchanges and fusions between different territories with common needs.

In this regard, it should be specified that among the terms used to describe the features of agricultural innovation systems, the AIS (Agricultural Innovation System) covers the widest group of actors. AKIS is used with the same meaning in the European Union, although its meaning in other contexts is more restrictive.

These differences can be explained, as mentioned before, by the eminently “contextual” nature of innovation and innovation-related policies. These features mean that the debate as to the rightness or wrongness of an innovation model or paradigm is sterile, and should instead invite reflection as to which model or paradigm can supply the best responses in a given territory or context. The central issue is now the demand for innovation and which tools can be used to meet and satisfy this demand.

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Notes

1 http://www.mofa.go.jp/policy/economy/summit/2008/; http://g20.org/

2 http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm

3 These data concern a survey conducted on the top 1400 world companies investing the largest sums in R&D, contained in “the 2011 EU industrial R&D Investment scoreboard”. European Commission, 2001 (http://iri.jrc.ec.europa.eu/research/scoreboard_2011.htm)

4 The important thing for Government is not to do things which individuals are doing already, and not even to do them a little better or a little worse; but to do those things which at present are not done at all”. Keynes, *The end of laissez-faire*, 1926.

Part Two

The territories and experiences

The European legal framework and rural development policies

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Abstract. The chapter offers a detailed examination of the legislation concerning EIPs. The European rural development policy integrates the rural knowledge system into the wider strategy for the consolidation of research and innovation in agriculture and forestry. Knowledge transfer and the dissemination of information in agriculture and forestry become priorities via the three key actions: strengthening of the human capital of the economic actors in rural areas, integration and networking between rural social and economic actors, and governance of the knowledge system involved in the "European Innovation Network" via networking and coordination. The EIPs follow the "interactive" innovation model, which concentrates on the creation of demand-driven partnerships, i.e. using a bottom-up approach, and bringing farmers, advisors, researchers, businesses and other actors (e.g. civil society, NGOs or government bodies) together in the so-called Operational Groups (OG). Since European legislation now appears to be more aware of the benefits deriving from investment in research and innovation, it would be desirable for the national and regional authorities to agree on a coordinated strategy to allow the many networks in the vast knowledge and innovation system to identify clear objectives and working methods.

Keywords. Innovation Partnerships (EIP) – Territory - Rural development – Local – European Union.

Le cadre règlementaire en Europe et les politiques de développement rural

Résumé. *Dans ce chapitre, nous allons parcourir la législation en matière de partenariat européen d'innovation (PEI). La politique européenne de développement rural inscrit le système de la connaissance en milieu rural dans une plus ample stratégie de renforcement de la recherche et de l'innovation pour les secteurs agricole et sylvicole. Le transfert de la connaissance et la diffusion de l'information dans le domaine agricole et sylvicole constituent donc un axe prioritaire autour duquel s'articulent trois actions principales : le renforcement du capital humain des acteurs économiques dans l'espace rural, l'intégration et la mise en réseau des acteurs socio-économiques ruraux et enfin, la gouvernance du système de la connaissance auquel est relié le "Réseau européen d'innovation", ayant des fonctions de mise en relation et de coordination. Les PEI adhèrent au modèle "interactif" de l'innovation qui repose sur la formation de partenariats orientés vers la demande. Ce modèle utilise une approche de bas en haut et met en relation les agriculteurs, les consultants, les chercheurs, les entreprises et d'autres acteurs (par exemple, la société civile, les ONG ou les instances gouvernementales) au sein des Groupes opérationnels (GO). Si le législateur européen est aujourd'hui plus conscient des avantages découlant de l'investissement dans la recherche et dans l'innovation, il serait souhaitable qu'une stratégie commune et coordonnée soit élaborée aussi au niveau national et régional pour permettre aux nombreux réseaux dans le vaste monde de la connaissance et de l'innovation d'identifier clairement les objectifs et les pistes de travail.*

Mots-clés. *Partenariats européens d'innovation (PEI) – Territoire – Développement rural – Local – Union européenne.*

I – Introduction

The European Union's renewed interest in agricultural knowledge and innovation has enlivened the debate surrounding the complexity and effectiveness of "national knowledge systems". Their importance and re-emergence as a driving force for development are due to the challenges agriculture will face in the future: from climate change to protection of rural areas, from food security to biodiversity, efficient use of resources, ecological production methods and territorial planning[1].

Since 2000, the European Union has directed its policy interventions towards promotion of the knowledge-based economy, seen as an important factor for the growth and development of all production sectors. More recently, it has decided to intensify this commitment by adding the concept of innovation to that of knowledge. Many studies support this emphasis on knowledge by demonstrating that investments in research and development have been responsible for an important share of the growth in agricultural productivity over the last fifty years. It is not possible here to discuss in detail the concept of innovation and its role, or that of research, but since many studies confirm the positive impact of research and development on agriculture, it is sufficient to recall that the concept of innovation has expanded far beyond the merely technical concept of "a new development produced by science". It now embraces the surrounding social, economic and productive contexts in which it brings about changes[2].

Both knowledge and innovation play a key role in achieving the objectives of the new European growth strategy delineated in "Europe 2020", aimed at tackling the challenges of global development and competitiveness. The short-term objective is to "overcome the recession" but the long-term challenge is growth, which is "intelligent" in that it is based on competitiveness provided by knowledge, "sustainable" in that it respects the environment, and "inclusive" in terms of favouring employment and social cohesion[3]. The EU's "Innovation Union" flagship initiative aims to direct implementation of the research, development and innovation strategy by strengthening all links in the knowledge chain, beginning with more theoretical research and continuing through to retail[4].

The new CAP also intends to meet the food, natural resources and territorial challenges of the future[5]: therefore, the rural development policy incorporates the main priorities of Europe 2020 Strategy, which, as already said, aims to advance the EU economy in the next decade by achieving five ambitious objectives for employment, innovation, education, social integration, and climate/energy[6]. In particular, one strategic objective of the new Regulation no. 1305/2013 is to improve agricultural productivity through research, knowledge transfer and the promotion of cooperation and innovation.

In order to aid integration of the policies directed towards the shared objectives of the Europe 2020 Strategy, the EU *Horizon 2020* research and innovation programme for the same period indicates the means to support research and innovation in food security, bio-economics and sustainable agriculture, and other issues affecting agriculture (climate change, efficient use of natural resources, and safe, clean and efficient energy)[7].

The new Framework Programme for Research and Innovation defines how the EU will support research, technological development and innovation to encourage industrial development in Europe and contribute to the construction of a knowledge-based economy. The challenge of *Horizon 2020* is to involve a wide range of connected sectors in order to enable interaction between researchers, businesses, producers, growers and consumers and ensure a cross-cutting approach in line with the principal European policies.

The programme has three priority aims: scientific excellence, industrial leadership, and societal challenges. Total investment is estimated at approximately €84 billion. The proposal emphasises the important role of research and innovation in agriculture, which has a specific dual objective. It must guarantee food security and develop competitive and efficient production systems to ensure supply, while promoting low carbon ecosystem services, to accelerate the transition towards a sustainable European bio-economy.

The agricultural innovation policies create a bridge between research policies and rural development policies. The establishment of the European Innovation Partnership (EIP) for agriculture specifically creates a link between research and the sector's specific needs, by encouraging the implementation of new models for knowledge transfer based on collaboration and the co-production of innovation[8].

II – *2014-2020 reform: approach and interventions*

As highlighted, the most frequent problem that emerges from studies of the agricultural sector is the weakness of the link between research and the level of implementation; this means that useful and interesting research results are often unavailable to potential users, who are often unaware of the new challenges dealt with by researchers.

The new European strategic agenda has therefore concentrated on the objective of enabling these innovation systems by creating a regulatory framework and operational context to encourage interactions between actors in the same systems. As already stated, starting with the "Europa 2020" strategy document, the European Union has confirmed its interest in the themes of knowledge and innovation by launching specific promotion and funding initiatives. The aim is to define a political and planning system to facilitate the effective diffusion of research and innovation results along the agrifood and forestry production chains. This will be achieved by 1) bringing research and business closer together through the creation of sustainable forms of cooperation that are widely representative of local actors, even if these are not directly involved in the sector economies; 2) redirecting research and innovation back to the real needs of the local production systems, and more generally those of the territories, and by differentiating research projects according to funding and themes; 3) giving consultants and trainers a central role in mediating relations and identification of needs, in learning and in the diffusion of innovative practices; 4) strategic use of monitoring at different levels of planning to identify and spread innovation and research actions and define *benchmarks*.

Starting with these premises, the rural development policy contained in Regulation no. 1305/2013 provides for an important reorganisation of the rural knowledge system, integrating it therefore within the wider strategy to consolidate agricultural and forestry research and development (in coordination with the *Horizon 2020* research framework). Knowledge transfer and the diffusion of agricultural and forestry information become a cross-cutting priority for completing all development interventions and a determining factor for achievement of the other five policy priorities. Knowledge system programming as outlined in the new regulation is based on the integration of three key actions

The first action is consolidation of the human capital of economic actors in rural areas, mainly through measures concerning (a) knowledge transfer, including training for entrepreneurs and technicians, and dissemination (art. 15)[9]; (b) farm management advisory, replacement and assistance services (art. 16), including support for advisory services regarding cross-compliance, and economic, agricultural and environmental performance, and support for the creation of advisory services and training of advisors.

The first element of note is a change in the role of interventions: training and advisory actions become cross-cutting, i.e. they serve the "macro" policy objectives (competitiveness, sustainability and local development). This involves expansion and diversification of training, improved funding conditions (refund of replacement expenses and demonstration projects) and expansion of the group of potential users (agrifood and forestry workers, SMEs, advisors and trainers, land managers, and other people working in the rural economy). Regarding the tools indicated: these are not only professional training courses and skills acquisition, but also *workshops*, *work experience*, pilot courses, and demonstrations. Articles 15 and 16 are aimed at service providers, not at entrepreneurs: trainers and advisors become proponents of services and acquire a central role in the learning processes and in knowledge transfer, ensuring that their own professional skills are continually updated.

The second key action is integration and *networking* between the rural socio-economic actors capable of encouraging the promotion and diffusion of business innovation. This action is linked to the measure regarding "Cooperation" (Art. 35), which supports every form of integration between the different production chain operators, including professional organisations, research bodies, and providers of advisory and training services. This measure promotes *collective* innovation processes.

In this context, the concept of innovation is wide and extensive in terms of the possible forms of cooperation and participants, so that it includes aspects regarding the environment, competitiveness and territorial reorganisation. In fact, "although the spirit of the concept has remained the same, i.e. the (successful) practical application of a new idea, innovation today is quite different from ten years ago. The principal features of the current concept of innovation use: a clearer distinction (which is not however a distance) between innovation and research; a new interaction between subjects (heterogeneous) involved in creating and implementing innovation; innovation with a wider and more articulated content" (Lattanzi and Trapè, 2013).

In particular, the Commission distinguishes between two forms of innovation: "linear" and "interactive". The "linear" form of innovation is led by science and research, which produce new ideas that must then be applied in a concrete way, while the interactive "system" means a bottom-up process in which the actors in the system, including farmers, take a leading role. This participatory system is considered more efficient and effective because it can accelerate acceptance, introduction and diffusion of new ideas, and at the same time it generates wider innovation, since it also includes knowledge that is not purely scientific[10].

Besides envisaging different forms of cooperation (economic, environmental and social) between many types of beneficiaries, transregional and transnational cooperation are also expressly included. The action also contributes to the expenses involved in carrying out pilot projects and innovative development and revolves around the operational groups that are central to EIP implementation (Art. 55). The European Commission envisages that these will become the driving force for local innovation and research processes and catalyse a series of actors considered important for these processes to be effective[11].

A typical example of interactive innovation is the European Innovation Partnerships. In particular, the EIP-AGRI, which aim to bring agriculture and research together at the regional, national and European levels, are an important factor in improving the effectiveness of actions connected with the innovation supported by rural development programmes, and the research and innovation supported by the European Union. There are two primary objectives: to promote agricultural productivity and efficiency and to promote agricultural sustainability. "Operational objectives of the EIP include successful bridge-building between cutting-edge research and technology and stakeholders, including farmers, businesses, industry, advisory services and NGOs. This should help to translate research results into actual innovation and to transfer innovation into practice more rapidly, to give systematic feedback from practice to science about research needs, to enhance the exchange of know-how, and to raise awareness about the need for joint efforts to invest in sustainable innovation."[12]

The third key action regards knowledge system governance. This involves the "European Innovation Partnership network" (Art. 53) in networking and coordination of the operational groups and the EIP to coordinate rural development policy with the EU research programme (*Horizon 2020*), and to disseminate research and innovation actions at the European, national and local levels. The objective is to promote competitive and sustainable agriculture and forestry "which can produce more using less, and in harmony with the environment" (Zanni, 2012).

Among the tools to make this possible: encouragement of more widespread diffusion of available innovative measures; promotion of putting innovative solutions into practice on a wider scale and more rapidly; providing more widespread information to the scientific community about the research needs of agriculture (Art. 55). In this sense, the EIP follows the "interactive" innovation model, which concentrates on creating partnerships led by demand, i.e. using a bottom-up approach to bring farmers, advisors, researchers, businesses and other actors (e.g. society, NGOs or government bodies) together in the so-called Operational Groups (OG), formed in member States and consisting of entrepreneurs, advisors and researchers. The EIP will work to achieve its objectives with the help of the OGs and the European Innovation network (which will facilitate an effective flow of information).

III – Conclusions

New competitive challenges mean that the effectiveness of traditional business organisation and production is being questioned, and innovation is now driving revision of the current agricultural knowledge and innovation systems. The relationship between research, innovation and productivity – but also between research and safeguarding resources - has become increasingly important in the European policies of the last decade, up until the most recent policies which focus on the objectives and on the means to achieve them, e.g. with new initiatives like the EIP.

It can be said that new needs and emerging challenges demand a new role and a new mission for the agricultural knowledge systems. New and growing numbers of actors are interested in approaching innovation (e.g. private sector participation is growing), there is a new agenda, and financiers are more interested in seeing concrete results of their investments. All these contextual factors invite reflection on the economic role of the State. The most extreme version of neo-classical economics maintains the superiority of the market in allocating resources and resolving economic problems, maintaining that the State is principally concerned with ensuring a stable legislative framework, enforcing its laws and making sure that contracts are respected, and becomes "the enemy of its citizens" when it becomes involved in economic questions. According to the most extreme neo-classical paradigm, this is best left to private enterprise; private operators must discover and exploit entrepreneurial opportunities, because they know if a venture will be profitable or not, and businesses which are profitable at market prices are the only ones that maximise individual and collective well-being.

The non-extremist version of the neoclassical paradigm admits "grey areas" in the workings of market economies, areas where the market "fails" in a certain sense, e.g. activities generating non-appropriable value, such as national defence. Non-extremist neoclassical economists will accept, and often call for, State control and investment in national defence. However, this is the age of the free market, and the prevailing idea is that the way to overcome a serious recession like the current crisis is for the State to withdraw from the economic situation, i.e. by reducing the public debt and public spending.

In this situation dominated by the neoclassical paradigm, a radical proposal invokes an "innovator State", i.e. a State which rather than compensating for market failures is actually an active driving force for development, and is innovative and entrepreneurial, taking courageous and far-reaching technological and entrepreneurial decisions. This is therefore a State that identifies and indicates the great areas of innovative research, and invites the universities and research centres to pursue these. This model was until recently identified with the US (and British) State, not with a European State. Nevertheless, it can now be said that the European Union has also begun to act as an "innovator State", following the launch of its new growth strategy and research policy[13].

The fact that these new policies are grafted onto fragmented knowledge and innovation systems that are disconnected from the production sector (which they support and which should provide their objectives) could make it difficult to exploit the opportunities offered by EU institutions, and could lead to further downscaling of what should be the driving force for agricultural development.

As said earlier, this implies that for an effective and efficient response to the current challenges facing agriculture, the agricultural knowledge and innovation systems must become innovative and adopt new operational methods. European regulations now appear more aware of the benefits deriving from investment in research and innovation (including dissemination), and there seems to be a desire to ensure constant and effective public intervention via long-term commitments. Therefore, it would be advantageous for the national and regional authorities to agree on a coordinated strategy that would allow the many networks in the vast knowledge and innovation system to identify clear objectives and working methods.

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1 European Commission, 2012. *Proposal for a regulation of the European Parliament and of the Council establishing Horizon 2020 - the framework programme for research and innovation (2014-2020) - Horizon 2020*. Brussels, COM (2011) 809 final 2011/0401; OCSE, 2011. Working Party on *Agricultural Policies and Markets. Summary of record of the OECD conference on Agricultural Knowledge Systems,* December 2011, Paris

2 Cf. European Commission, *Commission Communication* "*Innovation policy: updating the Union's approach in the context of the Lisbon strategy*" COM (2003) 112 final, 11 March 2003, which states that "innovation consists of the successful production, assimilation and exploitation of novelty in the economic and social spheres," and that "innovation is much more than the successful application of research results". In addition, research acquires value according to its capacity to modify the direction of development in its surrounding contexts and is subject to mediation involving not only those producing and adopting it, but also involving society surrounding the business and research body (Knickel et al. 2009)

3 European Commission, 2010. *Communication "Europe 2020 - A strategy for smart, inclusive and sustainable growth"*. Brussels, COM (2010) 2020 final.

4 Commissione Europea, 2010. *Communication to the European Parliament, the Council, the European economic and social committee of the regions – Europe 2020 Flagship Initiative: Innovation Union*. Brussels, COM (2010) 546 final.

5 European Commission, 2010. *Communication to the European Parliament, the Council, the European economic and social committee of the regions - The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future.* Brussels, COM (2010) 672 final.

6 EU 2013. Regulation no. 1305/2013 *On support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) no. 1698/2005*. In: *OJEU,* 20 December 2013, L 347, p. 487.
Compared with previous rural development planning, interest focuses on a limited number of "essential objectives" (v. considering no. 4 of the regulation); apart from particular attention to improving the competitiveness of rural SMEs, it focuses on knowledge transfer and agricultural innovation, achieved also via collective and integrated processes.

7 European Commission, 2011. *Communication to the European Parliament, the Council, the European economic and social committee of the regions – Horizon 2020 – the framework programme for research and*, Brussels, COM (2011) 808 final.

8 European Commission, 2012. *Communication from the Commission to the European Parliament and the Council on the European Innovation Partnership "Agricultural Productivity and Sustainability"*. Brussels, COM (2012) 79 final.

9 Moreover, a single measure (Art. 15: knowledge transfer) now contains the previous interventions regarding development of skills and vocational training for agricultural and forestry workers (Measure 111) and training and information for other economic operators in rural areas (Measure 331).

10 Cf. *Guidelines on programming for Innovation and the Implementation of the EIP for Agricultural Productivity and Sustainability, Programming period 2014-2020*, Version July 2014

11 European Commission, *Communication from the Commission to the European Parliament and the Council on the European Innovation Partnership "Agricultural Productivity and Sustainability"*, op.cit.

12 Ibid.

13 Cf. V. Mazzucato M., *Lo Stato innovatore* Laterza, Bari, 2014, which states that "..the proactive *entrepreneurial* State, capable of taking risks and creating a dense network of economic operators able to capitalise on the best of the private sector for the good of national society …. is the State, as the first investor and catalyser, which sparks this network to move and disseminate knowledge. The State must not only be a facilitator but must also be a creator of the economy and know-how" (p. 33).

Co-generation, sharing and transfer of technologies in Small and Medium agrifood Enterprises (SMEs)

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Abstract. The chapter focuses on the results of the INTRA Project (Introducing innovations in traditional agrifood products to increase SME competitiveness). This initiative belongs to the Greece-Italy territorial cooperation programme and aims to strengthen the services for sharing and transfer of innovations in the agrifood sector. INTRA has focused on analysing the innovation needs of traditional Italian and Greek businesses, beginning with experiences collected in Apulia (Italy) and the Ionian Islands (Greece), in order to propose possible methodologies and tools for improving the efficiency of the innovation supply chain. Coordinated by CIHEAM-Bari, the project has involved the participation of the Ionian University, the regions, and the Brindisi and Corfu chambers of commerce. This work has created a database, intended as a system for collecting the innovation needs of businesses and as a concrete system for increasing their active involvement in the new collaborative bottom-up agrifood innovation paradigm. The conclusions propose strategies for reducing the cultural and geographical divide separating the innovators developing new projects from businesses and public authorities. Annex 1 contains a detailed examination of the INTRA Database.

Keywords. SM – Incubator – Start-up – Territory – Local – Global - European Union – Innovation need.

***Cogénération, partage et transfert technologique dans les PME du secteur agroalimentaire* (avec ANNEXE 1).**

Résumé. *Dans ce chapitre, nous allons passer en revue les résultats du projet INTRA (Introducing innovations in traditional agrifood products to increase SMEs competitiveness), une initiative dans le cadre du programme de coopération territoriale entre l'Italie et la Grèce visant à renforcer les services de partage et de transfert des innovations dans le secteur agroalimentaire. INTRA a mis au centre de ses activités l'analyse des besoins d'innovation des entreprises traditionnelles italiennes et grecques, à partir des expériences collectées dans la région des Pouilles et dans les îles Ioniennes grecques, afin de proposer des solutions méthodologiques possibles et des outils favorisant une filière de l'innovation plus efficace. Le projet, coordonné par le CIHEAM-Bari, a mobilisé les universités dans les îles ioniennes grecques, les régions et les chambres de commerce de Brindisi et Corfou. Le travail réalisé a permis la création d'une base de données qui pourrait servir de centre de collecte des besoins d'innovation des entreprises, un dispositif pour renforcer leur rôle dans le nouveau paradigme de l'innovation de l'agroalimentaire, suivant une approche collaborative et de bas en haut. Dans les conclusions, des stratégies sont proposées pour réduire l'écart culturel et géographique entre les innovateurs qui élaborent de nouveaux projets, les entreprises et les institutions publiques. La base de données INTRA est examinée en détail dans l'Annexe I.*

Mots-clés. *PME – Incubateur – Start-up – Territoire – Local – Global – Union européenne – Besoin d' innovation*

I – Introduction

The INTRA project (Introducing innovations in traditional agrifood products to increase SME competitiveness) belongs to the international cooperation programme between Italy and Greece and aims to strengthen the services for sharing and transfer of innovations in the agrifood sector. INTRA has focused on the innovation needs of traditional Italian and Greek businesses, building on experiences collected in Apulia (IT) and in the Ionian Islands (GR), in order to propose feasible methodologies and tools for improving the efficiency of the innovation supply chain. Coordinated by CIHEAM Bari, the project has involved the participation of the Ionian University, the regions, and the Brindisi and Corfu chambers of commerce.

Joint work by MAIB and the Ionian University has created a system for collecting agrifood firms' innovation requirements, and this can provide a concrete tool for increasing their involvement in the new collaborative bottom-up innovation paradigm for the agrifood sector.

II – The context

Small and medium enterprises (SMEs), particularly in the agrifood sector, play a crucial role in the Italian, Greek and general Mediterranean economy for the growth of the system's competitiveness and for the creation of jobs. They represent the majority of businesses, and their competitiveness mainly consists of "*no price*" factors, i.e. factors related to product "quality", differentiation and diversification.

The economic recession and the decline in product demand have had negative effects on employment in our area, with a subsequent loss of work-related skills, and reduced investments in equipment and infrastructures, especially in Research and Development. Just as it is expensive to generate innovation because research requires time, capital and skills, and cannot ensure results, it is also true that SMEs may have difficulties in applying innovations proposed by others, due to a lack of resources and of qualified skills.

Therefore, it is important for the local economic system, including agrifood businesses, to improve the ability to perceive changes, in order to maintain competitive advantages not related only to prices. However, the ability to perceive changes firstly requires the introduction of new knowledge and new professional skills able to identify needs and provide possible solutions. This is extremely important for SMEs because their structure and internal organization is often inadequate to manage this process, which thus becomes exogenous. In some cases, despite the availability of public funds, businesses have evident difficulties in defining their innovation needs and in finding appropriate responses.

On the global scale, markets force firms to participate in relational networks that involve an investment in terms of time and resources, also providing an opportunity to keep up with local or global markets and with an increasingly "dynamic" demand. The principle is that the wider the network, the greater is the possibility of finding innovative solutions to improve business performances and market positions. The network, the quantitative and qualitative relationships become an asset of the firm's economic resources.

In this sense, the technological evolution and the web 2.0 are particularly useful, and more helpful than specific open innovation tools. Open innovation is "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external routes to markets if they want to improve their technological skills" (Henry Chesbrough, 2006).

In this framework, research becomes more successful the more it meets business needs and the more it is applied at the territorial level; this makes it possible to measure its effectiveness, identify criticalities and outline future developments. Innovation is thus the result of a systematic approach based on the creation of a network, on interactive learning, and on negotiation between a heterogeneous group of stakeholders centred on the entrepreneur.

This dialogue requires intermediate participants linking different stakeholders involved in innovation "strategies". Rather than mediating individual relations ("*one-to-one*"), this involves mediating "*in-between*" and "*many-to-many*" relations (Howells, 2006), i.e. facilitating knowledge sharing and transfer between the different stakeholders in the production chain (research bodies, assistance services and businesses, as well as the authorities and ordinary citizens), with the needs of business as the starting point. These intermediaries work to promote innovation, and aim to build relations suited to the systematic nature of the Agricultural Innovation System (AIS)[1] and to favour interaction between the different stakeholders involved in the innovation process. To date, the agricultural sector has mainly relied on the public sector intermediaries of the Agricultural Extension Services, often with a limited mandate and reduced effectiveness (Leeuwis, 2004; Rivera, Sulaiman, 2009).

If, on one hand, innovation requires the involvement of multiple stakeholders and effective interactions between them, the AIS approach also recognises an important role for the institutions, therefore also for laws, regulations, attitudes, customs, practices and incentives, in influencing stakeholder interaction (World Bank, 2006).

However, technological, societal, economic and cultural differences often hamper the establishment of effective links between heterogeneous groups of stakeholders, impeding the subsequent formation of "coalition" groups and partnerships between businesses and institutions and between public and private sectors (Pant, Hambly-Odame, 2006). Howells has coined the term "innovation broker" to define an organisation or entity that manages all aspects of the innovation process established between two or more parties. Although indicated as a possible solution to fragmentation and to the limited performance of knowledge infrastructures and of the innovation system (Clark, 2002; World Bank, 2008), this subject appears to have been less systematically investigated in the agricultural sector.

III – The situation in Europe

In order to deal with this situation, helped by the Directorate-General for Research and Innovation, the European Commission has launched the European Innovation Partnerships - EIPs (EU Regulation No. 1305/2013 art. 55) within the "Innovation Union" initiative of the Europe 2020 strategy. The EIPs aim to find innovative solutions to the great challenges facing society, such as climate change, energy, food security, health and population ageing. They gather together participants from different political entities, sectors and countries in order to integrate or launch initiatives, involving both supply and demand, along the entire cycle of research and innovation. Their objective is to overcome the weaknesses, bottlenecks, and obstacles in the European research and innovation system preventing or delaying the development of good ideas and their market opportunities. The main novelty is the method the Commission intends to use to transfer innovation. The proposed process involves greater integration between agricultural businesses and the knowledge-based system of universities, research centres and advisory services.

The European Innovation Partnership on food security, "Agricultural Productivity and Sustainability", has two main objectives by 2020:

– to promote agricultural productivity and efficiency, reversing the current downward trend of productivity increases;

– to ensure agricultural sustainability by maintaining soil functionality at a satisfactory level.

Therefore, the European Union's objective for the next programming period is to increase production through a more efficient and sustainable use of natural resources.

Within the 2014-2020 policies for rural development, the Commission intends to remove two of the most frequent obstacles to innovative processes: the divide between research outcomes and the resistance of farmers, businesses and advisory services to the adoption of new practices/ technologies. In order to remove these structural and cultural divides, the EU is applying the bottom-up approach, one of the main guiding principles of the rural policies of the last twenty years. The proposal involves setting up "EIP Operational Units" involving all stakeholders, in order to develop a Plan which describes the proposed innovative project, the expected results and the concrete contribution of the initiative to increasing agricultural productivity and competitiveness via sustainable resource management. This is, therefore, a process based on the principle of *co-generation and co-participation*, and is no longer a “linear transfer” of innovation.

Within its 2014-20 Rural Development Programmes, the European Union envisages a general strategy to identify innovation (EU Regulation no. 1305/2013 art. 8), alongside measures on “knowledge transfer and information actions” (art. 14), and “advisory services, farm management and farm relief services” (art. 15), in addition to the obvious actions to support and encourage “cooperation” (art. 35).

IV – Instruments for a new paradigm

Over the years, the INTRA research group has established a dialogue with the business community in the areas concerned. It has attempted to provide concrete tools and a practical application methodology of the paradigm described so far, with the aim of creating an innovation system attuned to the needs of businesses and territories via a genuine “bottom-up” approach.

The first important criticality concerns the creation of a method and relevant scenario for the identification and systematisation of innovation needs; this needs to be easy to update, exhaustive and cheap. In brief, there are two options:

a. construction of a framework of innovations available on the market that correspond to the needs of businesses and of communities

b. identification of innovation needs using listening and surveying techniques directly on farms to provide concrete solutions.

From an operational point of view, the above proposal aims to go beyond the catalogue of innovations available to the “production chain” (EIP - Operational Group), as provided for in 2014-20 programming.

Creation of an innovation catalogue entails many difficulties:

- the exhaustiveness of innovations recorded at the international level, since it would be too restrictive to refer only to the territorial level;
- the methodology for building, feeding and updating the catalogue;
- the methodology for transferring knowledge at the farm level.

Moreover, there is always the risk that the creation of a catalogue of innovations will maintain the current linear top-down approach, i.e. an innovation system largely dependent on research activity and not always attuned to producers’ needs.

At the same time, there are no effective methods to support the process of identifying and systematising innovation needs. Other criticalities include the following:

- lack of personnel sufficiently sensitive and qualified to deal with a development process related to innovation;
- limited ability to create networks and stable collaborative relations in the innovation chain;
- limited awareness of innovation’s key-role in business strategies;
- weakness in the current system of sharing and transferring knowledge due to linear approaches of scientific institutions and their research activity, which is far removed from the real needs of final operators.

This last aspect highlights the importance of reshaping the innovation chain in agriculture, and the issue has been positively addressed by the European Commission in (EU) Regulation no. 1305/2013, by making use also of interactive innovation and cross-fertilisation methods, i.e. by enlarging the chain to other economic and social sectors.

V – The methodological approach

In order to activate forms of dialogue, sharing and co-design of innovation among the stakeholders in the chain, a "bottom-up approach" has been applied which takes into account the obvious criticalities related to the excessive fragmentation of the national agricultural system, the predominance of small agrifood businesses, and the difficulty of interacting with businesses on innovation processes. These criticalities have been overcome by applying a *blended* analysis method, based on a rational collection of the most recent innovations in the agrifood sector (database) and on direct contact with a panel of 40 Apulian firms, surveyed about their innovation needs, problems related to the transfer and application of innovation, and the priorities on which research should focus. This has led to the creation of an "open innovation environment", favouring "*user-driven innovation*" in creating processes to co-generate new services, products and social infrastructures.

INTRA methodology has built on the successful experience of the Living Labs, meant as virtual open places where businesses and research bodies can interact to create, test and validate new products/services and supply their feedback on the application of innovation under real conditions and in a specific territorial context. The Living Labs are innovation catalysts and support the process by filtering demand and supply, stimulating the cooperation of all stakeholders; in addition, they supply decision-makers with clear indications about innovation strategies based on the needs of the local business community.

A living lab is developed in two stages: 1) mapping the needs of businesses (collection and cataloguing issues, needs and problems expressed by users; 2) catalogue of living lab partners, i.e. the research bodies able to offer innovative solutions or available to develop them with businesses; 3) living lab activation, i.e. collaboration and implementation and/or development of the innovation. At times, these processes are activated by public administrations, as in the case of Regione Puglia, with operational support programmes for business development.

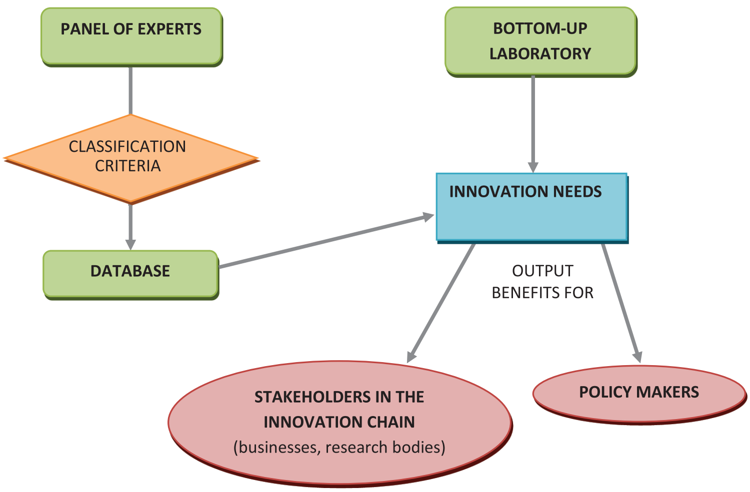

Table 1. INTRA methodology

The INTRA database makes it possible to identify innovations and facilitate analysis and statistics via the aggregation of data and information, and to provide indications about the main research directions or specific innovations, in addition to facilitating knowledge and interaction between the stakeholders in the innovation chain.

The Database provides data according to three hierarchical levels of innovation/research classification:

The first level of classification refers to the four clusters identified by Eurostat and the European Commission: *product, process, organizational and marketing* innovation. The innovative research studies included in the catalogue have thus been associated with the four categories.

The second level includes 13 different types of innovation, further subdivided into 61 aspects of innovation (third level).

Moreover, the database makes it possible to aggregate innovations according to the supply chain or patent.

The lists classified according to research priorities provide the basis for discussion with businesses (**bottom-up laboratories**). It is also worth mentioning that the innovative proposals included in the Database are already the result of a process shared by the different stakeholders in the innovation chain (scientific institution and firm), since this is a criterion used in creating the database. The bottom-up laboratory output is a **system for gathering** business innovation needs. In other words, a tool for discussion in the bottom-up laboratory, enabling a self-assessment aimed at awareness and identification of their innovation requirements. Therefore, the identification of needs makes it possible to recognise the potential for the development of innovation in the firm. In addition, the “database” allows the identification of possible collaborators (researchers and businesses) in the development of innovation at the territorial level (e.g., creating an operational unit for the EIP) or at the level of the individual business.

The database is also an important tool of analysis for public decision-makers, as it enables innovation clustering and identification of the priorities for territorial planning/programming.

Bearing in mind that traditional diagnostic methods (questionnaires, interviews, focus groups) provided no significant results, a new approach to interpreting business needs was attempted. This involved a mixed system including both the quantitative approach (database) and qualitative analysis related to the brainstorming/bottom-up laboratory among the stakeholders in the chain.

The content of the database is a crucial issue. The proposed system capitalises on the experience of previous information infrastructures of the same type, which failed because they were too expensive to update and maintain. In order to avoid this problem, the database is open and participatory, meaning that each innovation system stakeholder interested in participating will have an incentive to update it.

VI – Conclusions

In advanced economies, it is evident that the linear innovation models, in which “innovation” is a result derived from pre-determined inputs (investments, human capital, infrastructures), are replaced by collaborative models. These aim to build integrated innovation ecosystems, in which innovation is the result of the interaction between key participants (academic, institutional and business), and in which the existence of networks and optimisation of their effectiveness are critical factors of success. Another element of this ecosystem is the capacity to gather the needs of the stakeholders, who are no longer “subjected to” the research system, in addition to a level of openness to the external innovation market much greater than that of the individual business.

These aspects emerge clearly from the analysis, confirming that innovation is an extremely complicated process involving multiple dimensions, and not strictly limited to the economic field. At present, the quality of human capital is vitally important for the innovation process in any production system.

We conclude that it is essential to reduce the cultural and geographical divide separating innovators developing new projects from businesses and public institutions; this may be achieved via the following strategies:

- developing an innovation system based on business needs;
- creating an open integrated information system to link all stakeholders and spread information and contacts;
- creating new networks to facilitate the exchange of experiences and fusions;
- creating new professional profiles, in particular a kind of innovation manager to encourage and facilitate production chain and network innovation processes;
- researching advanced methodologies and platforms to encourage real bottom-up processes for identifying needs and co-designing solutions, defining the priority technological and research fields, so that these produce tools directed towards the market and competitiveness;
- defining collaborative fields (clusters), involving not only participants in the same sector (e.g. agrifood), but also in different areas (e.g. mechatronics applied to agriculture), so as to launch cross-fertilization between participants and clusters of different production areas.

The points listed above can and must be a stimulus to encourage a process of product/process innovation and enhancement, which must be viewed from different perspectives: those of businesses and the production chain, paying attention to the kind functions carried out in the production process, those of the local community where the product is made, those of consumers, and those of the institutions. Innovation is actually an open process stemming from the product's links with local culture and traditions. It is the stakeholders in the agrifood system who can combine the usage value of the product with other more complex values, such as economic, social and environmental sustainability. These values require careful consideration when formulating an industrial development strategy.

Notes

1 The Agricultural Innovation System is defined by the World Bank (World Bank, 2006) as a network of organizations, businesses, and individuals that focuses on bringing new products, new processes, and new forms of organization into economic use, in collaboration with the institutions and policies affecting the way different stakeholders interact to share, access, and foster knowledge and learning. An AIS system therefore consists of researchers, consultants and farmers and also includes private and public stakeholders, such as processing companies, input suppliers, retailers, policy makers, consumers and NGOs.

Conclusion

Cosimo Lacirignola

Secretary general of CIHEAM

Work in progress

In agriculture, as in other human activities, innovation means a dynamic relationship between necessity and creativity, which have their "incubation" times. Unlike other human activities, however, we are forced to accelerate when it comes to agricultural innovation. It is the critical element for humanity in meeting challenges that cannot be postponed, like ensuring that a world population that is growing and changing diet receives healthy and nutritious food through sustainable production processes able to withstand climate changes. This is an urgent need in some areas of the world where climate change is going to have a violent impact on agriculture, and the Mediterranean is one of these.

These concrete facts should give us a new awareness and allow us to overcome the barriers that for many years have transformed agricultural innovation into a battlefield. No option should be discarded *a priori*, from the latest advances in biotechnology to organic and biodynamic agriculture, from experimentation with new organisational and marketing systems to the rediscovery of traditional methods of sharing production inputs, looking not only to increase yields but also to provide low-cost solutions in order to reduce input costs.

It is not that innovation *in se* cannot be an element of conflict. On the contrary, it is also an element of risk because change involves risks. But this will not be greater than the risk we face if we choose to go ahead with "business as usual". This is why we need to make great efforts to spread and share knowledge. In economically developed countries the most common link - almost the only link - between field and table is the supermarket shelf, and this creates new challenges for the agricultural knowledge system, which needs to create ways of speaking to both the "field" and the "table".

Knowledge that remains inside closed technical systems is a squandered resource, in a context where the need for investments and funding is too important to allow this type of waste.

The creation of an agricultural sector capable of regaining its relationship with innovation requires knowing how to build up a dynamic relationship between the local territory and global dynamics, from one case to another. This mission requires listening to deep-seated local requests and needs, and paying attention to opportunities for exchanges and discussions with different and distant territories.

The effort to make the agricultural innovation systems more efficient requires not only a new conceptual framework, but also needs a renewed relationship between theory and practice, between ideas and actions. Rather than having conclusions to draw, it is a question of having a lot of work to do.

ANNEX

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The INTRA Project database as an application tool for business innovation

The database of innovations is intended as a catalyst to help SMEs become more competitive, and to ensure that stakeholders share a common language, allowing producers to focus on their own needs, and researchers to find the best solutions to meet demands.

The information is organised in different sections to facilitate research and analysis, even for each single piece of data. The information given for each innovation concerns:

Implementing body (research body and business); classification by innovation type; chain; traditional product, patent; public or private funding; keywords.

Technology transfer support services

The *Database of agrifood innovations in Puglia* contains information about the main items related to the needs of agrifood businesses, and is helpful in identifying the scientific institution that responds to a specific need. A panel of multi-sector experts has selected and collected this information from 313 studies made over the last 5 years that have led to innovation in the agricultural sector. The database allows searches by different criteria, and provides the innovative proposals in each category, subdivided into further categories .

The catalogue currently contains 182 innovative proposals obtained using the following criteria:

- research that has produced available innovations attuned to business needs:
- research involving a farm/agrifood business or a knowledge-generating body.

The innovations included in the Catalogue are organised according to *concept-based aggregations* (clusters), making it possible not only to catalogue 13 *different types* of innovation, but also to identify the main elements on which the primary sector is investing.

Each innovation is classified at three hierarchical levels according to the type of innovation.

The first level refers to the 4 clusters according Eurostat classification and definitions of the European Commission: *product, process, marketing and organizational innovations.*

1. **Product Innovation**: product or service completely new or upgraded in relation to its initial features;

2. **Process innovation**: new methods or methods significantly upgraded for the creation and supply of services;

3. Marketing Innovation: new marketing method involving significant changes in product design or packaging;

4. Organizational Innovation: implementation of an organisational method in business practices, workplace organisation or in external relations.

The second level of classification includes 13 different types of innovation, further sub-divided into 61 aspects of innovation (third level). (Table 3)

The graphs and tables below show the information collected in the database. This sample has no statistical value, but is aimed at developing an information model able to strengthen the application of the new innovation chain paradigm. The innovation clusters in the database mainly regard product and process innovations.

Table 2. Structure of the innovation databse.

id	313	314	362
title	VAL.TIP.OLI - Valorizzazione della tipicità degli oli extravergine di oliva salentini	Val. Negr. - Valorizzazione della qualità e della sicurezza delle produzioni vitivinicole a base Negroamaro	Studio dei Lieviti naturali per la valorizzazione di pani tipici del Mezzogiorno
objective	Valorizzare la tipicità degli **oli extravergine di oliva salentini** attraverso: 1. sviluppo di una metodologia scientifica e oggettiva di certificazione e di autenticazione delle produzioni olearie tipiche; 2. caratterizzazione e tipicizzazione a livello qualitativo e sensoriale dell'olio prodotto e miglioramento del processo produttivo in modo da incrementare le qualità organolettiche del prodotto;	Valorizzare la filiera viti-vinicola del **Negroamaro** attraverso: 1. Individuazione di cloni/biotipi di negroamaro dotati di caratteristiche di pregio destinati alla produzione di vini di alta gamma; 2. messa a punto di protocolli e di sistemi di coltivazione dei vigneti in grado di migliorare le caratteristiche tecnologiche e compositive delle uve Negroamaro; 3. messa a punto di protocolli innovativi in fase estrattiva piÃ¹ idonei a migliorare l'intensità e la stabilità del colore e la composizione aromatica di vini a base Negroamaro	produzione, caratterizzazione di lieviti naturali tipici per produzioni di **pane tipico pugliese** e miglioramento delle operazioni di manipolazione e conservazione dei lieviti naturali; 2)miglioramento delle caratteristiche reologiche, sensoriali e di conservabilità dei pani tipici pugliesi,
institution	Fanizzi e De Bellis (UNISALENTO) - Mita (ISPA CNR) - Frisullo (UNIFG)	La Notte e Giannini (CRSFA Basile Caramia)	DIPARTIMENTO DI PROTEZIONE DELLE PIANTE E MICROBIOLOGIA APPLICATA
enterprise			
Cluster (I level innovation)	PRODOTTO	PRODOTTO	PRODOTTO
II level innovation	caratteristiche prodotto	nuovo prodotto	caratteristiche prodotto
III level innovation	evidenze dell'origine	nuova varietà	shelf life del prodotto finito
food chain	olio	vino	cereali
traditional product T/N	T	T	T
status	privato	privato	pubblico
patent status	senza brevetto/licenze	senza brevetto/licenze	senza brevetto/ licenze
realized	Aumento delle qualità organolettiche degli oli extravergine di oliva salentini mediante miglioramento processo produttivo e certificazione	Vini di alta gamma mediante utilizzo di cloni/biotipi di negroamaro; Maggiore intensità e stabilità colore e composizione aromatica nel Negroamaro mediante realizzazione di protocolli innovativi	Pane tipico pugliese con maggiori caratteristiche di di manipolazione e conservabilità

Table 3. Classification of 4 innovation clusters.

Cluster	Number of identified research works	% of research works identified in the Database
Product Innovation	95	52%
Process Innovation	78	43%
Marketing Innovation	3	2%
Organizational Innovation	6	3%

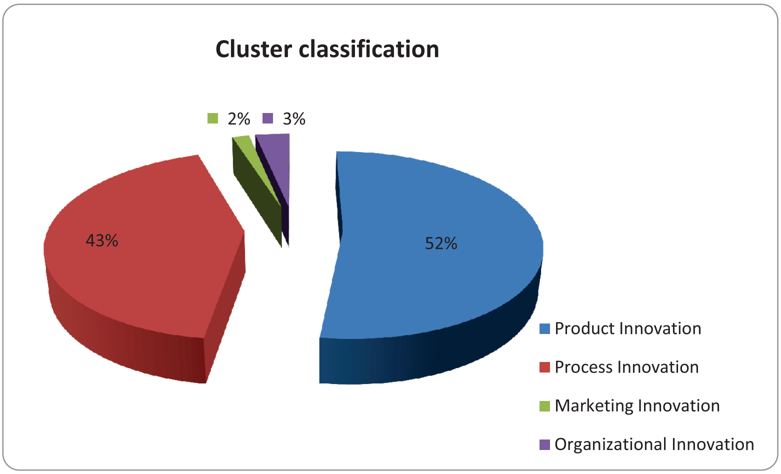

Figure 1. Innovation cluster classification.

Process innovation and organizational innovation are subdivided into three 2nd level innovation types, as in the graphs below:

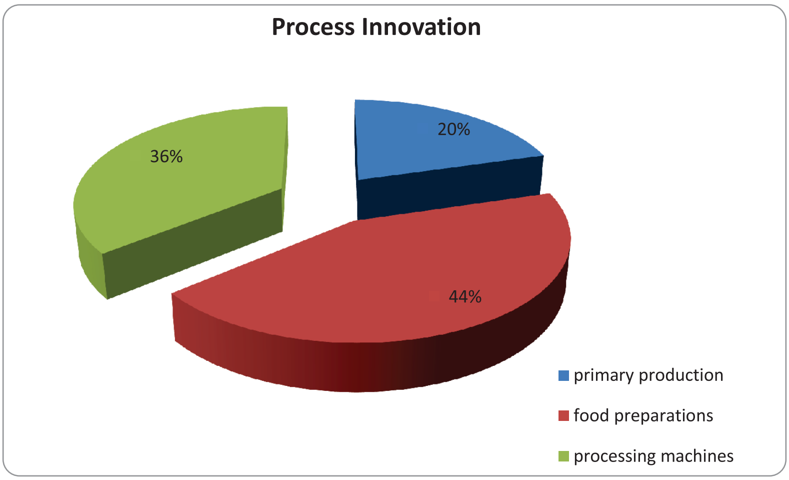

Figure 2. Process innovation classification.

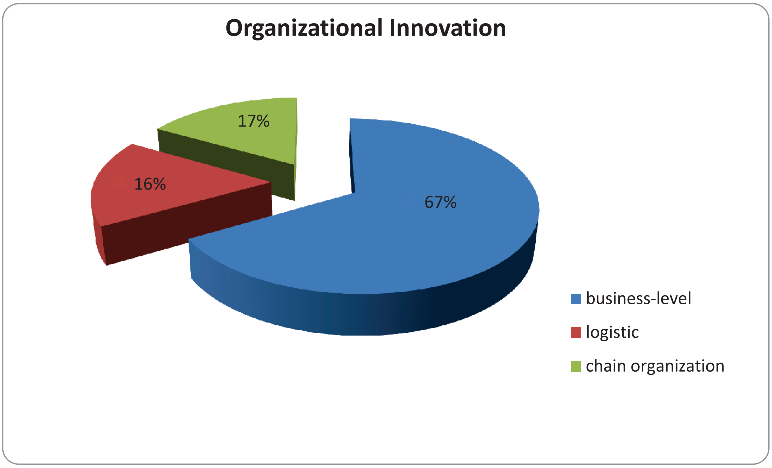

Figure 3. Organisational innovation classification.

Extracted data summarize the classification of innovations according to the type of innovation or the chain (research priority)

Table 4. Example of cluster subdivision for 2nd level innovations.

Innovation cluster	No.	Type of Innovation 2nd level	Research works Selected in the DATABASE
product	**1**	new product	34
	2	new composition of ingredients	14
	3	product features	13
	4	new service	34
process	**5**	primary production	16
	6	food preparations	34
	7	processing machines	28
marketing	**8**	communication	2
	9	new markets/prices	1
	10	new distribution in relation to retail outlets	0
organisational	**11**	business-level	4
	12	logistics	1
	13	chain organisation	1
TOTAL			**182**

Chain-based classification enables rapid identification of all the innovations produced in a given agrifood sector.

The third level of innovation provides a more detailed classification of existing research in the database.

Table 5. Innovation types.

Innovation Cluster	Type of Innovation 2nd level	Type of Innovation 3rd level	Research works selected
product	new product	new variety;	21
		fully new product	13
	new composition of ingredients	nutraceutical foods;	2
		functional foods;	11
		new ingredients	1
	product features	shelf life of the finished product;	6
		shape (size, colour, etc.);	/
		brand;	/
		packaging material;	3
		convenience;	/
		other certifications;	1
		evidence of origin	3
	new service	methodologies of the food product;	30
		product orders;	/
		product delivery;	/
		traceability	4

Table 6. Innovation types – Process innovation.

Innovation cluster	Type of Innovation 2nd level	Type of Innovation 3rd level	Research works selected
process	primary production	sowing;	/
		fertilisation;	2
		plant protection;	5
		irrigation;	1
		production systems;	1
		harvest;	/
		animal feeding;	2
		animal husbandry/growth/fattening	1
		milking/slaughtering;	/
		fisheries and aquaculture	3
	food preparations	post-harvest and preliminary processing;	6
		mechanical treatments;	3
		physical treatments;	5
		chemical treatments;	4
		biological treatments;	1
		biotechnological treatments	16
	processing machines	techniques for product storage;	9
		primary product processing;	11
		final product treatment process;	3
		reduction in energy absorption;	1
		reduction of environmental impact	4

Table 7 - Innovation types – Marketing innovation.

Innovation cluster	Type of Innovation 2nd level	Type of Innovation 3rd level	Research works selected
marketing	communication	promotion	1
		advertising;	/
		publicity;	/
		direct marketing;	/
		mix of communication strategies	1
	new markets/prices	search for new markets	1
		methodologies of market analyses;	/
		commercial positioning (prices)	/
	new distribution in relation to the points of sale	strategic alliances;	/
		e-commerce;	/
		personal selling;	/
		vertical integration of distribution channels;	/
		management of logistics and of supply chain;	/
		new distribution channels	/

Table 8 - Innovation types – Organizational innovation.

Innovation cluster	Type of Innovation 2nd level	Type of Innovation 3rd level	Research works selected
organizational	business-level	staff training	/
		business process management	2
		knowledge management	2
	logistics	relationship with suppliers;	/
		production planning and warehouse management;	1
		distribution and transportation strategies;	/
		information systems	/
	chain organization	horizontal integration;	/
		vertical integration;	/
		inter-clustering	1

Some comments on collected data

A further selection has been made among the 182 innovative proposals to enable a more thorough analysis of innovation in the agrifood sector. Consequently, empirical analysis has been performed on 30 research works that concern typical products from Puglia as the subject of innovation and/or the development of a prototype/patent. The results of this analysis show that the innovations produced and applied have not influenced the quality and the intended use of the main agricultural products, whereas priority has been given to the innovations linked to specific needs of the production process, including the recovery of waste and residues for different uses; choice of native varieties and local breeds to preserve genetic resources; plant breeding via sustainable biotechnologies; sustainable use of nutrients, plant protection products and products for animal health; use of microorganisms, beneficial insects and bioactive molecules for plant protection, including the selection of appropriate genetic resources; the microbial biodiversity, conservation, quality and fertility of soils.

Another emerging need is the relationship between **food** and **health,** which means focusing on the nutraceutical value of agrifood products, including reformulating traditional products, characterising them with their own intrinsic features and emphasising their healthy and functional properties.

Current research shows rising trends in food intolerance. These trends are well known, and are typical of a society which has an increased life expectancy. Other aspects of research concern all elements of packaging and its new functions related to the product; the production of high-quality foods for all (food security); product upgrading and food traceability; product characterisation and compliance with the relevant certification and food safety standards.

Analysis of the above elements shows that innovation concerning products is of primary importance for farms. Moreover, a growing number of the farmers at the production base are becoming aware that innovation cannot be provided only by others, but should derive from a process shared with research and experimentation centres, so as to facilitate the acquisition of intangible assets, such as skills, network relations, R&D, branding and communication.

This analysis shows that innovative farmers have focused on searching for new varieties and also on recovering and enhancing local traditions and environmental features. In this case, farmers can contribute their knowledge and skills to develop innovations that consumers will appreciate and reward. There are some agricultural production areas in which this has been successful, such as wine, oil, special flours, organic products, etc.

The primary sector is still far from considering clustering as a tool for creating value. Yet this kind of approach increases the potential value of possible innovations, and is a remedy for the isolation and small scale of agricultural businesses.

The stakeholders who are able to live and work in an environment with a wealth of knowledge and experimental studies can envisage innovative ideas and practices and can easily find the expertise and specialised services in their local area which are used to develop a new innovative vision, also by imitating the best firms.

The boxes below are examples of the descriptive data sheets for a sample of innovations in the database. The description begins with the problems of the main reference chains and their innovation requirements, followed by a description of the innovation produced by the collaboration between business and research body. Emphasis has been given not only to the results in terms of solutions, but also in terms of effects on market competitiveness and on profitability, without excluding the constraints and limitations involved in applying innovation.

BAKERY PRODUCTS SUPPLY CHAIN

Selection of natural yeasts for bread-making

Need

One central problem for bakeries making yeast-based products is that they are unable to sell the product on interestingly profitable markets because it cannot comply with the commercial requirements of fragrance, storage quality and ease of use.

Innovation

The innovation consists above all of selecting groups of microorganisms, i.e. lactic acid bacteria, to obtain a natural yeast suitable for bread-making, hence a yeast kit which bread-makers can buy.

Application and impact of innovation on business competitiveness

The innovation was applied to the production of "puccia", a typical bread product from Puglia. *Puccia* was initially sold in sealed packages with controlled atmosphere at traditional retail outlets; after the innovation was introduced, *puccia* has encountered consumer appreciation and a large-scale retail chain has begun to market the product.

Considering the promising results achieved for a product like *puccia,* it would be useful to see if this innovation can be applied to other typical bakery products with a locally-based quality label and which comply with production specifications. Bakers could thus obtain a product that they can sell at a higher price, due to its improved organoleptic characteristics, and to the income and volumes guaranteed by access to large-scale retail chains. In addition, they will also benefit from reduced running costs due to the use of home-produced yeast, and will not need to use controlled atmosphere to ensure product freshness .

OIL SUPPLY CHAIN

Metabolic profile maps of Apulian oils

Need

The olive sector encounters the difficulty of guaranteeing the origin of olives and olive oil: serious problems are involved in distinguishing between extra virgin oils produced in Puglia from local olives, and oils made from imported olives, or oils which are only bottled in Puglia. This problem has implications for the introduction of Apulian oils in some foreign markets and for certification of product typicality.

Innovation

The innovation consists of creating a database for the varietal recognition of oils via their metabolic profile. Operation of the database is strictly correlated to the rate at which it is updated whenever new analyses are carried out.

Application and impact of innovation on business competitiveness

The main beneficiaries of this innovation are the firms which bottle oil, especially those oriented towards export markets. The cost of innovation consists of a fee to access the database. The benefits are associated with greater sales opportunities on foreign markets, and the reduction in the cost of dealing with disputes concerning product origin, as well as with the possibility of having a territory-based quality mark on the label, stating that the product's territorial origin is analytically proven.

FRUIT AND VEGETABLE SUPPLY CHAIN

Varietal selection of Catalogna chicory for freezing

Need

Consumer demand for fruit and vegetable products is directed towards genuine, natural, easy and ready-to-use foods, both fresh and cooked. The shelf-life of fruit and vegetables becomes the strategic variable that can offer higher margins by facilitating access to distant markets, which increasingly demand typical products linked to the territory and to the quality of local varieties, expressing the production area, its climate and landscapes.

Innovation

The innovation consists of identifying local varieties, of Catalogna chicory in this specific case, which enhance the organoleptic features of the product and are also suitable for preparation and packaging as frozen products.

Application and impact of innovation on business competitiveness

The cost of innovation is connected with genetic selection of the plants and with the implementation of new production lines including product packaging. Benefits are largely linked to the possibility of adding value to native varieties, both in quantitative terms via genetic selection, and in economic terms by marketing the product through more profitable channels.

FRUIT AND VEGETABLE SUPPLY CHAIN

Functional tomatoes with low nickel content

Need

Food safety is a component of the demand for technological innovation that businesses express due to growing consumer attention paid to food healthiness. An area of special interest is the relationship between soil and plant, i.e. the transport of soil nutrients in the plant's edible parts, consequently ingested when the food is eaten.

Innovation

The innovation concerns the control of nickel contamination levels in tomatoes processed to produce tomato paste. Tomatoes were grown in soils containing a low nickel level and as protected crops on nickel-free substrates, using good agricultural practices to prevent nickel concentration in the soil and to reduce the existing levels.

Application and impact of innovation on business competitiveness

Testing confirmed that the tomatoes contained low nickel concentrations. Harvested tomatoes were used to make tomato paste for experimental use in a hospital; the products were given to a sample of patients with nickel-related health problems, whose response was excellent.

WINE SUPPLY CHAIN

Measuring vegetative vigour for precision viticulture

Need

The inefficient use of chemical inputs in agriculture has negative effects on the economic management of the business and on consumer health.

Innovation

Precision agriculture is an innovation enabling rational interventions based on the crop's actual requirements and improved agronomic and economic performances. The introduction of systems to survey the plants' physiological status using sensors and remote sensing equipment is the innovation chosen for the wine sector. It consists of collecting field data on vegetative vigour; the data are then processed by a special system to produce a vegetative vigour map, which provides a useful tool for planning fertilisation, irrigation and plant protection interventions.

Application and impact of innovation on business competitiveness

Positive effects include the improvement of wine quality levels, with statistically significant results, together with a lower environmental impact. In addition, there are improvements in the final economic budget, because product differentiation gives a competitive advantage. The use of precision farming techniques also enhances the social responsibility of the business.

The limitations to the introduction of this innovation are related to the costs of field data collection, and of training staff to interpret the data processed by the expert system and apply them in the field.

DAIRY PRODUCTS SUPPLY CHAIN

Formulating a liquid medium to extend the shelf-life of Apulian mozzarella

Need

There are difficulties in transporting dairy products, especially *mozzarella*, to markets located far from production sites,, because the travelling time involved damages product qualities and healthiness.

Innovation

The innovation consists of formulating a liquid medium which extends product shelf-life to 6-8 days, thus making it possible to sell the product on European markets.

Application and impact of innovation on business competitiveness

Excluding experimentation, innovation costs are very low and involve the tank containing the new liquid and the system for distribution of the liquid in the packages. On the other hand, the benefits are extremely positive, because of increased sales volumes deriving from the expansion of markets and a big reduction in returned goods.

OPTIONS
méditerranéennes

SERIES B: : Etudes et Recherches
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Innovation in the Mediterranean Agrifood Sector
Concepts, experiences and actors in a developing ecosystem

Edited by:
D. Petruzzella, A. Di Mambro

OPTIONS méditerranéennes

Although the Mediterranean area is generally seen as the cradle of agriculture and traditional food production, the issue of innovation is now making its way to the top of the political and research agendas. This is due, firstly, to the enormous challenges the Mediterranean will face in terms of food and nutrition security with the impact of expected climate changes and the evolution of consumption models. Then, the new EU research framework places great emphasis on the reorganisation of agricultural innovation via a collaborative and bottom-up multi-actor approach. Expo 2015 not only showcased Italian agriculture, but also favoured the emergence of a great many ambitious young entrepreneurs ready to carry out profound innovations in the production and food consumption models. This ferment of activity requires a deep-seated re-organisation of the Mediterranean's agricultural innovation system.
This book is needed to illustrate this developing system and is intended as an aid to orientation, providing some theoretical and regulatory reference points. Thanks to the INTRA Database developed by CIHEAM-Bari and the Ionian University, it also describes the concrete application of a new approach to innovation involving listening and interaction with the local territory.

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