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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%).

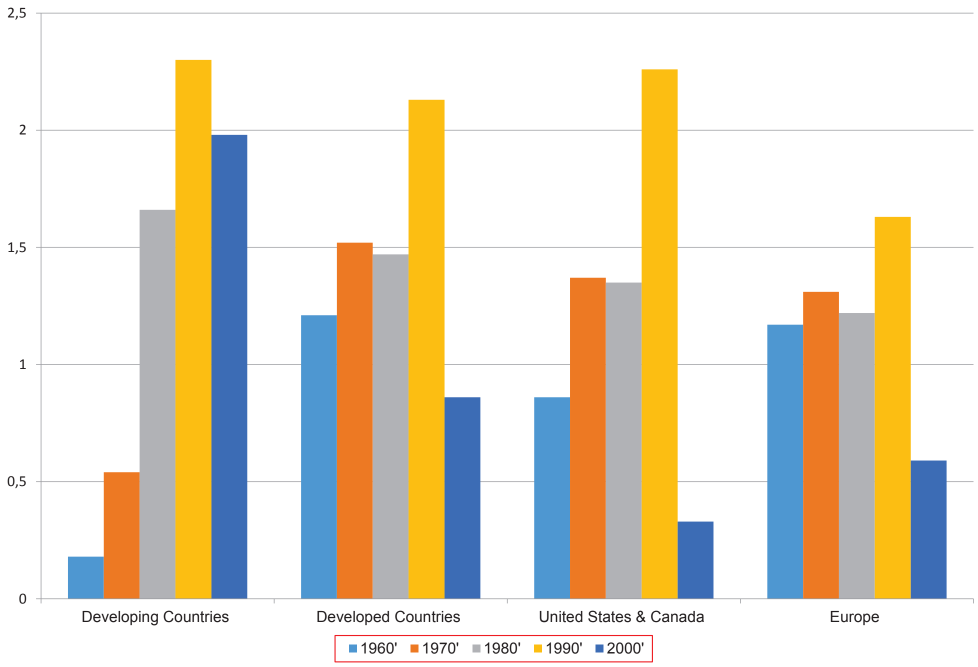

Figure 1. Average yearly increase in productivity in agriculture

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	**1960**
First flour bleaching agent	Chorleywood bread process
Milk pasteurisation	Instant mashed potato
Drum dryers	Polyunsaturated margarine
Sanitized tin cans	Enzymes for meat maturation
Pre-cooked tinned beans	UHT method for milk
1910	Aseptic Tetra Pak packaging
Oil hydrogenation	**1970**
Higher yield in flour extraction	Growth in services content
Post-harvest mechanization	Automation and computerization
1920	Slimming foods
A and D vitamins added to margarine	Granary bread
Plate heat exchanger	Aseptic bag packaging
Tubular blancher	**1980**
Juice extractors	new plastic material for packaging
1930	Single cell proteins (SCP) - Quorn
Slaughter-house mechanisation	Low-calorie ingredients
Lining of cans	Nutritional labelling
Technology of injection of curing solution	Chilled ready meals
Blast freezing technology	Mono-unsaturated margarine
Soluble coffee atomiser	Modified atmosphere packaging
Sliced and packed bread	Aseptic packaging of liquid foods (Particulate Food)
Milk in cardboard container	**1990s**
Refrigerated counter at the point of sale	Increasing specialization of businesses
1940	Fat replacers - Simplesse
Fortified bread (rickets)	Use of irradiation (limited)
Preservatives in meats	Minimal processing
Mass production of chocolate	Functional foods
Lyophilisation of vegetables	Growth of organic foods
Additives for flour processing characteristic	Genetically modified foods
HTST pasteurisation	
1950	
Preservatives in bakery products	
Controlled atmosphere preservation	
Aseptic canning	
Tetra Pak	
Frozen food (fish sticks)	
Tea bags	

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.