

## CONCEPTUAL MODELS, BARRIERS AND OPPORTUNITIES FOR ADOPTION AND DIFFUSION OF AGRICULTURAL INNOVATIONS

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### **Abstract**

*Agricultural innovations are considered a key driver in overcoming the global challenges related to climate change, natural resources scarcity and food security. However, the features of agriculture increase the degree of complexity in the implementation and adoption of the innovations. The aim of the study is to observe the theoretical and empirical literature on agricultural innovations adoption and diffusion and to outline the main conceptual models, barriers and opportunities in these processes. The study results show that there has been diversity in research linked to agricultural innovations adoption methods and models and therefore lack of globally accepted methodology. The surveys in the field represent different perspectives and outline social, economic and marketing points of view in the innovation diffusion system, which highlight the major challenges and prospects. The broader acceptance of agricultural innovations requires interaction and linkages between different stakeholders, knowledge transfer and the active role of the institutional setting in shaping the processes critical for agricultural innovation adoption.*

**Key words:** drivers of adoption, agricultural innovation system, knowledge transfer

### **INTRODUCTION**

Agricultural innovations are considered a key driver in overcoming the global challenges related to climate change, natural resources scarcity and food security. Agricultural innovations are a multi-disciplinary scientific and research field [15, 28, 43] that is related to sustainability, smart agriculture and social welfare. Agricultural innovations could lead to new paths and ideas that address emerging issues and increase the efficiency of products and services. [44, 51]. The diffusion of agricultural innovations is a complex and dynamic process that requires a multifaceted approach that takes into account the social, cultural, economic, and environmental dimensions of agriculture. By understanding and addressing the factors that influence the adoption and implementation of new ideas and practices, sustainable and inclusive agricultural development that benefits farmers, communities, and the environment could be promoted. The aim of the study is to observe the theoretical and empirical literature on agricultural innovations adoption and diffusion and to outline the main conceptual models, barriers and opportunities in these

processes. The paper is structured as follows: First, the methodological framework is presented. In the second part, the study observes the evolution of the agricultural innovation process that leads to change in adoption and diffusion. The main models, barriers and drivers in the process are also outlined. Based on the survey conclusions and recommendations are highlighted.

### **MATERIALS AND METHODS**

The survey is based on the methodological framework presented by De Alcantara et al. [13]. The methodology of their survey applies discourse analysis. This approach includes observation of literature (papers, reports, articles) on the topic in order to understand different models and interactions between actors to create new technologies [37]. In addition, a systematic literature review is conducted by applying methods proposed by [46].

### **RESULTS AND DISCUSSIONS**

Innovations are a key factor in improving productivity and competitiveness and play an

essential role in creating employment and generating income. FAO [18] defines agricultural innovation as a process „ when individuals and groups adopt new ideas, technologies or processes that, when successful, spread through communities and societies. The process is complex, involving many actors, and it cannot function in a vacuum". In the last decades have been significant changes in farming patterns in Europe. While part of the agricultural

holdings continues with traditional approaches related to increasing productivity, new methods in agriculture are developing and evolving. Due to limited resources in agriculture and strong dependence on natural factors, farmers have to adopt innovations related to new machines, processes and techniques and new business and management models. Innovations in the agricultural sector are the result of the interaction between different stakeholders in the sector.

Table 1. Approaches to agricultural innovation

Approach	Technology-oriented approach	System-oriented approach		
		Farming system	AKIS	AIS
Period	1950-1980	1980-1990	1990-2000	XXI century
Aim	Invention, diffusion and adoption of new technologies in order to increase productivity	Based on R&D adoption of new technology in order to improve farmers` welfare	Focus on local capacities for adoption in order to empower farmers and integrate different types of knowledge for sustainable development	Increase the capacity of diffusion in order to provoke institutional change
Main features	New technologies Technology transfer and efficiency	Adaptation to local conditions, knowledge transfer	Joint knowledge transfer and learning Value chain approach	Identification of the main stakeholders` Analysis and adaptation to the institutional environment
Innovation flow	Top-down	Top-down	Bottom-up	Multi-directional
Channels for adoption and diffusion	Extension of new technology Key role of mass media to facilitate adoption	Consultation in order to improve the speed of adoption Surveys to identify farmers` needs and models Theof adoption and diffusion	Joint knowledge and learning in order to improve adoption and diffusion	Development and implementation of multi-actor innovation platforms
Role of the farmers	Adopters of technologies	Adopters of knowledge and technologies Key role in the information process	Experimenter in the innovation and diffusion process	Active role as partners in the innovation and diffusion Part of innovation network
R&D	Develops technology and knowledge	Advises and experiments	Develop capacity for adoption Main role in knowledge transfer	Key role in innovation capacity improvement Part of the innovation network

Source: [30, 46, 58].

According to World Bank [59], innovation often results from collective action,

coordination and knowledge exchange between different stakeholders.

It should be noted that the concept of innovation in agriculture has evolved in recent years. It is no longer defined only as the adoption of new technologies. According to Sonnino and Ruanne [50], "it is more a successful combination of technologies and practices, new knowledge, institutions and forms of social organization".

In scientific literature it can be pointed out that there is an evolution from technology to system-oriented views in the analysis of the innovation process.

Klerkx et al. [30] outlines four approaches related to the development of the concept for agricultural innovation. (Table 1).

The technology-based approach is associated with a process in which the basic idea created by scientists and different researchers is presented and directed to the farm managers. [43] The minor role of farmers is considered a main weakness of the approach and leads to the development of more systems-oriented approaches [20]. The farming System is an important step toward the acknowledgment of farm manager role and position in the innovation process. However, the lack of acknowledgement of the influence of other drivers for agricultural innovations is the main weakness of the approach [21]. Therefore, a shift from top-down to bottom-up approaches to agricultural innovation was established, which evolved into the Agricultural Knowledge and Information Systems (AKIS) approach [17]. This development is linked to joint learning and interaction between researchers, farmers and other value chain actors as an important step for sustainable agricultural development [31]. On the other hand, the AKIS approach has a mainly local focus and does not take into account the multi-level links between stakeholders. The approach does not consider as important the unequal role of the stakeholder and poses challenges for innovation implementation.

Therefore, the agricultural innovations system (AIS) approach includes new aspects of innovation related to the political and institutional environment [24]. Some studies highlight the important coordination between

actors and institutions in agriculture [23, 29, and 45].

According to Peterson, and Horton [40], adapting and implementing innovations is a long process. As an important step, diffusion has been analyzed and is an object of different discussions. [27, 51]. Diffusion can be defined as the "spreading of new ideas, structures, and practices" [12]. Social science considers two key opinions in diffusion process definitions- "rational accounts" and "social accounts" of [5, 51]. "Rational accounts" of the process are related to the economic aspect of diffusion and are associated with the implemented innovation's costs, benefits and efficiency [41, 43, and 52].

"Social accounts" of diffusion have different focus and are linked mainly to sociology. This perspective analyses the pressure to adapt to society. Based on the institutional theory [47, 53], social accounts of diffusion follow how the effect of the group behavior can replace rationality. Social effects may cause the adoption and diffusion of innovation that are inefficient for individual farmers. [2, 52].

The main limitation of these two perspectives is related to understanding the diffusion of innovation as a reaction to a certain pressure or impact. [38]. On the other hand, in order to find solutions for global challenges, the implementation of innovations and expansion of new ideas need an active role of stakeholders active in the process rather than passive adoption.

In agriculture, few important studies define the main theories, models and methods that affect the adoption and diffusion studies [4, 7, 22, and 43]. These surveys are based on different aspects of social science- economics, sociology, marketing, and psychology.

Rogers [43] defined the diffusion process and focuses on the interaction among social system members. The author survey analyses the main factors influencing adoption: relative advantage, compatibility, complexity, trialability, and observability.

On the other hand, Griliches [22] highlighted profit advantage as the main factor for the diffusion of agricultural innovation. Bass applies the marketing model to define the adoption rate and speed [39]. The theory of

Planned Behavior [4] has been considered important for understanding the individual decision-making process and the influence of external factors, norms, and motives.

Young[60] and Montes de Oca Munguia et al.[36] adapted the different perspectives from social sciences in the agricultural sector. Based on surveys of [36, 60], three critical models of the diffusion of agricultural innovation can be outlined. Some surveys show that the adoption process needs to be understood from a multidisciplinary perspective. [49, 60]

The abovementioned studies highlight the main aspects and paths of agricultural innovation adoption and diffusion models (Figure 1).

The economic aspect focuses on profit and outcome. In the social path, adoption is influenced by social group behavior. In contrast, in marketing-based studies, the adoption and diffusion are linked to the connections and are affected by mass communication.



Fig. 1. Paths and aspects of agricultural innovation adoption and diffusion models  
 Source: Own research based on [36, 60].

The survey [36] analyses the main agricultural adoption and diffusion models based on the literature review. According to the author's survey findings, most of the analyzed adoption conceptual models in agriculture consider adoption a staged process [32, 41]. The main steps towards diffusion are related to a process of learning and experimentation. Rogers [43] includes five stages of the innovation's implementation process: "knowledge, persuasion, decision, implementation, and conformation". In addition, Adrian [3] analyses innovations in precision agriculture and adapted a model that presents and observes how a farmer understands, accepts and implements different new practices and technologies. Lindner et al. [32], on the other hand, highlighted that the diffusion process has a

time lag from the availability of agricultural innovation to the individual decision for adoption. Lindner et al. [32], point out that information plays a crucial role in the diffusion process.

Abadi Ghadim and Pannell [1], present a model that outlines farmers' personal perception and management skills as the main factors for the diffusion of agricultural innovation. Their model considers adoption as a rational economic decision with the objective of profit maximization [1].

The abovementioned models based on rational choice are often criticized for not taking into account social and psychological factors that can influence the adoption process, alongside the social norms and attitude of the social group. [56].

The Theory of Planned Behavior [4] is the main psychological decision-making model. The theory observes the relationship between attitudes and intentions to explain behavior. The theory is combined with other relevant theories [42] to explain farmers' decision to adopt agricultural innovation. However, the majority of studies in agriculture are not dominated by one particular theory [54, 55] Based on analyzed models, it can be concluded that there are diverse perspectives on the adoption and diffusion in agriculture. This variety can be explained with the application of different theories which have origins in different disciplines. Economic indicators such as profit, environmental and risk advantages are considered as main factors for adoption, especially in technological innovation. In addition, decision-making is also information-driven. The role of farmer skills and practice awareness influence the processes. From the social and psychological point of view, the

role of the group and advisers is the main driver for adoption and diffusion. On the other hand, important features of the adoption and diffusion processes are related to learning and practice. Johnson et al. [26] observe the relationship between adopters before and after adoption. In agriculture, this also refers to the relationship between farmers and innovation and also between farmers and the companies selling and servicing the new technology. It should be noted that external factors influence the decision-making process of adoption. However, some studies argue that diffusion remains an individual process [36]. Generally, a group of factors could be highlighted as drivers or limitations for agricultural innovation adoption and diffusion. Based on the literature review [10, 33, 34], observe the barriers to agricultural innovation adoption, diffusion and scaling. The studies of [10, 33] divide the limitation into two main groups: external and internal.

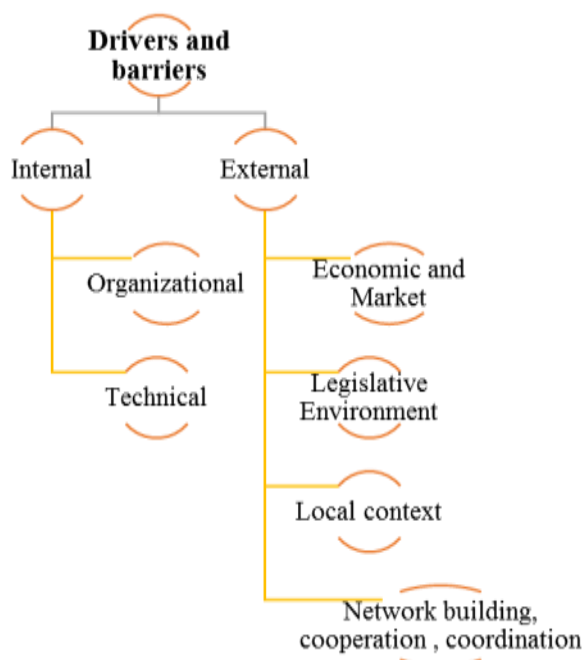


Fig. 2. Drivers and barriers for agricultural innovation diffusion  
 Source: Own research based on [10, 14, 33].

As an external factor, legislative and institutional environment and government support could boost agricultural diffusion. However, low institutional support or lack of regulatory framework, alongside bureaucracy,

can hinder the innovation and diffusion process [8, 19, 35]. Institutional settings play a central part and link different stakeholders and innovation flows [23].

Economic factors are an important part of the diffusion process. High initial investments, access to capital and a long pay-back period, and high implementation costs can be serious barriers [8, 9, 11].

Concerning the economic limitation the consumer behavior and lack of attractiveness, market uncertainty can delay or prevent the adoption and implementation of innovation.[8, 9, 35].

Adapting to the local context is an important part of the diffusion of innovation. The process could meet several challenges when the new practice or project does not consider the local specifics [11, 16, 25, 49, 57].

Knowledge transfer, networks and better coordination among actors, and dissemination could be an opportunity but, at the same time, also a barrier to innovations adoption and diffusion [6, 10, 48,].

These knowledge-sharing and learning processes are interactive and require linkages with different knowledge bases. The new technologies often are related to new links, actors and roles.

Internal factors include the inability to assess technologies and the lack of required competencies as technical limitations in the process [11]. Organizational factors such as management skills and leadership are crucial in implementing new technologies. Risk preferences and disposition could also be considered a barrier or a driver.

Human resources skills, training and capacity, are also important in the diffusion process.

The process of innovation diffusion requires the legislative environment, cooperation with a broader range of stakeholders and financial resources. Furthermore, adoption and diffusion could lead to a number of changes in external and internal environment, network and coordination, management skills and leadership models.

## CONCLUSIONS

Based on the survey, it can be concluded that the agricultural innovation process reshaped and evolved from a technology-based perceptive to a system-based approach. The

diffusion process also can be influenced by various factors and seen in different aspects.

One of the key challenges of agricultural innovation diffusion in a global context is ensuring that the new ideas are relevant to the community's local context and needs. This requires an understanding of the cultural, economic, and environmental factors that shape the local farming practices, as well as the priorities of the farmers.

The implementation and diffusion of agricultural innovations are linked to a number of factors that influence the speed of the process. The infrastructure and access to production factors are essential for farmers to adopt innovation practices. Other drivers in this regard are the markets and finance availability, but also national policy, government priorities and strategic plans. The institutional and political dimensions are crucial in supporting innovation and entrepreneurship in the agriculture.

It can be summarized that the diffusion of innovations requires serious investment, coordination, cooperation and network building in order to boost productivity, sustainability, circularity and competitiveness. The diffusion of agricultural innovations is a dynamic process that requires multidimensional links between stakeholders and should consider the sustainable development goals and agricultural transformation toward green growth.

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