الجمهورية الجزائرية الديمقراطية الشعبية

Democratic and Popular Algerian Republic

وزارة التعليم العالي والبحث العلمي

Ministry of Higher Education and Scientific Research

جامعة الوادي

University of El Oued

Faculty of Natural and Life Sciences

Department of Agricultural Sciences

Thesis

Presented for the Obtaining of the Doctorate Degree Third Cycle

SPECIALTY: Agricultural Sciences

OPTION: Plant Production

BY: MEHDA Ahmed

Theme

Typology and determinants of Agrotechnical innovation in El Oued State

Jury

PRESIDENT	ZAATER Abdelmalek	M.C.A	University Of El Oued
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Academic Year 2024/2025

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Dédicaces

Je dédie ce modeste travail à ma petite Famille en signe d'honneur et à mes petits frères en tant que mission

- j'ai commencé ce parcours pour que vous le poursuiviez –

À ma source d'inspiration, qui a été et reste mon modèle tout au long de ma vie, Dr. Mohammed MEHDA

- Paix à Son Âme -

À mon grand-père qui est parti avant que ce travail ne soit achevé.

- Paix à Son Âme –

A tous ceux qui m'aide au cours de ma carrière académique.

Ahmed

Remerciements

الحمدلله على الذي رزقني من غير حول مني ولا قوة

Je tiens à exprimer ma profonde gratitude envers le directeur de thèse

Dr. Azzeddine HADDAD

Pour ses efforts inestimables, son temps précieux ainsi que son soutien scientifique qui a été essentiels à l'achèvement de cette thèse.

Un remerciement Spécial va également à

M. Mohammed Ridha MESSAK,

Dont l'influence a été déterminante dans ma formation et qui m'a accompagné tout au long de mon parcours académique.

Je souhaite également adresser mes sincères remerciements aux **Membres du Jury de Soutenance** pour le temps qu'ils ont consacré à la discussion de ce modeste travail**.**

Enfin, je Remercie Chaleureusement le Département d'Agriculture de l'Université Hamma Lakhdar pour leur soutien continu.

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INTRODUCTION

Agriculture is vital to the economy of sub-Saharan Africa and Algeria, providing livelihoods and underpinning economic stability. Government is working to improve practices and infrastructure, but challenges like climate change, soil degradation, and limited access to technologies hinder food security (Tene M et Al., 2013). In Algeria, agriculture employs 20.7% of the workforce but contributes only 12% to GDP, reflecting sectoral structural issues with over 74% of rural employment reliant on agriculture (World Bank, 2023; Omari et al., 2012). The sector supplies 74% of national food needs, emphasizing the importance of boosting yields for food security amid population growth and climate challenges. Algeria is modernizing its agriculture through technological innovations and infrastructure improvements, focusing on crop diversification and productivity to reduce dependence on imports (Laouar et al., 2023). The government prioritizes developing southern rural areas, which hold significant untapped agricultural potential thanks to abundant arable land and sunlight, critical for achieving food self-sufficiency (Bouchareb et al., 2023).

To promote sustainable agriculture in arid regions, Algeria invests in projects and technical assistance to optimize water use and support farmer training, aiming to modernize practices and foster economic growth. The national goal is to make agriculture a key pillar of economic and social stability while reducing vulnerability to international market fluctuations, especially by developing the southern regions' resources (Faure et al., 2018). The Algerian Sahara has seen significant changes, notably after Law 83/18 APFA, which improved access to land for farmers and spurred new agricultural practices. Innovations include advanced techniques and an increase in input supply companies, reflecting a focus on profitability (Hadeid et al., 2018). However, public research and technical advice remain limited, with a mismatch between scientific advancements and farmers' practical needs, hindering the adoption of suitable innovations (Lejars et al., 2017).

The rise of profit-driven and speculative activities is transforming Saharan agriculture, raising concerns about natural resource management, farm viability, and community welfare (Hadeid et al., 2018). The government's development programs focus on integrating social, economic, and environmental aspects, aiming to strengthen community resilience, promote desert agriculture, and foster socio-economic stability (Mokhnane et al., 2023). Due to resource scarcity, policies prioritize revitalizing underused arable land and diversifying economic activities, especially in border regions like El-Oued, where new projects are reshaping Algeria's agricultural landscape (Bouzid et al., 2020; Mokhnane et al., 2023).

INTRODUCTION

El-Oued's rich history, dating back to prehistoric times, underscores its cultural and agricultural significance (Mokhnane et al., 2023). Despite technical and market challenges, the region demonstrates remarkable dynamism, with farmers transforming arid dunes into diverse cultivated lands, contributing over 63% to Algeria's fresh produce in 2024 (Djouhri et al., 2023). This resilience highlights the potential of desert agriculture, driven by water resource management and innovative practices, fostering sustainable development despite harsh conditions (Mokhnane et al., 2023). The region specializes in off-season vegetables and fruits, exemplifying adaptation and induced innovation through new techniques to overcome environmental constraints (Assassi et al., 2017; Jeder et al., 2013). To sustain growth, establishing effective market structures supported by technological and organizational innovations is essential (Bouzid et al., 2020). Notably, regions like Biskra and El Oued have achieved significant agricultural successes driven by common facilitating factors, independent of ecological factors.

The success of agricultural development in regions like El Oued is largely driven by strategic choices and proactive actors. The selection of high-value cash crops ensures strong market integration and optimizes productivity. Specializing in specific crops helps balance costs and improve quality, fostering competitiveness. The presence of dynamic actors—operators, skilled labor, artisans, and traders—who innovate and collaborate across value chains enhances resilience and market adaptability (Perrin & Nougarèdes, 2020). This synergy between agriculture and innovation reflects adaptation and sustainable development, transforming these territories into agricultural hubs. The development process involves diverse actors—farmers, researchers, government, and private companies—sharing knowledge and adopting new techniques through informal and multiplex arrangements, which foster innovation and improve farmers' expertise (Perrin & Nougarèdes, 2020; Mehda, 2017). This integrated approach constitutes an innovation system that strengthens agricultural practices and competitiveness.

Our work uniquely aims to catalog current agricultural innovations in the region, develop a typology of innovations, identify their adoption determinants, assess their diffusion levels, and highlight the role of field actors in facilitating access for farmers. We seek to understand the factors influencing the adoption of new practices and technologies and to provide a comprehensive overview of the region's innovation dynamics. By focusing on interactions among actors, we explore how social, economic, and institutional conditions shape agricultural innovation, while also identifying obstacles and opportunities to strengthen this process.

INTRODUCTION

In Algeria, research on agricultural innovations and their adoption by farmers is often fragmented or disparate, making it difficult to understand the current state and challenges in agriculture. Several studies such as Derderi et al., 2015; Ould Rebai et al., 2017; Meghni and Okaci, 2018; Naouri et al., 2020; Bouzid et al., 2020; Lezreg et al., 2022; Laouar et al., 2023, address various aspects of this issue, but a lack of coherence and interconnection between these researches remains noticeable. In this context, our objective is to discover the key factors influencing agricultural progress and to analyze how these elements energize the economy and attractiveness of El Oued region.

The choice of this subject motivated by several reasons. First, a current topic of great importance, considering the challenges that Algeria must face in terms of food security and sustainable development. El Oued region, in particular, has an agro-economic dynamic that could serve as an example of complementarity and synergy of a multitude of harmonized and complementary dynamics for the entire country. Exploring this dynamic can provide us with valuable insights into the best practices to adopt.

Furthermore, the well-known El Oued's farmer behaviour, recognized for his motivation and ability to exploit the land, produce, and adapt to technical innovations, is a key factor that deserves to be studied and analysed in order to better understand the processes of adopting innovations and their impact on agricultural productivity. By integrating these local practices into our analyses, we could identify innovation levers that could be applicable in other arid regions of Algeria.

This research also aims to contribute to the enrichment of agricultural knowledge and the development of the arid areas of our country. A better understanding of the mechanisms of innovation adoption and success factors can provide insights and recommendations to decision-makers, researchers, and practitioners working towards the development of sustainable and efficient agriculture in resource-deficient regions.

Our work will organized into three key sections.

Conceptual and theoretical framework: This section provides a literature review on innovation and agricultural dynamics. It defines various concepts of innovation and the economic theories of innovation. By integrating notions of sustainability and resilience, we identify the main key concepts in our research that justify the study.

Research Methodology: Here, the study area is presented, describing its geographical and socio-economic characteristics. The data collection methodology based on a field survey, involving questionnaires and interviews with various stakeholders in the field. The data analysis employs statistical tools.

Results and Discussion: The research findings are explained according to main themes related to agricultural innovation, accompanied by statistical data and interview quotes. This section discusses the results by comparing them with existing studies and contemporary issues.

Chapter One

Conceptual and Theoretical Part

1. towards a sustainable agricultural system

To ensure a sustainable agricultural system, monitoring is necessary; research and development institutions are hypothetically the founders and leaders of the development research of new technology and solutions to on-ground problems faced by farmers (Mendonça, 2019), collaborating with other nations through the exchange of experiences and scientific research, as well as through the development of region-specific knowledge and traditional solutions.

In the second decade of the 20th century, following the post-World War period in Central Europe, the movement of scientific agriculture and modern agricultural technology emerged, emphasizing efficiency and productivity (Kacperczyk, 2011). This led to significant advancements in agricultural production, but it also generated challenges, such as soil and water pollution due to the intensified use of chemicals (Considering that at the time it involved the agricultural, extractive, and chemical industries, its risks were neither known nor declared), and it created conflicts between the state and farmers (Soulard, 2014).

The environmental movement indeed developed in the 1960s and 1970s, during which period environmental concerns gained prominence, particularly the excessive use of pesticides, the degradation of agricultural land, and the loss of biodiversity (Bulmer et al., 2020). To steer global public opinion towards more sustainable agricultural practices, the efforts to transform the agricultural system by environmentalists faced immense challenges, which can attribute to the priority given to industrialization and ensuring food self-sufficiency in certain countries (Mtisi, 2012). The movement that paved the way for the concept of agricultural sustainability in the following decade.

The Brundtland report entitled "Our Common Future" from 1987 indeed defined the concept of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This report suggested the importance of developing sustainable agricultural practices to meet current needs without depleting resources for future generations. However, it did not mention any specific information on sustainable agricultural practices (Lotodé, 1987), and it is from this that the concept originated.

Organic agriculture indeed emerged in the 1990s as an alternative to intensive farming that uses chemical products. The key principles are production without synthetic fertilizers and pesticides, which means maintaining soil fertility and environmental sustainability by using the recycling of organic matter (Loyem et al., 2020), as the forest rent, which has biological diversity, has been depleted by conventional agriculture (Temple and Bon., 2020). Therefore, ensuring uninterrupted food security in accordance with natural dynamics.

The issues of climate change, ecosystem degradation, and biodiversity loss that affect food security, reducing agricultural land productivity, are beginning to manifest their cumulative impact over the decades and have a detrimental effect in the 2000s (Douafer., 2024). This has led to an increased interest in sustainable agricultural practices. The development of plant-based diets could be a possible and effective response to mitigate these negative effects (Vincey., 2018).

The 2010s were known for their several events and legislations related to food security, the preservation of biodiversity, and the reduction of greenhouse gas emissions in agriculture. In 2011, the European Union adopted new regulations on maximum residue levels of pesticides in food; and a Biodiversity Strategy for 2020, aimed at halting biodiversity loss and the degradation of ecosystem services (Alves, 2022).

In 2013, the Common Agricultural Policy (CAP) reformed to better integrate environmental objectives, and Regulation (EU) 1169/2011 on the provision of food information to consumers came into force (Bouillot, 2020).

The Paris Agreement, adopted at COP21 in 2015, heightened awareness of the urgency to act and highlighted the importance of sustainable agriculture to limit warming to 1.5°C, considering that the agricultural sector accounts for approximately 25% of global greenhouse gas emissions. This requires a significant increase in sustainable food production, a reduction in food loss and waste, as well as a transition to healthier and more environmentally friendly diets (Kumar and Madlener, 2018; Petit, 2018).

The integration of biodiversity issues into development projects through public development aid (Bernard, 2016) demonstrates that biodiversity transcends standard project management practices and requires a comprehensive and local approach. Wooded areas play an important role in agricultural landscapes (Deconchat et al., 2017) as ecological infrastructures that influence the characteristics of neighbouring environments, thereby making sustainable management of agricultural lands essential. Taking the example of innovative urban agriculture projects, those developed in Toulouse (Brin et al., 2017) highlight the importance of training future agronomists in transdisciplinary, multi-stakeholder approaches that take into account the uncertainty related to conflicts of use in urban and peri-urban spaces.

The COVID-19 pandemic has highlighted the importance of food security and the resilience of food systems. The crisis has led to disruptions in supply chains, loss of income and livelihoods (FAO, 2020), and exacerbation of food inequalities (NCBI, 2020). Nevertheless, local food systems and sustainable agricultural practices have demonstrated their resilience (Weinkauf and Everitt, 2023). To strengthen food security, it is essential to diversify supply sources, support small producers, and promote more sustainable agricultural practices (FAO, 2021). This experience should guide efforts to build more resilient and equitable food systems.

The transition to more sustainable agriculture is a post-COVID imperative. Some countries must rethink their agricultural development model to address structural challenges such as poor water management and insufficient labor income. The health crisis presents an opportunity to rethink agricultural models towards greater sustainability by diversifying economies. The pandemic has also revealed the dependence of many countries on food imports, despite agricultural exports supported by increased use of groundwater. A rebalancing of agricultural trade balances is necessary. This requires ambitious structural reforms in a context of budgetary austerity.

It is necessary to have a set of factors such as public policies in various economic, social, and environmental sectors. However, literature, public experiences, and the productive sector demonstrate the strategic importance of research and innovation in the pursuit of increasingly sustainable agriculture in economic, social, and environmental domains. For a country to achieve a reasonable level of sustainability, it must firmly restructure its economic development model. While conventional economics considers environmental impacts as externalities, it would be much more convincing to integrate them as an internal component of the economic, social, and ecological balance sheet, in a weighted and crosscutting measure of sustainability. The green economy approach focuses on ecological balance and social quality of life, considering the economic dimension as an aura dependent on society, while inserting it into a broader context called environment (Cato., 2009).

Similarly, a green economy involves a holistic approach, which signifies a high level of participation in its implementation, integrating all disciplines related to sustainability. There are elements of nature that cannot be monetarily evaluated as they are invaluable considering their interaction and influence on the complex environmental balance (Cato., 2009).

In the future, it’s necessary to reformulate the social and economic composition, based on parameters distant from rentierism and dependence on consumerism, which has created a standardization of tastes, and consequently large-scale but monocultural production systems, thereby amplifying the loss of biodiversity, the use of chemicals, and the pollution of soils, water, and living beings (Feenstra, 2018; Cato, 2009).

The economy depends on biodiversity to strengthen the genetic stocks of vegetation and animals intended for agricultural and livestock production; these potential uses of biodiversity resources can provide multiple value chains in food, medical, cosmetic, enzymatic, and bioenergy production (Barros de Mendonca and Laques, 2017).

Research and development has its economic value also because it will provide to the markets in the logic of innovation, and this has its economic and social value, as it generates jobs and inevitably an income, which is the key to the sustainability of society. However, research cannot be neglected or left to peripheral management, because the ecosystem surrounding this economic framework needs to be understood

in all its complexity, its structures, and its processes and this requires time, effort, and financial resources. Therefore, it is necessary to consider an equal importance of the three dimensions in the decision-making process.

The "environmental" and "social" dimensions must be taken into account with ethics and responsibility in decision-making, by assessing the impact risks of one dimension on the other, in terms of temporal resilience or irreversibility of impacts.

The "economic" dimension must include in the time factor, the return on investment, taking into account the risk factor of irreversibility of environmental impacts and resilience.

In this context, focusing on the analysis of impacts on sustainability, research and development institutions must take into account a balance of sustainability, which may result from government policies, strategies, and projects.

2. The role of research and development in sustainability

Economic growth is necessary for nations, but it does not imply sustainability, the case of Nauru Island as an example. Therefore, it is essential to add political and social regulations to ensure efficiency. The role of research, development, and innovation becomes crucial and indispensable, as it ensures the integration and harmonization of various complex factors.

Governments must reset these production processes, replacing obsolete products and services with more sustainable ones, based on principles, objectives, and guidelines that promote sustainable development. This transformation relies on continuous and successive innovation. It is essential that all institutions adopt this new approach to meet the growing demand in an ever-evolving market (Barbieri et Al., 2010).

Creative economy and social innovation are essential factors for strengthening the innovation process, as an intensive process and a broad interaction with all stakeholders (Fachinelli, D'arisbo and Maciel, 2014).

Research, development, and innovation are important activities in this process, but they are not sufficient on their own. It is necessary to have a set of factors that are also critical, including public policies, favourable financial conditions for production, a logistics network, good management, marketing, education for underserved areas (rural), and a social awareness among stakeholders throughout the entire value chains.

It is evident to expect lasting impacts from data and information producers, which are the government research institutions. It has become a trend for developed countries and particularly in developing countries to assess the impact of research on society. "Organizations that fund research are increasingly under pressure to justify their expenditures and demonstrate that research adds value to the community" (Grant, 2006).

The market and societal demand for standards is becoming increasingly aware and exaggerated, provided that it does not affect the interests of producers and guarantees them profitability, has driven research institutions to be more effective in generating sustainable innovations. Consequently, these frameworks must have an impact assessment methodology capable of measuring the sustainability level of their scientific production, as well as a means of preserving their reliability (Heckman, 2006).

If we seek to evaluate productive performance, it is not sufficient to assess production processes and results; evaluating the impact of innovation is essential to identify the satisfaction of farmers, industries, and consumers, as well as to contribute to the improvement of their quality of life, profitability, and to measure the effects on the environment.

In other words, one of the main objectives of agricultural research institutions is therefore to develop processes for evaluating the impact of innovation (Alston, Norton, and Pardy, 1995).

3. Measuring the impact of innovation: a comprehensive approach

Before diving into the concepts and methods related to measuring the impact of innovation, it is essential to understand the historical roots and cultural differences, the various linguistic contexts that have created this concept or term "innovation," the varied perspectives on the importance of measuring the impact of innovation, as well as similar challenges in designing effective approaches.

3.1. Innovation

The word 'innovation' comes from the Latin 'Novus' that means ''New'', originally, 'Novus' generates three verbs: ''Innovare'', ''Novara'' and ''Renovare''. Moreover, of which we find the derivative in French: ''Innovation'', ''Novation'' and ''Renovation''.

The term "Innovation" appeared in 1297, which, in its meaning, refers to "the act of introducing something new, yet unknown, into an established thing."

The term "Novation" appeared in 1307 and explains that it is: "a convention by which an obligation is extinguished and replaced by a new obligation; it is the act of bringing novelty to a deed."

The term "Renovation," the first known use of this term dates back to the 14th century, and refers to: "the restoration to its original state through profound transformations."

Innovation is the introduction of a new product and a new method of production to the market, the conquest of a new market, the use of new raw materials, or the establishment of a new form of organization (Schumpeter, 1934).

In other words, innovation is a process of creative destruction that replaces old elements with new ones (Schumpeter, 1942).

Innovation means a change, but not all changes are innovations (Becker and Whisler, 1967).

Innovation has often defined, compared, or assimilated to invention. Invention involves the creation of something new, while innovation involves the use of something new. (Mohr, 1969) That is to say, inventions are potential innovations.

Innovation can take the form of an idea, a practice, or a material artifact, each of these elements possessing an attribute of novelty, whether tangible or intangible. The common understanding attributed to innovation based on the notion of novelty (a change in the state of an element compared to its previous state) (Rogers and Schoemaker, 1971).

Innovation perceived in relation to the individual or organization that implements it, while change represents a structural and functional transformation of a social system. In the concept of change, it is presented as a temporal process, with innovation serving as a triggering element (Zaltman et al., 1973).

Therefore, (Bayerre, 1980) proposes to distinguish three contexts in which the term innovation is used, each context corresponding to a specific definition of the concept:

In a large sense, innovation refers to the overall process of creation, which involves the design, development and implementation of a new idea, product or service.

In an intermediate sense, innovation refers to the adoption of a novelty by an organization, society, or individual, which means integrating an existing innovation into its operation or strategy.

In a strict sense, innovation considered as novelty itself, regardless of its creation or adoption, i.e. the result of a process of learning and maturation without necessarily involving its implementation.

Innovation consists of a new combination of materials and forces that emerges discontinuously, generating new goods to which consumers are not accustomed, creating a new method of production, opening a new market, conquering new sources of raw materials or semi-finished products, or even engendering a new, more productive method of organization (Schumpeter, 1983).

Through the connection of existing and ancient knowledge, innovation aims to create new and original solutions that provide economic benefit and contribute to sustainable development. (Drucker., 1985)

Innovation is often reduced to the commercialization of an invention, but it goes beyond that. Inventing involves creating something new in relation to what already exists, while innovating means concretely implementing that creation within an organization. In other words, innovation is the process of producing and establishing a new idea to solve a problem within an organization (Mezias and Glynn, 1993).

"To innovate," means to introduce an innovation into an established system or process, injecting elements of novelty and creativity, in order to create a new and valuable wealth (Lachmann, 1993).

An element considered innovative if it evokes a perception of novelty in the individual, whether it is an object, a service, or an idea, even if they already existed before and actually being rediscovered for the first time. (Kotler and Dubois, 1994).

In a publication by the OECD (1994), innovation defined as the transformation of an idea into a new or improved product introduced to the market, or a new or improved operational process used in a given sector.

According to Rogers' (1995) theory on the diffusion of innovations, the adoption of a new idea, object, or practice depends on four key elements. The first factor is the innovation itself, regarded as a novelty perceived by an individual or an adopting unit. The perceived characteristics of the innovation, including relative advantage, compatibility, testability, observability, and complexity, influence the likelihood of its adoption. In this study, we will explore the role of these characteristics in the adoption and diffusion of practices for adapting to climate change and variability.

The concept of innovation deduces an intentional process of transformation, carried out individually or collectively, aimed at introducing, modifying, restoring, or relocating an element or system within a pre-existing environment (Adamczewski, 1996).

Innovation lies in the successful transformation of ideas and knowledge into added value, which can take the form of commercial profit, collective well-being, or an improvement in daily life. It is both a new product or process and the dynamic process that enables the achievement of this result (Morel., 1998).

Innovation involves creating, developing, and marketing new products or services, or introducing new methods and techniques to enhance the efficiency and performance of an individual or a business (Archirbugi et al., 1998).

Innovation is also a process that creates forms of organization, technical objects, modes of use, skills, rules, practices, or new actors. It is not limited to its technical aspects but encompasses all kinds of realities that are related to it (Dubuisson and Kabla, 1999).

In their literature review, Garcia et Calantone (2002) state that "the innovation process has been identified for radical, incremental, truly new, discontinuous, and imitative innovations, as well as for architectural, modular, enhancing, and evolutionary innovations."

Innovation is presented as an influencing process that leads to social or organizational change, and whose effect is to deteriorate existing barriers and propose new ones (Goux-Baudiment., 2004).

Innovation is essential to accelerate, equitably and sustainably transform agriculture, by promoting an increase in productivity, seeking sustainable practices, and conserving the environment and biodiversity, while reducing poverty and creating added value, in order to ensure long-term food security (OECD., 2005)

According to “L’académie Française”, innovation is the action of introducing something new into a practice, a custom, a belief, a scientific or philosophical system (Bénédicte., 2006)

"Innovation is the application of technological, institutional, and human resources and discoveries to production processes resulting in new practices, new products and markets, and new institutions and organizations with enhanced efficiency." (Pool et Burckly., 2006)

Researchers often use the term "truly new" innovation to refer to a concept that may be considered "radical" or "discontinuous" by others. However, the authors emphasize that a clear delineation between different degrees of innovativeness (high, moderate, or low) is rarely established and that there is no obvious link between these degrees and the categories of "radical," "truly new," or "incremental" innovations. This ambivalence can be explained, by the fact that the concepts used to study the phenomenon of innovation are not always precisely defined. Leading to confusion and a lack of consistency and identification of innovations. As well as non-compliant classification, since the same terms are used to refer to different types of innovations or even the same innovation is classified under different typologies (Eris and Saatcioglu, 2006).

"Innovation is at the very heart of the entrepreneurial approach. The concept of innovation is directly related to that of the enterprise, and practically all business projects are fundamentally based on an innovation." (Tidd et al., 2006).

However, it is important to explain the term "innovation" in the context of this study. To do this, it is essential to first acknowledge that the dynamism of local actors in terms of innovation in adaptation practices is increasingly recognized and valued in adaptation planning (Chouinard et al., 2006; Lepage, 2009).

"Innovation can be seen as the implementation of a product (good or service), a new or significantly improved process, a new marketing method, or a new organizational method in the practices of the company, the organization of the workplace, or external relations." (OECD, 2007)

Innovation is about making changes to what already exists by introducing something new. It can be radical or incremental, and can be applied to products, processes, or services in any type of organization. It can take place at any level of the organization, from management teams to departments and even at the individual level (O'Sullivan, 2008).

Farmers have always been subject to climatic uncertainties, but without necessarily adapting their practices. However, by considering climate change and variability as unprecedented phenomena in their scope, they have learned to modify their tools and agricultural practices over time, through experience and practice. These adjustments, referred to as "routine innovations" or "micro-inventions," often involve not only the adoption of new techniques but also the improvement and adaptation of existing practices, taking into account regional and local specificities. These actions are the result of a blend of new ideas, attitudes, and practices derived from diverse sources (Veen, 2010).

Innovation based on broad social understanding considers that society is at the heart of the economy and that the environment is an essential element. It creates a link between these different elements, including the sustainable development agenda. Social innovations are innovative solutions for products, processes, services, technologies, or models that simultaneously address a social need (Pisano et al., 2015).

The innovation process is fueled by interactions within a community of actors that bring together scientific and non-scientific knowledge to resonate with each other. (Barret et al., 2018).

3.2. Innovation: the result of ideas and discussions

Innovation is a key concept that influences economic, social, and technological development worldwide (Marchand et Laau-Laurin., 2024). It represents not only the creation of new ideas but also their implementation to provide added value.

Ideas are at the heart of the innovation process. They represent the essential starting point that allows for the transformation of abstract concepts into tangible products, services, or solutions (Hamdi‑Kidar., 2023). They can emerge from various sources. Innovation management involves the generation of ideas, the evaluation, and the implementation of these ideas. Techniques such as brainstorming and interdisciplinary collaboration are essential to stimulate creativity (Gall., 2015). By creating a free environment to share ideas, companies discover innovative solutions to complex problems (Chorfi et Al., 2024).

Discussions on innovation play a crucial role in the dissemination of ideas and best practices. They allow industry stakeholders to exchange viewpoints, learn from one another, and explore new perspectives (Hamdi‑Kidar., 2023). Forums, conferences, and workshops are ideal platforms for these exchanges. For instance, establishing a culture of innovation within an organization requires open communication across all hierarchical levels. This not only fosters a better understanding of the challenges the company faces but also encourages greater employee involvement in the innovation process.

The origin of innovation is a lively debate that opposes proponents of the "technology push" approach, who see scientific and technological breakthroughs as the source of innovation, to those who emphasize the role of market changes and demand. According to a synthesis of empirical studies conducted by Mowery and Rosenberg (1979), there exists a complex process of innovation that is influenced by both factors and cannot be reduced to a linear model. Von Hippel (1988) highlighted that the source of innovation can vary significantly, ranging from users to suppliers to manufacturers. Companies have also developed their own research and development systems to address specific needs related to information distribution, particularly for reasons of secrecy and competitive advantage. Dosi (1982) highlighted that market changes tend to lead to marginal innovations, but that changes in demand endowments cannot explain the emergence of radically new technologies.

3.3. Incremental and radical innovations

Innovations can be classified into two main categories (Chauveau et al., 1999): 1- incremental innovations, which involve gradual improvements. 2- radical innovations, which consist of creating new technologies or paradigms, and define them as follows:

Incremental innovations are progressive improvements and minor adjustments to existing products, services, or processes, aimed at optimizing efficiency and performance without disrupting the fundamental structures in place (Mansfield, 1968). According to Dosi (1982), these innovations operate within a technological paradigm, which guides technological development during a given period, allowing companies to remain competitive without engaging in radical changes. Innovation trajectories are often influenced by incremental innovations, which enable organizations to gradually adapt to market changes while maintaining their technological base (Tushman and Anderson, 1986). The advantages of these innovations include lower risk, controlled costs, and continuous improvement within organizations, thereby enhancing their agility. This allows companies to continue to innovate while minimizing disruption to their operations.

Radical innovations are distinguished from incremental innovations by their profound impact on the technical system, the forms of work organization, and the structure of the production system, disrupting not only existing technological paradigms but also the very morphology of the production system. These radical innovations lead to a break in trajectory both in the production process and in the market structure, challenging established production methods and creating new markets. This can be observed, for example, with the advent of electronics, which has transformed the home appliance and consumer electronics industries (Le Bas et Al., 2003). On the contrary, incremental or regular innovations involve the continuity of the technological trajectory in an already defined market, allowing for the improvement of existing products or services without fundamentally challenging the production methods or market structure. Revolutionary innovations, such as the introduction of jet engines in commercial aviation, combine a break in technological trajectory with market continuity, while niche innovations, such as the use of social networks for corporate communication, are characterized by the discovery of a new market without necessarily involving a break in technological trajectory (Chauveau et al., 1999).

3.4. Invention and innovation

According to Freeman (1982), invention and innovation are key concepts in tech and the economy. Invention is basically an idea or a model for a new process or product that can be patented, meaning it has to be original and bring something new to the table. But just because something is invented doesn't mean it will make money right away, like how the transistor was a big breakthrough in electronics but didn't start raking in cash immediately. On the other hand, an innovation represents a commercially viable use of an invention, involving the implementation of this idea in a business context where it can generate revenue. Research and development (R&D) plays a key role in this process of transforming an invention into an innovation, enabling the exploration of new ideas, testing their market viability, and ensuring that inventions can be adapted to market needs, which is essential for success in a competitive environment.

4 Innovation and economy

4.1. Economic studies on agricultural innovations and the utility of the adopter

Initial studies conducted by economists specializing in the rural sector focused on the process of diffusion of hybrid corn varieties (Ruttan, 1996). Griliches (1957) revisited research initially carried out by sociologists (Ryan and Gross, 1943) concerning the diffusion of hybrid corn varieties. His work primarily concentrated on the profitability generated by this innovation. He conducted an econometric study to examine variations in adoption levels, the rate of spread, as well as the observed adoption rates in various regions. According to Feder and his colleagues (1985), Griliches is the first to have studied the econometric adoption of an innovation over time, modeled by a sigmoid function. His study highlighted that economic factors such as income, agricultural yields, and the size of farms are the main drivers of the adoption and diffusion of agricultural innovations (Griliches, 1957).

From the late 1970s, a new way of analyzing innovation emerged in the economic field. One of the first approaches to diverge from that proposed by Griliches in 1957 is based on microeconomic equilibrium models (Ruttan, 1996). These models generally examine market relationships between producers and consumers of goods and services through a price system. Anchored in microeconomic theory, they perceive the diffusion of an innovation as the result of an interaction between potential users (consumers) and the object to be adopted (the innovative good). This method is based on two fundamental assumptions: first, information plays a limited role in the diffusion of an innovation, and second, economic agents act rationally, with farmers seeking to optimize their income based on their adoption choices (Faure et al., 2018).

Thus, in this context, a low diffusion rate can be interpreted as the fact that a given innovation does not present, for certain potential adopters, a significant advantage over existing options (Rahm and Huffman, 1984). Furthermore, from the perspective of rationality, this may also reflect an expectation from adopters for a moment deemed optimal for adoption (Lissoni and Metcalf, 1994; Ruttan, 1996). However, the gradual learning process also can explain this, where users acquire experience and knowledge about the innovation through their practice (Anderson et al., 1977; Ghadim and Pannell, 1999).

The analysis of adoption through microeconomic equilibrium models frequently utilizes econometric tools such as Probit or Logit models. The latter allows for the examination of individual adoption decisions at a given moment, without concern for the temporal evolution of diffusion (Lissoni and Metcalf, 1994). This research situated within this perspective by focusing on the elements that promote the diffusion and adoption of an innovation, rather than on the detailed analysis of its diffusion curve over time.

However, this approach has limitations (Feder et al., 1985; Ruttan, 1996), which leads us to incorporate other elements into the analysis of farmers' decisions. The underlying neoclassical model assumes linearity in the innovation process, often neglecting feedback or interactions in the diffusion of innovations (Silverberg et al., 1988). In these models, innovation presented as the exclusive result of scientific knowledge, without allowing for learning or appropriation by end users. In other words, innovations would simply be offered to farmers, without them having the actual opportunity to appropriate or adapt them to their needs.

On the contrary, our research adopts an approach based on the non-linearity of innovation. We take into account the interactions that may exist between the actors involved, namely farmers and institutions, in accordance with the logic of evolutionary models.

4.2. Economic flows and their role in the development of innovation

In his Theory of Economic Evolution (1911), Schumpeter, initially an admirer of neoclassical theory, seeks to develop a theory of economic evolution distinct from the static equilibrium of the neoclassicals. He proposes that the economic system possesses a source of energy disrupting the equilibrium, an idea akin to the teachings of Karl Marx, where economic evolution is an autonomous process generated by the system itself (Schumpeter, 1937/1989, cited by Fagerberg, 2003).

The Schumpeterian approach thus integrates elements from Marxist, neoclassical doctrines, and the German Historical School. It is distinguished by its emphasis on the historical specificity of economic issues and the necessity to analyze phenomena at the microeconomic level, rather than the global level (Fagerberg., 2003)).

Schumpeter initially believed that his theory of economic dynamics could coexist with the neoclassical theory of equilibrium. He defines the circular flow as an economy in equilibrium, where agents follow routines. Innovation, according to Schumpeter, disrupts these routines and triggers fundamental changes, producing winners and losers. An economy in innovation is therefore far from equilibrium and represents a break from usual practices (Nelson, 2012).

4.3. The Framework for micro-meso-macro analysis of evolutionary economy

Dopfer and Potts (2007) developed a micro-meso-macro analytical framework for economic evolution, based on three key concepts: rules, vectors, and trajectories. The concept of rules distinguishes between subject rules (cognitive and behavioral) and object rules (social and technical), which organize the actions of economic agents and their interactions. These rules are hierarchical: constitutional rules (order 0) define what is permitted within an economic system, while operational rules (order 1) govern daily functioning, and mechanism rules (order 2) pertain to the adoption of new rules (Dopfer & Potts, 2007).

The vectors of rules can be economic agents (individuals, or "*Homo Sapiens* œconomicus") or objects (organizations, products). Economic evolution results from an interaction between these vectors, which embody and propagate the rules through social and technical transformations (Ibid.). Trajectories represent the evolutionary paths of a rule, going through phases of innovation, adoption, and retention. This process, often described as "creative destruction," illustrates how an innovation, by breaking with existing practices, can transform a sector (Nelson, 2012).

In the agro-technical framework, innovation follows a similar trajectory. At the micro level, innovation materializes through the adoption of new practices or technologies by a local innovator or entrepreneur. At the meso level, these innovations adopted by a larger population, creating dynamics of selection and differentiated growth. At the macro level, the coordination of rules and their widespread adoption lead to a reorganization of agricultural practices at the regional level, influencing the structure of local agriculture. This process depends on the interaction between local actors, organizational structures, and agricultural technologies, as demonstrated by Dopfer and Potts (2007) in their analysis of evolutionary economic systems.

Thus, agro-technical innovation in the El Oued province can be seen as a co-evolutionary process, where technical and social rules intersect and reinforce each other to transform agricultural practices, guided by evolving innovation trajectories.

4.4. Innovation and Economic currents

4.4.1. Classical economists and innovation

The initial studies on innovation find their origins in classical economists (Conte, 2006; Spielman, 2005; Antonelli, 2009). Adam Smith ([1776] 2002) was the first to recognize the importance of technical change and its role in yields and society, highlighting the impact of new production techniques and divisions of labor. Morroni (1992), in Production Process and Technical Change, distinguishes three crucial dimensions for the economic analysis of productive activity and technical change: (i) The relationship between the quantities of inputs and physical yield, and, at given prices, between the costs of inputs and yield (profitability). (ii) The relationship between time, modes of execution, and the organization of productive units. (iii) The change that generates new inputs and/or outputs according to technological possibilities and demand (qualitative transformations). Classical economists have extensively studied these dimensions. For example, Adam Smith [1776] integrated them into his analysis of the relationships between efficiency and internal organization. Ricardo (1821), cited by Spielman (2005), laid the groundwork for the analysis of innovations and technological evolution in agriculture, emphasizing the impact of innovation on productivity, income, and well-being. Karl Marx (1867), cited by Antonelli (2009), viewed technological change as a driving force of capitalist development, stating: "It is not the articles produced, but the manner in which they are made, and with what instruments, that distinguishes the different economic epochs" (Marx, 1867).

4.4.2. Neoclassical economists and innovation

A large part of neoclassical literature has neglected technical change or treated it as an exogenous phenomenon. According to this perspective, technical change is perceived as an external adjustment of the production function, caused by factors such as changes in demand or relative prices of production factors (Hayami and Ruttan, 1985; Roseboom, 1999). This approach views innovation as an economic effect rather than a process in itself. Innovation in this theory primarily concerns the application of existing technologies to maximize profit by reducing unit costs and increasing return on investment, without focusing on radical changes in products or processes.

In neoclassicism, the firm is perceived as an element in a perfect market where economic agents are rational and omniscient, seeking to maximize their profit (Boussard, 1987). Innovation, which involves the creation of new products or technologies, contradicts this static view of the economy, as it introduces a dynamic that goes beyond mere adjustment to market signals. According to Douglass North (1993), the neoclassical theory of prices in a perfect market is inappropriate for analyzing development policies, as it overlooks the institutions that structure technological development and investments in human capital. Institutions, as defined by North (1990), are essential for reducing uncertainty and guiding economic choices in a context of change.

Thus, innovation is a dynamic process that challenges the assumption of a perfectly competitive market and highlights the crucial role of institutions in guiding and facilitating this change. This framework is well illustrated by the New Institutional Economics (NIE), which emphasizes the importance of institutions in economic development and change (North, 1991; Menard, 2003). Institutions, by structuring incentives and reducing uncertainty, play a key role in the adoption of innovations and in long-term economic development.

4.4.3. Schumpeter and Innovation

At the beginning of the 20th century, a theoretical framework for the analysis of innovation systems and technological transfer emerged, largely due to the contributions of figures such as Hick and, above all, Joseph A. Schumpeter, regarded as the father of innovation economics (Antonelli, 2009; Hall and Rosenberg, 2010). In his seminal work "The Theory of Economic Development" (1934), Schumpeter defined innovation as the application of new combinations of production factors. The entrepreneur, according to him, is not merely an inventor, but rather an agent who assembles various elements to create a new product, solve a problem, or enter a market.

Schumpeter's conceptions regarding the role of the entrepreneur in innovation have evolved over time. Initially, he viewed the entrepreneur as an individual who initiated a new venture, such as a farm. Later, he expanded this perspective, seeing the entrepreneur as a collective entity, a group, or a company that formalizes research and development functions. This evolution highlighted the professionalization of research and underscored the crucial role of teams and collective actors in the innovation process.

Schumpeter (1934) also defined his "famous trilogy" to describe technological change, dividing it into three phases: invention, innovation, and diffusion. The first phase, invention, pertains to the generation of new ideas and is generally associated with fundamental science and research. Innovation represents the transformation of these ideas into marketable products and processes, linked to technology and applied

research. Schumpeter distinguished five types of innovations: (1) a new product or a new quality of product, (2) a new method of production, (3) access to new markets, (4) the discovery of new resources, and (5) a new form of organization. The final phase, diffusion, involves the spread of these products and processes across various markets.

Technological evolution results from the continuous entry of entrepreneurs and innovation processes into the market. This leads to the obsolescence of old companies and production methods, thereby encouraging firms to invest in new products and processes, a phenomenon that Schumpeter refers to as "creative destruction" (Mark I model). A secondary model, "cumulative creation" (Mark II model), describes more mature societies where innovation continues over time, thanks to the accumulation of technological advancements and industrial changes.

4.4.4. The evolutionary approach and innovation

Just like the equilibrium-based approach, the evolutionary approach emerged because of Griliches' work in 1957 (Ruttan, 1996). According to Faure et al. (2018), this approach conceptualizes the adoption of an innovation as a process leading to the selection of the most suitable technology. It challenges the diffusionist paradigm of innovation, particularly its linearity, as well as traditional models of maximization and equilibrium (Dosi and Nelson, 1994; Nelson and Winter, 1973). According to Silverberg et al. (1988), an evolutionary model must take into account the complexity of implementing innovation, as well as the levels of learning and appropriation required. Furthermore, this model must include the diversity of economic agents, considering their abilities to master technologies, their levels of education, and their behaviors.

Furthermore, it is crucial that the model takes into account specific technical and economic factors for each agent, such as the size of the company (or the farm in the case studied), the competitive advantages related to innovation, as well as market shares. Lissoni and Metcalf (1994) and Ruttan (1996) identify three main theoretical axes for evolutionary models: the innovation cycle, the selection process of economic agents in relation to innovation, and the role of prior choices in adoption (path dependence).

The cycle of innovation illustrates how the profit of users of an innovation decreases with the gradual saturation of the market. Adopters alternate between phases of equilibrium (maximum profit) and disequilibrium (zero profit), following the life cycle of innovations, which corresponds to the process of disequilibrium described by Schumpeter (1935).

The selection process examines the diffusion of innovation as a competition in the market, where only those economic agents capable of innovating can sustain themselves (Nelson and Winter, 2004).

The dependence on the path manifested in the choice of types of innovations adopted, often guided by experiences or pre-existing habits. As a result, a superior technology less adopted than a less effective alternative due to the prior choices of users (Lissoni and Metcalf, 1994).

From the late 1980s, research based on the concept of innovation systems has emerged (Edquist, 2001; Freeman, 1991; Touzard et al., 2014). This concept views innovation as a systemic process, generated by a network of actors and institutions. According to Carlsson et al. (2002), an innovation system consists of actors, organizations, and networks interacting to generate innovation at various levels (technological, sectoral, regional, or national). This system relies on the creation, diffusion, and adoption of innovations within a diversity of interconnected actors.

Research on innovation systems revolves around three axes: the theoretical framework related to the concept (discipline or school of thought), the scale or field of application (technology, sector, or nation), and the purpose (context description, knowledge production, or policy development) (Touzard et al., 2014). Applying this concept allows for the exploration of the context of emergence and evolution of innovations in Burkina Faso, while integrating all farmers and institutional actors.

5. Adoption of innovation:

5.1. Adoption: characteristics and process

The adaptation to climate change and variability refers to a process by which natural and human systems adjust to respond to a constantly evolving environment (IPCC, 2007). It includes behavioral, technological, and structural modifications aimed at either reducing vulnerability or enhancing the resilience of any type of system. This process involves various actors, ranging from individuals to governments, each motivated by multiple and varied interests (Adger, 2005). Although it constitutes a continuous process, adaptation can be broken down into four main stages (Kandlikar and Risbey, 2000).

5.1.1. Warning phase:

This stage corresponds to the detection of early warning signals, often related to climate, but also incorporating socio-economic, political, institutional, and technological dimensions (Bryant et al., 2000; Smith and Skinner, 2002).

5.1.2. Evaluation:

During this phase, the decision-maker, whether an individual (such as a farmer) or an organization (such as a government), analyzes the extent of the threat and its likely consequences in order to define the necessary measures (Smith et al., 2009).

5.1.3. Decision-making:

This is the stage where a change in behavior or performance is observed in response to the identified threat.

5.1.4. Reaction:

The final phase consists of evaluating the effectiveness of the decisions made in relation to the established objectives.

5.1.5. The adaptation is not limited to a continuous process:

It is also complex and multidimensional, capable of taking several forms (Bryant et al., 2000).

5.1.6. Characteristics of stress:

They include the stimuli that actors and systems must face, whether related to climate, socio-economic conditions, demographic growth, or government policies.

5.1.7. Characteristics of the system:

These elements encompass cultural, economic, political, institutional, and environmental aspects. They influence the sensitivity, vulnerability, and adaptive capacity of systems, factors that can either facilitate or hinder adaptation (Smith et al., 2009).

5.1.8. Adaptive responses:

Adaptive responses can be classified according to their proactive or reactive nature (Bryant et al., 2000; OECD, 2009), their temporal scope (short or long term), their spatial scale (local or regional), or according to intentionality (autonomous or planned, passive or active) and the actors involved (public or private) (OECD, 2009; Smith and Skinner, 2002). In exploring adaptive responses, several studies have analyzed decision-making dynamics, particularly among farmers at the local level (Atari, 2009; Bessant, 2006; Bryan, 2009; Bryant et al., 2008; Chiotti and Johnston, 1995; Coles, 2009; Croppenstedt, 2003; James, 2010; Simpson, 2000; Sturdy et al., 2008; Ziervogel, 2006), private forest owners (Blennow and Persson, 2009), or within informal rural social networks (Ziervogel and Downing, 2004). These studies have focused on perceptions, the use of information, and the factors influencing decision-making processes.

5.2. Resilience and vulnerability to climate change

As indicated by the IPCC (2001), vulnerability represents the inability or sensitivity of a system to endure the negative impacts of climate change and extreme weather events. Reid et al. (2007) specify that in the agricultural context, vulnerability (V) primarily arises from two factors: exposure or sensitivity (E) to environmental changes, and the adaptive capacity (A) of the system in question. These interactions can be summarized by the following formula:

$$V\,(ist) = f\,(Eist; Aist)$$

In this equation:

Vist represents the vulnerability of a system i to a climatic stimulus s, at a time t.

Eist expresses the exposure or sensitivity of system i to stimulus s at the same time.

Aist illustrates the ability of this system i to adapt to the stimulus s at the same time.

This relationship shows that increasing system exposure or sensitivity leads to increased vulnerability, while improved adaptive capacity can reduce this vulnerability (Smit and Pilifosova, 2003).

The exhibition reflects the likelihood of degradation of a system under the influence of climatic stimuli, but this notion cannot be dissociated from other factors such as social, economic, or political constraints that also influence the stress experienced by agricultural systems.

In parallel, the capacity for adaptation refers to the potential of a system, community, or region to adjust its practices to minimize the impacts of climate change (Yohe and Tol, 2001). This capacity is influenced by various elements, including technology, institutions, and social networks.

The determinants of adaptive capacity include several essential aspects. Knowledge enables the identification and understanding of climate impacts and possible solutions. Access to innovative technologies is necessary to address climate challenges. Resources, whether financial or material, are indispensable for adaptation. Institutions, with their structure and balance of power, play a central role in the implementation of strategies. Human capital, which encompasses the education and skills of individuals, as well as social capital, which relies on community networks, are determining factors for effective collective action. Risk management involves proactive preparation and a distribution of responsibilities, while information management pertains to the collection, analysis, and use of data to guide strategic decisions (Bryant et al., 2008; Smit et Pilifosova, 2003; Yohe et Tol, 2001).

5.3. Coordination and Adaptation Strategies

5.3.1. Optimization of adaptation processes

The adaptation aims to mitigate the effects of climate change on natural and human systems through structural, technological, and behavioral adjustments. Although this practice is not new, its importance becomes crucial in the face of the unprecedented challenges posed by current climate change (Fussel, 2007).

Historically, strategies such as water resource management, land use planning, and public health measures have been employed to address climatic hazards. However, Fussel (2007) emphasizes that societies must now confront unprecedented environmental and climatic conditions, which necessitates a renewed methodological approach.

La planification de l'adaptation nécessite l'intégration de données actualisées sur les conditions présentes et futures pour développer des politiques pertinentes. Cette démarche repose sur deux piliers essentiels : réduire la vulnérabilité et renforcer la résilience des communautés (Dessai et al., 2005; Luers et al., 2006; Bedsworth, 2010).

The planning of adaptation requires the integration of updated data on current and future conditions to develop relevant policies. This approach is based on two essential pillars: reducing vulnerability and strengthening the resilience of communities (Dessai et al., 2005; Luers et al., 2006; Bedsworth, 2010).

5.3.2. Management of scales: A territorialized approach

The implementation of adaptation strategies relies on a multi-scale dynamic, where each organizational level, from local to national, plays an essential role (Lazarev, 2009). The specific characteristics of each territory, combined with the particularities of the actors involved, significantly influence the effectiveness of the adopted policies.

Lepage (2009) discusses a "paradigm shift" necessary to move away from traditional vertical approaches and better integrate local vulnerability into planning. A nuanced understanding of territorial interactions and socio-economic specificities is essential to ensure the success of adaptation strategies.

5.3.3. Complexity of relationships between levels of governance

The OECD (2009) highlights the distinction between decisions made at the national level and those adopted locally. However, Matisoff (2008) nuances this perspective by emphasizing that local factors, such as citizen demands and environmental conditions, play a decisive role in the formulation of climate policies.

This complexity is illustrated by Osbahr (2008), who studied the interaction of institutions in Mozambique, demonstrating that multisectoral collaborations can encourage learning and resilience in the face of climate risks. Conversely, they highlighted the conflicts between local strategies and scientific concepts, particularly during the Elbe floods in 2002.

These analyses confirm that the harmonization of policies between levels of governance is a major challenge, but also an opportunity to develop inclusive and effective solutions (Amundsen et al., 2010).

5.4. The Obstacles to Adaptation and Policy Development

According to Biesbroek (2009), the main complexity lies in the transition from the concept of "government" to that of "governance." Governance involves the participation of a diversity of actors, ranging from public and private institutions to civil society associations, NGOs, and other stakeholders. This participation can, in theory, stimulate initiatives, but it also complicates the development of adaptation strategies, constituting a hindrance to the successful implementation of local actions. It is not governance itself that is problematic, but rather its effects, among which are the dynamics of the actors. Indeed, these dynamics can be a major obstacle to integrated management that relies on negotiations between different stakeholders in the context of managing a resource, such as the Saint Lawrence River (Gareau and Lepage, 2005). In this context, certain actors, particularly the wealthiest and best organized, benefit from an advantage. Furthermore, the partial use of scientific expertise, often characterized by its uncertainty and difficulty of access and interpretation, becomes an additional obstacle to the realization of environmental projects in the Priority Intervention Zones (PIZ) (Gareau and Lepage, 2005).

In a similar perspective, Crabbe et al. (2006) identify the institutional barriers faced by local actors, particularly municipalities, by distinguishing between external and internal obstacles. External obstacles include the lack of information regarding the impacts of climate change on water infrastructure. However, the main hindrance lies in the limited duration of elected officials' mandates, a dissuasive factor for long-term planning. Internal obstacles are related to the inadequacy of resource management, such as water resources, between municipal administrative boundaries and natural watersheds, as well as the lack of local expertise and financial resources. Bassett (2010) extends this analysis by highlighting the incompatibility of the approaches adopted to develop adaptation strategies at the municipal level. These approaches are often not very inclusive and do not involve all stakeholders, while community participation is frequently low and access to data is considered complex.

According to Bedsworth (2010) and Amundsen et al. (2010), the development of an appropriate adaptation strategy requires overcoming numerous technical and institutional barriers, such as: i. Data uncertainty, particularly regarding the extent and nature of climate impacts. Climate models indicate greater variability (IPCC, 2007), rendering certain forecasts uncertain. ii. Conflicts of objectives and necessary compromises among stakeholders. iii. Outdated regulations. iv. Failures in coordination. v. A lack of local funding and expertise. vi. Institutional limitations, particularly the ambiguity of the role of central governments in the formulation of adaptation policies.

Thus, to be effective, public policies must be able to adapt to a dynamic and uncertain environment, such as climate change. A policy that does not work in this context or fails to detect its obsolescence could hinder adaptation (Swanson, 2010). This is why Walker et al. (2010), cited by Swanson (2010), emphasize the importance of integrating an uncertainty-based approach into policy design, using the following tools: (i) Integrated and forward-looking management, which assists decision-makers in designing policies in a retrospective and anticipatory manner. (ii) Integrated policy adjustment, which allows for the rapid adaptation of policies to new realities. (iii) Continuous learning, useful for identifying emerging issues that may affect policy. (iv) Participation of all stakeholders, facilitating the search for compromises and the recognition of shared values. (v) Encouragement of the autonomy of social networks, preserving existing social capital. (vi) Decentralization of decisions, promoting responsiveness to unforeseen events. (vii) Encouragement of diversity, which strengthens the resilience of systems in the face of changes.

Smith et al. (2009) share this vision and add that local leadership and public funding for adaptation are essential to align government actions with the various scales of climate change adaptation.

5.5. Local Knowledge and Adaptation

Numerous studies, such as those by Bryant et al. (2008), Bryant et al. (2000), and Smith and Skinner (2002), address the theme of adaptation to climate change, with particular attention given to case studies that illustrate how communities respond to climate changes. These studies, based on surveys and interviews, examine the importance of considering local knowledge in adaptation strategies. Indigenous peoples, often marginalized in discussions on adaptation and mitigation of climate change effects, are nonetheless among the most vulnerable (IPCC, 2001). Their survival depends on their ability to interpret natural cycles and adapt their actions accordingly.

Local knowledge, particularly that of indigenous peoples, plays a crucial role in the management of natural resources and can fill the gaps left by missing climate data. Green (2010) emphasizes that this knowledge is valuable, especially in regions where scientific observations are scarce. It is now recognized that adapting management strategies to the local context is fundamental. This approach is increasingly being applied for adaptation to climate change and climate variability.

Local knowledge is therefore a key element in understanding how to develop culturally appropriate adaptation strategies. However, the challenge lies in the complementarity between large-scale scientific research and local needs, requiring the engagement of researchers (Chouinard et al., 2006). Berkes (2007) goes further by emphasizing that local knowledge is not limited to a local scale, but can also inform changes at the regional level. He highlights the complementarity between traditional knowledge and modern science, particularly through the examples of the Inuvialuit and Samoan communities, which provide useful information to complement scientific data.

Neglected for a long time, traditional knowledge is now considered essential in the face of the challenges posed by climate change. By integrating this knowledge with scientific knowledge, it becomes possible to develop adaptation strategies that are better suited to the local context. Projects such as that of Tremblay et al. (2008) with the Inuit and Naskapi communities have demonstrated the importance of community participation in developing adaptation tools. Ogden and Innes (2009) support this view by emphasizing that adaptation strategies must combine local, scientific, and governmental knowledge to be effective.

5.6. Theories related to the adoption of innovations

They define this concept as a decision-making process by which an individual or organization chooses to use an innovation in order to achieve a specific objective (Rogers, 1995).

According to these theories, several factors influence the decision to accept or reject a new technology or method. Among these elements are essential questions such as:

• Does the innovation offer superior advantages compared to the user's current practices?

• Is it easy to understand and use?

• Have peers or other similar individuals adopted it, and if so, what have their experiences been?

• Does the innovation align with the user's values, beliefs, and identity?

• Can it be tested before making a definitive commitment?

• What risks are associated with its adoption?

All these considerations share a common denominator: the perception of the utility of innovation, which constitutes a central element of these theories.

5.6.1. Theory of Reasoned Action

The theory of reasoned action posits that human behaviour influenced primarily by behavioural intention, which plays a central role. Indeed, when a person expresses a clear intention to adopt a behaviour in a particular situation, this behaviour will materialize a strong likelihood. This intention shaped by three key elements:

Attitude toward the behaviour: This refers to the individual's beliefs about the positive or negative consequences associated with the behaviour, as well as the importance they attach to these consequences.

Subjective norms: They refer to the individual's perception regarding the expectations of significant others and their desire to conform to these expectations. For example, the adoption of an agricultural technique by a farmer may be strongly influenced by the opinion of a family member, such as their father.

Perception of behavioural control: It refers to how the individual perceives external factors that facilitate or complicate the adoption of a given behaviour.

This model, developed by Fishbein and Ajzen (1975), has its roots in social psychology and explores the relationships between beliefs, attitudes, norms, intentions, and behaviors. According to its designers, an individual's behavior is largely determined by their intention, which is influenced by their attitude and the subjective norms related to that behavior. Subjective norms are defined as the individual's perception of the expectations of their peers regarding the behavior in question. In summary, behavioral intention can be formulated as a combination of attitude and subjective norms.

This model is based on the idea that external stimuli can modify an individual's belief structure, thereby influencing their attitudes. Furthermore, the individual's normative beliefs and their level of motivation to adhere to these norms modulate subjective norms.

5.6.2. Technology Acceptance Model

Direct extension of the theory of reasoned action, the technology acceptance model (Davis, 1986) aims to predict the acceptability of an innovation and to identify the necessary adjustments to improve its performance and promote its adoption. This model is based on two fundamental factors:

- Perception of usefulness: For an innovation to be accepted, it must be perceived as beneficial for accomplishing the intended tasks.
- Perception of ease of use: A technology must be easy to understand and use to encourage its adoption. An intuitive interface, for example, gives the user a heightened sense of control, as highlighted by Lepper (1982).

However, Davis's (1989) research has shown that the intention to use an innovation is more influenced by perceived usefulness than by ease of use. Thus, perceived usefulness appears to be the main driver of adoption. A meta-analysis conducted by King and He (2006, cited by Manon, 2007) has consolidated the predictive validity and robustness of this model in various contexts.

5.6.3. Theory of Planned Action

The theory of planned behavior (Ajzen, 1985; 1991) is an evolution of the theory of reasoned action. It introduces an additional element to account for behaviors over which individuals have only partial control: the perception of behavioral control. Ajzen defines this concept as the individual's perception of the ease or difficulty of adopting a given behavior, influenced by their resources, abilities, opportunities available to them, and the likelihood of success.

5.6.4. Levels of technological preparation

The levels of technological preparedness (Parasuraman, 2000, cited by Jabeur, 2008) measure an individual's ability to adopt new technologies. This model is based on four main dimensions:

- Optimism: A positive view of technology, perceived as a lever for efficiency and flexibility.
- Innovative spirit: The tendency to quickly adopt new technologies.
- Discomfort: The feeling of not having enough control over technology.
- Insecurity: Distrust regarding the reliability of technological tools.

5.6.5. Model of Rational Adoption Choices

This model is based on the idea that technological adoption results from rational economic reasoning where the individual seeks to maximize a utility function under constraints (Domencich and McFadden, 1975; Hausman & McFadden, 1984, cited by Richefort, 2008). Adoption occurs when the expected utility with the technology exceeds that obtained without it. Despite its strengths, this model faces criticism, particularly for the limited role assigned to social interactions and learning.

5.6.6. The theory of diffusion of innovation

The diffusion and adoption of innovations represent major challenges in the agricultural sector. Sociologists, such as Rogers (1995), have studied the mechanisms of diffusion and categorized users into technological categories, notably "early innovators" and "followers." This adoption process often follows an S-curve, characterized by an initial phase of slow adoption, a rapid growth phase as the innovation becomes popular, and a final plateau when the market reaches saturation. Geographers, like Hägerstrand (1967), have focused on the spatial aspect of diffusion, particularly relevant in agriculture, where potential users are dispersed over vast geographical areas. This dispersion underscores the importance of analyzing the mechanisms that facilitate adoption.

Initially proposed in 1962 by Everett Rogers, the diffusion of innovations theory remains a central conceptual framework for understanding the acceptability and adoption of new technologies, both at the individual and organizational levels (Zaltman, Duncan & Holbeck, 1973). Rogers (1983) defines diffusion as "the process by which an innovation is communicated through certain channels over time to the members of a social system." This theory identifies four main elements: innovation, communication channels, time, and the social system.

According to Rogers (1995), several criteria influence adoption, such as relative advantage, compatibility, complexity, testability, and observability. These criteria demonstrate that adoption depends not only on perceived benefits but also on the social and cultural frameworks of the adopters. However, this model is not without criticism. Authors like Kpokpogbé (2000) highlight its limitations in terms of uniformity among adopters and the consistency of profitability over time, thereby justifying the use of other approaches, such as the rational choice model.

5.7. Innovation in agriculture

For millennia, innovation has shaped agriculture and rural activities, whether resulting from chance or from the informal yet intentional initiatives of rural communities seeking better-suited solutions for production and organization (Poole, 2006). The integration of these new organizational approaches enables farmers to enhance the efficiency of their production systems while providing them with means to overcome the challenges they face. Although few farmers directly adopt advanced technologies such as biotechnology, electronics, or computing, Bonny and Daucé have highlighted that many aspire, sometimes implicitly, to utilize their applications to address the increasing difficulties they encounter.

5.7.1. Induced innovation: rationality of farmers

The economic theory of induced innovation in agriculture establishes a close relationship between the technological choices of farmers and the environmental constraints they face. It suggests that certain environmental degradations may self-correct. The scarcity of resources or the increase in costs, whether private or social, resulting from these degradations, encourages the adoption of new agricultural practices and sustainable resource management methods (Zeller et al., 1998).

Based on empirical observations made by Ruttan and Hayami, this theory views innovation as a response of economic agents to the constraints encountered. These innovations emerge under the influence of economic conditions, particularly the scarcity of resources and the economic opportunities they generate (Mastaki Namegabe, 2006).

Ruttan and Hayami observe that innovation does not solely result from the reaction of companies, motivated by profit maximization in response to market price fluctuations, but also from the responses of public and private research institutions to changes in factor endowments and economic developments (Mounier, 1992).

According to these authors, the land/man ratio is a key factor influencing the direction of technical changes in agriculture. This theory also emphasizes that the pursuit of profitability encourages companies to be not only efficient but also to push the technological boundaries through research and the adoption of innovations. This allows for overcoming the constraints associated with the maximum exploitation of available resources. Farmers characterized by economic rationality.

5.7.2. Induced Innovation and the Dynamics of Agrarian Systems

Numerous studies confirm the validity of the induced innovation theory and its connection to the dynamics of agrarian systems. Ruthenberg (1980), in his analysis of tropical agrarian systems, identifies several agricultural innovations associated with population growth, increased population density, and greater market integration in various agroecological zones. He explains the observed changes in cultivation techniques and soil management by the scarcity of land and the degradation of its fertility.

5.8. The Factors of Adoption of Agricultural Innovations in Economics

5.8.1. The Socioeconomic Factors in the Adoption of Agricultural Innovations

In general, economists seek to explain the adoption of innovations by analyzing the relevance of several explanatory variables. Among these variables, socioeconomic factors such as age, education level, farm size, labor availability, income, and access to credit are often studied.

Age frequently plays a crucial yet ambiguous role. There is a negative correlation: older farmers tend to adopt fewer innovations, while younger ones are more inclined to innovate due to a longer time horizon (Adesina et al., 2000; Anderson et al., 2005). However, some studies indicate a positive relationship, suggesting that the experience of older farmers may offset this bias (Gedikoglu et al., 2011; Ghazalian et al., 2009).

The level of education is often associated with an increased adoption of innovations. A higher educational level enables individuals to understand and anticipate the benefits of new techniques (Abdulai and Huffman, 2005; Baffoe-Asare et al., 2013). However, in certain analyses, this variable has not always been significant.

The size of farms is positively correlated with the rate of adoption of agricultural innovations. This trend is highlighted in research conducted in South Asia, The Gambia, and Ghana, regarding the use of tractors or pesticides (Binswanger, 1978; Weil, 1970; Baffoe-Asare et al., 2013).

The availability of labor also influences adoption. Agricultural innovations requiring significant labor are often less adopted in regions where labor is scarce, particularly during the rainy season (Ouédraogo et al., 1982; Feder et al., 1985).

High incomes facilitate the adoption of agricultural innovations. Financial aid and subsidies can also play a key role in overcoming economic barriers (Mariano et al., 2012).

Access to credit is a decisive factor. Farmers who face difficulties in obtaining loans are less likely to adopt new technologies, especially those with low collateral (Abdulai and Huffman, 2005; Pingali, 2012).

5.8.2. The Factors Related to the Characteristics of Agricultural Innovations

In addition to socioeconomic factors, the intrinsic characteristics of innovations strongly influence their adoption. These characteristics determine their perceived utility by farmers, a central concept in the consumer theory developed by Lancaster (1966).

Farmers primarily adopt innovations that meet their specific needs, particularly in varied agroecological contexts. For instance, in arid areas, techniques aimed at alleviating water stress, such as supplementary irrigation, are widely favored (Binswanger and Pingali, 1988).

The perceptions of farmers regarding the benefits of an innovation also play an important role. For example, the quality of seeds or the cooking time of agricultural products are key elements that influence adoption decisions in certain African countries (Adesina and Baidu-Forson, 1995).

5.8.3. The Risk Aversion Levels of Farmers

The inherent economic risks associated with agriculture, such as climate variations or price fluctuations, influence farmers' behaviors. Individuals who are more risk-averse are more hesitant to adopt innovations, as demonstrated in several studies (Feder and Umali, 1993; Menapace et al., 2015).

Various approaches have been employed to assess attitudes towards risk, ranging from lottery games to questionnaires on personal preferences (Binswanger, 1980; Dohmen et al., 2011). However, these analyses are often static, even though the adoption of innovations is a dynamic process involving several stages, such as initial investment, acquisition of equipment, and effective use.

6. Procedure and approach of innovation

6.1. The innovation process and its specificities

Innovation can be defined as a process of value creation (Morel, 1998), related to the enhancement of the value of products and services, particularly through the increasing integration of intangible aspects (Taravel, 2004). This specificity distinguishes it from invention (Garcia and Calantone, 2002). According to Boly (2004), the value of an innovation is based on eight components: financial, strategic, intellectual, commercial, functional, related to novelty, reputation, and the pleasure of stakeholders.

An innovative process is characterized by its permanent and dynamic nature. It incorporates constant evolutions of products, modes of thinking, and knowledge (Morel, 1998). However, it is also marked by a high level of uncertainty, due to technical performance, market attitudes, and resource contingencies. This uncertainty increases with the degree of innovation (Ferney-Walch and Romon, 2006).

The risks associated with innovation are numerous, ranging from financing to profitable exploitation, including technical, human, or financial obstacles (Boly, 2004; Tidd et al., 2006). Despite these challenges, failing to innovate exposes companies to risks of stagnation or disappearance. Technological, commercial, and organizational innovation remains essential, although it requires rigorous management and the mobilization of significant resources (Le Masson et al., 2006).

According to Khalil (2000), the technological innovation process comprises eight phases, from fundamental research to continuous product improvement. These phases necessitate synergy among the company's skills, resources, and objectives. Innovation also relies on complex processes, particularly due to multiple interactions between variables, industrial contradictions, and the emergence of new ideas (Boly, 2004).

Giget (1994) emphasizes that the success of innovation mobilizes the best skills and resources of the company. The approaches to managing innovation, whether managerial, economic, or social, contribute to its complexity (Galanakis, 2006). Innovation seen as a deliberate and organizational process that enhances the strategic position and capabilities of companies (Ferney-Walch & Romon, 2006).

6.2. The operational levels of intervention in the field of innovation

To effectively measure a given quantity, it is essential that the operator has a precise and comprehensive understanding of the characteristics of this quantity, in order to minimize the effects of so-called influencing factors (external phenomena that may alter the measurement) that could bias the results.

Applied to technological innovation, this nuanced understanding of the subject of study allows for the identification of the most relevant indicators as well as the strategic levers to improve the management of innovative processes. However, a thorough analysis of the literature on innovation management reveals a lack of consensus regarding the precise levels of intervention available to decision-makers to optimize their strategies.

Some authors, such as Schumpeter (1934), highlight fundamental concepts such as the introduction of a new product or an innovative process. According to him, innovation manifests itself through initiatives such as the marketing of a new product, the adoption of new production methods, the exploration of new markets, or the structural reorganization of companies. In contrast, other researchers, such as Millier (2005) and Mazzarol and Reboud (2006), focus more on innovative projects.

Additional perspectives enrich this vision. Bienaymé (1994) emphasizes the cognitive dimension of innovation, describing it as a process that transforms ways of thinking and conceiving products. Dert (1997) expands this approach by highlighting the success of integrating inventions into the social fabric, a success that transcends purely technical frameworks to encompass economic, industrial, and cultural dimensions.

In light of this diversity of approaches, it is essential to clarify the levels of operational intervention within the framework of innovation management. In this perspective, we adopt the classification proposed by Boly and Morel (2006), which distinguishes five main levels:

The business environment: It encompasses the external actors interacting with the company, such as research centers, financial partners, or competitors. Actions at this level aim to optimize collaboration with these stakeholders while leveraging the opportunities presented by regulatory and competitive frameworks.

The company and its project management processes: This level includes all the resources and structures mobilized for innovation, requiring an appropriate organization, optimal resource allocation, and rigorous technological monitoring.

The project: Considered as the organizational core, this level focuses on the management of dedicated resources, the coordination of teams, and collective decision-making to ensure the success of innovative projects.

The product and its technological evolution: Represents the culmination of the innovation process, requiring reflection on specifications, life cycles, and opportunities for improvement or replacement.

Individuals and groups: Encompasses the actors responsible for the implementation and evolution of the innovation process. Managerial actions here include skill development through training and inter-company cooperation.

These five levels provide a structured and tailored approach to manage effectively innovation processes.

7. The typologies of innovation: a review of existing classifications

Numerous studies on innovation agree on distinguishing two main categories of innovations: incremental innovation and radical innovation, also known as disruptive innovation. These types are addressed under various titles in the literature: "revolutionary/incremental," "evolutionary/revolutionary," or "continuous/discontinuous" (Freeman, 1991; Kessler and Chakrabarti, 1999; Gutmann, 2003; Schilling, 2005; Schmickl and Kieser, 2008).

According to Veryzer (1998), two dimensions allow for the categorization of innovations:

Technological capability: Reflects the degree of technological development relative to current limits.

Product capability: Corresponds to the perceived advantages by the user.

7.1. Typologies of innovations from several perspectives

7.1.1. Veryzer's Typology (1998):

Veryzer distinguishes four types of innovations by crossing the levels of technological development and the benefits produced:

• Continuous innovations,

• Commercially discontinuous innovations,

• Technologically discontinuous innovations,

• Technologically and commercially discontinuous innovations.

7.1.2. Typology of Geroski and Markides (Prax et al., 2005):

This classification is based on two dimensions:

- The impact on the capabilities of established companies,
- The effect on consumer habits.

It identifies incremental, strategic, major, and radical innovation.

7.1.3. Macro/micro perspective and marketing/technology (Garcia and Calantone, 2002):

Garcia and Calantone differentiate:

- Radical innovations
- Truly new innovations
- Incremental innovations.

7.1.4. Ferney-Walch and Romon approach (2006):

These authors highlight four typologies based on the perception of novelties: Repositioned products, Reformulated products, Original products Innovations according to technology, concept, and market.

7.1.5. Typology of Cheng and Shiu (2008):

These researchers add a third category: re-innovations, which optimize costs and timelines while maintaining competitive potential. The analysis of the literature shows a great diversity of typologies for classifying innovations.

This plurality complicates the understanding of the concept of innovation and the convergence of research in this field. Harmonization of classifications could facilitate the advancement of studies on the development of new Products

8. The Methods of Evaluating Innovation

Evaluating, quantifying, and structuring innovation competencies and practices represents a major challenge for many modern organizations. This process is also crucial for assessing their overall performance (Frenkel et al., 2000). The measurement of innovation has become a central topic for researchers, industry professionals, and public authorities, as it allows for an understanding of the strengths and weaknesses of existing systems and optimizes the use of available resources (human, financial, etc.). Several studies have explored the necessary conditions for effectively managing the innovation process within companies (Griffin and Page, 1996; Chiesa et al., 1998; Adams et al., 2006; Guan et al., 2006; Wang et al., 2008).

In literature, a wide variety of definitions and evaluation criteria for innovation coexist. Adams et al. (2006), in their analysis, emphasize that no universal model currently exists to measure this process. The methods currently available may even sometimes contradict each other. A holistic approach that encompasses these diverse perspectives would be a considerable asset, as it would prevent the dispersion of measurement efforts and provide a coherent view.

a). The Challenges of Measurement Models

The measurement of innovation often fragmented into several distinct studies, each addressing specific needs of businesses or researchers, such as the identification of inputs or outputs. Some focus solely on initial resources or outcomes, neglecting the intermediate processes that transform these resources into results (Cordero, 1990; Kim and Oh, 2002). The existence of multiple approaches also reflects the diversity of innovation intervention levels: socio-political territory, enterprise, project, product, or individuals. Each of these levels requires tailored methods and practices, further complicating the establishment of a unified framework.

The models of innovation processes also influence approaches. Some authors consider this process to be linear (Daft, 1978), while others describe it as dynamic and iterative, involving complex interactions (Schroeder et al., 1989; Szymanski et al., 2007). Linear models, although simplistic, have historically dominated practices (Cooper and Kleinschmidt, 1987). However, dynamic models, which take into account the multiple interactions among actors, are now regarded as more representative of modern organizational realities (Ford and Sternman, 1998).

b). Evaluation Dimensions

Adams et al. (2006) propose a structured framework around seven key dimensions to measure the effectiveness of innovation management within companies:

- Resource management,
- Knowledge management,
- Innovation strategy,
- Organizational culture,
- Project portfolio,
- Project management,
- Commercialization.

c). Typology of Evaluation Modes

Romon (2006) distinguishes three main modes of evaluating innovation performance, based on the chosen indicators (quantitative or qualitative) and the scale of analysis (company, department, project portfolio):

Quantitative evaluation: Analysis of market shares or the number of patents filed.

Performance of future projects: Use of financial tools such as business plans.

Qualitative evaluation: Technological, commercial, and image impact, through unweighted criteria.

8.1. Analysis of Inputs

Historically, the evaluation of inputs within the innovation process has primarily relied on measuring R&D intensity, typically expressed in terms of allocated expenditures and personnel engaged in R&D (Dubuisson and Kabla, 1999; Guellec, 2003; Hagedoorn and Cloodt, 2003).

These indicators reflect the efforts made by companies in the field of research as well as the skills developed in terms of innovation, which influence their performance. R&D efforts are not limited to the current inputs of the company but also represent previous successes that constitute an essential part of the capabilities that the company builds by developing a long-term project-focused R&D strategy. R&D inputs are part of a broader set of routines adopted by companies in their innovation approaches, where previous investments influence future contributions to R&D (Hagedoorn and Cloodt, 2003).

These efforts also provide insight into the resources that companies allocate to the innovation process as well as the initiatives aimed at enhancing scientific and technological knowledge (Guellec, 2003). However, these indicators do not provide any information on the outcomes of these activities or on innovations that do not explicitly rely on scientific or technological content (Guellec, 2003). Furthermore, R&D does not encompass all the innovation efforts undertaken by companies, as certain sources of technical progress, such as learning by doing, fall outside this strict definition (OECD, 2005).

In a similar perspective, a study conducted by Chastenet and Boucherand (2007) for the Ernst & Young department explored the influence of company size (or human capital) on value creation and, consequently, on their performance. Based on a sample of 510 French companies listed during the period 2003-2006, this study compared indicators of intangible value creation, such as the relative share of intangible assets in long-term capital. It appears that this rate is all higher as the size of the company increases, reaching 76% for large companies in 2006, compared to 68 to 74% for small and medium-sized enterprises.

The results also show that medium-sized companies are more specialized in niches, particularly technological ones, for nearly 30% of them, compared to only 10% for large companies. At the same time, the human capital coefficient (the ratio of workforce to intangible assets) is significantly higher in medium-sized companies (26%) than in large ones (4%). This highlights that medium-sized companies rely more on their human resources to generate intangible value.

For all categories of businesses, the analysis of value creation requires monitoring traditional financial indicators based on profitability and growth, as well as specific indicators related to intangible capital, such as human capital, which constitutes a source of competitive advantages (Arocena and Sutz, 2003). Although economic growth increasingly relies on knowledge and innovation, it necessitates a significant reliance on a highly skilled workforce.

Despite the growing interest in this field, measurement approaches and indicators remain limited. Evaluations often focus on traditional R&D inputs (expenditures and workforce). Studies such as that of Barthet (2007) propose multicriteria methods to assess industrial machines and equipment by considering strategic, transactional, and economic aspects.

Research and development expenditures and human capital are key indicators for assessing the inputs of the innovation process. Their impact on technological performance and the creation of new products is well demonstrated (Parthasarthy and Hammond, 2002; Simonen and McCann, 2008). However, these inputs alone are insufficient to explain the process that does not utilize them or the results obtained, highlighting the importance of the internal dynamics of innovation (Iansiti and West, 1997)

8.2. Evaluation of Innovation Activities

According to the OECD (2005), innovation activities encompass all scientific, technological, organizational, financial, and commercial actions aimed at or resulting in the realization of innovations. Some of these actions are intrinsically innovative, while others, although not new, are essential for the achievement of innovations. These activities also include research and development (R&D) that is not related directly to a specific innovation.

Various researchers to assess their role in the success of companies' innovation activities have analyzed the technological innovation capabilities (ICTs). Several models been developed to audit these capabilities, with the idea that strengthening them can enhance the competitiveness of companies. Freeman (1994) emphasizes that, in the long term, technological innovation constitutes a major source of competitive advantage. Furthermore, Jonker et al. (2006) established a significant link between ICTs and the economic performance of companies. Adler and Shenbar (1990) identify four essential innovation capabilities for companies:

• Designing new products that meet market needs.

• Producing these products using appropriate technological processes.

• Responding to future needs through the development and market introduction of new products and processes.

• Adapting to unforeseen opportunities generated by competitors.

Christensen (1995) proposes four necessary assets for successfully achieving technological innovation, emphasizing their combination: assets of scientific research, process innovation, products, and aesthetic design. According to Burgelman et al. (2004), a company's ICTs encompass all organizational characteristics supporting its innovation strategy. These authors identify five key ICTs: resource management, understanding of competitive strategies, technological evolution, organizational structures, and strategic management.

Other analytical frameworks, such as that of Chiesa et al. (1998), detail the processes of technical innovation by distinguishing between core processes (design and production of new products) and supporting processes (management of human and financial resources).

Romijn and Albaladejo (2002) add to these indicators measuring the innovation capabilities of small enterprises, such as patents or product novelty, while emphasizing the need to reduce the subjectivity associated with these measures.

Yam et al. (2004) structure the evaluation of ICTs into seven capabilities: learning, R&D, resource management, production, marketing, organization, and strategic planning, associated with performance indicators (sales growth, number of new products, etc.).

Guan et al. (2006) and Koc and Ceylan (2007) highlight the close links between these capabilities and the competitiveness of companies, emphasizing the importance of effective management of internal processes to maximize innovation and its economic impacts.

8.3. Evaluation of Results

For decades, the available data to assess the outcomes of scientific, technical, and innovative activities have been limited to the number of registered patents (Schmookler, 1953; Dubuisson and Kabla, 1999; Guellec, 2003). This evaluation method applies both at the company level and to its environment. Patent counting allows for measuring the effectiveness of inventive activity, reflecting the research effort leading to technological advancements.

However, this method has several limitations:

- The patent only covers a part of the trajectory between R&D and innovation.
- It ignores the efforts made in areas such as production, marketing, and development.
- Only patentable technological inventions are taken into account, excluding other forms of innovation.
- A significant proportion of inventions are neither patented nor patentable.
- Some patents remain unused while others protect multiple innovations.
- Patents can vary in value, but no distinction is made between their relative importance.
- Patent behaviour differs across sectors, countries, and company sizes.

Despite these shortcomings, patent counting remains a commonly used indicator for assessing the inventive performance of companies in terms of innovative technologies or products (Griliches, 1990). An alternative is to analyze patent citations, a method increasingly utilized by researchers, particularly in economics (Hagedoorn and Cloodt, 2003). Unlike simple counting, citations measure the quality of a patent through its technological impact.

However, this method has its skeptics, as it requires a deep understanding of the research reports associated with the cited patents. Consequently, Guellec (2003) considers patents to be an imperfect measure of outcomes. Crepon et al. (2000) suggest adding indicators such as the percentage of sales from new products (less than five years), providing a more comprehensive view that includes improvements and imitations.

Other indicators include bibliometric statistics, articles in professional journals, and data on technological exchanges. Registered trademarks and designs, while relevant, are sometimes criticized for measuring inputs or indirect outcomes rather than the innovation activity itself (Jensen and Webster, 2004).

Furthermore, other qualitative approaches exist, such as specialized assessments by experts or surveys of managers, which provide a more detailed perspective but present challenges in implementation and comparability.

More integrated methods, such as those proposed by Tomola (2002), examine the impacts of innovation on its environment through several specific indicators, inspired by risk analysis principles (FMEA). These approaches, while useful, also suffer from limitations, particularly in terms of the reliability and subjectivity of the indicators.

In conclusion, although numerous efforts have been made to measure the outcomes of innovation, these methods often focus on specific aspects, neglecting the inputs and underlying processes. This complicates the analysis of the links between resources, activities, and outcomes, thus requiring more comprehensive and integrated approaches.

8.4. Cross-evaluation

Some approaches aim not only to evaluate an isolated phase of the innovation process (inputs, activities, outcomes) but also seek to integrate multiple stages coherently.

For example, (Chiou et al., 1999) developed a method called Technology Oriented Productivity Measurement Model (TOPMM), which allows for the assessment of both the effectiveness and efficiency of technological development processes. This model analyzes the relationships between input and output criteria, thereby providing an integrated perspective on technological productivity.

The entry criteria include:

- Development costs,
- Labor expenses,
- Material investments,
- Capital expenditures,
- Energy costs,
- Expenses for computer and robotic equipment,
- Training expenses,
- And other technological or administrative expenses.

As for the exit criteria, they include:

• Research and Development (R&D): innovations, prototypes, scientific publications, patents, etc.,

• Engineering: technical performances, advanced prototypes, technical drawings, etc.,

• Production: intermediate or finished products, associated results,

• Marketing: market studies, generated revenues,

• Finance: financial reports and analyses,

• Human resources management: training, number of employees, hours worked.

• This model, while useful, remains complex to implement, hence the authors' suggestion to integrate it into the company's information systems.

On the other hand, Hagedoorn and Cloodt (2003) propose an evaluation based on several indicators such as R&D inputs, patents, their citations, and innovative products. This composite approach addresses the limitations of isolated indicators by providing a more comprehensive and accurate measure of innovation performance.

The authors use Venn diagrams to illustrate the relationships between these indicators and to determine when it would be relevant to use a single indicator or a combination. For example, a strong overlap between indicators allows for focusing on one, while a weak overlap necessitates a detailed analysis of each indicator. Studies conducted on a panel of 1200 high-tech companies show a homogeneity of results across sectors and countries, validating the multi-indicator approach for these specific industries. However, this method remains to be tested in other sectors, particularly services, to confirm its relevance.

Finally, surveys such as the Community Innovation Survey (CIS), initiated in the 1990s by Eurostat, have enabled the measurement of innovation in companies through internationally comparable indicators. These surveys, based on the Oslo Manual, provide essential data for formulating appropriate innovation policies. They notably reveal that innovative companies often outperform their counterparts in terms of productivity and profitability. In the United States, a recent government initiative aims to develop a more precise metric for innovation. According to Walters (2007), this project relies on expert consultation to develop a measurement system validated by the public, allowing policymakers to access consensual and reliable data.

Current evaluative approaches, although effective, have shortcomings. Composite methods provide a richer overview but sometimes suffer from a lack of clarity or international comparability. Additional efforts are needed to refine these tools and adapt them to diverse sectors.

Chapter Two

Presentation Of the Study Area And the Work Methodology

I. El Oued Region

El Oued, nestled in the vast expanses of the great eastern Erg of the desert, stands out for its exceptional landscape and geographical richness. Indeed, it is positioned in the heart of the northern Sahara, of which it is an integral part. This region, known for its arid climate and high temperatures, nevertheless possesses a unique beauty due to the dominant presence of the sandy dune chain that characterizes it (Mokhnane et al., 2023).

These dunes, formed by wind erosion over the centuries, take on varied shapes and are in perpetual transformation, offering a striking spectacle to visitors and residents alike. The grains of sand, often of a brilliant golden hue, play with the sunlight, creating an impressive interplay of shadows and reflections, thus attracting desert landscape enthusiasts (Ould Rebai et al., 2017).

The Eastern Erg, which extends over several kilometers, is also the site of surprising biodiversity despite extreme climatic conditions. Furthermore, El Oued has oases that, although relatively rare in this arid expanse, provide vital water points and support plant and animal life. These fertile areas, with their lush palm groves, strongly contrast with the surrounding desert and allow for the development of adaptive agricultural activities, such as date cultivation, which is a flagship product of the region.

Thus, El Oued is much more than just a simple portion of desert; it represents a fascinating ecosystem, a rich culture, and a natural heritage to be preserved, while attracting the curious eager to discover the mysteries and beauty of the northern Sahara and its enchanting landscapes.

I.1. Climate

El Oued is distinguished by a hyper-arid climate, characterized by exceptional drought and a nearly total absence of precipitation for the majority of the year. The average annual temperature is relatively high, around 22 °C, making it one of the hottest regions in the country. Summers are particularly scorching, with temperatures reaching extremely high levels, while winters are generally mild and dry (Mokhnane et al., 2023).

Average annual precipitation is extremely low, amounting to only 78 mm according to data from the National Meteorological Office (ONM) in 2012. This low rainfall is attributed to the geographical situation of the region, which is exposed to dry and hot winds from the Sahara Desert. Precipitation is rare and often violent, taking the form of sandstorms or torrential rains that can cause sudden flooding. The scarcity of precipitation and the persistent drought have a significant impact on the environment and human activities in El Oued, necessitating adaptation measures and water resource management to cope with these extreme climatic conditions.

I.2. Water Reserve

The region benefits from a considerable underground water reserve, which is essential not only for water supply but also for the sustainable development of its agricultural, industrial, and domestic activities. This resource consists of three distinct aquifers: a free aquifer, which allows groundwater to flow freely, and two confined aquifers, namely the terminal complex and the intercalary continental. Each of these aquifers has its own hydrogeological, recharge, and sustainability characteristics, contributing to the diversity of the water resource in the region (Ould Rebai et al., 2017).

Although the desert aquifer is classified as a non-renewable resource due to its slow recharge rate, the analysis of the current extraction rate indicates that this aquifer can still meet water needs for a period exceeding 2000 years, provided that management and extraction practices remain cautious and responsible. These figures reflect a proactive approach to resource management, where strategic measures are implemented to ensure efficient and balanced use of this valuable resource (Bessaoud et al., 2019).

This scenario brilliantly illustrates an example of responsible and sustainable long-term management, highlighting the importance of human planning and intervention in maintaining the integrity of water resources. Indeed, the adequate conservation of groundwater and awareness of sustainable irrigation techniques, coupled with constant monitoring of the quality and quantity of extracted water, are essential elements to ensure that future generations can also benefit from this vital resource. Furthermore, it is important to emphasize that this approach is part of an environmental governance framework aimed at promoting a fair and equitable use of water while protecting the surrounding ecosystems that depend on these aquifers.

I.3. Population

El Oued has a population of 716,905 inhabitants. This figure reflects a dynamic settlement, of which a significant portion, namely 441,915 individuals, constitutes the active population. This active population is crucial for the economic development of the region, as it represents an important pool of available human resources for the labor market (Mokhnane et al., 2023).

Within this active population, approximately 292,500 workers are actually engaged in various professional activities. The agricultural sector, which plays a vital role in the local and national economy, employs around 130,800 individuals. This figure highlights the vitality of agriculture in the El Oued region, where niche agriculture, particularly date cultivation, is notably represented (Mokhnane et al., 2023).

From a structural perspective, it is interesting to note that among these agricultural workers, a significant proportion of 62% consists of permanent workers. This not only indicates a certain stability in agricultural jobs but also a long-term commitment to the sector, which is crucial for ensuring the sustainability of agricultural activity and strengthening local capacities. This highlights the importance of agriculture as a supporting sector for the economic life of the region, while raising questions about the challenges faced by seasonal workers and fluctuations in the agricultural market.

I.4. Agricultural Sector

El Oued has transformed into a true agricultural hub in recent years, thereby consolidating its essential role in the quest for food self-sufficiency in Algeria. This region is distinguished by the great diversity of its agricultural productions, which not only meet local needs but also contribute to the national economy. Indeed, according to recent data, El Oued ranks first nationally in agricultural production. Among the emblematic crops of the region, the potato holds a predominant position, with a production reaching 1.1 million tons in 2014. This figure already represented 35% of the total production of the country, generating an estimated turnover of around 360 million euros in 2017 (Ould Rebai et al., 2017).

Today, El Oued positions itself as the main supplier of potatoes in the country, controlling approximately 40% of the national market, which reflects its strategic importance for food security and the Algerian economy (Djouhri et al., 2023).

In parallel, the region is also distinguished by the cultivation of tomatoes, peanuts, and tobacco, all of which are agricultural products that play a crucial role in the local economy. These crops not only diversify the agricultural economy of El Oued but also meet the growing demand in national and international markets. The region has managed to develop innovative and sustainable agricultural techniques, thereby promoting high-quality production that has enabled these achievements.

Furthermore, El Oued is not limited to these flagship products. The region also ranks second nationally in date production, a fruit that holds considerable cultural and economic significance in the country. The dates from El Oued, renowned for their quality, are highly sought after in both local and international markets. In summary, the versatility of the crops, combined with advanced agricultural practices, makes this region an essential player in the Algerian agricultural landscape (Mokhnane et al., 2023).

The agricultural sector of the province has experienced rapid and significant expansion in recent years, resulting in a striking increase in cultivated area, production volume, and the value of agricultural products. This growth dynamic is particularly notable, with an annual growth rate exceeding 7.47%. This impressive figure reflects not only the effectiveness of agricultural practices but also the investments made in this field, aimed at modernizing infrastructure and adopting innovative technologies (Mokhnane et al., 2023).

The total value of agricultural production in this region has been estimated at 191.2 billion Algerian dinars (DZD), highlighting the strategic importance of this sector for the local economy. Representing 6.4% of the gross domestic product (GDP) of the wilaya, agriculture stands as a fundamental pillar of economic development, playing a crucial role in job creation and the stability of rural populations' incomes (Mokhnane et al., 2023).

Furthermore, this agricultural sector occupies a prime position within the regional economy, ranking second globally in terms of total quantity and diversity of available agricultural products. This performance is the result of a combination of favorable factors, such as conducive climatic conditions, a rich diversity of soils, and an increasingly skilled workforce. The varied crops, ranging from cereals to fruits and vegetables, as well as livestock, contribute to enriching the local supply while meeting the food needs of the population (Djouhri et al., 2023).

Furthermore, this growth is not limited solely to quantitative increases but also includes a qualitative aspect, with increased attention paid to sustainability and environmental preservation. Industry stakeholders are implementing sustainable agricultural practices to ensure that this growth dynamic is both beneficial for the economy and respectful of natural resources. In this constantly evolving landscape, the future prospects for the agricultural sector of the region appear promising, with a still largely untapped potential to enhance its contribution to the regional and national economy.

I.5. Agricultural History

Since the 2000s, the El Oued region has experienced significant and rapid growth in the agricultural sector, characterized by a considerable expansion of agricultural activities. This agricultural dynamic is primarily due to the development of open-field vegetable crops, which has allowed farmers in the region to diversify their productions and increase their productivity (Ouendeno, 2019).

The beginning of the rise of field vegetable crops was marked by the development of the potato, which has become one of the most profitable and sought-after crops in the region. The lands of the El Oued region, which were once primarily intended for the cultivation of cereals and other food crops, have gradually been converted into fallow land for potato production. This conversion has allowed farmers to benefit from the advantages of irrigation and improved cultivation techniques, which have significantly increased potato productivity in the region.

Alongside the rise of the potato, the tomato has also been cultivated in open fields. These vegetable crops have been focused on privatized lands, which have been allocated to private farmers by the Algerian government. This privatization has allowed farmers to manage their lands more flexibly and to benefit from the subsidies and tax advantages offered by the state for vegetable crops (Ould Rebai et al., 2017).

The rapid growth of field vegetable crops has contributed to the increasing involvement of the El Oued region in the Algerian and international markets. The production of potatoes and tomatoes has enabled farmers in the region to gain profitability and competitiveness, which has contributed to the increase in wealth and prosperity of the region (Ould Rebai et al., 2017).

I.6. The Agricultural Evolution of El Oued

The emergence and expansion of agriculture in the El Oued region are closely linked to the dissemination of the pivot irrigation technique, an innovative method that has transformed agricultural practices in many arid and semi-arid regions. This technique, which relies on the use of large rotating equipment to ensure uniform water distribution over vast areas, originated in the United States of America, where it was developed to maximize the productivity of arable land in areas with limited water resources (Jeder et al., 2013).

The pivot irrigation was subsequently adopted and adapted in the context of the Middle East and North Africa, supported by large state programs aimed at modernizing agriculture and improving food security in these regions. These initiatives often included massive investments in hydraulic infrastructure, training farmers in modern water management techniques, as well as financial incentives to encourage the adoption of these new practices (Benmihoub, 2015).

The implementation of this technique has not only increased the cultivated area but has also promoted the diversification of crops, allowing farmers to transition from subsistence farming to more market-oriented production. Thanks to pivot irrigation, high value-added crops, such as fruits and vegetables, have been introduced, thereby increasing farmers' income and stimulating the local economy.

Furthermore, pivot irrigation contributes to a more efficient management of water, a crucial issue in a region where water resources are limited. This technique reduces water loss through evaporation and promotes a more targeted and controlled use, thereby optimizing yields while preserving water resources (Benmihoub, 2015).

Starting from the 1970s/1980s, a significant transformation began in the agricultural sector, characterized by a shift towards artisanal pivot irrigation, which gained popularity due to its advantages in efficiency and sustainability. According to research conducted by Bisson in 2003, these irrigation systems, designed and manufactured locally, were specifically developed to adapt to the realities of the region's farms. In general, this equipment aims to irrigate an average area of about one hectare, thereby allowing farmers to optimize water use and improve crop productivity.

This transition to a mode of irrigation more suited to local conditions has had a considerable impact on cultivated and irrigated areas. Indeed, the statistical data provided by the Ministry of Agriculture shows that within a few years, the area utilized by this type of irrigation experienced remarkable expansion, increasing from 800 hectares in 2000 to 35,000 hectares in 2013. This impressive progression illustrates an exponential growth of approximately 4,300% in less than 15 years, highlighting the importance of this reform in the agricultural landscape (Ould Rebai et al., 2017).

This boom in the adoption of artisanal pivot irrigation is not limited solely to an increase in irrigated areas. It also reflects a paradigm shift in cultivation methods, promoting more sustainable and environmentally friendly practices. This has also enabled farmers to diversify their productions and strengthen their resilience against the harsh climatic uncertainties of the Sahara.

The ambition behind the integration of irrigated pivots was to transform agriculture in the twenty-first century by modernizing it and increasing its productivity, with a particular focus on cereal farming. The aim was to respond effectively and sustainably to the growing food needs of developing countries, where population pressure and demand for food continue to increase exponentially. Irrigated pivots, through their ability to ensure a regular and controlled supply of water over large areas, were seen as a promising technical solution to improve agricultural yields, reduce the risks associated with climatic variations and maximize cultivated areas. (Ould Rebai et al., 2017).

However, the implementation of these pivot systems has been largely hampered by a series of significant failures, particularly in Algeria, where the expected results have not been achieved. The reasons for these failures are multiple and complex. On the technical side, the infrastructure required for the installation and maintenance of pivots has often proven to be insufficient or inadequate, leading to breakdowns and high maintenance costs. From an agronomic point of view, challenges such as adapting cultivation methods and sustainable soil management also played a crucial role. For example, the intensive monoculture promoted by this approach may have led to soil degradation and a decrease in biodiversity, thus compromising the long-term sustainability of farms.

Socio-economic factors have also contributed to the difficulty of integrating the pivots. Local farmers, often lacking the financial and technical resources to adapt to these new farming methods, have encountered cultural resistance and concerns about their ability to manage such intensive cropping systems. In addition, unequal access to water and tensions over this precious resource in many regions have exacerbated the difficulties encountered, highlighting the need for a more integrated and locally sensitive approach to succeed in modernizing agriculture. Thus, although the concept of irrigated pivots is a source of hope for the future of agriculture, its implementation is subject to considerable challenges that require sustained attention and solutions adapted to the specific realities of each country.

During the 1980s, the region was at the heart of a large state program dedicated to cereal farming, with particular emphasis on pivot irrigation. These pivots, which extended over impressive lengths of 350 to 400 meters, were designed to irrigate agricultural land ranging from 39 to 50 hectares. This technical innovation was aimed at modernizing agricultural practices and increasing crop productivity. However, the high cost of this technology posed a major challenge, often proving to be unsuited to the objectives and technical capacities of local farmers, who lacked sufficient financial resources and training to use this equipment optimally (Benmihoub, 2015).

Despite these challenges, the appearance of potatoes on the agricultural market, introduced in 1987 by the National Office of Fruits and Vegetables of El Oued, has aroused great interest among farmers in the region. This crop quickly gained popularity thanks to the very promising yields it offered, ranging from 30 to 40 tons per hectare. These encouraging results have not only attracted the attention of farmers, but have also generated a collective momentum to diversify agricultural practices and improve food security in the region. Thus, while the pivot irrigation program was encountering difficulties, the introduction of potatoes illustrates the importance of innovation and adaptation to the realities of the field for local agricultural development (Benmihoub, 2015).

Thanks to particularly favourable climatic conditions during the winter season, the region benefits from an extended growing season, allowing farmers to produce crops in the late season. This ability to harvest fresh produce at times when market competition is reduced gives a real competitive advantage in the national market (Benmihoub., 2015).

During the 1990s, a notable failure of state programs in the agricultural sector prompted local artisans to rethink their approach to irrigation. They have thus developed a handcrafted pivot system, of more modest dimensions, measuring between 25 and 50 meters in length. This type of installation makes it possible to irrigate relatively small plots, ranging from 0.5 to 1 hectare, making irrigation more accessible and adaptable to the needs of local farmers. This innovation has not only improved irrigation efficiency, but it has also led to a significant expansion of the area dedicated to potato cultivation in the region. As a result, this increase in production has contributed to a local economic boom, while also meeting the growing market demand for this essential food product (Ould Rebai et al., 2017).

I.7. Economic and Social Analysis of the Agricultural Evolution of El Oued

Local initiative and resilience in the face of public policy challenges have enabled a new dynamic in the agricultural sector, where farmers have been able to adapt quickly to optimize their production while relying on innovative and sustainable irrigation techniques. This transformation is a testament to the ability of local actors to take advantage of available resources, even in times of economic difficulty, and to assert their place in the market as competitive producers.

This new dynamic has had a significant impact on local economies, not only providing income to local people, but also promoting job creation on farms. Indeed, this development has led to the emergence of various employment opportunities, both for seasonal workers and permanent employees, thus contributing to the reduction of unemployment and the improvement of living conditions in rural communities.

In addition, this dynamic has given rise to a dense and interconnected network of services and supplies, which brings together a plurality of actors, ranging from farmers to suppliers of agricultural equipment, processing companies and distributors. This diversification of economic actors has not only strengthened the resilience of local agricultural systems, but has also introduced a synergy that is conducive to innovation and the improvement of agricultural practices.

The sequence of interventions within this network has made it possible to create various synergies, where each actor plays a key role in the agri-food value chain. For example, farmers can access technical training from experts, which helps them adopt new farming methods or better manage their farms. Thus, cooperation between the various stakeholders promotes the sharing of knowledge and the transfer of skills, strengthening not only the productivity of farms, but also the quality of products.

An in-depth analysis of the emergence, then the design and dissemination of the artisanal pivot in the Wilaya of El Oued reveals a complex and multifaceted phenomenon, marked by the interaction of a dense network of craftsmen and traders who maintain close relations with local farmers. This process has highlighted the transition from a model of the great pivot, initially imported and widely promoted by the State, to an artisanal pivot, which is both economical, robust and adapted to the specificities of the cultural choices of local producers as well as to the conditions of exhaustion imposed by the difficult environment of the Sahara.

This transformation is not only limited to a material change, but also represents a dynamic of appropriation and local innovation, echoing the work of Akrich et al. (1988) who emphasize in a general way that "To adopt an innovation is to adapt it; it needs to be transformed, modified according to the site where it is implemented". In this respect, this perspective highlights the crucial importance of the local context in the success of innovation.

In addition, Stewart (2007) highlights the role of local artisans as key players in this process of adapting new technologies. Their practical expertise and knowledge of local realities allow them to significantly influence potential users of innovation, facilitating the integration of these technologies into agricultural practices. They act as intermediaries, enriching the transfer of knowledge and adaptations necessary for these technological innovations to be truly functional and accepted by the community.

According to Sørensen (2006), it is essential to note that "most technologies involve the construction of collective repertoires and frames of reference for action and meaning". This collective dimension underlines the importance of social interactions and shared representations in the design and use of these handcrafted pivots. Thus, the success of the integration of these new technologies is not only a question of engineering or cost, but also a question of social adhesion and rootedness in already existing cultural and agricultural practices. In this context, the emergence of the artisanal pivot in the Wilaya of El Oued is part of a dynamic of open and collaborative innovation that enriches not only the economic landscape, but also the social fabric of the region.

This knowledge encompasses not only a thorough understanding of the dynamic functioning of the region, but also a detailed assessment of the "potential market" of the innovations underway. In reality, these local artisans have an intimate knowledge of local production systems, as well as the specific expectations and varied behavior of the different farmers with whom they interact regularly. This frequent interaction allows them to take into account the realities on the ground and the specific needs of farmers, which can vary depending on the types of crop, climatic conditions and available infrastructure. In addition, these craftsmen do not hesitate to adjust the design of the equipment they manufacture in real time, taking into account their customers' feedback to improve the functionality and durability of the products.

As far as the distribution of their equipment is concerned, they implement flexible strategies adapted to the constraints of the farmers. This includes services such as on-site relocation and assembly, ensuring that the equipment is properly installed and operational upon arrival. In addition, they adopt mass production methods whenever possible, making it possible to quickly meet growing demand while maintaining uniform quality. To make their products accessible to a wider range of farmers, some artisans also offer credit sales options. This makes it easier to acquire expensive equipment for those who might otherwise be hesitant due to financial constraints.

They don't just sell equipment; They also provide attentive after-sales service and efficient repair, ensuring the continued satisfaction of their customers and strengthening their relationship of trust with them. This integrated, customer-centric approach not only ensures the sustainability of their business, but also contributes to the growth of innovation in the region.

In the framework of our study, we have chosen to explore how an entry through the innovation process can offer an enriching perspective on a dense and complex network of actors, made up of traders and craftsmen. They play varied and interconnected roles at different levels of the business cycle: from the import and distribution of parts and equipment to the manufacture and assembly of components. Without neglecting the crucial stages of assembly, installation and after-sales service, each player contributes to creating an integrated value chain essential for the proper functioning of the whole.

The in-depth analysis of socio-technical networks, when combined with a meticulous monitoring of the practices and narratives of the actors involved, has made it possible to "make invisible social relations visible" (Cross et al., 2002). This approach highlights the complexity of existing social ties and underlines the diversity of socio-technical dynamics that intervene throughout the innovation process. Indeed, this process is not linear and is influenced by multiple interactions between different economic agents (Mahdi, 1993); Thus, it becomes crucial to examine the ramifications of these relationships to better understand how innovations emerge and spread. In addition, this analysis helps us to identify the factors that can promote or hinder innovation, while revealing the often underestimated or invisibilized roles of certain actors within this interconnected web (Bouzidi et al., 2011). Ultimately, this socio-technical approach makes it possible to understand the richness of human interactions mixed with technologies, thus offering a nuanced vision of innovation environments.

II. Work Methodology

II.1. Aim of Study

To conduct a thorough scientific analysis of the phenomenon of continuous innovative dynamics that we have observed, it is crucial to understand how this dynamic is adopted by the people of the region. With this in mind, our study will focus on several important dimensions. First, we will examine the level of diffusion of innovations through a rigorous methodology, aimed at quantifying the extent to which these innovations are integrated into local agricultural practices.

At the same time, we will look at the contribution rate of the different actors in the field, who play a decisive role in facilitating farmers' access to innovations. This includes identifying intermediaries, such as cooperatives, non-governmental organizations, as well as research and development institutions that support farmers in adopting new practices and technologies. Through questionnaires and interviews, we will try to identify the strategies put in place by these actors to promote innovation.

We will also look at the mechanisms of diffusion of innovations, looking at the ways in which new ideas and technologies circulate among farmers: for example, how is information shared within communities, which communication channels are most effective, and what barriers might hinder this diffusion? We will also analyze the impact of social networks and farmer partnerships in this process.

The aim of our research is to achieve an overview of the innovation dynamics in the region, assessing not only its current state, but also the prospects for future development. To do this, we have carried out surveys with three types of professional actors in the field, which will allow us to obtain a varied and nuanced view of the situation. These actors include farmers themselves, representatives of cooperatives, as well as experts in agricultural innovation. This multi-stakeholder approach is key to identifying different perceptions and practices, and to formulate concrete recommendations that could further support and stimulate innovative momentum in the region.

II.2. Sample size and details

We have undertaken in-depth investigations involving three types of major actors on the ground who play a critical role in the agricultural sector. To do this, we have constituted a strategic sample that includes 20 administrative agents, 35 associations, 18 cooperatives, 43 agricultural input sellers and 34 craftsmen. This diverse sample was selected in order to gather accurate and diverse information on the key factors influencing the dynamics of agricultural innovation in the region. By integrating the contributions of these different actors, we aim to highlight their respective perspectives and experiences, which will allow us to understand the multiple dimensions that shape the agricultural world.

The analysis of the statements and feedback from these actors will inform us not only about the obstacles and opportunities encountered in the innovation process, but also about the mechanisms for the dissemination of agricultural innovations. Thanks to this collection of information, we will be able to draw up an accurate and nuanced overview of the local agricultural ecosystem, revealing the complex interactions between the different actors and the trends that emerge within this environment. This will provide a solid basis for better understanding agricultural development in the region, highlighting collaborative dynamics as well as innovative practices that can contribute to the sustainability and competitiveness of the sector.

II.3. Description of the information collection instrument (Interview Support - Questionnaire)

The present study implemented a rigorous approach to collect information on all the communes of the wilaya of El Oued. To ensure the quality and reliability of the data collected, a specific interview guide was designed taking into account the cultural and linguistic diversity of the region. This interview guide has been designed in such a way as to be accessible and understandable for all stakeholders, using the Arabic language with a local dialect, which is the mother tongue of the inhabitants of the Region.

This choice of language helped to strengthen the credibility and credibility of the research, ensuring optimal understanding and participation of the interviewees. By using the Arabic language to the local dialect, we were able to gather more accurate and detailed information, as the interviewees were able to express their thoughts and opinions in a freer and more authentic way. In addition, the design of this interview guide required a multidisciplinary approach, involving social scientists, linguists and anthropologists, to ensure that the guide is relevant, effective and adaptable to the reality on the ground.

The interview guide was then implemented for each group in our sample, taking into account the particularity of each group and its specific needs. This has made it possible to collect more precise and diversified information, which faithfully reflects the reality of the municipalities of the wilaya of El Oued. Finally, the implementation of this interview guide required a great deal of flexibility and adaptability, to meet the specific needs and constraints of the interviewees and the field.

The methodology used for the implementation of this interview guide has been carefully studied to ensure that the information collected is reliable and representative of the target population. The questions were carefully worded to be clear and easy to understand, and respondents were encouraged to express their opinions and thoughts freely and spontaneously

Figure 01: Interview guides used for data collection (Mehda, 2024)

II.4. Method used during the interview

The interviews were conducted directly with the participants, with a focus on face-to-face interactions, which resulted in data that was not only accurate, but also rich in detail. This direct approach fostered an environment conducive to authentic exchanges, as it allowed participants to feel more comfortable and confident. Indeed, human contact plays a crucial role in the quality of the answers obtained, as it reduces the anxiety often associated with evaluation or questioning situations. As a result, participants were able to share their opinions, feelings, and experiences without the barrier of physical distance or anonymity, which encouraged a more spontaneous and nuanced expression of their views. In addition, this method allowed the researchers to observe nonverbal cues, such as body language and facial expressions, which bring additional depth to the understanding of the answers provided. The face-to-face interaction also fosters a dynamic of dialogue where participants can ask questions and clarifications, making the investigation process even more interactive and engaging. In sum, this method of data collection is proving to be particularly effective in capturing not only the essence of the opinions expressed, but also the underlying emotions and beliefs that motivate them.

Figure 02: The researcher at a participant's workplace (Mehda, 2024)

II.5. Data Collection Period

The data collection took a place from April 2022 to April 2024, ensuring a comprehensive and thorough analysis of the information collected. In order to ensure the quality and relevance of the data, the researcher deployed all available means to visit personally the workplace of each participant. This methodological choice aimed to establish a direct and authentic connection with the participants, thus promoting a richer and more meaningful interaction. The researcher had to show great flexibility and rigorous organization by taking into account the busy schedules of the participants, often marked by time constraints and unforeseen professional events. To do this, prior contacts were made, making it possible to establish appointments adapted to the daily reality of each person, while ensuring their availability. In addition, these field visits were carefully planned, taking into account not only the personal preferences of the participants, but also the dynamics of their working environment.

This approach has fostered a more relaxed and open environment for frank and enriching exchanges. It also made it possible to directly observe work practices and interactions within the teams, which greatly contributed to the richness of the data collected. The researcher was thus able to collect first-hand testimonies and observe specific situations that might otherwise have gone unnoticed in questionnaire surveys or remote interviews.

The data collection period was characterized by a deep commitment and a willingness to immerse the researcher in the participants' work context to enhance data quality and ensure its reliability.

Figure 03: The researcher with a participant during the interview (Mehda, 2023)

II.6. Analysis and interpretation of collected data

The data was carefully collected and analyzed using two well-known tools, namely the IBM SPSS program (Version 25) and Microsoft Excel (Version 2013). Their advanced features and their ability to process large amounts of information motivated the choice of these tools efficiently and accurately.

The SPSS software was specially used for the inventory and data manipulation, thus allowing the information to be managed in a systematic and orderly manner. With its multiple features, SPSS offered a robust framework for performing in-depth statistical analysis. His data processing tools, such as statistical testing, analysis of variance, and

regression, have made it possible to analyze the relationships between different variables and to highlight significant trends within the data. In addition, SPSS also makes it easy to detect outliers and inconsistencies, ensuring the integrity of the results.

At the same time, Microsoft Excel played a key complementary role. Used for the presentation of data in the form of tables and graphs, Excel made it possible to visualize the information in a user-friendly and intuitive way. This visualization is crucial for a better understanding of the results, as it transforms complex datasets into more accessible and understandable formats. In addition, Excel was used to perform basic analyses, such as calculations of means, medians, and standard deviations, which helped to deepen the interpretation of the data. This approach allowed for simple but effective comparisons, providing preliminary insights that facilitated the identification of patterns or behaviors within the data.

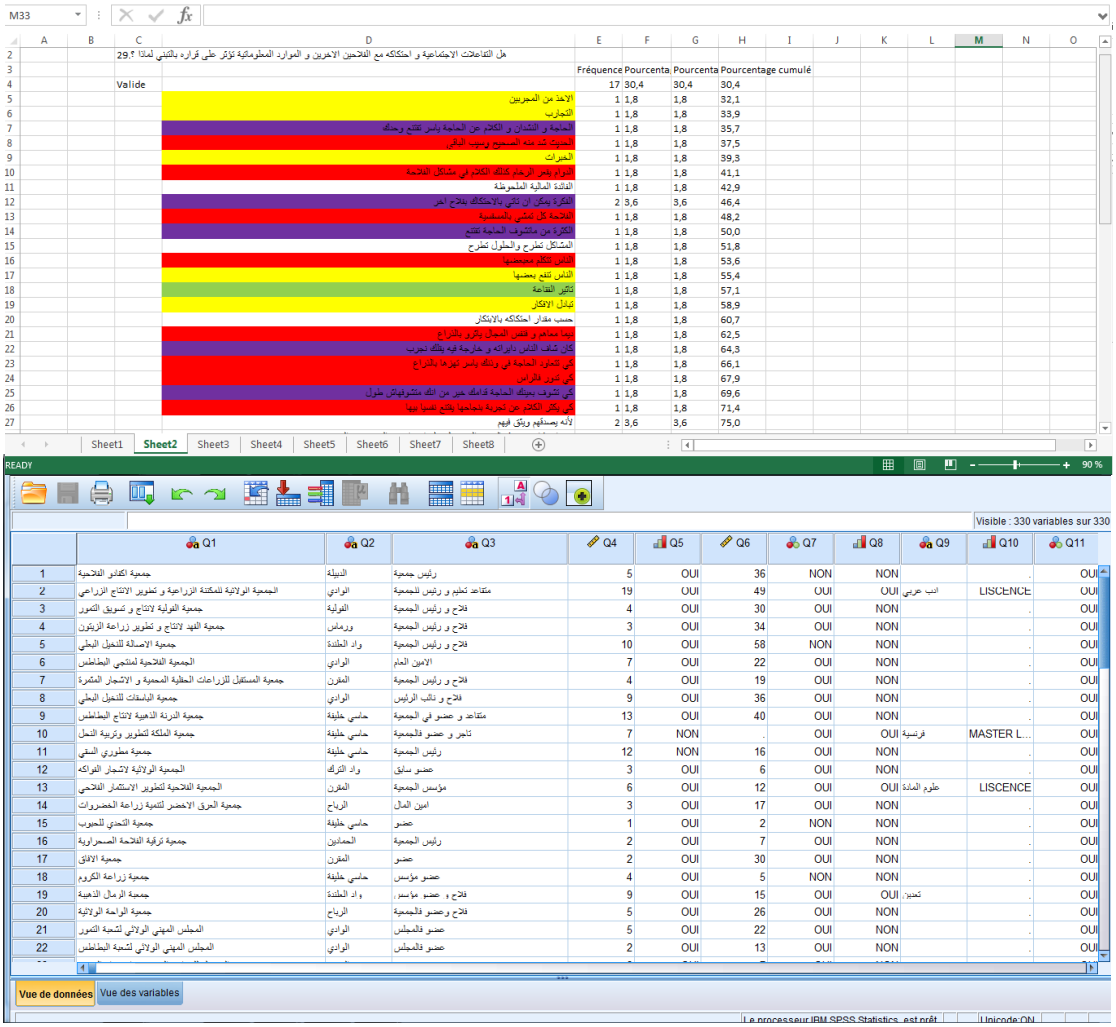


Figure 04: Software used for data analysis

Chapter Three

Results And Discussions

1. The main drivers of innovation in the El Oued region

According to the survey results (Shown in Figure N°05), a clear majority of participants, 71.4%, consider that farmers play a leading role as drivers of innovation in the agricultural sector in the wilaya of El Oued. This perception is significant because it highlights the vital link between the work of farmers and the evolution of agricultural practices and technologies, which are essential for the yields and sustainability of farms. However, the respondents do not stop there: they also attribute an important place to sellers of agricultural inputs, who are recognized as an innovative force. Indeed, 48.2% of participants believe that these actors, by providing suitable products and services, contribute significantly to the growth of innovations in the field. In addition, a significant proportion of respondents, 62.5%, emphasize the crucial role of artisan manufacturers, more commonly known as "Haddadi", in this dynamic of regional innovation. These artisans, through their expertise and creativity, enrich the agricultural landscape by offering adapted and often locally inspired solutions.

In addition, the contributions of rural communities and the various actors involved in the agricultural sector are perceived as a fundamental element of innovative dynamism in the region. This opinion shared by 71.4% of respondents, who recognize that commitment and initiatives within these communities are crucial in fostering an atmosphere conducive to innovation.

It is also essential to consider the role of the market, both in terms of supply and demand. According to 51.8% of respondents, the market is a determining factor in the adoption and diffusion of innovations within the agricultural sector in El Oued. This market dynamic directly influences the decisions of farmers and economic actors, encouraging them to adopt new practices and technologies in response to consumer expectations and needs. Thus, the interaction between all these actors creates a fertile ecosystem for innovation, where each element plays a complementary role in the evolution of the agricultural sector.

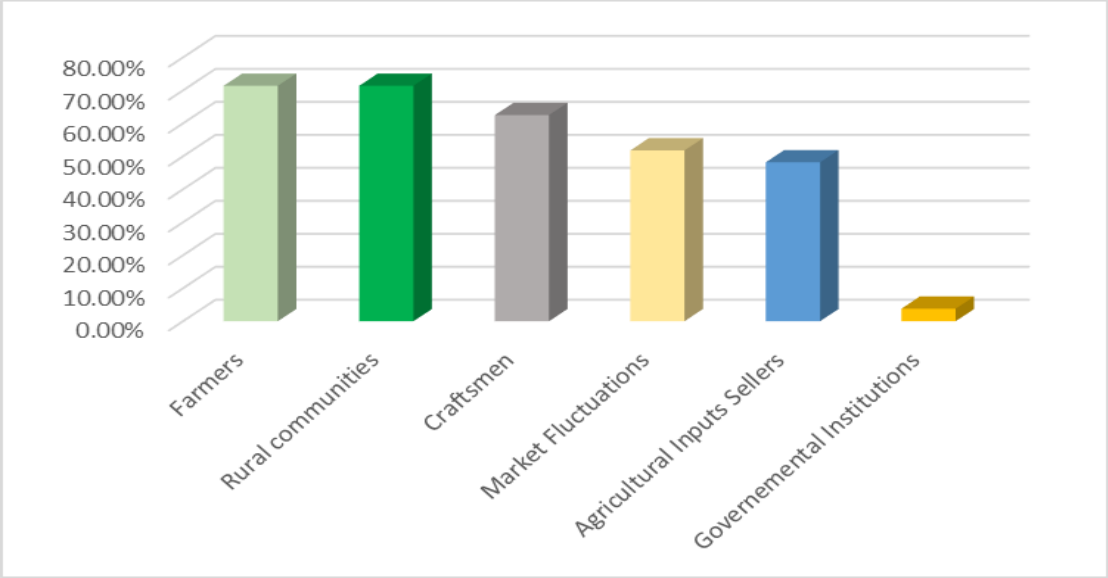


Figure 05: The main drivers of Innovations in El Oued Region.

The craftsmen were not particularly inclined to answer this question, emphasizing that they are often the originators of innovative ideas and that they have in-depth knowledge of the field, being in permanent contact with farmers. This direct and constant relationship allows them to better identify the real needs and challenges faced by producers. In a survey conducted, 23.1% of participants stated that craftsmen are the main driver of innovation in the agricultural sector in El Oued. This statement is all the more significant as it reflects the privileged position of these artisans within the local agricultural ecosystem.

Next come farmers, with 15.4% of the votes, who, although they are the practitioners of agriculture, are relegated to a secondary role in terms of innovation. At the same time, social mentality also seems to play a role, also collecting 15.4% of opinions, which underlines the importance of cultural beliefs and perceptions in the development and adoption of new agricultural practices. After that, wholesalers from outside the region and agricultural engineers are cited, each with a rate of 7.7%, which illustrates their marginal influence in the innovation process on the ground, despite their technical skills and theoretical knowledge. Finally, in last position, we find agricultural input traders. The survey participants justify their low impact by arguing that they are generally content to follow production without innovating, often increasing production costs for the benefit of their own profit margin. Their main interest seems to focus on maximizing profits, leaving little room for a significant contribution to improving agricultural practices. This raises questions about the dynamics of collaboration between different players in the sector, as well as the need for a more integrative approach to foster innovation and respond to contemporary agricultural challenges.

2. The factors that influence the decision of innovation adoption among farmers.

The respondents assessed the influence of the following factors on the decision to adopt an innovation in the agricultural sector:

Table 01: Factors influencing the decision to adopt an innovation among farmers according to professional agents.

Factors	Mean (SD)	Median	Percentage of respondants
Cost	3.63 (0.752)	4	73.2% Very Influential 21.4% Influential
Risk	2.45(1.463)	3	34.5% Very Influential 26.8% Quite influential 16.1% Influential
Benefit	3.51(0.663)	4	58.9% Very Influential 30.4% Influential
Availability	2.55(1.278)	5	37.5% Influential 25% Very Influential 16.1% Quite influential
Necessity	3.57(0.568)	4	60.7% Very Influential 35.7% Influential
Time of appearance	3(0.923)	3	48.2% Influential 30.4% Very Influential
Field observation	3.39(0.705)	4	51.8% Very Influential 35.7% Influential
Professional experience	2.8(0.931)	3	50% Influential 21.8% Quite influential 19.6% Very Influential
Knowledge acquired in the field	2.47(1.016)	3	39.3% Influential 35.7% Quite influential
Financial capacity	3.25(0.919)	3	48.2% Very Influential 37.5% Influential

The table presents in detail the various factors that influence farmers' adoption of innovations, while drawing on the perspective of professional agents directly involved in the field. The results of this analysis highlight the crucial importance of costs, potential benefits and the perceived necessity of an innovation in farmers' decision-making. It is clear that economic factors play a primary role in their choice, suggesting that farmers first assess the financial implications of adopting a new technology or method.

In addition, the necessity often arises from specific production, sustainability or competitive needs, reinforcing the idea that decision-makers must consider not only the immediate benefits of an innovation, but also its adequacy with local contexts and market realities.

However, it is interesting to note that other factors such as the risk associated with adoption and the availability of innovations seem to exert a relatively lesser influence on the decision to adopt. This phenomenon could be explained by farmers' increased sensitivity to uncertainty: they generally show a rather low risk tolerance, preferring options that are perceived as involving a low level of risk or that promise substantial rewards. This behavior indicates a certain prudence, where farmers prefer to adopt innovations that offer a guarantee of proven success, rather than engage in risky experiments. Thus, by analyzing these dynamics, it is possible to better understand the practical realities faced by farmers, while shedding light on the ways in which professional agents can support a wider and more effective adoption of innovations

According to the statements of professional actors in the agricultural sector, it is clear that craftsmen also share a strong opinion on the importance of two determining factors: cost and necessity. These elements are perceived as essential in farmers' decision-making regarding the adoption of new practices or innovations. However, it is interesting to note that, contrary to initial expectations, craftsmen believe that the benefits associated with these innovations are not as significant as one might think.

When it comes to risks, a worrying reality emerges. Artisans explicitly expressed that these risks exert a considerable influence on the decisions of farmers, who tend to be particularly cautious and reluctant to engage in risky approaches. This behavior contrasts with the perspective of experts who are often more inclined to accept a certain amount of risk in the context of their practice. Another essential dimension to take into account is the abundance factor, which seems to play a crucial role in the perception of artisans. Indeed, 77% of artisan participants affirmed that this abundance has a substantial impact, emphasizing that farmers cannot afford to compromise their production by taking the risk of trying innovations, especially if these are likely to be hampered by the scarcity of necessary resources or by the absence of appropriate means.

In addition, several other aspects also influence farmers' adoption decisions. The time available to adapt to new practices, the field vision that can guide decision-making, and the prior knowledge accumulated during their experience play a significant role. All of these factors combined create a complex landscape that farmers must navigate, carefully weighing the pros and cons before committing to innovative directions that could transform their working methods and, potentially, the future of their production.

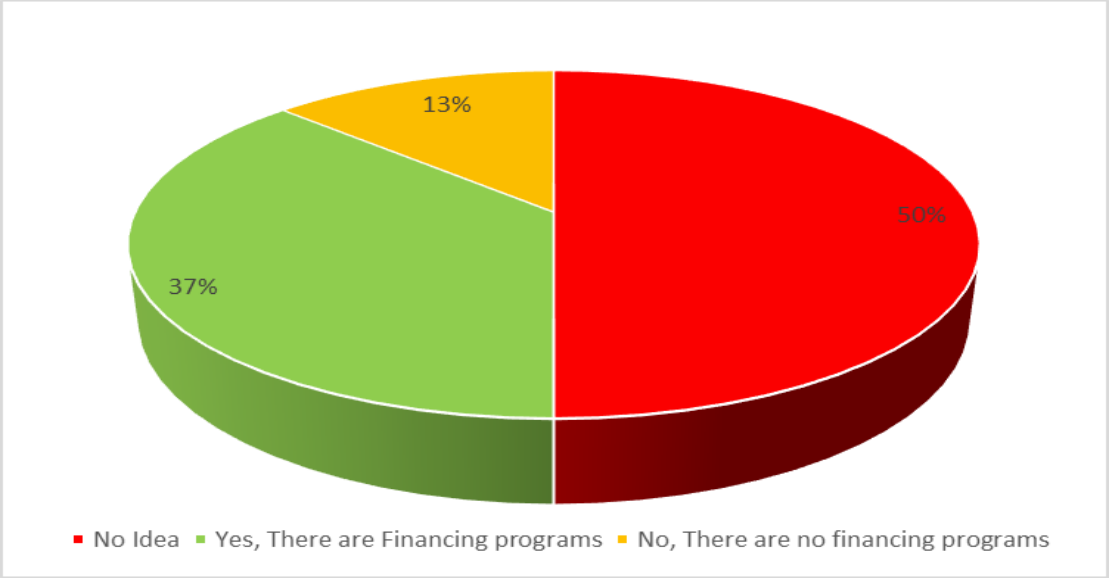


Figure 06: Professionals' Knowledge about financing programs for Innovative Farmers

The Figure N° 06 Presents Professionals' opinions on the possibility for farmers to obtain financing to develop innovative agricultural projects, the opinions are very contrasting. It is notable that 50% of survey participants did not report having information on this subject, which raises questions about the transparency of access to financing for farmers.

However, 37% of participants confirmed the existence of financing for this type of project in the public banking system. This percentage suggests that public banks do indeed provide financing opportunities for farmers wishing to develop innovative projects.

Unfortunately, this is not the only position that was shared. Indeed, 13% of the participants denied the existence of this type of financing. This position, although it constitutes a minority, poses a certain ambiguity regarding the availability of financing for farmers wishing to develop innovative agricultural projects.

This ambiguity can be a significant obstacle for entrepreneurial initiatives in the agricultural sector. Indeed, farmers wishing to launch new projects to improve the effectiveness or efficiency of their farm may find themselves facing financial difficulties if financing were not accessible.

It is therefore important to highlight the current situation regarding financing for farmers wishing to develop innovative agricultural projects. More should be known about the financing programs that exist, what criteria for selecting financing applications are and how the evaluation and decision-making processes are set up. This could help clarify the situation and facilitate access to finance for farmers who want to innovate in their agricultural operations.

3. Properties of innovation that influence the farmer's decision.

For the properties of innovations and their influence on adoption among farmers from an administrative perspective, the results are as follows:

Table 02: Properties of innovations and their influence on adoption among farmers from an administrative perspective.

Properties	Mean (SD)	Median	Percentage of respondants
Level of Complexity	2.20 (1.458)	3	38.2% Influential 23.6% Completely ineffective 18.2% Very Influential
Testable before adoption	2.93 (1.291)	3	46.4% Very Influential 25% Influential
Suitable for his needs	3.46 (0.631)	4	53.6% Very Influential 39.3% Influential
Remarkable Results	3.62 (0.489)	4	62.3% Very Influential 37.7% Influential
Short time frame	3.14 (0.923)	3	46.4% Very Influential 25% Influential 25% Quite influential

The results reveal that several characteristics play a major role in farmers' decision to adopt an innovation. First, the level of complexity of the innovation stands out as a major obstacle to adoption. Indeed, nearly 38.2% of respondents believe that the complexity of the innovation significantly influences their choice. An innovation deemed difficult to understand or implement can slow down farmers, who often prefer simple and accessible solutions.

In addition, the possibility of testing the innovation before fully committing to its adoption considered a determining criterion for many farmers. Around 46.4% of respondents emphasize that this testing capacity perceived as a very influential factor. This reflects a need for validation in the field, allowing farmers to ensure that the innovation meets their expectations and needs before making a final decision.

Furthermore, the adequacy of the innovation to the specific requirements of farmers turns out to be an essential criterion in their decision-making process. With an impressive 93.3% of respondents considering this factor as highly influential, it is clear that farmers are looking for innovations that integrate seamlessly into their practices and working environment. They therefore favour solutions that align with their farming methods and objectives.

The visibility of the results generated by the innovation is also a crucial aspect. Around 62% of farmers believe that the possibility of observing the benefits of a new practice or technology strongly influences their decision to adopt the innovation.

Farmers want to be able to assess the positive impact that the innovation could have on their production before investing resources in it.

The time required to observe tangible results from the innovation also perceived as an important element. Nearly 46% of respondents say that this aspect is highly influential in their choice. Farmers, often subject to time and resource constraints, want to maximise their return on investment and favour solutions that achieve rapid and measurable results.

These different elements highlight the complexity of the decisions taken by farmers regarding the adoption of innovations and underline the importance of taking into account their specific needs and concerns to promote successful adoption.

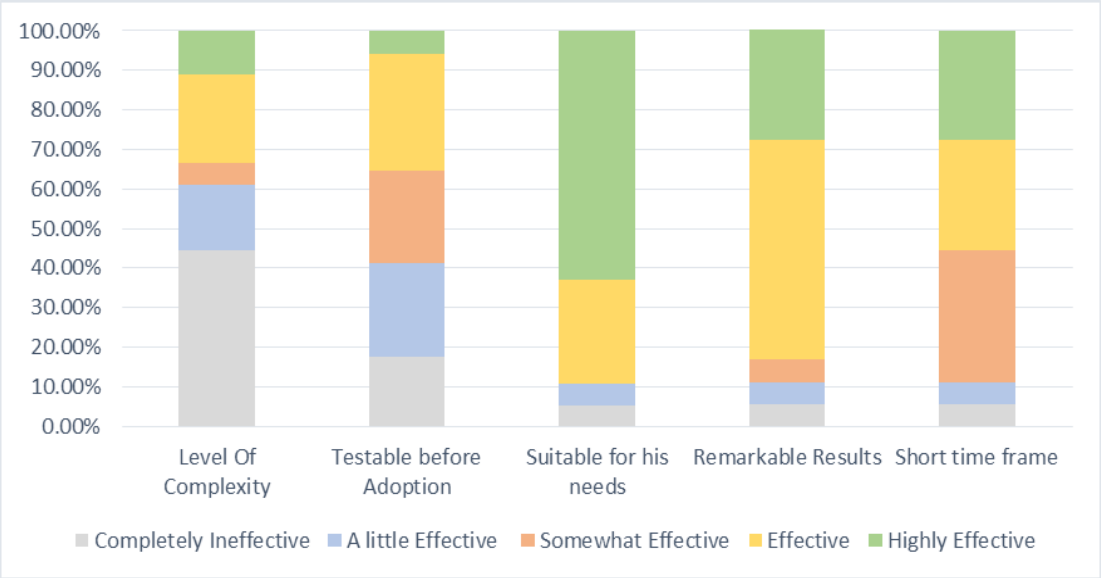


Figure 07: Influence of properties of innovations on adoption among farmers (Craftsmen perspective).

The results previously mentioned reveal a nuanced perception of the way in which artisans understand the adoption of innovation by farmers. The Figure N°07 that represents the same proprieties but from another perspective, shows a significant proportion of 55.6% of the craftsmen surveyed, believe that the suitability of an innovation plays a determining role in farmers' decision to integrate it into their practices. This suggests that a certain apprehension towards new technologies or methods can hinder their adoption, particularly when the processes involved seem too difficult or esoteric.

40% of craftsmen perceive the complexity of innovations as Completely Ineffective, indicating that a significant portion view complexity as a major barrier to adoption. 10% rate their efforts at being Highly Effective and consider ease of use to be essential.

Farmers and Craftsmen, who prioritize practicality and simplicity, may resist innovations that perceived as challenging or intricate. Therefore, by delivering hands-on training and simplifying the design process, adoption rates can be significantly

increased, this obstacle must be addressed as even the most valuable innovations may face rejection if they're perceived as too complex.

Innovations can be tested by craftsmen in practical applications, resulting in reduced risk perception and uncertainty. This property is especially important for practical adoption, as farmers prefer to be able to see the results on field first.

Innovations that fit into existing practices and solve immediate problems are the top priorities for farmers. To make the most of this, innovators should involve skilled craftsmen in the customization process and ensure that innovations are adaptable to local conditions, which enhances perceived relevance.

20% of artisans consider outstanding results to be Highly Effective, highlighting the importance of tangible benefits. The focus on measurable benefits and providing concrete proof can greatly expedite adoption, as artisans seek solutions that provide significant advantages. Highly effective is the rating given to a short time-frame by 27% of the participants.

While not as influential as results or simplicity, time efficiency holds significant importance, innovations that offer immediate or rapid benefits are preferred by craftsmen due to their ability to reap immediate returns or require little time investment.

Complexity seems to be the biggest barrier. Therefore, simplicity and practicality are key, although innovation’s testability and relevance to needs are important; they aren't the sole determinants of tangible benefits or user-friendliness.

In another case, craftsmen stress that the possibility of experimenting with an innovation does not appear to be such a decisive factor. They analyze the behavior of farmers and notice a marked tendency towards caution. Indeed, they show a reluctance to take risks, generally preferring to stick to proven and well-established methods that offer guaranteed results. This attitude toward experimentation could arise from a fear of uncertainty and the need for security in a sector where the economic stakes are often considerable.

Furthermore, regarding the alignment of the proposed innovations with the real needs of farmers, there is a consensus among the artisans. They agree on the importance of observing the concrete results of such innovations before adopting them. This also involves taking into account the time required to evaluate the effectiveness of these new methods or technologies. Thus, whatever their category, artisans share the conviction that the relevance of innovations in relation to realities on the ground, as well as the capacity to measure the effects of these new practices, are crucial elements which must be integrated into the process of Agricultural innovation

4. The motivations for adopting agricultural innovation.

After examinations in depth the different factors and properties inherent to innovations, it is essential to recognize that the motivations determining the adoption of these innovations by farmers also play a crucial role. These motivations can be classified into several categories, each of which has a significant impact on a farmer's decision to integrate a new technology or method into their farming practices. Here is an exploration of these motivations:

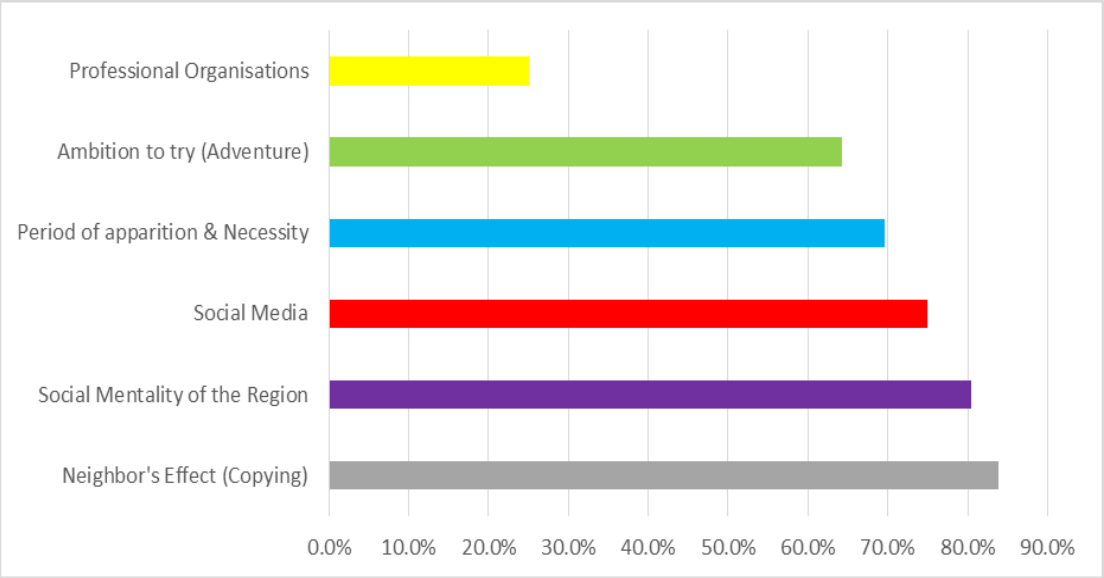


Figure 08: The motivations that lead farmers to adopt an innovation.

Figure 08 highlights the different motivations that push farmers to adopt innovative practices. These motivations seem to be strongly anchored in the social sphere and the local environment, highlighting the importance of community interactions and proximity dynamics in the decision-making process. Indeed, more than 80% of the farmers surveyed claim that neighborhood effects and the social mentality of the region significantly influence their choice regarding agricultural innovations.

This indicates that the social context, which includes relationships between farmers, local customs and community norms, plays a key role in the adoption of new technologies or methods. In addition, social networks, whether formal or informal, are a determining factor in this dynamic. About 75% of respondents report being influenced by the recommendations and practices of other farmers, which illustrates the importance of learning through observation and sharing experience within these networks.

Farmers appear to be more likely to adopt an innovation when it is validated by peers whom they consider as references, reinforcing the idea that trust and reputation within the community play a crucial role in the diffusion of innovations.

The timing of the emergence of innovations appears to be another determining aspect according to the responses collected. About 70% of farmers consider that the timing

of the introduction of certain innovations is critical for their adoption. This suggests that farmers are particularly attentive to the relevance and opportunity of innovations and that they are more likely to consider those that offer a clear competitive advantage.

However, this sensitivity to innovation may be accompanied by a certain reluctance towards solutions considered too innovative or costly, which could lead them to adopt a more cautious approach in their decisions. In summary, these results highlight not only the importance of social relations and interpersonal influences in the adoption of agricultural innovations, but also the temporal and economic aspects that can modulate these decisions.

On the other hand, our survey results highlight an interesting trend: it appears that motivations related to personal ambition and the spirit of adventure, which could be perceived as positive and enriching drivers, occupy a relatively marginal place in decision-making within this sector. With a rate of affirmation of only 64% of respondents indicating that ambition and the taste for adventure play a role in their professional commitment, it is clear that these factors have less impact than other considerations.

Furthermore, it is particularly revealing only a fraction, or 25% of farmers, mention the influence of professional organizations. This statistic suggests that the role of these entities, usually perceived as essential supports for the agricultural community in terms of networking, training and access to resources, is in reality more limited than one might expect. Farmers therefore seem to turn to other sources of motivation that seem more essential to their daily lives.

This finding highlights the fact that farmers primarily driven by practical and economic considerations. This may include imperatives such as farm profitability, the search for innovative techniques to optimize production, or the need to respond to increasingly demanding markets. In short, these more down-to-earth motivations seem to take precedence over more noble or emotional aspirations, such as the desire to contribute to an environmental cause or the quest for personal satisfaction. Thus, this analysis raises important questions about how policies can evolve and better meet farmers' real expectations and needs, by integrating more personal and altruistic dimensions into an essentially pragmatic approach.

Artisans expressed varied and sometimes contradictory views regarding the impact of the surrounding society on farmers' decisions, as well as the influence exerted by farmers in their neighbourhood. According to the results of a survey, 15.4% of participants admitted that neighbouring farmers play a significant role in farmers' decision-making, suggesting a social dynamic where neighbourhood and interpersonal relationships can shape agronomic choices.

However, this perception is not unanimous; many artisans doubt the real importance of these interactions, which reflects a divergence in the interpretation of social influences. Furthermore, artisans, based on their experience and regular contact with the agricultural world, believe that the motivations that incite farmers to adopt a particular innovation are not significant. They observe that farmers tend to rely on practices and techniques that've been tested, adopted and validated by others.

This tendency to rely on concrete evidence and proven results seems to take precedence over the search for bold or unproven innovations. Artisans, through their proximity to farmers, note that the latter often prefer proven methods, which reflects a certain prudence and a need for security in their choices. Thus, even if some artisans recognize that social interaction exists, the general trend seems to be one of disdain for motivations based on external influences, in favor of a pragmatism guided by experience and tradition.

5. The impact of the environment on innovation adoption

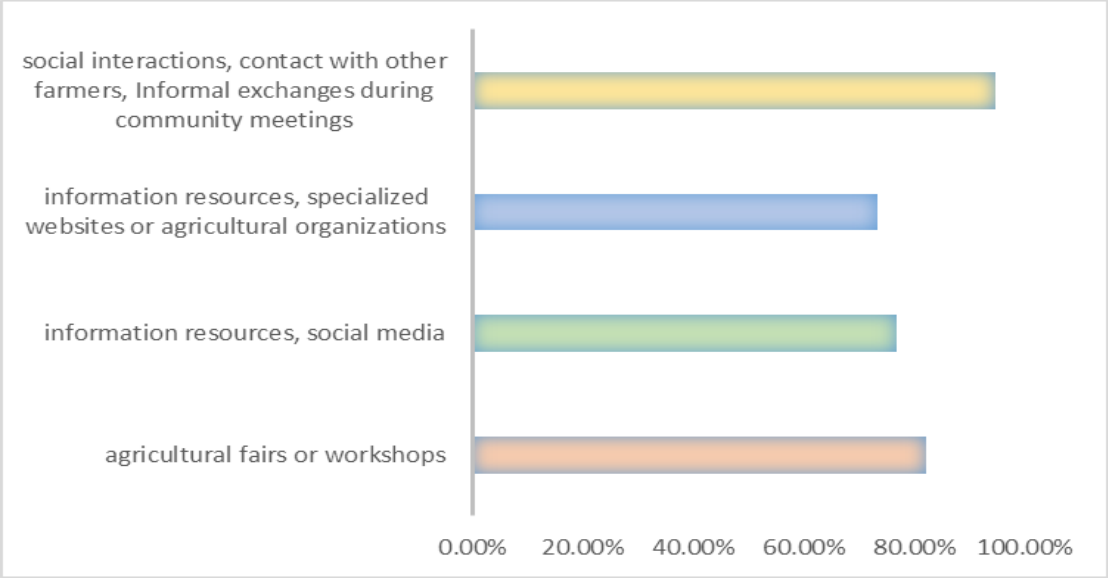


Figure 09: Social and resources influence on decision-making of farmers.

The Figure N°09 shows the social & resources influence on decision-making of farmers, The vast majority of respondents, 92.7%, say that social interactions, regular contact with other farmers, and access to information resources play a determining role in their decision-making regarding the adoption of innovations. This finding reveals the crucial importance of community dynamics within the agricultural community. Indeed, these interactions not only allow for the exchange of ideas and practices, but they also foster the creation of a climate of trust and mutual support, allowing farmers to feel less isolated in their choices.

The results of this survey suggest that farmers do not make their decisions in isolation, but rather by taking into account the opinions and experiences of their peers. Informal exchanges during community meetings, agricultural fairs or workshops are often privileged opportunities to share feedback, ask questions and receive practical advice. Thus, group dynamics can strongly influence the adoption of new techniques or technologies, as farmers tend to draw inspiration from the successes or failures of those around them.

Furthermore, access to information resources, whether from social networks, specialized websites or agricultural organizations, is also an important motivating factor. This information, whether technical, economic or environmental, allows farmers to understand better the advantages and disadvantages of the different innovations available on the market. By keeping up to date with the latest trends and research in sustainable development, they are better able to justify their choice to invest in certain innovations, based on concrete data and convincing examples.

Thus, this interdependence between social interactions and information resources underlines the importance of creating and maintaining cooperation networks between farmers. This could also encourage sector stakeholders, such as agricultural organizations or research institutions, to develop initiatives aimed at fostering these exchanges, such as discussion groups, collaborative training or information exchange platforms. By highlighting the significant influence of these interactions on decisions to adopt innovations, it becomes crucial to support these social dynamics and facilitate access to quality resources to maximize farmers' chances of success in their quest for innovation.

Participants provided remarkably rich and varied explanations of how farmers affected by changes in their environment adopt new practices and technologies. However, six key ideas can be identified that are key to the effectiveness of this adoption.

Conviction by frequency effect, which represents 23.3% of the testimonies, emerges as a fundamental element. This notion illustrates the phenomenon of the social effect, where the simple fact of seeing that other farmers adopt an innovation in turn encourages others to do the same. When farmers see that, their peers benefit from a new method, their confidence in this innovation increases, which stimulates their propensity to adopt similar practices.

Field vision comes in second place with 18.6%. This dimension is crucial, because it is imperative that farmers have the opportunity to observe directly innovations before deciding to adopt them. Visualizing tangible results on neighbouring farms fuels farmers' enthusiasm and confidence, allowing them to assess the potential benefits of new practices.

In addition, imitation, also at 18.6%, appears to be a powerful psychological mechanism. Farmers tend to be more receptive to adopting an innovation that has already proven itself among other farmers. Thus, rather than embarking on uncertain paths, they prefer to follow the example of their neighbours or colleagues who have already been through the wringer. This search for security in collective knowledge strengthens adoption dynamics.

Taking into account the experiences of other farmers, which represents 16.3% of the concerns expressed, considered essential. Adoption decisions are often influenced by the successes or failures encountered by their peers. When a farmer sees that one of his colleagues has managed to overcome challenges thanks to a specific innovation, this can weigh considerably in his decision to follow the same path.

Discussions about agricultural problems often lead to solutions, a point that also captured the attention of 16.3% of participants. These exchanges allow farmers to confront their challenges and collectively develop appropriate strategies. Collaboration and sharing of ideas foster a climate of mutual assistance and innovation, making it more conducive to the adoption of new practices.

Curiosity, although represented by a modest 7.0%, plays a significant role in the adoption of innovations. In some exceptional cases, farmers with high curiosity may be more inclined to explore new ideas. This proactive attitude can make them more receptive to necessary changes and enable them to evolve towards more sustainable and innovative practices.

Thus, from these elements, it is clear that the adoption of innovations within farms based on social dynamics, practical concerns and a collective desire for exchange and learning.

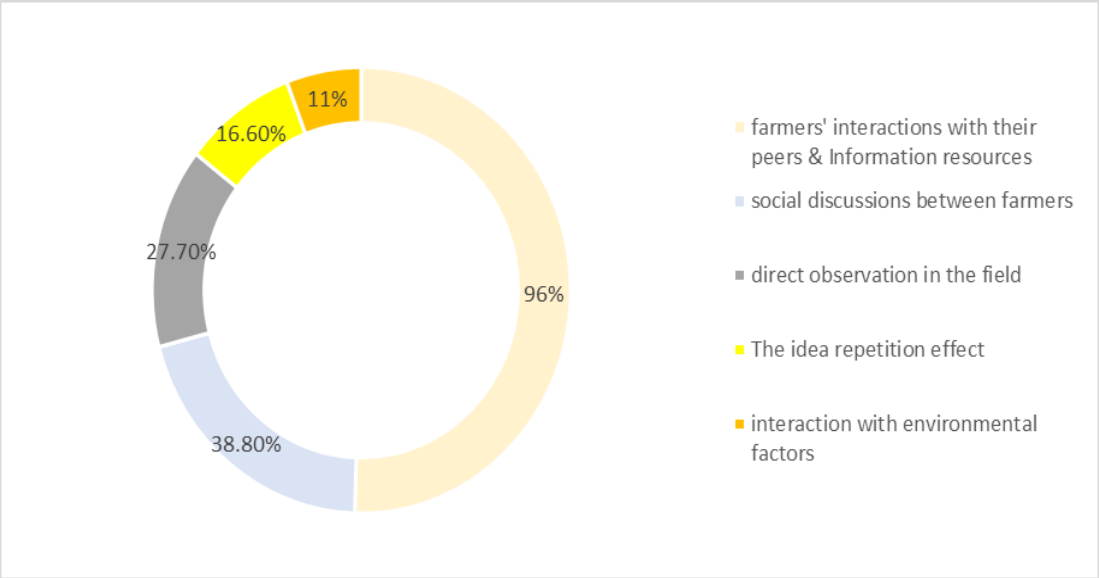


Figure 10: Major Influencers of innovation adoption from craftsmen vision.

The Figure N°10 shows the major influencers on innovation adoption from the point of view of Craftsmen, the perceptible impact of information resources and farmers' interactions with their environment, as well as with their peers, proves to be a fundamental element in the decision-making process relating to the adoption of new agricultural practices. According to the data collected, 96% of the artisans who participated in the study agree that these interactions have a significant influence on their choices.

Among the different facets of this impact, social discussions between farmers occupy a prominent place, representing 38.8% of the responses. These exchanges allow farmers to obtain an enriched and diversified overview of the available innovations as well as their effectiveness. By sharing experiences and testimonies, farmers can not only assess the potential benefits of new practices, but also measure their risks. This social dynamic deepens a collective understanding of innovations and can strongly influence the decision to adopt or not a new technique.

Next comes the importance of direct observation in the field, which was cited by 27.7% of participants as a key factor. Indeed, the majority of artisans believe that seeing the successful application of a technique in their immediate environment is a powerful driver of adoption. The ability to observe directly clear results allows farmers

to assess the feasibility and relevance of an innovation according to their own context, thus reinforcing their confidence in their potential choice of adoption.

The idea repetition effect, mentioned by 16.6% of respondents, highlights a psychological aspect that should not be underestimated. Proponents of this view point out that frequent exposure to certain ideas or techniques stimulates curiosity and fosters deeper understanding. This habituation process can lead to a greater propensity to consider adopting these innovations, as farmers may come to see them as viable solutions.

11% of artisans argue that interaction with environmental factors, such as climate, soil conditions, or market influences, often directs their choices towards imitating the successes observed among other farmers. This tendency to align with the practices of successful peers can influence not only individual decisions, but also broader dynamics of change within farming communities.

5.5% of artisans, in agreement with agricultural input sellers, argue that this interaction is in reality an amalgam of all these factors, thus highlighting the complexity and interdependence of the influences at play. This opinion indicates that the adoption of new practices depends on a delicate balance between interpersonal exchanges, empirical observations and psychological conditioning, thus shaping a dynamic landscape where information and interaction constitute the cornerstone of agricultural decisions.

The results of the survey conducted among agricultural input sellers highlight the unanimous opinion of the participants concerning the significant impact of environmental factors on the decisions made by farmers, particularly with regard to the adoption of agricultural practices and innovations. Indeed, the data collected indicate that the perception of the field, that is to say the direct and immediate experience of farmers in connection with their farms, turns out to be the most determining factor in the decision-making process, with a proportion of 54.76%. This statistic reflects a key reality: farmers often prioritize tangible and measurable elements of their immediate environment such as climate conditions, soil quality, water resources and other ecological variables. Thus, when evaluating the opportunity to integrate new practices or technologies, they take into consideration these material factors that directly influence the productivity and viability of their farms.

Interaction with experts in the field, as well as informal exchanges with other farmers, rank second and third, with rates of 28.57% and 7.14% of mentions, respectively. These results illustrate the importance recognized by farmers of staying informed about the latest trends and innovations in the sector. They highlight the crucial role of discussions with seasoned professionals and other farmers, who share practical advice based on their own experiences. These interactions allow farmers to acquire valuable knowledge and information, strengthening their capacity to evaluate new technologies and agricultural practices.

It is also important to highlight that other traders clarified a fundamental aspect of this analysis: the influence of environmental factors does not result from an isolated element, but rather from a complex combination of multiple variables. Farmers, aware of the various dimensions that characterize their farm and their environment, take care to evaluate all the relevant characteristics globally. This global approach allows farmers to arrive at informed and considered decisions regarding the adoption of innovations. In conclusion, the survey reveals a dynamic of interaction between practical experience, the exchange of information and a holistic evaluation of environmental factors, all playing a key role in the decision-making process of farmers in the face of innovation.

6. The impact of internet usage on the decision-making of the farmer.

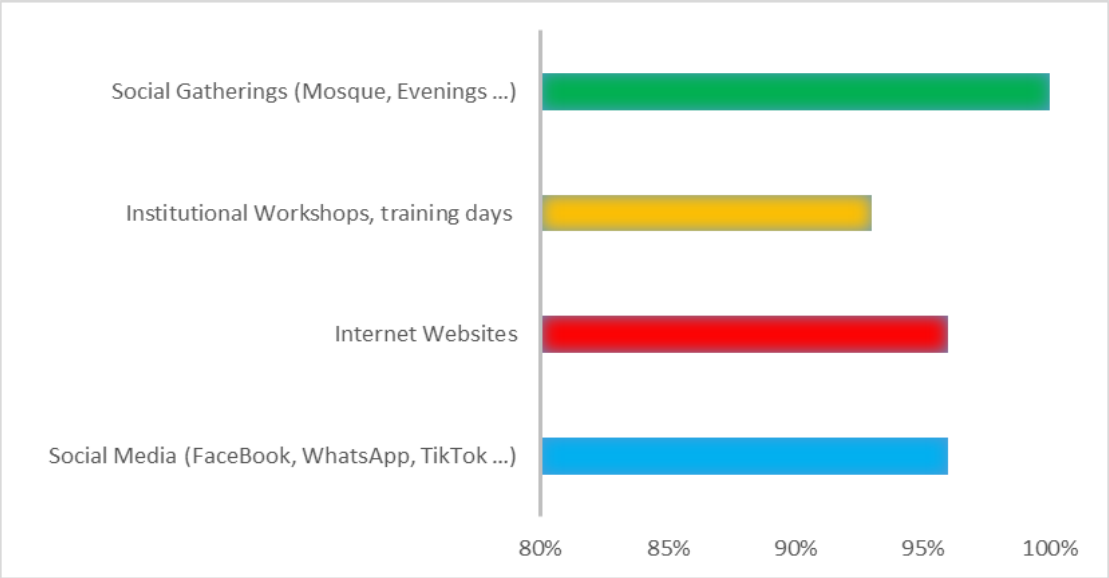


Figure 11: Impact of The Internet as a Source of information.

According to the professional stakeholders interviewed as part of this survey & shown in Figure 10, the sources of information considered reliable by farmers to keep up to date with the latest agricultural technologies and innovations available are mainly social networks and websites. Indeed, an overwhelming majority of 96% of participants cited social media platforms such as Facebook, Instagram, TikTok and WhatsApp, which play a leading role in the dissemination of agricultural information. These platforms not only allow farmers to access diversified content, but also to interact with other professionals in the sector, thus promoting a real-time exchange of knowledge.

Farmers use social networks to follow influencers, agricultural organizations, and even agronomy experts who regularly share updates, advice and innovative practices. This allows them to inform themselves in a dynamic and reactive way, based on discussions and sharing of experiences from their peers and recognized professionals, which reinforces the credibility of the information and its relevance.

At the same time, websites perceived also as an essential resource. Farmers cite not only news and information sites specializing in agriculture, but also video platforms such as YouTube, where it is possible to find tutorials, demonstrations of new technologies and feedback on innovative cultivation methods. These videos offer them a visual and practical approach, often more intuitive than written articles.

Government websites dedicated to agriculture represent a reliable and structured source of information, offering regulatory data, subsidies, as well as valuable technical advice. In this sense, these online resources contribute to creating a complete and accessible source of the latest developments in the sector.

All of these digital tools allow farmers to navigate efficiently in a constantly changing environment, strengthening their capacity to adopt modern and sustainable agricultural practices. These results highlight the importance of targeted communication and easy access to agronomic information in contemporary agricultural development strategies.

This trend highlights the changing modes of communication in the agricultural sector, where digital tools are playing an increasing role in sharing and disseminating knowledge. Farmers, often in search of efficiency and productivity, are turning to these channels for tips, tutorials, and updates on the latest innovations, which shows a growing trust in these online media.

Furthermore, according to the information collected, 73% of participants highlighted the crucial importance of training activities, such as workshops, meetings and seminars, organized by the Ministry of Agriculture and agricultural government institutions. These events, designed to promote knowledge exchange and dissemination of good practices, are key elements in setting up an effective training program.

Workshops, which provide a platform for the exchange of experiences between experts, professionals in the sector and farmers, play a crucial role in improving farmers' knowledge and skills. Indeed, through these workshops, farmers have the opportunity to interact directly with experts in the field and learn about the latest technologies, innovative farming methods and good practices. This allows them to improve their knowledge and understanding of complex agricultural issues, helping them make informed decisions.

In addition, the workshops provide farmers with the opportunity to ask questions and discuss the challenges they face in the field. This allows them to share their experiences, difficulties and suggestions, which strengthens the connection between policy makers, sector professionals and industry stakeholders. This two-way communication allows decision makers to gain valuable insights into the real needs of farmers, enabling them to make informed decisions and develop effective policies.

Interestingly, 94% of participants also recognised the value of social gatherings of all kinds – whether informal discussions at parties, community events or meetings at places of worship such as mosques – as reliable sources of information for farmers. This highlights the importance of informal communication in disseminating information and creating a network of mutual support among farmers.

These social interactions not only allow for the sharing of practical experiences and tips, but also build solidarity within the farming community. Informal exchanges among farmers can cover topics such as farming methods, choice of plant varieties, irrigation techniques, water resource management, pest and disease control, and product marketing strategies. These discussions allow farmers to draw on the real-world experiences of their peers, which can be more effective than simply consulting manuals or online resources.

Social gatherings foster strong bonds between members of the farming community, which can lead to the establishment of systems of solidarity and mutual support. For example, farmers can help each other in times of difficulty, exchange tools or equipment, or even participate in collective initiatives to improve the productivity and sustainability of their farms.

The results reveal a complex dynamic in the way farmers inform and train themselves, combining modern tools and traditional practices to optimize their activity. Farmers use social networks, mobile applications and websites to access technical information and online resources, but they also continue to value social interactions and informal exchanges to supplement their knowledge and strengthen their community.

This hybrid approach, which combines the advantages of technology with the benefits of interpersonal communication, allows farmers to develop a deeper understanding of their environment and practices, and to address better the challenges related to sustainable agricultural production. Ultimately, the recognition of the value of social gatherings and informal exchanges for farmers underlines the importance of taking into account the social and cultural aspects of agriculture, in addition to the technical and economic aspects, in developing effective and sustainable rural development strategies.

There is a clear consensus among members active in the agricultural sector and artisans regarding the importance of information sources for farmers. The results of the responses show that the different sources of information, including evening events, the use of social networks and browsing specialized websites, considered having a similar influence to that of meetings and workshops organized in government institutions. This means that farmers and artisans recognize the usefulness of these different channels to keep themselves informed about best practices, innovations, policies and resources available in their sector. Despite this recognition of the importance of information sources, the statistics reveal a reality that seems paradoxical. Only 3.8% of participants considered that these information activities were effective. This low assessment of effectiveness could be attributed to several factors, including the geographical or conceptual distance of government agencies from the agricultural sector. Government institutions, although supposed to provide services and advice to farmers, may be perceived as being too bureaucratic, distant from the specific needs of rural communities, or not sufficiently responsive to the daily challenges and concerns of farmers and artisans.

The perceived isolation of government agencies may be reinforced by insufficient or ineffective communication between these institutions and farming communities. Farmers and artisans may feel that their voices are not heard enough or that their needs are not properly understood, which may explain why they find the information activities offered by these institutions to be ineffective. It is therefore crucial that government agencies and organizations involved in agricultural development reassess their communication and information strategies to better meet the needs and expectations of farmers and artisans, and thus improve their effectiveness in supporting the agricultural sector.

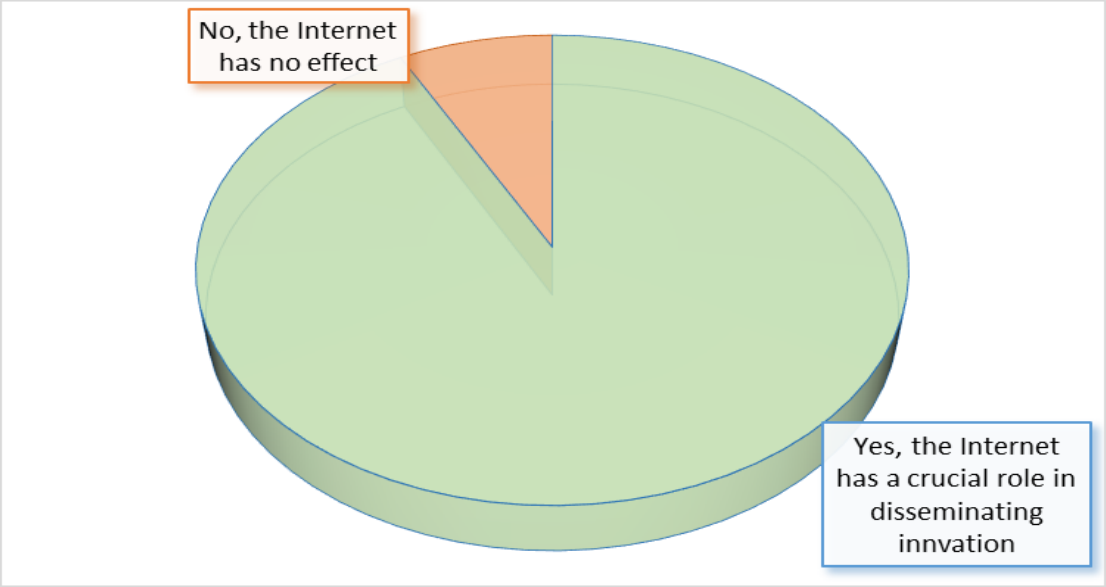


Figure 12: Role of Internet in disseminating innovation (by Craftsmen).

The vast majority of artisans, representing nearly 92.3% of them (Figure 12), highlighted the crucial importance that the Internet plays in the development of agriculture within the region. This digital connection is not limited to access to information only, but also extends to facilitating the sharing of knowledge and technological innovations. Through the Internet, artisans have the opportunity to connect easily with other actors in the sector, whether they are producers, researchers or service providers.

These digital links allow for the rapid and efficient dissemination of equipment and technologies that are not locally manufactured only, but also adapted to the specific needs of farmers in the region. This has the effect of strengthening the autonomy and adaptability of farmers in the face of contemporary challenges, such as climatic variations or market fluctuations.

Artisans also find that the Internet allows them to share their experiences and knowledge, exchange ideas and learn about innovative agricultural practices implemented elsewhere. This process of exchange and collaboration promotes the continuous improvement of agricultural methods and the optimization of resources.

In addition, the online sale of agricultural products and equipment allows them to reach a wider audience, thus increasing the profitability and visibility of artisans and their work.

Results from agricultural input sellers reveal that 87.8% of participants believe that the Internet is a crucial tool for promoting agricultural innovations. This striking statistic highlights the major impact that digital technology has on the agricultural sector, transforming the way ideas and technologies circulate.

They see that the Internet allows unprecedented access to a wealth of relevant information on new cultivation techniques, seed varieties and equipment available on the market. Through online platforms, discussion forums and social media, farmers can easily learn about the latest innovations, while sharing their own experiences and knowledge. This not only strengthens individual capacities, but also fosters a collaborative dynamic within the farming community.

On the other hand, it has revolutionized farmer training, offering varied educational resources such as webinars, video tutorials, and specialized online courses. These e-learning tools are particularly beneficial for farmers living in remote rural areas, where access to traditional training can be difficult. By providing these farmers with access to cutting-edge and up-to-date knowledge, the Internet helps improve their farming practices, thereby increasing the productivity and sustainability of their business.

The Internet also stimulates local innovation in equipment and technology. Agricultural entrepreneurs and start-ups can use digital tools to promote their products, reach a wider audience, and gather valuable feedback on their offerings. This creates a dynamic ecosystem, where innovations not only come from large companies, but also emerge from the field, driven by the real needs of farmers.

Although the study participants clearly recognize the crucial importance of the Internet and social networks in the dissemination of innovations to farmers, it is very worrying to note that 96.4% of them affirm that digitalization not implemented in the processes of diffusion of innovations within the institutions in which they operate. This finding highlights a significant gap between the awareness of the benefits that technology can bring and the reality of institutional practices.

In other words, although the majority of participants are aware that digital tools, such as social networks, online platforms, and mobile applications, can facilitate the exchange of information, access to educational resources and the sharing of experiences among farmers, these tools are not integrated yet systematically into the working methods of institutions. This lack of practical application of digitalization to the diffusion of innovations suggests institutional, technical or organizational barriers that hinder the adoption of these technologies.

It is also important to consider that the failure to implement digitalization may limit the ability of agricultural institutions to reach farmers, especially those who may be far from traditional resource centres. In a world where information flows rapidly and agricultural practices are constantly evolving in response to environmental and economic challenges, the delay in the use of digital tools could have significant consequences on the effectiveness and relevance of innovation diffusion initiatives.

Therefore, it becomes imperative for agricultural institutions to rethink their approaches and incorporate digital strategies into their mode of operation in order to improve the transmission of innovations. This could include, for example, training dissemination agents on the use of digital technologies, developing content adapted to online platforms, or creating collaborations with IT experts to optimize the design of these tools. It is not enough to recognize the importance of digital technologies; it is also essential to take action to leverage their benefits in order to promote a wider and more effective adoption of innovations in the agricultural sector.

Regarding the use of social networks by artisans, it is interesting to note that only 46.2% are actually integrated.

This proportion indicates a relatively limited use of these platforms by a group that could nevertheless benefit from them, given the visual and connected nature of these modern media. Among these artisans, 30.8% take the initiative to share their innovations and creations, which underlines the importance of visibility and communication in their profession.

However, this dynamic also reveals that a significant percentage of artisans do not fully explore the possibilities offered by social networks to promote their products and knowledge. For those who choose not to use social networks, the situation is even more complex. Indeed, only 26.9% of them have a trusted person, often a family member or a close friend, to ensure the dissemination of their innovations through social media. This suggests a desire to avoid direct engagement with these platforms, while implicitly recognizing the importance of communication and promoting their work, even indirectly.

Furthermore, those who completely reject the use of social networks express varied and relevant reasons. Some believe that they do not need advertising because they already benefit from sufficient notoriety in their community or market, which pushes them to favor traditional word-of-mouth to the detriment of digital media. Other artisans fear that their presence on social networks could harm their reputation, due to the risks associated with the image they project and the way their productions can be perceived or criticized.

Finally, there is also a fringe of artisans who simply declare themselves disinterested in celebrity and the need to be highlighted, preferring to work in the shadows and escape the pressure of public exposure. This diversity of points of view highlights the nuances and personal reflections, which underlie the choices of artisans with regard to modern communication tools.

7. The impact of stakeholders on decision-making among farmers.

The Figure N° 13 represents the stakeholders in the field who have an influence on farmers and their decisions, according to the Craftsmen.

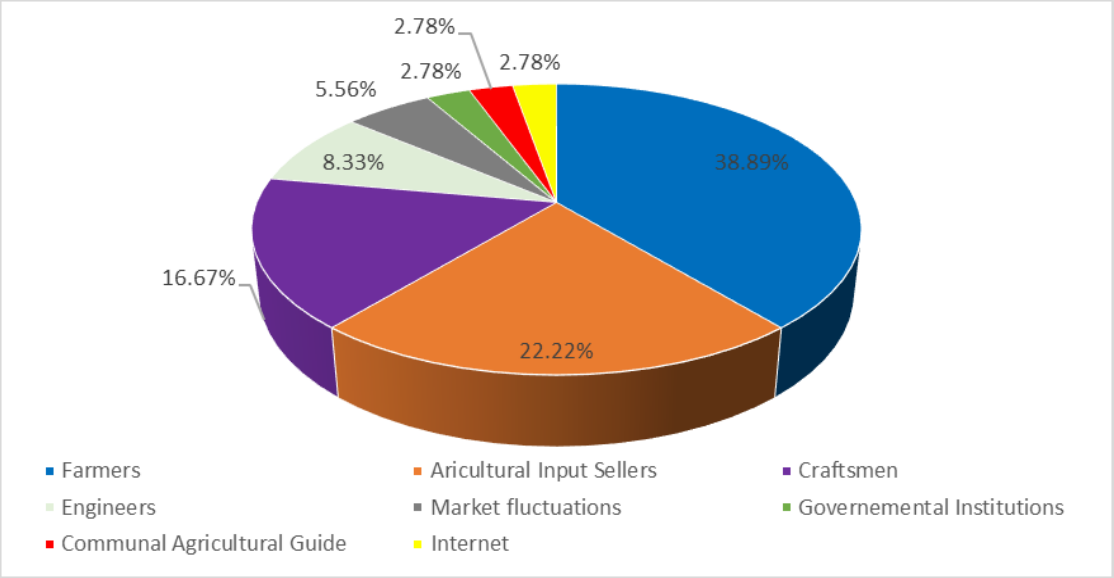


Figure 13: The Influencers on Farmers According to craftsmen.

Farmers undeniably stand out as the central actors in the agricultural sector, exercising a significant influence on the decisions that concern them. Indeed, with 38.89% of mentions, their role is not limited to that of simple beneficiaries of the choices made, but also encompasses a genuine decision-making responsibility. This high figure demonstrates their direct involvement in decision-making processes, as well as their in-depth knowledge of agronomic issues. This position of strength underlines not only their expertise in cultivation and livestock breeding, but also their ability to shape the dynamics of their own activity.

Other actors, such as seed merchants, also occupy an important place in this chain of influence. With 22.22% of mentions, the latter play a crucial role in the marketing and distribution of agricultural products. Their function goes beyond the simple sale of seeds and inputs; they are often seen as strategic partners who can offer advice on best cultivation practices, the most suitable varieties, and market trends. This close connection between seed merchants and farmers places the latter in a position of influence, as their recommendations can have a direct impact on farmers' decision-making.

Artisans, for their part, represent 16.67% of the recognized influences. Their contribution is valuable, not only by providing essential services such as equipment maintenance, construction of agricultural structures, or by offering specific products that meet farmers' needs. Thanks to their local knowledge and proximity to farmers, they are able to provide solutions adapted to the daily challenges encountered in the field. Thus, their role is not limited to simple support; they constitute an essential link that allows farmers to optimize their production and navigate efficiently within a constantly changing agricultural environment.

It is also important to mention the less influential position of other actors such as engineers (8.33%) and government institutions (2.78%). The relative weakness of their impact can be explained by perception that these actors, although they have technical and regulatory skills, often operate at a more theoretical level and removed from daily agricultural realities. Farmers may perceive the advice of engineers or government directives as being too general or lacking in anchoring in their specific reality. Contextual variables specific to each farm often carry more weight than recommendations from these more distant actors.

The influence linked to market fluctuations (5.56%) and the Internet (2.78%) are perceived as marginal in the decision-making process of farmers. Indeed, although these elements can offer information and a broader vision of agricultural trends, they are not necessarily integrated into daily decision-making. This can explained by a lack of direct access or by a difficulty in translating this global information into concrete strategies on the ground.

The agricultural guide (2.78%) is often considered a secondary and not very influential actor, particularly by artisans who see it as an additional source of information, but not essential. Its low influence may result from a perception that it is too academic or theoretical, lacking the relevance and practicality that farmers seek in their daily work.

The analysis reveals a complex and varied hierarchy of influence within the agricultural world, where farmers, seed merchants and artisans stand out as the main actors in decision-making, while more distant entities such as engineers or government institutions, although potentially valuable, struggle to integrate into the daily life of farms.

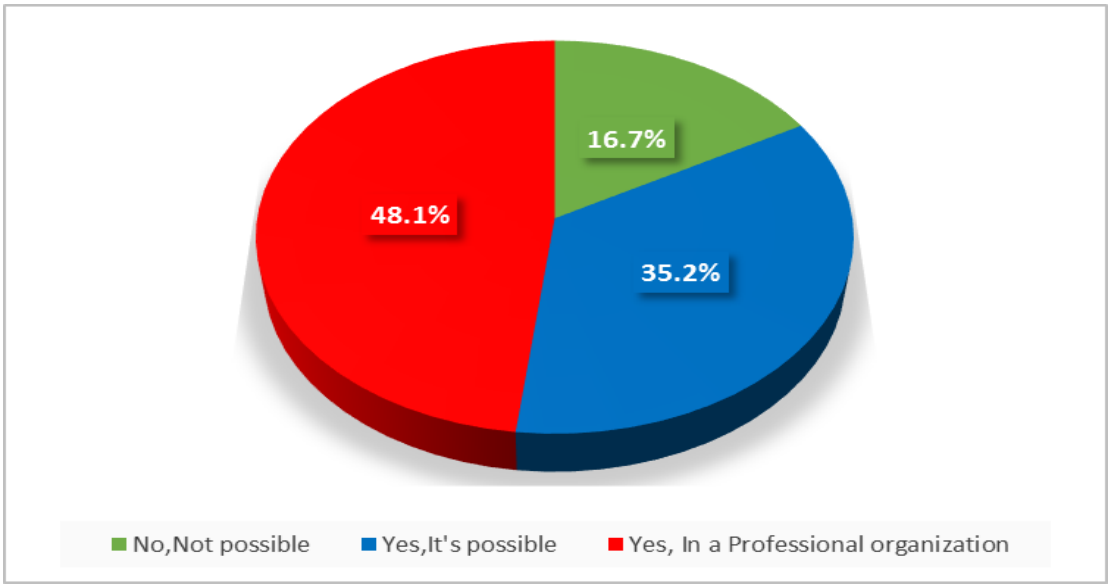


Figure 14: The possibility of cooperation to develop innovations.

The Figure N° 14 illustrates farmers' perceptions of the cooperation needed to develop innovations in the agricultural sector, a crucial aspect to address contemporary challenges. According to the analysis of the field experts interviewed, the majority of participants consider that this cooperation is not only desirable, but also feasible. However, opinions diverge significantly on the modalities for implementing this collaboration.

In detail, 48.1% of experts support that for cooperation between farmers to be effective and fruitful, it is essential that they organize themselves within formal entities such as agricultural cooperatives or agricultural unions. These structures indeed would be perceived as catalysts, providing not only a platform for sharing ideas, but also a framework for effective collective action. Cooperatives, for example, allow for the pooling of resources, facilitate access to financing and strengthen the voice of farmers in discussions with other actors in the value chain.

On the other hand, a significant number of experts, representing 35.2%, are of the opinion that cooperation can be achieved informally and without the need for a pre-established formal organization. This suggests that there may be a willingness or capacity for collaborative innovation based on interpersonal relationships, networks of trust or local initiatives. These agronomists envisage that spontaneous interactions between farmers, even outside an organizational structure, can lead to innovative projects, thus promoting the sharing of agricultural knowledge and practices.

Also, 16.7% of experts express significant reservations about the possibility of effective cooperation between farmers for innovation, arguing that structural, cultural or economic obstacles could hinder this collaboration. These sceptics potentially highlight issues such as competition for limited resources, differences in priorities between farmers or reluctance to share ideas and techniques, fearing that this could jeopardize their competitive advantage.

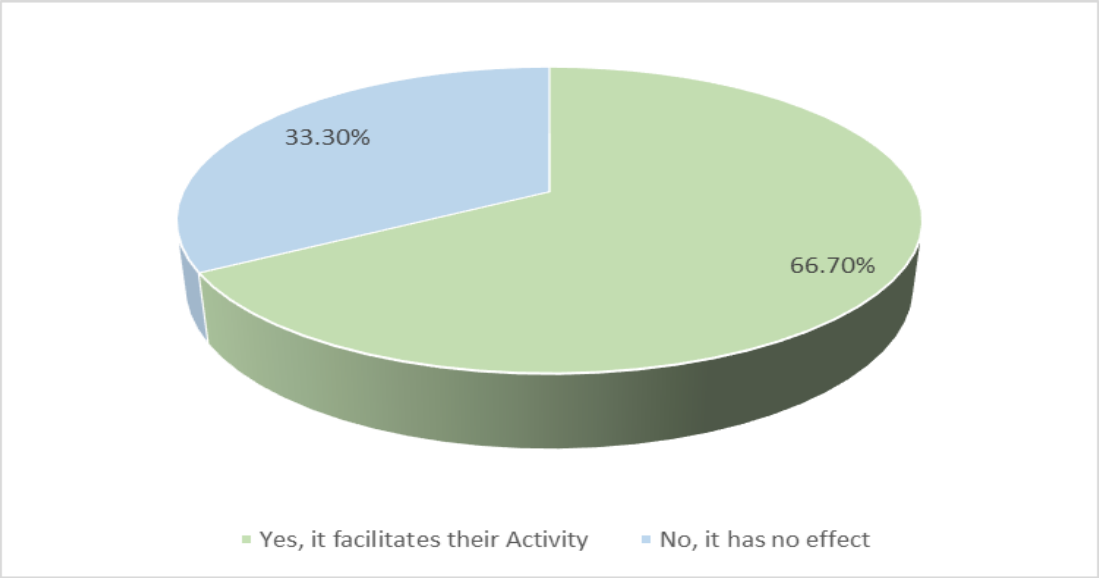


Figure 15: The Importance of Membership in Professional organizations (By Craftsmen).

The Figure 15 illustrates the importance of affiliation in Professional Organizations according to the results from artisans, a significant proportion of 66.7% recognize the crucial importance of cooperation between farmers and membership in professional associative activity frameworks. This collaboration seen as a fundamental lever to facilitate the diffusion of innovations within their practices. Indeed, when artisans and farmers join forces, they create an environment conducive to the exchange of ideas and knowledge, which can lead to new working methods, the adoption of innovative technologies and the continuous improvement of their products and services.

Membership in professional associative structures also provides a formal framework to coordinate their actions, share resources, and organize awareness-raising and training events. These regular interactions not only promote the exchange of experiences, but also the establishment of solid professional networks. By sharing their successes and failures, artisans and farmers can learn from each other, thus going beyond the singularities of their respective sectors to benefit from a broader perspective.

In addition, these collaborations can include the exchange of contacts, thus facilitating access to markets, suppliers, and potential partners. Such synergy can also strengthen the competitiveness of their respective activities, allowing them to innovate together and better respond to changing market requirements.

8. The impact of agricultural input sellers.

Agro-input traders play a crucial role in the development and revitalization of the agri-food sector in the state. They are aware that their most significant contribution to stimulating the dynamics of innovation lies in the provision of a set of services that go well beyond the simple sale of products. Indeed, these economic actors are actively engaged in offering technical advice, strategic orientations and financial support, which are essential elements to encourage farmers to adopt new practices and technologies.

With this in mind, they set up payment facilities to improve access to agricultural inputs, thus making these expensive resources often more accessible to farmers. These facilities, which can include flexible credits or staggered payment terms, are a direct response to the financial challenges faced by many farmers, thus enabling them to invest in innovations that could increase their productivity and profitability.

Interestingly, these traders do not sufficiently increase the dissemination of agricultural innovation techniques to farmers. Their preference seems to be for providing tailored advice and explanations, rather than a more mechanical approach to transmitting techniques. This strategy reflects a deep understanding of the complexity inherent in decision-making regarding agricultural innovation. Indeed, farmers are faced often with complex choices that require a careful assessment of various factors, including cost, long-term profitability and environmental impact.

Therefore, by providing personalized support and taking into account the specific needs of each farmer, these traders show that they are not simply imposing ready-made solutions, but rather that they seek to accompany farmers in their decision-making process. This contrasts with a more traditional approach, where standardized recommendations would be disseminated without taking into account the local contexts, crops and infrastructures specific to each farmer. In this context, these traders assert themselves as true partners in innovation, playing a key role both in supporting the agricultural transition and in encouraging more sustainable and resilient agriculture. Their commitment to support that values the local agricultural ecosystem reinforces the relevance of their intervention in the sustainable development of the region.

Similarly, the results from professional actors in the agricultural sector revealed that 75% of them recognize the crucial role played by agricultural input sellers in the dissemination of modern technologies and the improvement of agricultural practices in the field. These sellers do not just market products, but they also act as relays of essential information. They have an active role in raising awareness among farmers about new practices and technologies that could improve their yield and the sustainability of their farms.

In practice, this translates into direct interaction with farmers, during which these sellers offer sound advice and guidance tailored to the specific needs of farmers. Not only do they present the advantages of certain technologies or inputs, but they also ensure that this information is integrated into the daily lives of farmers.

Moreover, this support does not stop at simple sales. Vendors regularly conduct field monitoring to assess the impact of the innovations introduced. This allows them not only to verify the effectiveness of proposed solutions, but also to make adjustments based on farmers' feedback. They become aware of the specific challenges faced by producers and tailor their advice accordingly, taking into account the varied requirements of farms. It is also essential to mention that these vendors take into consideration the economic realities of farmers. They propose solutions that are not only innovative but also financially viable. This includes agricultural input options that suit farmers' investment capacities, while respecting the specificities of their soil, crops and climate. This tailor-made approach is essential to ensure that farmers can truly benefit from available technologies and improve their productivity without putting themselves in financial difficulty.

9. The influence of artisans on the dynamic of the region.

For artisans, we undertook an in-depth analysis to understand the different factors that influence their choice to implement farmers' ideas. In this study, 38% of participants indicated that farmers base their decisions mainly on the precise description of the problems they encounter. This approach allows artisans to benefit from a first outline of what is needed, thus providing them with essential information to consider suitable solutions. It is a collaborative process where the clarity of a problem is crucial for the creativity and efficiency of artisans in finding answers.

Furthermore, 15.2% of participants highlighted the importance of exchanges between the artisan and the farmer, stating that discussion and the exchange of ideas play a crucial role in developing solutions. These interactions make it possible to adjust proposals according to the expectations, specific needs, and constraints of farmers. It is also during these dialogues that artisans can appropriate the concerns of farmers and propose innovative improvements or technical alternatives.

7.6% of respondents reported that some farmers seek to optimize the resources they have by reducing the number of parts needed for their equipment. They often prioritize recycling and reusing existing materials, thus seeking to avoid purchasing new parts or modifying those already in their possession. This trend towards the circular economy highlights not only a desire to reduce costs, but also a growing environmental awareness among farmers.

Other participants emphasized that the reputation and experience of craftsmen in the agricultural sector are determining factors in their choice. Trust in an artisan, acquired through previous successful work, is a key factor influencing farmers' decision. They seek not only technical knowledge, but also informed advice based on experiences. In sum, this study reveals a nuanced image, showing that farmers' choice of craftsmen is the result of a combination of technical, relational and value factors. This dynamic interaction between farmers and craftsmen is essential for the effective implementation of innovative solutions in the agricultural sector.

In addition, the survey revealed that 80% of the artisans surveyed said they had already collaborated with farmers, which highlights the importance of this synergy between the two professions. During these collaborations, the artisans not only shared their ideas and suggestions, but they also supervised the implementation of these solutions on the ground. This interaction is crucial, as it allows the artisans to adapt their skills and expertise to the specific needs of the farmers, while taking into account the realities of the agricultural world.

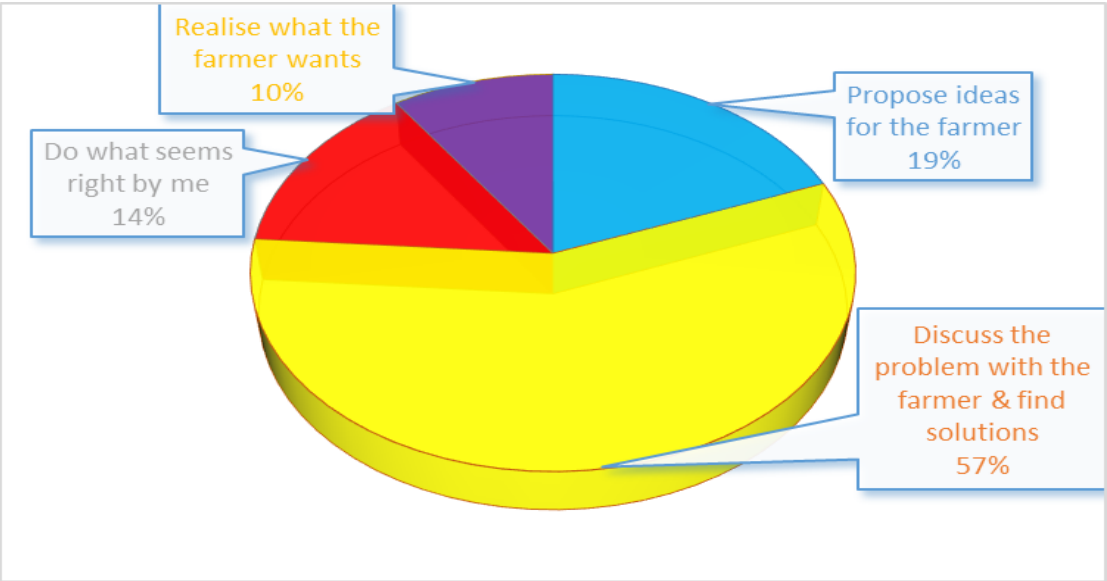


Figure 16: Brainstorming from the perspective of Craftsmen

Regarding the phase of concretization of the joint projects, an interesting insight was provided by the testimonies of the artisans, as shown in Figure 16, Indeed, 57.1% of them indicated that they prefer dialogue by discussing and consulting the farmer as well as other artisans during the implementation process. This collaborative approach not only promotes a better understanding of each other's needs, but it also strengthens the feeling of involvement of the different actors in the project, which can result in more satisfactory results adapted to the reality on the ground.

In a slightly different logic, 19% of respondents stated that they prefer to propose their own ideas, which they consider appropriate, before moving on to implementation. In these cases, if the farmers agree, the implementation process can then begin. This demonstrates a certain autonomy of the artisans who, while remaining attentive to their farmer partners, take the initiative in designing solutions.

On the other hand, 14.3% of the artisans mentioned that they plan and implement projects without involving the farmer, which raises questions about the effectiveness and relevance of the proposed solutions. This method could potentially lead to results disconnected from the real needs of the farmers, calling into question the adequacy of the interventions carried out.

Also, 9.5% of the artisans opted for an approach where they simply implement the ideas suggested by the farmer, without making any modifications or adaptations. While this method may seem respectful of the farmer’s opinion, it may also lack innovation, as it does not take into account the technical expertise that craftsmen could bring to the project.

It is also interesting to note that a significant majority, 64% of craftsmen, confirmed that farmers tend to place more importance on the efficiency of equipment than on its aesthetics, as it is confirmed by the proofs found in the field by the researcher in Figure 17. This finding highlights a clear priority among farmers: their ultimate goal is to optimize their productivity and yield, which can influence the type of equipment they choose to acquire or use. This dynamic reveals not only farmers' expectations for practical solutions, but also the need for craftsmen to orient their creations towards functional, robust tools that are adapted to the demands of daily agricultural work.

Figure 17: Some Innovations from the Field (Mehda, 2024)

An important finding is that no less than 80.8% of artisans are willing to design and build complex machines based on their current skills, provided they have detailed illustrations and diagrams. This result not only demonstrates their adaptability, but also their boundless creativity, revealing a clear willingness to innovate despite barriers such as their level of formal education.

It is important to note that approximately 68% of the artisans concerned have not gone beyond Middle school level of education, which does not prevent them from engaging in ambitious projects.

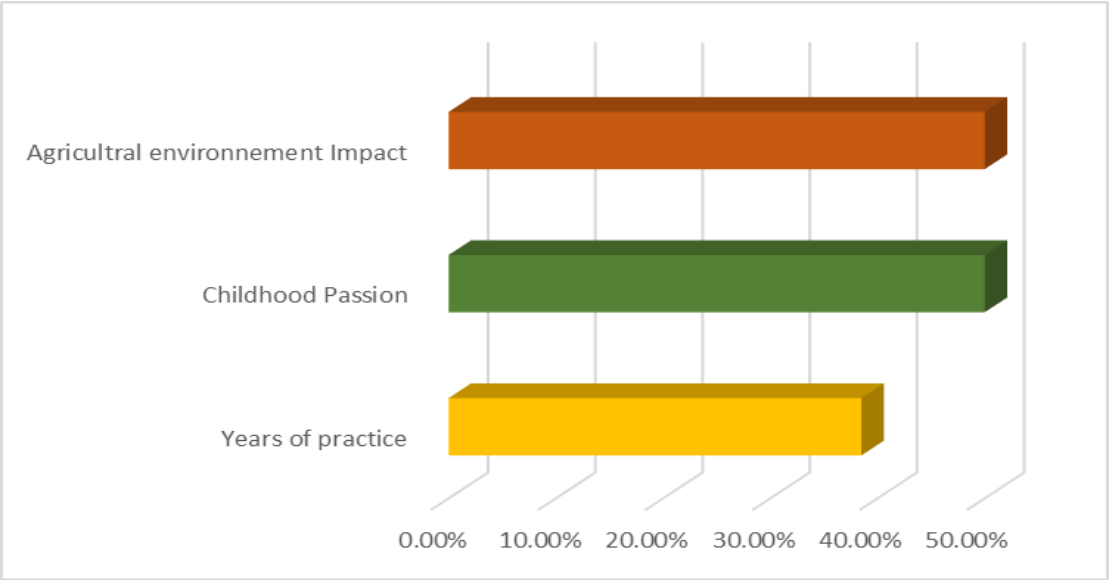


Figure 18: Roots of manufacturing capability of Craftsmen

Artisans play a vital role in agricultural innovation within their state, often acting as drivers of significant change in their communities. To understand this dynamic better, an in-depth study was conducted on this particular category of the working class. The results presented in Figure 18 illustrates that 38.5% of the artisans surveyed believe that they have developed their skills through years of practice in their field. Most of them started by making spraying axes (AKA: Pivot), a key element of many agricultural activities. This initial choice is part of a tradition where learning through experience is essential.

In addition, almost half of the study participants admitted that the manufacture and development of artisanal machines had been a passion cultivated since their childhood. This passion is not only the result of a personal inclination, but also the result of continuous interaction with their social environment. The influence of societal values and educational opportunities, although limited, played a decisive role in the development of their skills.

These artisans were thus able to take advantage of their local context, combining traditional knowledge and technical innovation, to meet the specific needs of their small farming communities, thus contributing to the economic and social vitality of their region. These artisans perfectly illustrate the synergy between culture, practice, and innovation, highlighting their importance in rural development and the transformation of agricultural methods.

As for the personal motivations that prompted these artisans to get involved in their field of activity, the responses collected reveal a remarkable diversity. Among the participants, 15.2% mentioned that their choice to get involved in this sector was mainly motivated by the perception that it offered real opportunities for employment and profit. This search for financial stability and professional success attracts many individuals to this world, thus highlighting the importance of economic issues in choosing a career.

Another group, representing 19% of artisans, shared that their passion for manufacturing and industry was the driving force behind their commitment. For these individuals, working with their hands and creating tangible products is not only a means of livelihood, but also a source of personal fulfilment. This passion can be sparked by an interest from a young age, exposure to an artisanal environment or an innate curiosity for manual trades.

A particularly telling fact is that another 19% of participants indicated that they were attracted to this field because of the growing demand and specific needs of their region. This highlights the importance of the local context and community expectations in the choice of artisanal professions. These artisans respond to a concrete need while adding value to their territory, thus developing a symbiosis between their activity and the demands of the local market.

On the other hand, 7.6% of respondents reported that they had inherited this family vocation. This intergenerational transmission highlights not only the importance of tradition and craftsmanship, but also the weight of family and cultural expectations that can weigh on individuals' career choices. These artisans thus perpetuate valuable craft skills and techniques that risk disappearing without this family continuity.

Another interesting aspect also concerns the circumstances that led 7.6% of participants to make the leap to crafts after working as welders. This demonstrates that career development is often guided by life circumstances, whether it is a reconversion by personal choice or a need for change in the face of unsatisfactory job prospects.

In addition to the experiences shared, one participant revealed that his interest in this profession had followed him since childhood. He mentioned that he had borrowed money to invest in his dream and that he had then undertaken a self-training path, culminating in the recognition of his talent within the agricultural community in his region. This story highlights not only the determination and dedication it takes to succeed in a craft field, but also the importance of passion and personal initiative in building a fulfilling career.

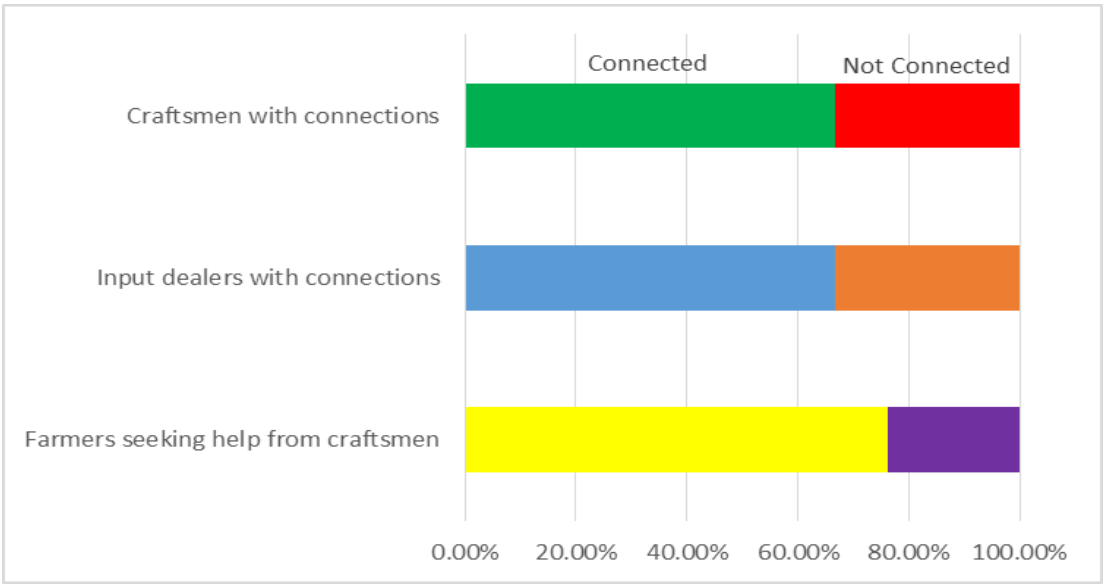


Figure 19: Interconnections among Farmers, Craftsmen, and Agricultural Input Dealers

The results reveal that 76.2% of agro-input dealers reported that farmers actively seek their support to refer them to local artisans (Figure 19). This need for referrals highlights the importance of trust that exists within this value chain. Farmers, in search of solutions tailored to their specific needs, appear to rely on the expertise of dealers not only to acquire quality inputs, but also to connect with artisans who can bring innovations and improvements to their farming practices.

Among the artisans who participated in the survey, 66.7% admitted to having direct and regular relationships with agro-input dealers (Figure 19). These interactions often take the form of exchanges of ideas and feedback, thus creating a professional framework where collaboration becomes the cornerstone of innovation. This dynamic is particularly significant because it illustrates how the synergy between artisans and vendors can catalyze the development of new techniques, tools, and practices that can improve not only the productivity, but also the sustainability of local agriculture.

This interconnection between farmers, input vendors, and artisans is evidence of a vibrant and collaborative agricultural dynamic in El Oued. It also reveals how this interaction fosters innovation, thereby strengthening the economic fabric of the region. Exchanges of expertise and professional collaborations contribute not only to solving specific agricultural issues, but also to promoting a culture of innovation that could facilitate the adoption of new technologies and practices within the agricultural community.

10. The influence of geographical and social proximity on diffusion and decision-making.

By identifying the core target groups of the study, which include various social and economic segments related to the agricultural sector and those who are close to farmers from different social classes. Specifically, this includes three main categories: agricultural stakeholders, artisans, and agricultural input sellers. All of these represent key groups that influence and whom influenced by the factors affecting the decision-making process to adopt innovations and new technologies. The data has shown that the impact of these factors on the opinions of each group is significant, with each of these factors playing an important role in shaping farmers' decisions. The diagram 20 explains the Network of Determinants on innovation uptake,

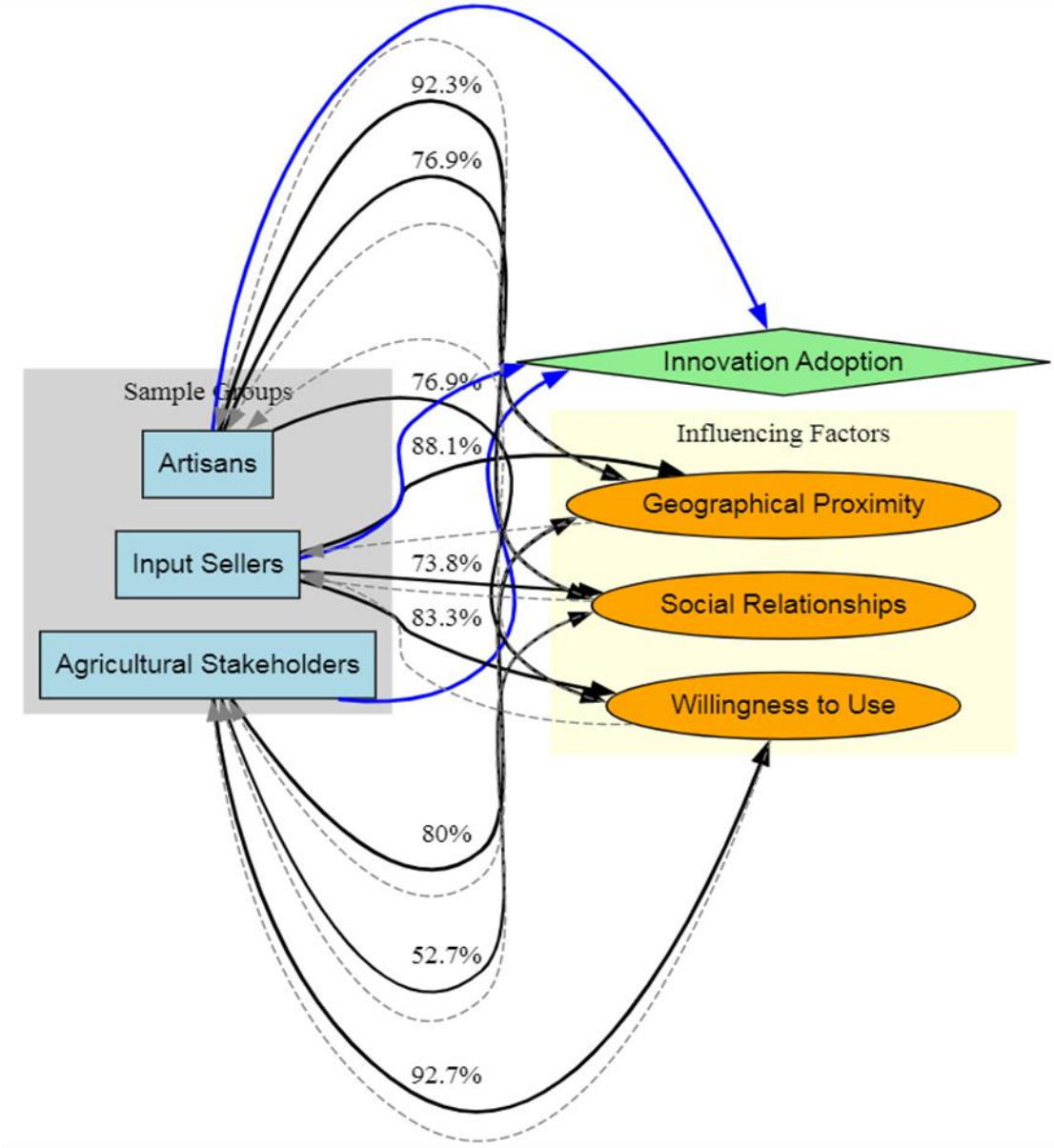


Figure 20: Network of Determinants on innovation uptake

According to professionals in the agricultural sector, the geographical proximity of the areas where innovations are applied is considered a crucial factor in promoting the adoption of these new practices or technologies. A study revealed that about 80% of the participants strongly believe that this geographical proximity plays a significant role in increasing the chances of adopting an innovation.

This is partly explained by the fact that farmers are more likely to experiment with innovations whose results they have seen in their immediate environment, which increases their confidence and motivation to integrate these new methods into their own agricultural practices.

Direct observation of the successes or challenges encountered by neighbors or colleagues in the application of these innovations can also serve as a valuable source of information, thus encouraging faster adoption. On the other hand, it is interesting to note that about 52.7% of the participants also highlighted the importance of social proximity in the decision-making process regarding the adoption of innovations. This social proximity can be manifested through relationships with neighbours, business partners or even friends who have already experienced the innovation in question. These interpersonal relationships play a key role, as they allow for the exchange of information, experiences and practical advice. Their peers often influence farmers, and the trust established in these relationships can give them the boost they need to embark on new initiatives.

Thus, a farmer's social network can act as a catalyst, creating an environment conducive to the adoption of innovations that might otherwise seem too risky or uncertain. In short, both geographic and social proximity prove to be essential factors that can greatly influence the dynamics around the adoption of innovations in the agricultural sector.

The geographic proximity of the regions where agricultural innovations are implemented is a determining factor in the adoption of these innovations by farmers, as highlighted by the responses of 88.1% of participants in a study on the subject. This trend reveals that farmers are more likely to adopt innovative technologies or practices when they are close to their own environment. The opportunity to visit sites where these innovations are already in place not only allows farmers to directly observe the results obtained but also to understand the methods used in a family context.

In addition, proximity provides opportunities for dialogue and exchange of experiences among farmers. By talking to their peers who have already integrated these new practices, farmers can ask questions, address specific concerns, and gather concrete feedback on the major advantages and disadvantages of innovations. These social interactions foster a form of trust and camaraderie that can greatly influence the decision to adopt an innovation.

Furthermore, geographic proximity helps mitigate some of the costs often associated with adopting new practices. By reducing the distances to access support services, resources, and the training needed to implement innovations, farmers can save on transportation and logistics costs. In addition, proximity can also mitigate the risks inherent in adopting new techniques, as farmers can evaluate the performance of innovations in a familiar local context, which provides them with a certain level of security and predictability.

Our study results highlight the critical importance of social proximity to innovation adopters, a key element that significantly influences farmers' adoption of new practices and technologies. The data reveal that an overwhelming majority of 73.8% of agro-dealers agree that social proximity has a substantial positive effect on farmers' likelihood to adopt innovations.

This element raises interesting questions about the social dynamics surrounding decision-making in agriculture. The interpersonal relationship between farmers and innovation adopters, whether they are other farmers or industry professionals, is a key factor in the adoption process. Indeed, when a farmer observes his peers – neighbours, colleagues, or friends – using an innovation and expressing satisfaction with it, he is much more likely to consider and try the same innovation. This is explained by a well-known psychological phenomenon, where the impact of social norms and observed behaviours in one's immediate environment can strongly influence individual attitudes and decisions.

In addition, this social proximity promotes the sharing of authentic and concrete experiences relating to the results and benefits associated with the use of the innovation. Informal exchanges between farmers create an environment conducive to mutual learning and the dissemination of knowledge, thanks to the establishment of trusting relationships. Farmers are often more receptive to recommendations and advice from people with whom they have close relationships, which means that they are likely to openly discuss the advantages and disadvantages of the innovations tested.

Social relationships should not be underestimated when it comes to boosting the adoption of innovations in the agricultural sector. Not only does it create fertile ground for constructive exchanges, it also strengthens the credibility of innovation messages. By revealing an influential and engaged social network, sector stakeholders can therefore better orient their technology diffusion strategies, by integrating approaches that value and exploit these proximity relationships.

Geographic proximity to innovative areas appears to be an essential key factor in fostering the adoption of innovation, as affirmed by an impressive 92.3% of the artisans surveyed. This statistic underlines the importance of dynamic and creative environments, where new ideas and emerging technologies abound, by facilitating access to information, resources and networks of expertise. By being located near these innovation hubs, artisans not only have the opportunity to draw inspiration from best practices, but also to benefit from collaborative synergy with other actors, whether entrepreneurs, academics or research centers.

This dynamic can reduce the barriers to entry related to the adoption of new technologies, as artisans can directly observe the successes and failures of their neighbors, which helps them to assess the risks and benefits associated with innovation. In addition, social proximity plays an equally crucial role in the decision-making process of adopting innovation. Indeed, according to 76.9% of the study participants, interactions with individuals who have already integrated innovations into their practices are perceived as a determining factor.

This social distance translates into an exchange of experiences, advice and valuable feedback that can facilitate the acceptance of new ideas. An artisan can benefit from the informal learning that these interpersonal relationships provide, reassuring themselves about the feasibility of innovation through concrete testimonies.

In addition, the creation of a social support network around innovators helps to build trust and minimize apprehensions about upcoming changes, thus encouraging even more artisans to consider integrating new innovative solutions. In short, the combination of geographical proximity to innovation centers and social proximity to early adopters constitutes a powerful catalyst for accelerating the innovation process in the agricultural sector.

11. Farmer's vision of innovation

In our in-depth survey to understand farmers' views on agricultural innovation, we gathered crucial information on their perceptions and expectations regarding new technologies and practices. Agricultural stakeholders were able to identify several key points that illustrate their relationship with innovation.

On the one hand, an impressive 58.2% of farmers surveyed expressed their belief that these innovations represent a real competitive advantage. They believe that adopting new techniques can significantly contribute to improving their market position, allowing them to optimize their production and, consequently, increase their income. On the other hand, farmers also perceive innovations as essential levers for reducing production costs, a major concern in a sector where the profit margin is often narrow. Indeed, 67.3% of participants highlighted that implementing innovative processes or tools can save on various aspects of production, whether through better resource management, increased automation or the adoption of more sustainable practices. This dynamic aims not only to increase profits but also to make their activity more resilient to market fluctuations.

However, a revealing element was observed regarding farmers' perceptions on another fundamental aspect of innovations: their ability to reduce risks associated with crops and production systems. Indeed, only 27.3% of participants were optimistic that some agricultural innovations could offer effective solutions to mitigate these risks. This raises a significant concern, as the ability to produce consistently and reliably over a long period is crucial for the economic sustainability of farms.

This finding raises questions about farmers' attitudes towards the environmental and economic risks associated with the adoption of innovations. While technological advances have the potential to transform agricultural practices, it also seems necessary to consider environmental issues, impacts on biodiversity and natural balances, and the long-term sustainability of production systems. Farmers may need more support and information on how innovations can be integrated safely and responsibly, in a way that promotes not only their immediate economic success but also the sustainability of their farms and the health of surrounding ecosystems.

The fundamental element that motivates farmers to adopt innovations in their agricultural practices, from the point of view of artisan manufacturers, is undoubtedly the need, as indicated by their experience and observations in the field. Indeed, according to a study conducted among these professionals, the need turns out to be the main motivation for 23.1% of them. This concept underlines the crucial importance of adaptation to the practical and immediate necessities encountered during agricultural production. Artisans know very well that innovations can only be justified if they provide a real response to specific challenges, such as improving yields or resource management. After the need, we see that imitation of successful examples also plays a significant role in the adoption of new practices, representing 19.2% of the stated motivations.

Artisans strive to learn from the successes already experienced by others, which reduces the risks associated with experimenting with new techniques. Adopting proven strategies can therefore be seen as a way to protect against the uncertainty inherent in agriculture, while remaining competitive in the market.

Furthermore, the attempt to compensate for the lack of resources, also estimated at 19.2%, highlights that many farmers find themselves forced to seek innovative solutions in the face of financial or material limitations. This quest for innovation becomes essential to overcome obstacles that could otherwise harm the productivity and viability of their farms.

Economic considerations, such as minimizing production costs and reducing the time and effort required for agricultural operations, appear as equally crucial factors, each accounting for a weight of 15.4%. Farmers are constantly looking for ways to optimize their resources, as effective management of time and expenses can directly affect their profitability.

It is also relevant to note that supply and demand aspects seem less decisive in this process with only 11.5% of causes identified. This may reveal a view rooted in operational reality, where farmers move more in response to personal needs than in response to changing market conditions.

As for technological development, it occupies the last place in the order of priorities with only 3.8%. This may suggest that, even if technological innovation is recognized as a key factor for transformation, farmers in El Oued remain cautious about its adoption, often preferring less risky and more proven methods, perhaps due to financial concerns or a lack of confidence in their ability to effectively integrate these technologies into their practices.

Farmers in the El Oued region base their approach primarily on facilitating agricultural operations, drawing inspiration from concrete successes on the ground.

Their decision-making is thus pragmatic and influenced by a mix of personal experience, economic context and immediate needs. They avoid adventure in favour of proven solutions, while navigating a complex landscape where market pressures and their financial capacities dictate their ability to evolve and innovate. This reality illustrates not only the challenges they face but also their resilience and ingenuity in adapting to the demands of the agricultural sector.

A crucial aspect that deserves special attention in our study is the central role of agro-input traders, who were explicitly mentioned by participants as influential actors. These traders were indeed accredited for their significant impact on the decisions made by farmers, which led us to question the perceptions and opinions of farmers themselves regarding the adoption of agricultural innovations.

On the one hand, it is essential to note that sellers of agricultural inputs interpret farmers' behavior as a manifestation of the collective intelligence of the region's inhabitants.

According to them, this adoption of innovations is not simply the result of a desire for improvement, but also a pragmatic response to daily challenges, including the lack of material resources and mechanization in agricultural practice. Indeed, 47.6% of the responses collected confirm this: farmers adopt innovations not out of a pure desire to innovate, but often out of necessity, due to the constraints on their activities.

On the other hand, the analysis of the results reveals a dual logic of imitation and adaptation. About 50% of traders believe that the adoption of innovations is based on observing and imitating successful examples, whether from other farmers in the region or practices that have proven their effectiveness elsewhere.

This phenomenon highlights the importance of information networks and exchanges within farming communities, where successes can serve as models to follow.

Furthermore, a significant portion of respondents, 40.5%, considers that the choices made by farmers are logical and appropriate decisions. This highlights the ability of farmers to assess their situation and act rationally in a difficult context. Indeed, this pragmatic approach allows farmers to optimize their production by drawing on available resources, even limited ones, and to adopt innovative solutions that directly meet their needs.

Therefore, it is legitimate to conclude that the dissemination of innovations in El Oued cannot be considered without taking into account the specific context of need and scarcity of resources, as well as the difficult production conditions faced by farmers.

These interconnected elements, combined with the dynamics of imitation and the pragmatic logic of agricultural decisions, paint a complex but illuminating image of the factors that influence the adoption of innovations in this region.

This finding also opens avenues for future research on the mechanisms of innovation in agricultural systems, and the policies to be considered to support this dynamic in a more structured and effective framework.

12. The sustainability of practices among farmers, and the measurement of effectiveness.

According to professional stakeholders in the agricultural sector, it is apparent that farmers have different assessment capacities regarding the impact of agricultural innovations, particularly regarding the financial and quantitative dimensions of new practices. Indeed, the data collected reveal that the two main assessment criteria used by farmers are the quantity of products harvested and the financial returns resulting from these innovations. For 96.4% of farmers' responses, these two aspects are crucial indicators for measuring the success of the adoption of new techniques or technologies.

However, a notable contrast emerges when examining farmers' capacity to assess the sustainability of innovations. With a rate of only 64.8%, it appears that the consideration of environmental dimensions is largely below that given to financial and quantitative results. This observation suggests a significant gap in farmers' awareness of sustainability issues, which could be linked to a dominant commercial investment mentality in the region.

Indeed, in many contexts, farmers tend to view agriculture primarily as a source of short-term income, which may lead them to favour innovations that generate immediate returns at the expense of a more in-depth assessment of long-term environmental impacts.

This situation may also reflect a lack of training and information on tools and methods to measure the sustainability of agricultural practices. Farmers, often facing economic pressures, may be hampered in their ability to analyse environmental impacts, which are considered less urgent than financial concerns.

Moreover, the absence of incentive policies to integrate sustainability indicators into the innovation assessment process may exacerbate this tendency.

Farmers' perceptions of agricultural innovations are a complex phenomenon, influenced by a diverse selection of interconnected factors. These perceptions are not homogeneous and vary widely across several parameters, each of which has a significant impact on how farmers welcome new methods or technologies.

Our study participants highlighted key elements that appear to play a crucial role in this dynamic. First, farmers' previous experiences, cited by 96% of participants, appear to be a predominant factor. Indeed, past successes or failures in adopting new techniques or equipment can profoundly influence their willingness to try future innovations.

A farmer who has already experienced positive results will be more inclined to adopt changes, while those who have experienced disappointments may develop a more skeptical disposition.

Farmers' level of education, reported by 73% of respondents, also plays a significant role. Higher education can foster a better understanding of innovations, thus increasing confidence in their potential benefits. In addition, adequate training can enable farmers to better assess the relevance of an innovation in their specific context, thus enabling them to make informed decisions.

Another important element is the level of financial ease of farmers, mentioned by 95% of respondents. Access to adequate financial resources often determines a farmer's ability to invest in new technologies. A farmer with limited financial means will be less inclined to take the risk of adopting an innovation whose profitability he doubts. On the other hand, those with sufficient financial resources are more likely to experiment with new methods, believing in their long-term profitability potential.

The farmers' wide network of relationships, highlighted by 70% of respondents, is another determining factor. Interactions with local managers, professional organizations and agricultural cooperatives allow an exchange of information and experiences, fostering a climate of trust towards innovations. These social relationships can thus serve as catalysts, encouraging the testing of new ideas based on the testimonies and feedback from their peers.

Farmers' perceptions are strongly influenced by the relationship between the cost and the benefit of the innovation, which 84% of respondents referred to. This notion of proportionality is crucial: if the initial investment seems too high compared to the anticipated benefits, farmers are likely to reject the idea of adoption. On the contrary, an innovation perceived as profitable and advantageous can quickly gain popularity.

Also, it is clear that farmers' perceptions of agricultural innovations are the result of a complex interaction between their experiences, their educational level, their financial situation, their networks of relationships, as well as their assessment of costs and benefits. Each of these factors contributes to shaping a nuanced and interconnected landscape, influencing not only individual decisions to adopt innovations, but also the general evolution of agricultural practices.

The results of the survey conducted among seed merchants provide valuable insights into farmers' perceptions of the adoption of new technologies in the agricultural sector. Indeed, a remarkable 83.3% of respondents say they are in favor of the idea that farmers have a significant capacity to integrate these technologies into their daily practices. This massive support highlights not only an open-mindedness, but also a tangible desire to evolve in a constantly changing agricultural environment.

It is essential to understand that this adaptability is not the result of chance, but rather the result of an urgent need. Faced with the growing challenges posed by climate change, market fluctuations, and increasing food demand, agriculture is forced to seek innovative solutions to maintain its competitiveness. New technologies, whether precision agriculture, geographic information systems, or agricultural robots, offer powerful tools to optimize production and minimize costs.

Furthermore, farmers are proving to be innovators in their field. They are often at the forefront of testing new methods and tools, seeking to improve not only their yields, but also the sustainability of their agricultural practices. This proactive attitude towards innovation demonstrates a commitment to the continuous improvement of their practices and results. By integrating technological innovations, farmers are not simply seeking to comply with standards, but are truly aspiring to transform the way they work, diversify their practices and increase their efficiency. This reveals a dynamic of learning and adaptation that is crucial in a sector where conditions can change quickly and unpredictably.

Thus, farmers' acceptance and enthusiasm for new technologies illustrate a key trend: that of resilient agriculture, capable of innovating and reinventing itself in the face of a constantly changing environment. These results suggest that, to support and strengthen this dynamic, it would be wise to continue to encourage training and awareness-raising initiatives for new technologies, in order to maximize the benefits of this openness to innovation.

Similarly, 76.9% of the artisans participating in the study believe that farmers have both the capacity and the disposition to adopt and experiment with new technologies. This openness to innovation is subject to a fundamental criterion: the technologies must first have been tested in the field and validated through concrete demonstrations. This observation highlights the fact that farmers, far from being reluctant to change, are on the contrary driven by a strong desire to improve and optimize their working methods.

Indeed, this willingness to experiment among farmers is part of a broader dynamic of modernizing agricultural practices. It reflects a heightened awareness of the contemporary challenges they face, such as climate fluctuations, the need to maximize crop yields, and the need to meet growing demand for sustainable, quality products.

This context therefore fosters a culture of continuous learning, where farmers seize every opportunity to develop their skills and enrich their knowledge. This positive sentiment toward new technologies is accompanied by a willingness to make thoughtful investments.

Farmers show a strong interest in technological advances that could bring them substantial benefits. This commitment to innovation pushes them to seek training, participate in seminars, or partner with research institutions to better understand and integrate these technologies into their farms.

Agricultural input dealers were also asked to provide a typical perception of farmers who are prone to innovation. The results are shown in the Figure below.

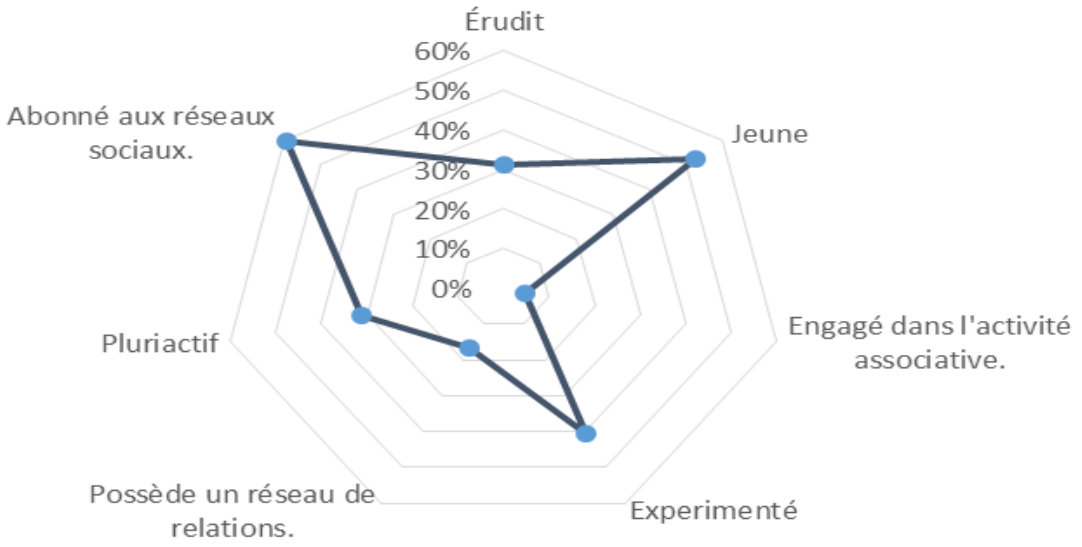


Figure 21: The characteristics of an innovative farmer from the perspective of agricultural input sellers

Figure 21 illustrates the different characteristics of an innovative farmer, a profile clearly highlighted by agro-input traders. The latter have identified a specific typology of farmers likely to adopt innovative practices. This typology is defined by a specific combination of traits that promote and facilitate the integration of innovation in their agricultural activities.

First, one of the predominant characteristics of these farmers is their youth, with 52.40% of them being under 40 years old. This data reveals an interesting dynamic in the agricultural sector, where youth is often synonymous with flexibility, openness to change and enthusiasm for trying new methods and techniques. These farmers bring with them renewed energy as well as a willingness to explore unconventional approaches, which is crucial in a constantly changing environment.

Experience should not be underestimated, as 40.50% of innovative farmers already have a significant record of accomplishment in the agricultural field. This experience gives them a solid frame of reference to assess the risks and uncertainties inherent in innovation. By being sufficiently experienced in the face of the vagaries of the profession, these farmers can make informed decisions and adopt innovative practices with greater confidence.

Another essential aspect of this innovative farmer profile is their tendency to be multi-active. Nearly 31% of them carry out several activities simultaneously, which allows them to diversify not only their sources of income, but also their knowledge. This diversification is strategic: it not only reduces financial risks in the event of market fluctuations, but it also allows them to benefit from synergies between different activities, thus enriching their experience and adaptability to the challenges of the agricultural market.

The active presence of these farmers on social networks is particularly revealing of their commitment to innovation. With 59.50% of them being subscribed to various social platforms, these farmers use these tools to exchange knowledge, share experiences and keep themselves informed of the latest trends and innovations in the agricultural field. This demonstrates a willingness to learn from each other and integrate innovative solutions from various collaborations.

It is worth mentioning that a small proportion of them, representing 4.80%, actively participate in associative activities or professional organizations. This engagement in groups or unions not only offers them a platform to share their experiences and realize synergies, but also the opportunity to defend their collective interests and contribute to the evolution of agricultural practices on a broader level.

This sense of community and belonging strengthens their innovation capacities and the exchange of ideas, thus fostering an environment conducive to innovation.

Discussion of the Results

Professional agricultural stakeholders of El Oued share a clear vision of the innovative dynamics within the agricultural sector, attributing a leading role to farmers and sellers of agricultural inputs. Indeed, according to the data collected, 71.4% of the professionals surveyed believe that farmers are the real drivers of agricultural innovation, thus confirming their central position in the process of adopting and disseminating new practices and technologies. Similarly, 48.2% of respondents emphasize the importance of sellers of agricultural inputs, who play a facilitating role by providing products and services essential to the implementation of these innovations.

These observations contrast with the conclusions of the study conducted by Bouzid et al. in 2020, which identified government institutions as the main catalysts of innovation in the sector. This raises questions about the role of public policies and their support or hinder the innovative momentum of field actors. It is relevant to note that artisans, although as peripheral actors, are also perceived as a significant driving force of innovation, with 23.1% of respondents explicitly citing them. This indicates a recognition of their creativity and their ability to respond to the specific needs of the sector, providing practical and adapted solutions that promote the evolution of agricultural practices.

The interaction between rural communities and actors in the agricultural sector is highlighted as a dynamic and essential element to stimulate innovation. This perspective is corroborated by the results of a recent study conducted by Lezreg et al. in 2022, which states that innovation comes from a multitude of social and institutional interactions. This highlights the importance of a collaborative environment where the exchange of ideas and synergies between different actors can enrich the innovation process.

The role of the market is also crucial in this context. Indeed, the way farmers interact with their economic partners significantly influences their propensity to adopt new techniques. The results of the study by Bouzid et al. in 2020 reveal that farmers specializing in cereal cultivation are reluctant to adopt innovative methods, often due to their dependence on a single economic partner for the sale of their production.

This finding highlights the challenges related to the diversification of outlets and opening up to new distribution channels, which could nevertheless promote greater adoption of innovations and strengthen the competitiveness of the agricultural sector in El Oued.

It appears that innovation in the agricultural sector is the result of a complex ecosystem where various actors, from farmers to artisans, including economic partners and institutions, intersect. This dynamic requires special attention in order to create an environment conducive to innovation, which is based on solid interactions and mutually beneficial exchanges between all stakeholders.

The decision to adopt an innovation in the agricultural sector is a complex process influenced by various factors, among which economic aspects occupy a prominent place. The costs associated with innovation, the expected benefits and the need to adapt agricultural practices to contemporary requirements represent crucial elements that shape farmers' choices. Interestingly, these elements can appear contradictory, especially when the anticipated benefits of an innovative technology or method seem out of step with the initial costs invested.

In our study, our results corroborate the conclusions of Bouzid et al. (2020), who highlight that farmers are often motivated to adopt innovations because of the benefits they offer. However, we disagree on some points of their analysis, particularly regarding the relationship between farmers' financial affluence and their propensity to integrate innovations into their practices.

Bouzid et al. (2020) argue that financial affluence is not a determining factor. On the other hand, they indicate that the area cultivated is a key element in the adoption decision, an assertion that is not echoed in our results. Conversely, we align with the findings of Maghni and Oukaci (2018) as well as Mabah Tene et al. (2013), who highlight the importance of innovation costs as a decisive criterion for farmers.

It is also relevant to highlight that farmers' risk culture plays a crucial role in their decisions. Indeed, farmers often have a low risk tolerance, which leads them to favor innovations deemed safe and likely to bring tangible benefits in the short term. This trend resonates with the findings of Maghni and Oukaci (2018), who also observed this propensity to adopt innovations perceived as low risk.

Other non-economic factors, such as time management, perceptions of the field, prior knowledge and experience acquired in the sector, also exert a significant influence on the adoption decision. These elements are in line with the results of Mabah Tene et al. (2013), who highlight the importance of a base of skills and knowledge in the integration of new technologies.

However, a major obstacle to innovation in the agricultural sector remains the lack of adequate financing for innovative projects. This lack of financial resources can hamper entrepreneurial initiatives, as repeatedly highlighted by Maghni and Oukaci (2018) and Bouzid et al. (2020), particularly with regard to access to credit. Although Lamani and Ilbert (2016) acknowledge that there are various financing opportunities for innovative projects, the lack of adequate financial support remains a significant challenge that can deter farmers from adopting innovations. The dynamics of innovation adoption in the agricultural sector are shaped by a set of interrelated factors ranging from economic considerations to more subjective elements related to risk perception and personal experience.

The study results highlight that farmers consider a diverse set of characteristics when deciding to adopt an innovation in their agricultural practices. First, the level of complexity of the innovation plays a key role in this dynamic. Indeed, if an innovation is deemed too complex or difficult to implement, farmers are unlikely to choose to adopt it, fearing that it will lead to unforeseen difficulties or failures in their operation. This complexity can also manifest itself in various forms, such as the use of new technologies, modified management procedures, or the need to acquire specific skills.

Another crucial factor is the possibility of trying out the innovation before committing fully. This ability to test the innovation in a limited setting allows farmers to assess its effectiveness and its adequacy with their existing practices. A pre-test reduces perceived risks and gives farmers the confidence to proceed with adoption, knowing that they have had the opportunity to experiment without committing fully.

Adapting the innovation to the specific needs of farmers is also a key dimension. Innovations that do not take into account local realities, crops grown or traditional methods may not find their place on farms. Thus, a good understanding of farmers' needs and contextual production contexts is necessary for the innovation to be perceived as relevant and beneficial.

The ability to visualize the results that the innovation can generate is another determining aspect. Farmers are often motivated by tangible and measurable benefits. If an innovation does not allow for clear gains in terms of yield, cost reductions or quality improvements to be anticipated, the adoption of this innovation could be compromised.

The time required to observe the beneficial effects of an innovation is an element that farmers must also consider. In a sector where decisions often have to be made quickly based on crop cycles and climatic conditions, an innovation that requires a prolonged adjustment period before producing results may be less attractive. Farmers generally prefer solutions that offer rapid returns on investments.

At the same time, artisans, although in a different sector, share similar concerns about the characteristics that influence their decision to adopt an innovation. However, their perception may vary regarding the importance of the possibility of experimenting with an innovation. For them, prior exploration of new techniques or products may be perceived as less crucial compared to other factors, such as the immediate impacts on their production or feedback from other users. This divergence shows the importance of understanding the specific contexts and dynamics of each professional group, in order to adapt innovation diffusion strategies in the sectors concerned.

Farmers often make the decision to adopt innovations based on motivations deeply rooted in their social and environmental context. This trend highlights a key aspect of the adoption process, emphasizing that community and environmental factors can sometimes outweigh more institutional influences, such as those exerted by government agencies. Indeed, the results of our study indicate that 80% of the farmers surveyed emphasize the importance of neighborhood effects and the social mentality prevailing in their region. This suggests that adoption decisions are not made in a vacuum, but are rather shaped by collective dynamics and social interactions within rural communities. This observation seems to contradict the work of Maghni and Oukaci (2018), as well as those of Bouzid et al. (2020), who assert that government agencies are the main source of innovation for farmers.

On the other hand, our results are in line with those of Mabah Tene et al. (2013), who highlight the significant impact of social effects on adoption decisions. Indeed, social networks, informal recommendations and practices implemented by other farmers will play a determining role in how farmers perceive and adopt new technologies. These interrelations reinforce the idea that agriculture is a social as well as an economic activity, where knowledge sharing and community mutual aid are essential.

However, it is important to note that personal motivations related to ambition and adventure-seeking in the adoption of innovations seem to play a less prominent role. Farmers are often more attracted to innovations that promise a clear competitive advantage, such as improved yields or reduced costs. This underlines a pragmatic approach in their decision-making: although innovation is popular, it must meet tangible and measurable needs.

On the other hand, the study also reveals a certain reluctance to adopt innovations that are considered too new or excessively costly. This hesitation can be explained by fear of the unknown and risk aversion, factors that can slow adoption even when innovations could potentially bring benefits. These results are consistent with the findings of Mabah Tene et al. (2013), who also discuss the need for innovations to reassure farmers about their economic viability and their adaptation to proven agricultural practices.

The dynamics of adoption of innovations among farmers turns out to be a complex process, where social motivations, community interactions and pragmatic considerations play a central role, challenging more traditional assumptions that emphasize the influence of formal institutions.

The results of our study highlight the significant role of social interactions, informational resources as well as environmental factors in farmers' decision to adopt technological innovations. Our findings corroborate previous work that has demonstrated that previous experience as well as imitation of colleagues and neighbors play a crucial role in farmers' decision-making regarding the adoption of new practices or technologies (Bouzid et Al., 2020). Indeed, the influence of peers in the agricultural environment cannot be underestimated, as farmers tend to rely on their observations and social network to assess the potential benefits of innovations.

Furthermore, our study revealed that the use of the Internet, combined with regular exchanges with experts and agricultural advisors, emerges as a determining factor for farmers wishing to make informed decisions. These digital platforms offer farmers access to a wealth of information, ranging from case studies to proven practices, which is crucial in a context where the speed of technological change is constant.

Nevertheless, it should be noted that our results present a contrast with some previous works that attribute a limiting responsibility to the relationships established with public agricultural advisory and research organizations in terms of the diffusion of innovations (Bouzid et al., 2020). According to these works, such institutions could sometimes hinder innovation processes due to their communication methods or their resistance to change.

At the same time, our study highlights the idea that the influence exerted by environmental factors cannot be attributed to a single isolated element. On the contrary, the adoption of innovations often results from a complex and interconnected combination of several factors. This is in line with the findings of Eastwood et al. (2017) who highlight that the dynamics of adoption are shaped by a set of variables, such as climate, topography, local cultural practices and economic expectations. It is also essential to note that the initial uncertainty in adopting new technologies tends to diminish over time. As some farmers within the same region begin to adopt an innovation and gain experience with it, they become references for their peers. Indeed, the example and positive results of these early adopters encourage other farmers to consider similar practices (Mabah Tene et al., 2013).

This phenomenon of imitation and sharing of experiences enriches discussions around the challenges faced by farmers, thus consolidating the importance of social interactions and information exchanges in the decision-making process related to agricultural innovation. This highlights the need for actors in the agricultural sector to create environments conducive to knowledge sharing and collaboration, in order to facilitate the diffusion of innovations in rural areas.

Digitization and the increasing use of the Internet play a fundamental role in the diffusion of agricultural innovations within the state. This technological change has transformed communication and information exchange practices between farmers, researchers and institutions. Participants in our surveys express increased trust in social networks, specialized websites and informal meetings, which are perceived as reliable and relevant sources of information. This trend contrasts sharply with the results of the work of Bouzid et al. (2020), who mainly identified agricultural advisors and government institutions as the information channels preferred by farmers.

This shift towards increased reliance on digital tools highlights an important transition in the agricultural landscape. However, it is essential to recognize that, despite the growing importance of technology, agricultural institutions in the wilaya have not yet managed to fully exploit digital tools to effectively disseminate information and knowledge. Government officials, while acknowledging that the Internet is today the most effective tool for the dissemination of innovations, also admit that government commitment to the use of these new platforms is still insufficient. This situation recalls the findings of Bouzid et al. (2020), who highlighted the lack of investment and institutional commitment in the use of digital resources to improve services offered to farmers.

Looking at other actors in the field, it appears that artisans are not yet taking full advantage of digital tools. Only 46.2% of them actively use social networks to get information or share knowledge, while only 30.8% actually publish their innovations. In addition, a modest 26.9% have people dedicated to sharing their innovations via these same social networks. These figures highlight the crucial importance of developing training and awareness initiatives to encourage the use of digital tools within the sector.

It has become imperative to continue digitalization efforts in the agricultural sector to promote the adoption of innovations and improve communication between all stakeholders. By investing in digital education and facilitating access to online resources, we could create an environment conducive to collaboration and the exchange of ideas, which could ultimately strengthen the competitiveness and sustainability of agriculture in the wilaya. Such an approach would not only improve the individual performance of farmers and artisans, but would also contribute to the overall evolution of the agricultural sector towards a more modern and connected approach.

Farmers play a central role in the agricultural ecosystem, acting as key actors who not only influence their own decisions, but also exert significant influence on the choices of other farmers. This study reveals that 38.89% of the mentions relate to their impact, reflecting similar findings found in various previous research, including those by Temple et al. (2011), Klerkx et al. (2012) and Mabah Tene et al. (2013). These studies highlight the extent to which farmers are interconnected, often motivated by exchanges of information, experiences and good practices within their communities

In addition, other actors, such as seed merchants and artisans, also play notable roles within the agricultural value chain. Their expertise and ability to provide essential resources to farmers contribute to the development of efficient and sustainable practices.

However, it should be noted that the influence of government institutions, engineers and market actors is relatively weaker. This finding is corroborated by results from studies conducted by Bouzid et al. (2020), which show that, despite their sometimes crucial role in developing policies and standards, these actors do not exert sufficient pressure to guide farmers' daily decisions.

Furthermore, cooperation between farmers to develop innovations is seen as a promising possibility by the majority of field experts consulted. However, opinions differ on how to implement this cooperation, highlighting a need for unity and a common vision facilitated by clear collective structures.

This issue deserves special attention, as many professionals insist on the crucial importance of such initiatives to lighten farmers' workload and improve their production conditions. Studies, such as those by Temple et al. (2011), Klerkx et al. (2012) and Mabah Tene et al. (2013), also confirm that agricultural associations and cooperatives play a key role in the dissemination and adoption of new agricultural techniques. This dynamic is particularly valid in small, isolated communities, where trust and social interactions strengthen the effectiveness of these organizations.

Interestingly, despite the existence of a considerable number of agricultural associations (56 in total) and cooperatives (33 identified), their impact and activities vis-à-vis farmers are still considered insufficient.

This suggests an untapped potential in the future, where these organizations could play an even more central role in rural development. By strengthening their presence, resources and support, it is expected that their influence on agricultural practices will increase, which could lead to more collaborative and innovative approaches, essential to address contemporary challenges in the sector. In sum, collaboration and mutual assistance within agricultural communities appear to be indispensable levers for the development of a sustainable and dynamic sector, and it is imperative to continue to promote and encourage these collective dynamics.

Agricultural input dealers occupy a key position in modern agricultural dynamics, playing a crucial role in the dissemination of promising technologies and ensuring proactive awareness on the ground. Indeed, their function is not limited to simply selling products; they also provide valuable support to farmers by providing practical advice, strategic guidance and regular monitoring of the application of agricultural techniques. These direct interactions with farmers allow them to understand the specific needs and challenges that producers face, thus promoting a more effective adoption of agricultural innovations.

The results of our study corroborate the conclusions of previous research, notably those carried out by Laouar et al. (2023), which highlight the importance of this link in the agricultural sector. It is clear that input sellers, thanks to their expertise and proximity to farms, can help stimulate innovation by providing personalized support adapted to the realities on the ground for farmers. This support can take several forms, including technical advice on the optimal use of inputs, crop management and investment decisions. In addition, the payment facilities that these sellers are able to offer, as highlighted by Bouzid et al. (2020), constitute a major asset in enabling farmers to access the necessary inputs without encountering financial barriers that could slow down their projects.

To go further in improving access to agricultural inputs, the development of new business models appears as an innovative response to the imperfections that characterize the markets for credit and technical advice. Daoudi (2016) notes that these imperfections can often lead to an underuse of available technologies, thus limiting the growth potential of farms.

Initiatives aimed at creating more inclusive distribution systems, combined with more flexible financing options, can thus play a decisive role in boosting agricultural practices and promoting sustainable and profitable agriculture. In short, the role of agricultural input sellers goes well beyond simple marketing; they are key actors in the transformation of the agricultural sector, contributing both to innovation and to improving farmers' living conditions. Artisans occupy a prominent place in the dynamics of agricultural innovation, acting as fundamental pillars in the design and production of machines and equipment specifically adapted to the varied and often complex needs of farmers (Ould Rebai et al., 2017).

Their role goes far beyond simple manufacturing; they stand as true partners in agriculture, intimately understanding the challenges that farmers face in the field. When interviewed, these artisans highlight several determining criteria that influence farmers' choices when searching for technical solutions.

On the one hand, the very nature of the problem encountered by the farmer plays a central role in this process. Artisans take the time to listen and understand the specific issues that arise. On the other hand, direct dialogue between the artisan and the farmer is crucial. This interaction allows artisans to gather valuable information and share their expertise, while establishing a relationship of trust based on reputation and recognized experience in the field. Farmers are often inclined to collaborate with those who not only have technical expertise but also have a proven track record in similar contexts.

The materialization of artisans' innovative ideas relies on close cooperation, not only with farmers, but also with other artisans. This includes the co-design of multifaceted solutions, where collective knowledge is leveraged to create equipment that precisely meets the requirements of modern agricultural work. Through open dialogue and a continuous exchange of ideas, artisans are able to innovate effectively, making their creations not only functional but also adapted to the real needs of farmers.

Their determination to produce complex machines is remarkable. Artisans are able to create prototypes and models based on detailed illustrations and diagrams that reflect their design process. This is a testament not only to their technical mastery, but also to their ability to adapt to changes and new demands in the agricultural sector. Their creativity is often fueled by their curiosity and desire for continuous improvement, essential characteristics in a constantly evolving field.

It is worth mentioning that artisans' passion for their craft and their commitment to developing innovative solutions are deeply rooted in their educational background and social environment. Formal or informal education, community exchanges, as well as artisanal traditions passed down from generation to generation, fuel their desire to design tools that make a real difference in the practice of agriculture. In short, thanks to their expertise, creativity and passion, artisans play a crucial role in transforming and optimizing agricultural practices, thus consolidating their position as key players in innovation in this vital sector.

The results of the study highlight the fundamental importance of geographical and social proximity in the adoption process of agricultural innovations. Regarding geographical proximity, it is found that when innovations are applied close to farms, this greatly promotes their diffusion. Farmers then have the opportunity to go directly to the application sites to observe the results and methods in action.

This field experience also allows them to interact directly with other users of these innovations, thus promoting the exchange of practices, advice and ideas. These face-to-face interactions strengthen the understanding and acceptance of new techniques, creating an environment conducive to their adoption. At the same time, social proximity plays an equally crucial role. It establishes a relationship of trust between farmers, making it possible to share experiences and practical results related to the use of innovations.

When farmers come from close social or family networks, they are more likely to rely on the recommendations and testimonies of their peers, which strengthens their confidence in the proposed innovations. This dimension of social proximity is not limited only to personal relationships, but also encompasses community dynamics that facilitate collective learning and mutual assistance between farmers.

These findings are consistent with previous research, which has also demonstrated a significant link between the adoption of new agricultural practices and the social and family fabric of farmers, as indicated by the work of Mabah Tene et al. in 2013. However, it is important to emphasize that these results are not sufficient to account for the complex intertwining of social relations and sociotechnical dynamics that influence innovation processes.

According to Ould Rebai et al. in 2017, there are a multitude of social, cultural and technical factors that interact in the adoption of agricultural innovations, and these elements deserve to be studied in greater depth. Sociotechnical network analyses, which include rigorous monitoring of practices as well as narratives of the actors involved, such as those presented by Bouzid et al. (2020), Cross et al. (2002), Mahdi (1993) and Bouzidi et al. (2011), provide a better understanding of these dynamics by highlighting "invisible social relationships".

These studies thus advocate for a more nuanced and multidimensional approach in exploring the mechanisms underlying the adoption of agricultural innovations. Consequently, it is crucial to integrate qualitative research that examines human interactions and sociocultural contexts into the analysis, in order to develop fully effective support strategies in the field of innovative agriculture.

Our results confirm the work of Faure et al. (2018) as well as those of Pouch (2015), which highlight the crucial role of innovation in the agricultural sector. These studies highlight that in the face of a constantly changing market environment, farmers are faced with the need to adapt and improve their practices to maintain their competitiveness.

However, our survey highlighted a significant gap: the consideration of the risks associated with these innovations as well as their environmental impacts remains largely insufficient. This finding stands out from the conclusions of previous studies, which have highlighted the importance of integrating the notion of sustainability into the innovation process, in order to ensure that technological advances effectively contribute to preserving our environment and mitigating the adverse effects of agricultural practices.

Furthermore, our results indicate that various factors influence the adoption of innovations by farmers. Among them, the facilitation of agricultural operations figures prominently, as does the limited availability of resources, whether financial or material. It is also crucial to note that proven success stories on the ground play a decisive role in boosting the adoption process. This corroborates the observations made in previous studies, which have also identified these elements as catalysts for innovation.

A concerning point raised by our data, particularly those reported by Bouzid et al. (2020), is the low adoption rate of sustainable production technical innovations. These results are particularly surprising in light of initial expectations, which predicted a stronger commitment of farmers to environmentally friendly practices. At the same time, it is fascinating to look at the specific sector of potato production. Our analyses reveal that these producers seem to innovate mainly in areas related to marketing, investing 20 to 35% of their efforts in storage, packaging and exploring new markets. This trend suggests that innovation can manifest itself in diverse and varied forms, adapting not only to operational needs, but also to market trends and consumer behaviors.

Thus, the different agricultural sectors can exemplify innovation trajectories that, although heterogeneous, reflect a general willingness to adapt and respond to contemporary challenges. The results of our research reveal a notable willingness of farmers in the wilaya of El Oued to adopt new agricultural technologies. This adaptive capacity seems to be strongly corroborated by the testimonies of the farmers themselves, who clearly indicate that the integration of technical innovations has not only improved the economic profitability of their farms, but has also had a positive impact on the yield of their productions (Bouzid et Al., 2020).

However, while this enthusiasm for the adoption of new agricultural practices is undeniable, our study raises an important concern: the measurement of the impact of innovations seems to focus almost exclusively on quantitative indicators such as the quantity of product harvested and the income generated. This raises questions about the sustainability of the practices implemented, as this approach is hardly in line with contemporary environmental priorities that advocate sustainable and environmentally friendly agriculture. When it comes to disseminating information, it is clear that farmers favor interpersonal interactions and their own social network. Indeed, 98% of them identify direct exchanges, particularly with other farmers and agro-suppliers, as the most effective way to access relevant information and knowledge (Bouzid et al., 2020).

This dynamic raises questions about formal communication channels and their role, as shared learning within farming communities could be a vector for significant progress. Furthermore, our study identified key characteristics that seem to typify innovative farmers, including their relative youth, their experience in the agricultural field, a commitment to pluriactivity, and the use of social networks. These elements constitute significant assets for the adoption of innovations. In addition, it is interesting to note that our analysis reveals a predominant age group among farmers, between 31 and 41 years old, as also observed by Mokhnane et al. (2023).

This trend is consistent with the results of previous studies that have highlighted the importance of age, professional experience and commitment in promoting innovation among farmers (Roussy et al., 2015; Mabah Tene et al., 2013).

This suggests that a certain maturity in terms of both age and experience is essential to foster openness to innovation. However, a surprising aspect of our results is the lack of correlation between farmers' associative activity and their propensity to adopt innovations, which goes against the findings of Szabó (2002).

The latter highlighted the importance of agricultural cooperatives as a means to overcome farm size constraints and stimulate innovation. This divergence may indicate a need to further explore the reasons why associative links do not necessarily translate into wider adoption of innovations, and suggests that alternative mechanisms to promote innovation and good agricultural practices should be considered.

Overall, our study offers valuable insights into the motivations and barriers to innovation in the agricultural sector of El Oued, while highlighting the need to adapt support strategies to the reality of these farmers.

General Conclusion

CONCLUSION

Sustaining innovation in agriculture depends on several interconnected factors. The rural community, especially farmers in cooperatives or associations, plays a vital role through shared experiences that influence perceptions and adoption of innovations. Market fluctuations, driven by global or local factors, also significantly impact farmers' decisions by affecting crop profitability. Economic considerations, such as the costs and expected benefits of new technologies—covering financial, sustainability, quality, and regulatory aspects—are crucial in the adoption process. Additionally, personal factors like weather conditions, farmers' perceptions of their farm needs, and their prior knowledge and experience influence their willingness to experiment with new practices.

The characteristics of an innovation influence its adoption; simpler innovations are more easily embraced, while complex ones may deter farmers. Testing innovations on a small scale helps reduce risks, and tailoring innovations to farmers' specific needs increases their relevance. However, a key shortcoming is the limited consideration of environmental risks, with many farmers prioritizing immediate economic benefits over potential long-term environmental impacts, which can lead to issues like soil degradation and water contamination. The National Policy for the Development of Saharan Agriculture in Algeria offers opportunities to leverage digital platforms, which enhance the dissemination of innovations and facilitate communication among farmers, researchers, and institutions. Digitalization can improve access to new technologies, optimize yields, reduce losses, and promote knowledge sharing, leading to more sustainable and efficient practices suited to Saharan conditions.

Farmers in El Oued view innovations as vital for increasing yields and gaining a competitive edge in the market, helping them meet rising demand and access new markets. Key actors such as farmers, input sellers, and artisans are central to innovation, with their interactions—shaped by knowledge sharing and local networks—being crucial for adopting new practices. Promoting innovation requires considering cultural, traditional, and infrastructural differences across regions to develop tailored strategies. Providing targeted training and advice enhances farmers' understanding of new technologies and practices, supporting those already open to innovation. Facilitating dialogue and experience-sharing among farmers and stakeholders fosters experimentation, boosts confidence, and encourages adaptation of innovations to local contexts.

In Algeria, fostering farmers' creativity is essential for increasing productivity, competitiveness, and supporting economic and social development. Innovation enables the adoption of sustainable practices amid challenges like climate change and resource pressure. However, farmers face risks such as market fluctuations and weather uncertainties, making them hesitant to adopt new techniques. To address this, systematic initiatives—such as training programs, financial support, and risk assessment—are needed to promote low-risk, high-reward innovations. Encouraging idea-sharing through networks and cooperatives can also strengthen collective innovation, enhancing sector resilience, food security, and farmers' livelihoods.

References

References

Abdulai, A., & Huffman, W. E. (2005). The diffusion of new agricultural technologies: The case of crossbred-cow technology in Tanzania. American Journal of Agricultural Economics, 87(3), pp. 645–659.

Adamczewski, G., (1996). “La notion d'innovation : figures majeures et métaphores oubliées“ In. L'innovation en éducation et en formation, Collection Pédagogies en développement, De Boeck Université, Belgique

Adesina, A. A, & Baidu-Forson, J. (1995). Farmers’ perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural Economics, 13(1), pp. 1–9. https://doi.org/10.1016/0169-5150 (95)01142-8

Adesina, Akinwumi A., Mbila, D., Nkamleu, G. B., & Endamana, D. (2000). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. Agriculture, Ecosystems & Environment, 80(3), pp. 255–265.

Adger, W.N. (2005) Successful adaptation to climate change across scales. Global Environmental Change-Human and Policy Dimensions 15, 77-86.

Adler, P.S., Shenbar, A., (1990). Adapting your technological base: the organizational challenge. Sloan Management Review 25, 25–37.

Aidat, T., Benziouche, S. E., Cei, L., Giampietri, E., & Berti, A. (2023). Impact of Agricultural Policies on the Sustainable Greenhouse Development in Biskra Region (Algeria). Sustainability, 15(19), 14396.

Ajzen, I. (1985). "From intentions to actions: A theory of planned behavior". In J. Kuhl & J. Beckmann (Eds.), Action Control : From cognition to behavior (pp. 11- 39). Heidelberg: Springer.

Ajzen, I., (1991). "The theory of planned behaviour". Organizational Behavior and Human Decision Processes, vol. 50, pp. 179-211.

Akinbamijo, Y., & Wachira, F. (2015). Sciences, la Technologie et l'Innovation (STI) dans la Transformation Sociale et Économique de l'Agriculture en Afrique. In : Recherche et Développement. Document de référence.

Akrich, M., Callon, M., & Latour, B. (1988). A quoi tient le succès des innovations 1: L'art de l'intéressement; 2: Le choix des porte-parole. Paper presented at the Gérer et comprendre. Annales des mines.

Alston, J. M., Norton, G. W., & Pardey, P. G. (1995). Science under scarcity: Principles and practice for agricultural research evaluation and priority setting. International Service for National Agricultural Research.

REFERENCES

Alves, C. M. (2022). La biodiversité, patrimoine commun de l'UnioN européenne alliance naturelle ou mariage contre-nature?. Revue Juridique de l'Environnement, (S2), 243-252.

Amundsen, H., Berglund, F., Westskog, H. (2010) Overcoming barriers to climate change adaptation a question of multilevel governance? Environment & Planning CGovernment & Policy 28,276-289.

Anderson, J. B., Jolly, D. A., & Green, R. D. (2005). Determinants of farmer adoption of organic production methods in the fresh-market produce sector in California: A logistic regression analysis. (No. 1846-2016-152504).

Anderson, J. R., Dillon, J. L., & Hardaker, B. (1977) Agricultural Decision Analysis. Monographs: Applied Economics.

ANSEJ. (2016). Mise en valeur des terres pour l'agriculture. Fiche technique. Algérie : ANSEJ.https://ansej.dz/images/fiches/agriculture/Mise_en_valeur_des_terres_pour_l_agriculture.PDF

Antonelli C, (2008). The economics of innovation critical concepts in economics. Eds Routledge London.

Antonelli C, (2009). The economics of innovation critical concepts in economics. Eds Routledge London

Archirbugi D, Howells J et Michie J, (1998). Innovation Systems in a Global Economy. University of Manchester, UK. 14pp. In. Liberio J, 2012. Factors contributing to adoption of sunflower farming innovations in MLALI WARD, MVOMERO district, Morogoro Region – Tanzania. Mémoire master. University Of Agriculture. Morogoro, Tanzania.

Arocena, R., Sutz, J. (2003). Inequality and innovation as seen from the South. Technology in Society 25, 171–182.

Assassi, S., Daoudi, A., & Lejars, C. (2017). Les profits" excessifs" des commerçants de fruits et légumes en Algérie: réalité ou préjugé infondé? Le cas de la tomate primeur à Biskra.

Atari, D.O.A. (2009) What motivates farmers to participate in the Nova Scotia environmental farm plan program? Evidence and environmental policy implications. Journal of environmental Management 90, 1269-1279.

Aydalot, P. (1985). Economie régionale et urbaine. (No Title).

Baffoe-Asare, R., Danquah, J. A., & Annor-Frempong, F. (2013). Socioeconomic factors influencing adoption of CODAPEC and cocoa high-tech technologies among small holder farmers in Central Region of Ghana. Journal of Experimental Agriculture International, pp. 277–292.

REFERENCES

Barbieri, J. C., Vasconcelos, I. F. G. D., Andreassi, T., & Vasconcelos, F. C. D. (2010). Innovation and sustainability: new models and propositions. Revista de Administração de Empresas, 50, 146-154.

Barret, D. ; Blundo Canto, G.; Faure, G.; Hainzelin, E.; Monier, C. ; Triomphe, B. (2018). Impress Ex-Ante : Une proposition de démarche pour construire ex ante les chemins de l'impact. CIRAD. Available at : https://agritrop.cirad.fr/587110/1/ID587110.pdf.

Barthet, C. (2007). Evaluation des machines et des équipements industriels. Option finance : Le premier hebdomadaire des décideurs financiers, Hors-série n°22, Lundi 2 juillet 2007, Paris.

Bassett, E. (2010) Innovation and Climate Action Planning. Journal of the American Planning Association 76, 435-450.

Bayerre, P.-Y. (1980). Typologie des innovations. Revue française de gestion, janvier/février, P.9-15.

Becker S. W., Whisler T. L., (1967). "The Innovative Organization: A Selective View of Current Theory and Research". Journal of Business, vol. 40, 1967, p. 462-469.

Bedsworth, L.W. (2010) Adaptation to Climate Change. Journal of the American Planning Association 76, 477-495.

Belaidi, S., & Benmehaia, A. M. (2024). The selection of modern irrigation technologies within a rural community in Algeria: Stated preferences approach. Journal of Rural and Community Development, 19(2).

Bellec, C. (2007). La capacité des entreprises à innover: Etude sur un échantillon d'entreprises hautnormandes pour évaluer leur rapport à l'innovation. Mémoire Master RICI, INPL Nancy, France.

Beltran, L. F., Hernández, M. A. A., Flores-Armillas, V. H., Trejo, K. S., Vázquez, M. L., & Rubio, A. O. (2020). Technology transfer offices as promoters of technology, innovation and regional development in mexico. International Journal of Innovation: IJI Journal, 8(1), 121-136.

Bénédicte A., (2006). Technologies de l'information et de la communication et innovation : implications organisationnelles et stratégiques dans les entreprises touristiques des Alpes-Maritimes. Thèse de doctorat en Sciences de Gestion de l"Université de Nice Sophia Antipolis.

BENMIHOUB, A. (2015). MODÉLISATION DU COMPORTEMENT DES AGRICULTEURS EN SITUATION DE RISQUE SUR LE REVENU. ENSA,

Berkes, F. (2007) Collaborative Integrated Management in Canada's North: The Role of Local and Traditional Knowledge and Community-Based Monitoring. Coastal Management 35, 143-162.

REFERENCES

Bernard, C. (2016). La biodiversité par projet : Réflexivité engagée et dispositif stratégique en Albanie.

Bessant, K.C. (2006) A farm household conception of pluriactivity in Canadian Agriculture: motivation, diversification and livelihood *.(Essay). The Canadian Review of Sociology and Anthropology 43, 51.

Bessaoud, O., Pellissier, J.-P., Rolland, J.-P., & Khechimi, W. (2019). Rapport de synthèse sur l'agriculture en Algérie. CIHEAM-IAMM,

Bienaymé, A. (1994). L'économie des innovations technologiques. Collections « Que saisje ? », Presses universitaires de France, Paris, France

Biesbroek, G.R. (2009) The mitigation-adaptation dichotomy and the role of spatial planning. Habitat International 33, 230-237.

Biggs, S. D. (1990). A multiple source of innovation model of agricultural research and technology promotion. World development, 18(11), 1481-1499.

Binswanger, H. P. (1978). The economics of tractors in South Asia. Agricultural Development Council, New York and International Crops Research Institute for the Semiarid Tropics, Hyderabad, India.

Binswanger, H. P. (1980). Attitudes toward risk: Experimental measurement in rural India. American Journal of Agricultural Economics, 62(3), pp. 395–407.

Bisson, J. (2003). Mythes et réalités d'un désert convoité: le Sahara: l'Harmattan Paris.

Blennow, K., Persson, J. (2009) Climate change: Motivation for taking measure to adapt. Global Environmental Change-Human & Policy Dimensions 19, 100-104.

Boly, V. (2004). Ingénierie de l'innovation : organisation et méthodologies des entreprises innovantes, Lavoisier, Paris, France

Boly, V., Morel, L. (2006). Définition des niveaux d'action pour piloter l'innovation et constribution à une métrique de l'innovation. Dans Ait-El-Hadj, S., Brette, O. (2006). Innovation, management des processus et création de valeur. L'Harmattan, France, 2006.

Bouchareb, N., & Morad, I. (2023). Contribution of the Algerian water management strategy to the agricultural sector of Setif province. Journal of Innovations and Sustainability, 7(2), 08-08.

Bouillot, P. E. (2020). Enjeux juridiques de la transition protéique: le droit de la consommation aveugle aux enjeux de l'alimentation durable?. Revue européenne de droit de la consommation/European Consumer Law Journal, 1.

Boussard, J. M., (1987). " Économie de l'agriculture". Paris : Économica.

REFERENCES

Bouzid, A., Boudedja, K., Cheriet, F., Bouchetara, M., & Mellal, A. (2020). Facteurs influençant l'adoption de l'innovation en agriculture en Algérie. Cas de deux cultures stratégiques: le blé dur et la pomme de terre. Cahiers Agricultures, 29, 15.

Bouzidi, Z., Abdellaoui, E. H., Faysse, N., Billaud, J.-P., Kuper, M., & Errahj, M. (2011). Revealing local innovation networks in large-scale irrigation schemes. Citrus development on the Gharb plain in Morocco.

Brin, A., Dumat, C., Chochon, G., Bachelier, É., & Devienne, T. (2017). L'agriculture urbaine : un terreau propice à l'innovation sociale et pédagogique !

Bryan, E. (2009) Adaptation to climate change in Ethiopia and South Africa: options and constraints. Environmental Science & Policy 12, 413-426.

Bryant, C.R., Singh, B., Thomassin, P. (2008) Evaluation of Agricultural Adaptation Processes andAdaptive Capacity to Climate Change and Variability: The Co-construction of New Adaptation Planning Tools with Stakeholders and Farming Communities in the Saguenay-Lac-Saint-Jean and Montérégie Regions of Québec. Ottawa. Rapport de recherche pour projet A1332, soumis à la fin du mois de juin 2008 à Ressources naturels Canada, CCIAP 400.

Bryant, C.R., Smit, B., Brklacich, M., Johnston, R.T., Smithers, J., Chiotti, Q., Singh, B. (2000) Adaptation in Canadian agriculture to climatic variability and change. Climatic change 45, 181-201.

Bulmer, S., Parker, O.N., Bache, I., George, S., & Burns, C. (2020). 7. The First Years of the European Economic Community (the 1960s and into the 1970s).

Burgelman, R.A., Christensen, C.M., Wheelwright, S.C., (2004). Strategic Management of Technology and Innovation, 4th edition. McGraw-Hill, New York.

Carlsson, B., Jacobsson, S., Holmén, M., & Rickne, A. (2002). Innovation systems: Analytical and methodological issues. Research Policy, 31(2), pp. 233–245.

Carter, M. R. (2009). Investir pour innover en monde rural. Afrique contemporaine, 229(1), 151-170.

Caswell, M., Fuglie, K. O., Ingram, C., Jans, S., & Kascak, C. (2001). Adoption of agricultural production practices: lessons learned from the US Department of Agriculture Area Studies Project.

Cato, M. Scott (2009). Green economics. london: Earthscan (pp. 36-37). ISBN 978184407-571-3.

Chaouch, S. (2018). Dynamique de l'espace agricole et mutations dans le Sahara algérien, cas de la région de Ouargla (le pays d'oued M'ya).

REFERENCES

Chastenet, E., Boucherand, C. (2007). “Small & mid caps” : le rôle du capital humain dans la création de valeur. Option finance : Le premier hebdomadaire des décideurs financiers, Hors-série n°22, Lundi 2 juillet 2007, Paris.

Chauveau JP, Cormier-Salem MC et Mollard E. (1999). L'innovation en agriculture : Questions de méthodes et terrains d'observation. Eds IRD. Paris.

Cheng, C.J., Shiu, E.C.C. (2008). Re-innovation: The construct, measurement, and validation. Technovation 28, 658–666.

Chiesa, V., Coughlan, P., Voss, C.A., (1998). Development of a technical innovation audit. IEEE Engineering Management Review 26 (2), 64-91, Summer.

Chiotti, Q.P., Johnston, T. (1995) Extending the boundaries of climate- change research-Adiscussion on agriculture. Journal of Rural Studies 11, 335-350.

Chiou, W.-C., Kuo, H.-W., Iuan-Yuan, L. (1999). A technology oriented productivity measurement model. International Journal of Production Economics 60-61, 69-77.

Chorfi, S., Hassaine, A., B. Maliki, S., & Hilmi, N. (2024). Impact de l’innovation éducative sur l’entrepreneuriat chez les étudiants algériens. Maghreb - Machrek.

Chouinard, O., Plante, S., Martin, G. (2006) Engagement des communautés face au changement climatique : Une expérience de gestion intégrée à Le Goulet et Pointe Du Chene au Nouveau Brunswick. VertigO 7.

Christensen, J.F. (1995). Asset profiles for technological innovation. Research Policy 24, 727–745.

Coles, A.R. (2009) Vulnerability and adaptation to climate change and variability in semiarid rural southeastern Arizona, USA. Natural Resources Forum 33, 297-309.

Conte A, (2006). The Evolution of the Literature on Technological Change over time: A Survey. Discussion Papers on Entrepreneurship, Growth and Public Policy

Crabbe, P., Robin, M., Arvai, J., Koontz, T., Robbins, P., Sohngen, B., Thompson, A. (2006) Institutional adaptation of water resource infrastructures to climate change in Eastern Ontario.

Crepon, B., Duguet, E., Mairesse, J. (2000). Mesurer le rendement de l’innovation. Economie et Statistique, Volume 334, p. 65-78.

Croppenstedt, A. (2003) Technology Adoption in the Presence of Constraints: the Case of Fertilizer Demand in Ethiopia. Review of Development Economics 7, 58-70.

Cross, R., Borgatti, S. P., & Parker, A. (2002). Making invisible work visible: Using social network analysis to support strategic collaboration. California management review, 44(2), 25-46.

D’Souza G, Douglas C, and Tim P. (1993). "Factors Affecting the Adoption of Sustainable

REFERENCES

Agricultural Practices". In Agricultural and Resource Economics Review,(22) 159-165 **In** D. FORAY et J. MAIRESSE (1999). (eds), Innovations et performances. Approches interdisciplinaires, Paris, Editions de l'école des Hautes Etudes en Sciences Sociales, Paris,

Daoudi, A. (2016). Le financement informel du secteur maraîcher en Algérie : le cas du crédit fournisseur. Techniques financières & développement(3), 107-116.

Daoudi, A., & Lejars, C. (2016). De l'agriculture oasienne à l'agriculture saharienne dans la région des Zibans en Algérie. Acteurs du dynamisme et facteurs d'incertitude.

Davis, F.D. (1986). A technology acceptance model for empirically testing new end-user information systems: theory and results. Ph. D. dissertation, MIT Sloan School of Management, Cambridge, MA.

Davis, F.D., Bagozzi, R., and Warshaw, R., (1989). "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models". Management Science, Volume 35, 1989, pp. 982-1003.

De Mendonca, S. B., & Laques, A. E. (2017). Sustainability Impact Assessment–An Overview with a Holistic and Transdisciplinary Perspective towards Agricultural Research. Environmental Management and Sustainable Development, 6(2), 211-239.

Deconchat, M., Blanco, J., Sourdril, A., Andrieu, É., Kwetchou, A.N., Vigan, M., Corcher, C., Vialatte, A., & Bounab, M. (2017). Les forêts dans des territoires agricoles : nouveaux atouts d'une relation bénéfique.

Derderi, A., Daoudi, A., & Colin, J.-P. (2015). Les jeunes agriculteurs itinérants et le développement de la culture de la pomme de terre en Algérie. L'émergence d'une économie réticulaire. Cahiers Agricultures, 24(6), 387-395.

Dert, F. ; (1997) ; « L'art d'innover ou la conquête de l'incertain » ; Paris, Maxima

Diederen, P., Van Meijl, H., Wolters, A., & Bijak, K. (2003). Innovation adoption in agriculture: innovators, early adopters and laggards. Cahiers d'Economie et de Sociologie Rurales, 67, 29-50.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G. G. (2011). Individual risk attitudes: Measurement, determinants, and behavioral consequences. Journal of the European Economic Association, 9(3), pp. 522–550.

Domencich T. A. and McFadden D., (1975). " Urban Travel Demand: A Behavioural Analysis", North Holland

Dopfer K. et Potts J., (2007). The General Theory of Economic Evolution. Taylor & Francis eLibrary

REFERENCES

Dosi G, (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Research Policy 11, No. 3: 147-62.

Douafer, L. (2024). The 1st National Seminar on Biodiversity, Health and Environment: Sustainable Development Issues. URBAN ART BIO, 2(3), 279. https://doi.org/10.35788/uab.v2i3.108

Drabenstott, M. (2008). Universités, innovation et développement régional : l'expérience américaine. Politiques et gestion de l'enseignement supérieur(2), 49-64.

Drucker P., (1985). " Les entrepreneurs". Paris, L'expansion Hachette, Collection Pluriel.

DU, N. D. O. C., MONDIALE, G. D. L. B., & DE L'OMC, E. (2023). COMMERCE NUMÉRIQUE un catalyseur du développement de l'Afrique.

Dubuisson, S, Kabla, I. (1999). Innovations et compétences : compte rendu d'une réflexion collective. **In** D. FORAY et J. MAIRESSE (eds), Innovations et performances. Approches interdisciplinaires, Paris, Editions de l'école des Hautes Etudes en Sciences Sociales, Paris, 1999.

Eastwood, C., Klerkx, L., & Nettle, R. (2017). Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: Case studies of the implementation and adaptation of precision farming technologies. Journal of rural studies, 49, 1-12. Econometrica, 25(4), pp. 501–522.

El INTIDAMI, M. E., & BENAMAR, F. (2022). Applications du Modèle d'Acceptation de la Technologie (TAM) à la prédiction de l'adoption des technologies en agriculture. International Journal of Economic Studies and Management (IJESM), 2(4), 750-764.

Eris, E. D., Saatcioglu, O. Y. (2006). System look for technological innovation: Firm based perspective. European and Mediterranean Conference on Information Systems (EMCIS), July 6-7/2006, Costa Blanca, Alicante, Spain.

Fachinelli, A. C., D'arisbo, A., & de Melo Maciel, E. (2014). A importância da inovação social e da economia criativa como indutores para o desenvolvimento sustentável. International Journal of Knowledge Engineering and Management, 3(5), 276-293.

Fagerberg J., (2003). Schumpeter and the revival of evolutionary economics: an appraisal of the literature. Journal of Evolutionary Economics, 13: 125–159.

FAO. (2020). Impacts of coronavirus on food security and nutrition in Asia and the Pacific: Building more resilient food systems. Issue paper.

FAO. (2021). Impacts of COVID-19 on food security and nutrition: developing effective policy responses to address the hunger and malnutrition pandemic. HLPE issues paper.

REFERENCES

Faure, G., Chiffoleau, Y., Goulet, F., Temple, L., & Touzard, J.-M. (2018) Innovation et développement dans les systèmes agricoles et alimentaires. Éditions Quae. ISBN: 9782759228133.

Feder, G, & Umali, D. L. (1993). The adoption of agricultural innovations: A review. Technological Forecasting and Social Change, 43(3–4), pp. 215–239.

Feder, G, Just, R. E., & Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. Economic Development and Cultural Change, 33(2), pp. 255–298.

Feenstra, G. (2019). Increasing the capacity for place-based food systems. Journal of Agriculture, Food Systems, and Community Development, 9(A), 61-66.

Ferney-Walch, S., Romon, F. (2006). Management de l'innovation : De la stratégie aux projets. Vuibert, Paris

Fishein, M.A. and Ajzen, I., (1975). "Belief, attitude, intention and behavior: an introduction to theory and research", Reading, MA, Addison Wesley

Foltz, J. D., & Chang, H. H. (2002). The adoption and profitability of rbST on Connecticut dairy farms. American Journal of Agricultural Economics, 84(4), 1021-1032.

Freeman C. (1982). The Economics of Industrial Innovation. London: Pinter Publishers

Freeman C. (1991). The nature of innovation and the evolution of the productive system. In: OECD, editors. Technology and productivity-the challenge for economic policy. Paris: OECD, 1991. p. 303–14.

Freeman, C., (1994). Critical survey: The economics of technical change. Cambridge Journal of Economics 18, 463–514.

Fussel, H.M. (2007) Adaptation planning for climate change: concepts, assessment approaches, and key lessons. Sustainability Science 2, 265-275.

Galanakis, K. (2006). Innovation process. Make sense-using systems thinking. Technovation 26, 1222- 1232.

Gall, A.L. (2015). Pratiques de représentations visuelles des concepts en équipe d'exploration : rôles et caractéristiques des objets intermédiaires en fonction de leurs contextes d'usage.

Garcia, R., Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. The Journal of Product Innovation Management, Volume 19, p. 110-132.

Gareau, P., Lepage, L. (2005) Vers la gestion intégrée du fleuve Saint-Laurent : Les défis d'une action collective : Enjeux environnementaux contemporains : les défis de l'écocitoyenneté [Integrated management of Saint Lawrence river : challenges of collective action]. Nouvelles pratiques sociales (Sainte-Foy), vol 18, 104-116.

REFERENCES

Gedikoglu, H., McCann, L. M.-J., & Artz, G. M. (2011). Off-farm employment effects on adoption of nutrient management practices. Agricultural and Resource Economics Review, 40(1203-2016–95483), pp. 293–306.

Ghadim, A. K. A., & Pannell, D. J. (1999) A conceptual framework of adoption of an agricultural innovation. Agricultural Economics, 21(2), pp. 145–154.

GIEC (2001) Summary for Policymakers. Climate Change 2001: Impacts, Adaptation, and Vulnerability, A report ofWorking Group II of the IPCC, Geneva, IPCC.

GIEC, (2007) Bilan 2007 des changements climatiques. Contribution des Groupes de travail I, II et III au quatrième Rapport d'évaluation du Groupe d'experts intergouvernemental sur l'évolution du climat [Équipe de rédaction principale, Pachauri, R.K. et Reisinger, A. GIEC. GIEC, Genève, Suisse, p. 103.

Giget, M. (1994). L'innovation dans l'entreprise. Techniques de l'ingénieur A4010.

Gilly, M. C., & Zeithaml, V. A. (1985). The elderly consumer and adoption of technologies. Journal of consumer research, 12(3), 353-357.

Gould, B. W., Saupe, W. E., & Klemme, R. M. (1989). Conservation tillage: The role of farm and operator characteristics and the perception of soil erosion. Land Economics, 65(2), pp. 167–182

Goux-Baudiment, F. (2004). Prospective et innovation : fertilisation croisée. in Christofol, H.,Richir, S. Samier, H. (2004). L'innovation à l'ère des réseaux. Lavoisier, Paris, France.

Green, D. (2010) Indigenous Australians' knowledge of weather and climate. Climatic change 100,337-354.

Griliches, Z. (1957) Hybrid Corn: An Exploration in the Economics of Technological Change.

Griliches, Z. (1990). Patent statistics as economic indicators: a survey. Journal of Economic Literature, 28, 1661–1707.

Guan, J. C., Yam, R. C. M., Mok, C. K., Ma, N. (2006). A study of the relationship between competitiveness and technological innovation capability based on DEA models. European Journal of Operational Research, Volume 170, Issue 3, 1 May 2006, Pages 971986.

Guellec, D (2003). Mesurer l'innovation : quelques leçons de l'expérience de l'OCDE. 8e séminaire de la Direction des Statistiques d'Entreprises, Innovation : de l'idée à la performance Insee Méthodes n°105.

Gu-Konu, E. (1999). Les concepts d'analyse du processus d'innovation agricole en Afrique. L'innovation en agriculture. Questions de méthodes et terrains d'observation, IRD Editions, 186-198.

REFERENCES

Gutmann, R. (2003). Innovation in Integrated Electronics and Related Technologies: Experiences with Industrial-Sponsored Large-Scale Multidisciplinary Programs and Single Investigator Programs in a Research University. The International Handbook on Innovation, Pages 548-555.

Hadeid, M., Bellal, S. A., Ghodbani, T., & Dari, O. (2018). L'agriculture au Sahara du sudouest algérien: entre développement agricole moderne et permanences de l'agriculture oasienne traditionnelle. Cahiers Agricultures, 27(1), 15005.

Hagedoorn, J., Cloodt, M. (2003). Measuring innovative performance : is there an advantage in using multiple indicators ? Research Policy 32. 1365–1379.

Hägerstrand T. (1967). Innovation Diffusion as a Spatial Process. Chicago: University of Chicago Press. In Gijsbers GW, 2009. Agricultural Innovation in Asia: Drivers, Paradigms and Performance. Doctorat thesis. Rotterdam university P. 317.

Hamdi‑Kidar, L. (2023). L'innovation par les consommateurs lors des phases de prototypage : apports à la théorie du lead-user. Innovations.

Hausman J., and Mc Fedden D., (1984), "Specification Tests for the Multinomial Logit Model", Econometrica, vol. 52, nº 5, pp. 1219-1240.

Hussein Kazem, A. (2023). The Role of Modern Agriculture in Rural Development. International Journal of Modern Agriculture and Environment, 3(1), 71-79.

James, P.A.S. (2010) Using Farmers' Preferences to Assess Development Policy: A Case Study of Uganda. Development Policy Review 28, 359-378.

Jeder, H., Khalifa, A. B., & Sghaier, M. (2013). Impact des changements climatiques sur l'agriculture dans la plaine de Jeffara sud-est tunisien. Journal of Agriculture and Environment for International Development (JAEID), 107(2), 229-242.

Jensen, P. H., Webster, E. (2004). Examining Biases in Measures of Firm Innovation. Melbourne Institute Working Paper No. 10/04.

Jonker, M., Romijn, H., Szirmai, A., (2006). Technological effort, technological capabilities and economic performance: a case study of the paper-manufacturing sector in West Java. Technovation 26 (1), 121–134.

Kacperczyk, K. A. (2011). L'adaptation de l'agriculture polonaise à la politique agricole commune et aux défis de la mondialisation (Doctoral dissertation, Strasbourg).

Kalpaka, A., Sörvik, J., Tasigiorgou, A., & Rissola, G. (2020). Digital Innovation Hubs as policy instruments to boost digitalisation of SMEs.

Kandlikar, M., Risbey, J. (2000) Agricultural impacts of climate change: If adaptation is the answer, what is the question? An editorial comment. Climatic change 45, 529-539.

REFERENCES

Karl Marx (1867) se référait à ces différentes dimensions en discutant les divers aspects du rapport social entre les producteurs dans le mode de la production capitaliste

Kempton, L. (2021). Wishful thinking? Towards a more realistic role for universities in regional innovation policy. **In** Dislocation: Awkward Spatial Transitions (pp. 271-288): Routledge.

Kessler, E.H., Chakrabarti, A.K. (1999). Speeding up the pace new product development. Journal of Product Innovation Management 16, 231–47.

Khalil, T. M. (2000). The key to competitiveness and wealth creation. Mac Graw-Hill international editions.

Klerkx, L., Van Mierlo, B., & Leeuwis, C. (2012). Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. Farming Systems Research into the 21st century: The new dynamic, 457-483.

Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. Food policy, 32(1), 25-48.

Koc, T., Ceylan, C. (2007). Factors impacting the innovative capacity in large-scale companies. Technovation 27, 105–114.

Kotler P., Dubois B., (1994). " Marketing Management". Publi-Union, Paris, 1994.

Kpokpogbé C. K., (2000). Construction sociale d'innovation technologique et résistance paysanne au changement : Le phénomène d'hybridation du palmier à huile dans le sudest du Bénin. Thèse Ph. D. Université de Laval.

Kronik, J., Verner, D., (2010) The role of indigenous knowledge in crafting adaptation and mitigation strategies for climate change in latin America, in: Mearns, R., Norton, A. (dir.), Social Dimension of Climate Change: Equity and Vulnerability in Warming world. The International Bank for Reconstruction and Development/The World Bank, Washington DC, pp. 145- 169.

Kumar, S., & Madlener, R. (2018). Energy systems and COP21 Paris climate agreement targets in Germany: an integrated modeling approach. 2018 7th International Energy and Sustainability Conference (IESC), 1-6.

Lachmann J., (1993). " Le financement des stratégies de l'innovation". Économica, Paris, 1993.

Lamani, O., & Ilbert, H. (2016). La segmentation du marché oléicole. Quelles politiques de régulation du marché d'huile d'olive en Algérie ? New Medit, 15(3), 19-28.

Lancaster, K. J. (1966). A New Approach to Consumer Theory. Journal of Political Economy, 74(2), pp. 132–157. https://doi.org/10.1086/259131

REFERENCES

Laouar, N., Daoudi, A., & Dugué, P. (2023). Les vendeurs d'intrants agricoles, des traducteurs locaux d'un système d'innovation agricole mondialise. Cas du maraichage sous serre a Biskra (Algérie). Les cahiers du Cread, 39(2), 177-200.

Laura German, Jeremias Mowo, Kingamkono, M. (2006) A methodology for tracking the ''fate'' of technological interventions in agriculture. Agriculture and Human Values 23, 353–369.

Lazarev, G., (2009) La gouvernance territoriale et ses enjeux pour la gestion des ressources naturelles: Des approches novatrices pour lutter contre la désertification et la dégradation des terres et des eaux, in: UNCCD (dir.), 1er ed. Secrétariat de la Convention des Nations Unies sur la Lutte contre la Désertification.

LE BAS, C., Cabagnols, A., AND Gay, C. (2003), "An Evolutionary View on Persistence in Innovation: An Empirical Application of Duration Model," in P. Saviotti, ed., Applied Evolutionary Economics, Northhampton, MA: Edward Elgar.

Le Masson, P., Weil, B., Hatchuel, A. (2006). Les processus d'innovation - Conception innovante et croissance des entreprises. Collection Stratégie et Management, Hermès Lavoisier, Paris, France.

Leeuwis, C. (2010). Changing views of agricultural innovation: implications for communicative intervention and science. Research to impact: case studies for natural resource management for irrigated rice in Asia, 15.

Leeuwis, C., Leeuwis, C., & Ban, A. (2004). Communication for rural innovation (Vol. 231): Wiley Online Library.

Lefale, P.F. (2010) Stormy weather today: traditional ecological knowledge of weather and climate. The Samoa experience. Climatic change 100, 317-335.

Lejars, C., Daoudi, A., & Amichi, H. (2017). The key role of supply chain actors in groundwater irrigation development in North Africa. Hydrogeology Journal, 25(6), 1593.

Lepage, L., (2009) Adaptation aux changements climatiques : entrevue avec Laurent Lepage http://vertigo.hypotheses.org/472. VertigO, 18 décembre 2009.

Lepper, M. R., (1982). "Microcomputers in education: Motivational and social issues". Paper presented at the annual meetings of the American Psychological Association, Washington, D.C.

Lissoni, F., & Metcalf, J. S. (1994) Diffusion of Innovation: Ancient and Modern: A Review of the Moen Themes. In M. Dodgeson and R. Rothwell (Eds.), Industrial Innovation.

Liu, B., Wang, J., Li, R. Y. M., Peng, L., & Mi, L. (2022). Achieving carbon neutrality–the role of heterogeneous environmental regulations on urban green innovation. Frontiers in Ecology and Evolution, 10.(923354).

REFERENCES

Lotodé, R. (1987). Rapport de mission auprès de la CSSPPA-Abidjan (mars 1987). Projets de prévisions de récolte concernant le cacao et le café.

Loyem, N.L., Lengha, N.T., & Mubeteneh, C.T. (2020). Agriculture biologique : Nécessité d'appropriation par les producteurs et attitudes des consommateurs au Moungo-Cameroun. Journal of the Cameroon Academy of Sciences.

M.A.D.R. (2017). Évaluation de la mise en œuvre du Renouveau agricole. Campagne agricole 2017, Bilan final.

M.A.D.R. (2024). Évaluation de la mise en œuvre du Renouveau agricole. Campagne agricole 2024, Bilan final.

Tene, M., & Laure, G. (2013). Déterminants socio-économiques et institutionnels de l'adoption d'innovations techniques concernant la production de maïs à l'ouest du Cameroun.

Madani, L., & Moumou, S. (2020). L'importance des énergies renouvelables dans l'agriculture saharienne en Algérie. Université Mouloud Mammeri,

Mahdi, M. (1993). Innovation et système social. Cahiers Options Méditerranéennes, 2(1).

Mangematin, V., Bereziat, Y., Corneloup, F., Orcel, L., Saussac, M., & Dufour, A. (2000). Le rôle local des écoles d'agronomie et d'agriculture dans l'innovation réalisée par les PME du secteur des IAA. Recherche pour et sur le développement régional, Montpellier.

Manon B. (2007), utilisation du modèle d'acceptation technologique chez les professionnels intéressé à la réalité virtuelle comme outil thérapeutique : Quels sont les facteurs influençant leur décision. Essai doctoral. Université du Québec à Montréal

Mansfield, E. (1968). Industrial research and technological innovation: An econometric analysis. New York: Norton for the Cowles Foundation for Research in Economics, Yale University.

Marchand, I., & Laau-Laurin, O. (2024). La participation sociale des personnes aînées : un pilier au développement des communautés locales ? Interventions économiques.

Mariano, M. J., Villano, R., & Fleming, E. (2012). Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines. Agricultural Systems, 110, pp. 41–53.

Marty, A.-G. (1955). Analyse critique de l'oeuvre de joseph Scumpeter. Bordeaux,

Mastaki N, (2006). Le rôle des goulots d`étranglement de la commercialisation dans l`adoption des innovations agricoles chez les producteurs vivriers du Sud-Kivu (Est de la R.D.Congo). Thèse de doctorat, Academie Universitaire Wallonie-Europe : Faculté universitaire des sciences agronomiques de GEMBLOUX. Pp. 240

REFERENCES

Matisoff, D.C. (2008) the Adoption of State Climate Change Policies and Renewable PortfolioStandards: Regional Diffusion or Internal Determinants? Review of Policy Research 25, 527- 546.

Mazzarol, T., Reboud, S. (2006). Evaluation du risque lié à une innovation pour les PME : proposition d'un outil. Revue internationale PME, vol. 19, n°2.

Mehda, N. (2017). الميزة التنافسية للجزائر في الحاصلات الفلاحية دراسة حالة: المحاصيل المبكرة بولاية بسكرة. Université Mohamed Khider-Biskra,

Menapace, L., Colson, G., & Raffaelli, R. (2015). A comparison of hypothetical risk attitude elicitation instruments for explaining farmer crop insurance purchases. European Review of Agricultural Economics, 43(1), pp. 113–135. https://doi.org/10.1093/erae/jbv013

Menard C., (2003). "L"approche néo-institutionnelle: des concepts, une méthode, des résultats", Cahiers d'économie politique, n° 44. L'Harmattan

Mendelson, R., Dinar, A., (2009) Climate Change and Agriculture:An Economic Analysis of Global Impacts, Adaptation and Distribution Effects. Edward Elgar Publishing Limited, Cheltenham, UK. Northampton, MA, USA.

Mendonça, S. B. (2019). Modèle conceptuel d'évaluation de l'impact de l'innovation : basé sur des études de cas des organisations de recherche agricole en France, Brésil et Australie (Doctoral dissertation, Université Montpellier).

MESSAK, M. R. (2011). Recherche sur les causes de l'adoption ou de la non-adoption des techniques d'irrigation économes en eau.

Messaoud, L., Kousseila, B., Amel, B., & Sabria, L. (2022). INNOVATION'S ADOPTION BY FARMERS: EVIDENCE FROM MILA REGION OF ALGERIA. Russian Journal of Agricultural and Socio-Economic Sciences, 126(6), 3-16.

Mezias S.J. et GLYNN M.A., (1993). "The three faces of corporate renewal: institution, revolution, and evolution". Strategic Management Journal, Vol. 14, 2, (77-101).

Millier, P. (2005). Modèle synthétique des conditions de succès d'un projet d'innovation. Cahiers de recherche.

Mohr L. B., (1969). "Determinants of Innovation in Organizations". The American Political Review, Vol. 63, (111-126).

Morel, L. (1998). Proposition d'une Ingénierie Intégrée de l'Innovation vue comme un processus permanent de création de valeur. Thèse de doctorat, INPL Nancy, France.

Moreno, R., Paci, R., Usai, S. (2005). Geographical and sectoral clusters of innovation in Europe. The Annals of Regional Science 39, 715–739.

Morroni M, 1992. Production process and technical change. Cambridge University Press

REFERENCES

Moulaert, F., & Mehmood, A. (2008). Analyser le développement régional. Géographie, économie, société, 10(2), 199-222.

Moulaert, F., & Sekia, F. (2000). Innovative region, social region? An alternative view of regional innovation. Towards a radical cultural agenda for European Cities and Regions: Paris 1999.

Mounier A, (1992). Les théories économiques de la croissance agricole, Inra-Economica, Paris. In Mastaki N, 2006. Le rôle des goulots d`étranglement de la commercialisation dans l`adoption des innovations agricoles chez les producteurs vivriers du Sud-Kivu (Est de la R.D.Congo). Thèse de doctorat, Academie Universitaire Wallonie-Europe : Faculté universitaire des sciences agronomiques de GEMBLOUX. Pp. 240

Mowery DC, Rosenberg N, (1979). The Influence of Market Demand Upon Innovation: A critical review of some recent Empirical Studies" Research Policy 8. 102-53.

Mtisi, R. (2012). "They Promised That the Game Fences Would Be Torn Down": Nationalist Politics and Contested Control of Natural Resources in Southeastern Zimbabwe, 1960s-1970s*.

Naouri, M., Kuper, M., & Hartani, T. (2020). The power of translation: Innovation dialogues in the context of farmer-led innovation in the Algerian Sahara. Agricultural Systems, 180, 102793.

NCBI. (2022). Effect of COVID-19 on food security, hunger, and food crisis. PMC article.

Nelson R.R., (2012). Why Schumpeter has had so little influence on today's main line economics, and why this may be changing. Journal of Evolutionary Economics, 22:901–916.

Nesrine, D., Boualem, B., & Lakhdar, D. M. (2023). Study of the Sustainability of Potato Farms in the Region of Oued Souf (Southern Algeria). Turkish Journal of Agriculture-Food Science and Technology, 11(2), 197-201.

North, C.D., (1990). "Institutions, Institutional Change and Economic Performance". Cambridge: Cambridge University Press, 1990, 152 p.

Nyong, A., Adesina, F., Elasha, B.O. (2007) The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. Springer Science+Business Media B.V. 12, 787–797.

OCDE (2005). Manuel d'Oslo : Principes directeurs pour le recueil et l'interprétation des données de l'innovation - 3e édition. Les éditions de l'OCDE, Paris, France.

OCDE (2009) Integrating Climate Change Adaptation into Development Cooperation: Policy Guidance OCDE, http://www.oecd.org/editions/corrigenda.

REFERENCES

Office national de la météorologie (ONM). (2012). Bulletins mensuels de relevés des paramètres climatologiques en Algérie de 1992 à 2012. Centre climatologique national (CCN), Dar El Beïda, Alger.

Ogden, A.E., Innes, J.L. (2009) Adapting to Climate Change in the Southwest Yukon: Locally Identified Research and Monitoring Needs to Support Decision Making on Sustainable Forest Management. Arctic 62, 159-174.

Omari, C., Moisseron, J.-Y., & Alpha, A. (2012). L'agriculture algérienne face aux défis alimentaires* Trajectoire historique et perspectives. Revue tiers monde (2), 123-141.

Osbahr, H. (2008) Effective livelihood adaptation to climate change disturbance: Scale dimensions of practice in Mozambique. Geoforum 39, 1951-1964.

O'Sullivan, D. (2008) Applying Innovation. : Sage Publishing, Thousand Oaks, California, pp 3.

Otmane, T., & Kouzmine, Y. (2013). Bilan spatialisé de la mise en valeur agricole au Sahara algérien. Mythes, réalisations et impacts dans le Touat-Gourara-Tidikelt. Cybergeo: European Journal of Geography.

Ouédraogo, I., Newman, M. D., & Norman, D. W. (1982). The farmer in the semi-arid tropics of West Africa: A partially annotated bibliography. Research Bulletin No. 4(2), p. 135. International Crops Research Institute for the Semi-Arid Tropics.

OUENDENO, M. (2019). Journal Algérien des Régions Arides (JARA). Journal Algérien des Régions Arides (JARA), 13(2), 114-128.

Ould Rebai, A., Hartani, T., & Kuper, M. (2022). The outward journey of a local innovation: diffusion of an artisanal irrigation pivot from the Algerian Sahara.

Parasuraman, A., (2000). "Technology readiness index (TRI): A multiple-item scale to measure readiness to embrace new technologies", Journal of Service Research. Vol. 2(4), pp. 307-321.

Parthasarthy, R., Hammond, J. (2002). Product innovation input and outcome: moderating effects of the innovation process. Journal of Engineering and Technology Management 19, 75–91.

Pearce, T.D., Ford, J.D., Laidler, G.J., Smit, B., Duerden, F., Allarut, M., Andrachuk, M., Baryluk, S., Dialla, A., Elee, P., Goose, A., Ikummaq, T., Joamie, E., Kataoyak, F., Loring, E., Meakin, S., Nickels, S., Shappa, K., Shirley, J., Wandel, J., Furgal, C. (2009) Community collaboration and climate change research in the Canadian Arctic [La collaboration entre communautés et la recherche sur le changement climatique dans l'Arctique canadien]. Polar research, vol 28, 10-27.

Perrin, C., & Nougarèdes, B. (2020). Le foncier agricole dans une société urbaine. In: Cardère.

REFERENCES

Petit, Y. (2018). Rapport introductif « La lutte contre le réchauffement climatique après l'Accord de Paris : quelles perspectives ? ».

Pingali, P. L. (2012). Green revolution: Impacts, limits, and the path ahead. Proceedings of the National Academy of Sciences, 109(31), pp. 12302–12308.

Pisano, Umberto, Lange, Lisa and Berger, Gerald. (2015). Social Innovation in Europe An overview of the concept of social innovation in the context of European initiatives and practices. ESDN Quarterly Report N°36, April 2015. European Sustainable Development Network - Institute for Managing Sustainability. Vienna University of Economics and Business. Available at: http://www.sdnetwork.eu/quarterly%20reports/report%20files/pdf/2015AprilSocial_Innovation_in_Europe.pdf.

Pool, N., et Burckly C.P., (2006). " L'innovation : enjeux, contraintes et opportunités pour les ruraux pauvres". Rapport FIDA. Janvier 2006

Pouch, T. (2015). L'agriculture et l'enjeu de l'innovation : dimensions générales et éclairage méditerranéen. CIHEAM Watch Letter, 32(5).

Prax, J.-Y., Buisson, B., Silberzahn, P. (2005). Objectif Innovation : Stratégies pour construire l'entreprise innovante. Dunod, Paris, France

Rahm, M. R., & Huffman, W. E. (1984) the adoption of reduced tillage: The role of human capital and other variables. American Journal of Agricultural Economics, 66(4), pp. 405–413.

Rebai, A. O., Hartani, T., Chabaca, M. N., & Kuper, M. (2017). Une innovation incrémentielle: la conception et la diffusion d'un pivot d'irrigation artisanal dans le Souf (Sahara algérien). Cahiers Agricultures, 26(3), 35005.

Reid, S., Smit, B., Caldwell, W., Belliveau, S. (2007) Vulnerability and adaptation to climate risks inOntario agriculture. Mitig Adapt Strat Glob Change, 609–637.

Richefort L., (2008). Processus de sélection des technologies d'irrigation par les agriculteurs: entre interactions sociales et choix rationnels. Thèse de Doctorat en Sciences Économiques Université de La Réunion

Rogers E. M. and Shoemaker F. F., (1971), "Communication of innovations. A Cross Cultural Approach". New York, the Free Press.

Rogers E., (1983): Diffusion of innovation, Free Press. London

Rogers, E., (1995): Diffusion of innovations Fourth Edition. The Free Press.

Romijn, H., Albaladejo, M. (2002). Determinants of innovation capability in small electronics and software firms in southeast England. Research Policy 31, 1053-1067.

Roseboom J, (1999). Technological innovation in agriculture: the contribution of agricultural input industries. The Hague: ISNAR.

REFERENCES

Roussy, C., Ridier, A., & Chaib, K. (2015). Adoption d'innovations par les agriculteurs : rôle des perceptions et des préférences. Rural Sociology, 8(1), p. 15.

Ruthenberg H, (1980). Farming Systems in the Tropics, Claredon press, Oxford. **In** Mastaki N, (2006). Le rôle des goulots d`étranglement de la commercialisation dans l`adoption des innovations agricoles chez les producteurs vivriers du Sud-Kivu (Est de la R.D.Congo). Thèse de doctorat, Academie Universitaire Wallonie-Europe : Faculté universitaire des sciences agronomiques de GEMBLOUX. Pp. 240.

Ruttan VW, et Hayami Y, (1984). Toward a theory of induced institutional innovation. Journal of Development Studies, 20, 203–223.

Ruttan, V. W. (1996) What Happened to Technology Adoption-Diffusion Research? Sociologia Ruralis, 36(1), pp. 51–73.

Ryan, B., & Gross, N. C. (1943) the diffusion of hybrid seed corn in two Iowa communities.

Sabah, A., Reguia, K., & Tarek, M. (2023). The contribution of desert agriculture to sustainable agricultural development in the state of Oued Souf. International Journal of Economic Performance-02)6 ,المجلة الدولية للأداء الاقتصادي(.

Schilling, M.A., (2005). Strategic Management of Technological Innovation. McGrawHill/Irwin , New York

Schmickl, C., Kieser, A. , How much do specialists have to learn from each other when they jointly develop radical product innovations?, Research Policy 37, 473-491.

Schmookler, J. (1953). Patent Application Statistics as an Index of Inventive Activity. Journal of the Patent Office Society, Volume 35, pp. 539-550.

Schumpeter J, (1934). The Theory of Economic Development. Cambridge (Mass.): Harvard University Press, 1st edn. 1912.

Schumpeter J.A. (1942). " Capitalisme, socialisme et démocratie". Payot, Paris, 1984.

Schumpeter, J. A. (1934). The Theory of Economic Development. Oxford, London.

Schumpeter, J. A. (1983). The theory of economic development. Transaction Publishers, New Brunswick, New Jersey, USA, pp. 112-160. Original material copyright 1934 by the President and Fellows of Harvard College. ISBN: 978-0-87855-698-4.

Silverberg, G., Dosi, G., & Orsenigo, L. (1988) Innovation, Diversity and Diffusion: A SelfOrganization Model. The Economic Journal, 98(393), pp. 1032–1054.

Simonen, J., McCann, P. (2008). Firm innovation: The influence of R&D cooperation and the geography of human capital inputs. Journal of Urban Economics, vol 64, 146–154.

Simpson, B.M. (2000) Adoption et adaptation de techniques agricoles innovantes dans le sud-ouest du Mali [Adoption and adaptation of innovative farming techniques in south-west Mali]. Autrepart (La Tour d'Aigues), no, 5-27.

REFERENCES

Smit, B., Pilifosova, O., (2003) From Adaptation to Adaptive Capacity and Vulnerability Reduction, in: Huq S, S.J., Klein RTJ (dir.) (dir.), Enhancing the capacity of developing countries to adapt toclimate change., Imperial College Press, London.

Smith, A. (2002). An inquiry into the nature and causes of the wealth of nations. Modern Library.

Smith, B., Skinner, M.W. (2002) Adaptation options in Agriculture to Climate Change: A typology. Mitigation and Adaptation Strategies for Global Change. Kluwer Academic Publisher, 85- 114.

Smith, J.B., Jason, M.V., John, E.C.I. (2009) An architecture for government action on adaptation to climate change. An editorial comment. Climatic change 95, 53-61.

Sørensen, K. H. (2006). Domestication: the enactment of technology. Domestication of media and technology, 46.

Soulard, C. T. (2014). Pratiques, politiques publiques et territoires : construire une géographie agricole des villes (Doctoral dissertation, Université Michel de MontaigneBordeaux III).

Spielman DJ, Ekboir J, Davis K, (2009). The art and science of innovation systems inquiry: Applications to Sub-Saharan African agriculture. Technology in Society 31. Pp. 399–405.

Stewart, J. (2007). Local experts in the domestication of information and communication technologies. Information, Community and Society, 10(4), 547-569.

Sturdy, J.D., Jewitt, G.P.W., Lorentz, S.A. (2008) Building an understanding of water use innovation adoption processes through farmer-driven experimentation. Physics & Chemistry of the Earth 33, 859-872.

Swanson, D. (2010) Seven tools for creating adaptive policies. Technological forecasting and social change 77, 924-939.

Szabo, M. (2002). Educational reform as innovation diffusion: Development of a theory and test of a model using continuing professional development and instructional technology. Paper presented at the 2002 Informing Science+ IT Education Conference.

Taravel, B., préface du livre de Christofol, H., Richir, S. Samier, H. (2004). L'innovation à l'ère des réseaux. Lavoisier, Paris, France.

Tarek, M., Sabah, A., & Reguia, K. (2023). Agricultural development as a mechanism for protecting borders: Oued Souf region as a model. Journal Algérien des Régions Arides, 16(1), 113-123.

Temple, L., & Bon, H.D. (2020). L'agriculture biologique : controverses et enjeux globaux de développement en Afrique. Cahiers Agricultures.

REFERENCES

Temple, L., Kwa, M., Tetang, J., & Bikoi, A. (2011). Organizational determinant of technological innovation in food agriculture and impacts on sustainable development. Agronomy for sustainable development, 31, 745-755.

Tene, M., Laure, G., Havard, M., & Temple, L. (2013). Déterminants socio-économiques et institutionnels de l'adoption d'innovations techniques concernant la production de maïs à l'ouest du Cameroun.

Tidd, J., John, B., Pavitt, K. (2006). Management de l'innovation : intégration du changement technologique, commercial et organisationnel. De Boeck & Larcier s.a., Bruxelles, Belgique.

Tomola, F. (2002). Proposition de modèles et méthodes pour l'aide à l'évaluation des performances d'une innovation dès que le stade de la conception, thèse université de Valenciennes et du Haut Cambrésis. **In** Ferney-Walch, S., Romon, F. (2006). Management de l'innovation : De la stratégie aux projets. Vuibert, Paris, p. 164.

Touzard, J.-M., Temple, L., Faure, G., & Triomphe, B. (2014). Systèmes d'innovation et communautés de connaissances dans le secteur agricole et agroalimentaire. Innovations, 1, pp. 13–38

Touzard, J.-M., Temple, L., Faure, G., & Triomphe, B. (2014). Systèmes d'innovation et communautés de connaissances dans le secteur agricole et agroalimentaire. Innovations, 43(1), 13-38.

Tremblay, M., Furgal, C., Larrivée, C., Annanack, T., Tookalook, P., Qiisik, M., Angiyou, E., Swappie, N., Savard, J.P., Barrett, M. (2008) Climate change in the northern Quebec: Adaptation strategies from community-based research. Arctic, 61, 27-34

Triomphe, B., Randriamanalina, J.-M., & Razatovomanitriniarivo, H. (2014). La toute jeune plateforme paysanne d'innovation du Lac Alaotra (Madagascar) a-t-elle un futur? Principaux résultats et perspectives de la visite réalisée du 2 au 10 avril 2014.

Tushman, ML., and Anderson P, (1986), "Technological discontinuities and organizational environments." Administrative Science Quarterly, 31: 439-465.

Vanderlinden, J.-P., Chouinard, O. (2006) Gestion intégrée des zones côtières du nord et de l'est du Nouveau-Brunswick: un programme de recherche au service des communautés dans un contexte d'adaptation et d'innovation. Études canadiennes 3, 195-205.

Veen, M.v.d., (2010) Agricultural innovation: invention and adoption or change and adaptation, World Archaeology. World Archaeology, University of Leicester, pp. 1-12.

Veryzer, R. W. (1998). Discontinuous Innovation and New Product Development Process. Journal of Product Innovation Management 15, 304-321.

Vincey, M. (2018). L'avenir alimentaire est-il végétal ?

REFERENCES

Von Hippel, E, (1988). The sources of innovation. New York: Oxford University Press. In Zook MA, (1997). Technological innovation and theories of regional development. Inside Field Statement. University of California-Berkeley

Walters, H. (2007). An Official Measure of Innovation. Business Week Online, 4 avril 2007.

Weil, P. M. (1970). The introduction of the ox plow in central Gambia. African Food Production Systems: Cases and Theory, pp. 229–263.

Weinkauf, K., & Everitt, T. (2023). Food system resilience during COVID-19: The role of local producers in rural Canada. Canadian Food Studies, 10(2), 82-101.

Yam, R.C.M., Guan, J.C., Pun, K.F., Tang, E.P.Y. (2004). An audit of technological innovation capabilities in chinese firms: some empirical findings in Beijing, China. Research Policy 33, 1123–1140.

Yohe, G., Tol, R.S.J. (2001) Indicators for Social and Economic Coping Capacity - Moving Toward a Working Definition of Adaptive Capacity. Global Environ Change, 25-40.

Zaltman G., Ducan R., Holbek J. et Pasmore W.A., (1988). “Designing Effective Organizations: The Socio-technical Systems Perspective“. Wiley, New York, NY.

Zaltman G., Dungan R., Holbeck J. (1973). “ Innovation and organizations“. JohnWiley

Zeller M, Minten B, Lapenu C, Ralizon E et Randrianarisoa C. (1998). Les Liens entre la Croissance Economique, Réduction de la Pauvreté et Durabilité de l`Environnement en Milieu Rural à Madagascar, Article synthèse du Cahier de la Recherche sur les Politiques Alimentaires (19), 45. IFPRI/FOFIFA, Antanarivo.

Ziervogel, G. (2006) Adapting to climate variability: Pumpkins, people and policy. Natural Resources Forum 30, 294-305

Ziervogel, G., Downing, T.E. (2004) Stakeholder networks improving seasonal climate forcasts. Climatic Change 65, 73-101.

Annexes

Annexe 01 :

دراسة علمية حول الابتكار الفلاحي في منطقة وادي سوف

استبيان لاستقصاء رأي الفاعلين في الميدان الفلاحي

(1- هيئات الإدارة والبحث والتطوير الفلاحي)

ملاحظة: هذه الدراسة تعرف الابتكار الفلاحي على انه أي تقنية جديدة او الاستخدام الجديد لاحد عوامل الإنتاج او توليفة من عوامل الإنتاج او الاشكال الجديدة من التنظيم، التسويق، التصرف الفلاحي. يكون هذا السلوك مستحدث وقليل الانتشار في استعماله بالغرض منه زيادة المردود و/او تقليل التكاليف و/او تحقيق مزايا أخرى (الوقت والجهد و السهولة ...).

1. المؤسسه المنتمي لها المشارك : _____
2. عنوان المؤسسة: _____

1, الخصائص المهنية للمشارك:

3. الوظيفه المشغوله حاليا: _____
4. عدد سنوات خبرتك في هاته المؤسسه: _____
5. هل مارست او تمارس الفلاحة في ولاية الوادي؟ (عندك ارض مفلحها هنا؟) : **0,لا 1,نعم**
6. اذا كنت مارست ولا مزالك تمارس الفلاحه, تقدر تقلي شداش خبرتك فالفلاحه في ولايه الوادي؟ : _____ سنه
7. التكوين المستمر: هل تابعت تكوين مهني فلاحي ؟ (حتى تكوينات تع بضع أيام)؟ : **0,لا 1,نعم**
8. هل واصلت تكوينك في الجامعة؟ **0,لا 1,نعم**
9. إذا نعم وناد التخصص لي درستو في الجامعة؟: _____
10. الديبلوم اللي تخرجت بيه من الجامعة؟
    1. **تقني سامي**
    2. **ليسانس**
    3. **مهندس دولة (انجينيورا)**
    4. **ماستر ل م د**
    5. **ماجيستر (كلاسيكي)**
    6. **دكتوراه**

2, التعريف وتصنيفات الابتكارات:

11. هل تعتبر ولاية الوادي ولاية رائدة في المجال الفلاحي؟ **0,لا 1, نعم**
12. هل تعتبر ولاية الوادي منطقة متقدمة في مجال الابتكار و التطوير الفلاحي مقارنة بالولايات الأخرى بالجنوب الشرقي ؟ **0,لا 1,نعم**
13. هل للديناميكية الفلاحية في الوادي علاقة مباشرة بديناميكة الابتكار الفلاحي؟ **0,لا 1, نعم**
14. ما الذي يدعم هذا الراي _____
15. هل ديناميكية الابتكار في وادي سوف تتزايد مع الوقت ؟ **0, لا 1, نعم**
16. بصفتكم أحد الفاعلين الميدانيين هل لاحظت عن قرب ابتكارات فلاحيه يطبقها الفلاحين في منطقه واد سوف؟
    (الرجاء وضع اجابتكم في الجدول التالي – من المهم تصوير الابتكارات التقنية)

Annexe 02 :

دراسة علمية حول الابتكار الفلاحي في منطقة وادي سوف

استبيان لاستقصاء رأي الفاعلين في الميدان الفلاحي

(2- الحرفيين الصانعين ـالحدادية-)

ملاحظة: هذه الدراسة تعرف الابتكار الفلاحي على انه أي تقنية جديدة او الاستخدام الجديد لاحد عوامل الإنتاج او توليفة من عوامل الإنتاج او الأشكال الجديدة من التنظيم، التسويق، التصرف الفلاحي يكون هذا السلوك مستحدث وقليل الانتشار في استعماله بالغرض منه زيادة المردود و/او تقليل التكاليف و/او تحقيق مزايا أخرى (الوقت والجهد و السهولة ...).

1- الحرفي

1. الاسم (اختياري): .....**(المراسلة لا تذكر ولن تتطرق لاسماء المشاركين)**
2. العمر (اختياري): .....
3. الحالة الاجتماعية: 1-اعزب 2-متزوج 3-مطلق 4-ارمل
4. مكان الإقامة: 1- **(نفس بلدية المحل)** 2- **(بلدية مجاورة لبلدية المحل)** 3- **(عاصمة الولاية)**
5. المستوى الدراسي: 0- امي 1- **الكتاب (المدارس القرانية)** 2- الابتدائي 3- **المتوسط** 4- الثانوي 5- **الجامعة (مع تحديد التخصص)**.....
6. عندك بطاقة حرفي؟ 0,لا 1, **نعم**
7. البلوم الحرفي المتحصل عليه ان امكن: .....
8. هل انت منتمي للضمان الاجتماعي؟ (سوري؟) 0,لا 1, **نعم**

2- نشاطات الحرفي

9. مجال نشاطك الرئيسي :.....
10. عدد سنوات خبرتك فالمجال الرئيسي :.....
11. هل تعتبر الفلاحة احد نشاطاتك الاقتصادية ؟ 0,لا 1, **نعم**
12. هل انت: 1- متخصص 2- متعدد التخصصات
13. هل انت متخصص في : 1- النشاط الفلاحي 2- النشاط الصناعي 3- تصليح المعدات (الترقيع) 4- كل المذكورة
14. في نظرك ايهما انجح : 1- المتخصص 2– متعدد التخصص . ولماذا؟ .....
15. هل مارست او تمارس الفلاحة؟ 0,لا 1, **نعم**
16. عدد سنوات خبرتك في الميدان الفلاحي: .....

3- المحل

17. مساحة المحل تاعك ان امكن: .....م²
18. صفة المحل (الروجيستر): .....
19. ما هو تقييمك للضرائب الناجمة عن نشاطك : 1- منخفضة 2- متوسطة 3- مرتفعة 4- مرتفعة جدا
20. المكان لي فيه المحل : 1- مكان عمراني 2- منطقة فلاحية 3- منطقة صناعية
21. هل عندك خدام معاك فالمحل؟ 0,لا 1, **نعم ,عدد العمال** .....
22. انا كان نعم , عمر العامل و مستواه الدراسي؟: .....
23. هل المحل؟ 1- مكري 2- ملك 3- أخرى .....
24. كم من سنة وانت في هذا المحل ؟..... هل تنوي تغيير مكان المحل ؟ 0,لا 1, **نعم** ولماذا؟.....

4- الابتكار في منطقة الوادي

25. لماذا في منطقه الوادي نحسو بلي كاين حركه فلاحيه كبيرة مقارنه بولايات اخرى؟ .....
26. في رايك لماذا الوادي تتميز بكثرة الابتكارات الفلاحيه مقارنه بمناطق اخرى؟

1- حضور قوي للمتعلمين فالمجال 2- الوادي تاريخيا منطقة ابتكارية ابتداءا من الغوط 3- الطبيعة الصعبة للمنطقة ترغمك انك تخدم مخك 4- وفرة الحرفيين الصانعين الذين بدورهم يساعدون في تجسيد التصورات و حل المشاكل 5- الانترنت 6- حركة التجارة فالولاية التي جرت على اثرها حركة فلاحية داعمة 8- تاثير التوجه الوطني لدعم الطاقات الشابة 9- ميزة استغلال المشاكل لخلق الفرص 10- التوجه الوطني للفلاحة الصحراوية 11- ميزة المحصول المبكر/ الإنتاج على مدار العام 12- سبب اخر.....

27. منذ متى لاحظت الحركيه الابتكاريه فالوادي؟ .....

Annexe 03 :

دراسة علمية حول الابتكار الفلاحي في منطقة وادي سوف

استبيان لاستقصاء رأي الفاعلين في الميدان الفلاحي

(-3- تجار المدخلات الفلاحية)

ملاحظة: هذه الدراسة علمية بحتة، وهي تهدف إلى فهم أفضل لكيفية انتشار الابتكارات الفلاحية في ولاية الوادي.
الباحث يسعى لجمع ما يكفي من المعلومات حول الموضوع، مع الحفاظ على السرية التامة للمعلومات الخاصة بالمشاركين .
تعتبر عينة تجار المدخلات الفلاحية اهم عينة نظرا لوجودهم الفعال بالميدان و تأثيرهم القوي على قرار الفلاح وكذا امتلاكهم النظرة العلمية و العملية للميدان الفلاحي

هذه الدراسة تعرف الإبتكار الفلاحي على انه أي تقنية جديدة او الاستخدام الجديد لاحد عوامل الإنتاج او توليفة من عوامل الإنتاج او الأشكال الجديدة من التنظيم، التسويق، التصرف الفلاحي. يكون هذا السلوك مستحدث وقابل الانتشار في استعماله بالغرض منه زيادة المردود وأو تقليل التكاليف وأو تحقيق مزايا أخرى (الوقت والجهد و السيولة ...).

فتكرم مسبقا للعلم معنا على انجاز هذه الاطروحة وبارك الله في علمكم و عملكم

1- التعريف بصاحب المحل

1- الاسم (اختياري): .....(الدراسة لا تذكر ولن تتطرق لأسماء المشاركين)
2- العمر (اختياري): .....
3- الحالة الاجتماعية: 1-أعزب 2-متزوج 3-مطلق 4-ارمل
4- مكان الإقامة: 1- (نفس بلدية المحل) 2- (بلدية مجاورة لبلدية المحل) 3- (عاصمة الولاية)
5- المستوى الدراسي: 0- امي 1- الكتاب (المدارس القرآنية) 2- الابتدائي 3- المتوسط 4- الثانوي 5- الجامعة
6- هل درست علوم فلاحية فالجامعة ؟ 0,لا 1, نعم (اذا كانت الإجابة بنعم الرجاء ذكر الجامعة ..... و التخصة .....)
7- هل انت منتمي للتعاون الاجتماعي؟ (مسوري؟) 0,لا 1, نعم
8- هل مارست او تمارس الفلاحة؟ 0,لا 1, نعم
9- عدد سنوات خبرتك فالمجال الفلاحي .....
10- هل خدمت سابقا في محل تجارة مدخلات فلاحية قبل ان تفتح محلك الخاص (حصلت على تكوين ميداني)؟ 0,لا 1, نعم و كم كانت مدة التكوين .....
11- عدد سنوات خبرتك في مجال تجارة المدخلات الفلاحية .....
12- ما هي المحفزات التي جعلتك تستثمر طاقاتك المالية و العقلية في هذا المجال؟
1- بحكم انه تخصصي العلمي 2- لأنه نشاط مربح 3- الفرصة الوحيدة المتاحة امامي آنذاك 4- لتوفير المواد المطلوبة للفلاحين 5- لقربها من الميدان
6- لنشر التقنيات الفلاحية 7- نشاط عائلي 8- حافز اخر .....

2- التعريف بنقطة البيع

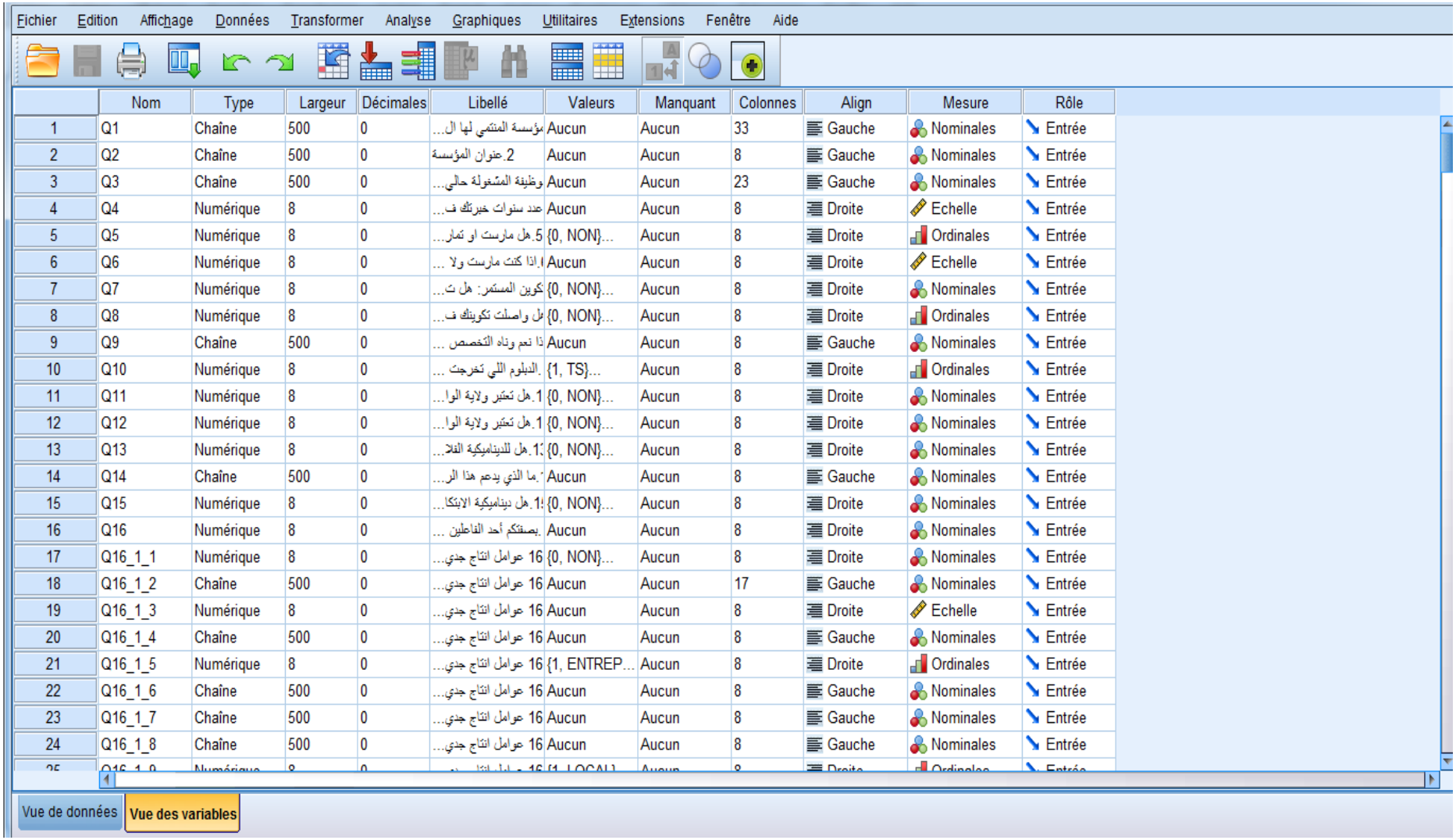
13- بلدية المحل: .....
14- لماذا اخترت هذه البلدية للعمل فيها؟ 1- منطقة فلاحية (طلب كبير) 2- القرابة الاجتماعية (العائلة) 3- قرابة اجتماعية 4- سبب اخر.....
15- هل توجد إعلانات تحسس الزوار بأخذ الحيطة والحذر اثناء التعامل مع الادوية؟ 0,لا 1, نعم
16- مرتب الادوية فالمحل تتباعك على أساس : 1- الخطورة 2- النوع 3- المصدر (اوريجينال و جينيريك) 4- غير مرتبة
17- في نظرك ما هي سلبيات نشاط بيع المدخلات الفلاحية؟ 1- التأثير على الصحة 2- الأثر على البيئة 3- التربدي 4- عقلية الفلاحين 5- المنافسة غير شريفة
18- هل عندك استعداد انك تكمل فهذا النشاط ان شاء الله؟ 0,لا 1, نعم

3- الابتكار الفلاحي و نشاط تجارة المدخلات الفلاحية

19- هل سبقلك و بعت بعض المعدات الفلاحية المستعملة محليا؟ 0,لا 1, نعم
20- اذا كانت قد بعت, تفكر تقلي وشمن معدات بتبيعهم و مصدرها(المنتج من وشمن بلدية) ؟ الالة:..... مصدرها:.....
21- اذا لم يسبقلك و انك بعت هذه المعدات المستعملة محليا, هل عندك استعداد انك تبيع هذه الالات ان جالك الفرصة؟ 0,لا 1, نعم
22- هل هاته المعدات في نظرك كتغير فالميدان الفلاحي : 1- ذات جودة مماثلة للمستورد 2- ذات جودة اقل من المستورد 3- ذات جودة اعلى من المستورد
23- هل سبقلك و تلقيت طلبات من الفلاحين على هاته المعدات؟ 0,لا 1, نعم
24- هل سبقلك و تلقيت طلبات من فلاحين ان تبلغهم الى احد هؤلاء الحرفيين المسلمين؟ 0,لا 1, نعم
25- اذا مايمشيش تفكر تقلي علاه؟ 1- مش مهتم 2- مالقيتش فرصة 3- مش تخصصي 4- هوما يبيعو وحدهم مكلاه الوسطاء
26- هل عندك معاملات مع هؤلاء الحرفيين ؟ 0,لا 1, نعم
27- حسب خبرتك الكبيرة و اطلاعك فالميدان الفلاحي تفكر تتكرلي بعض هاته المكونات لي شفتها ؟

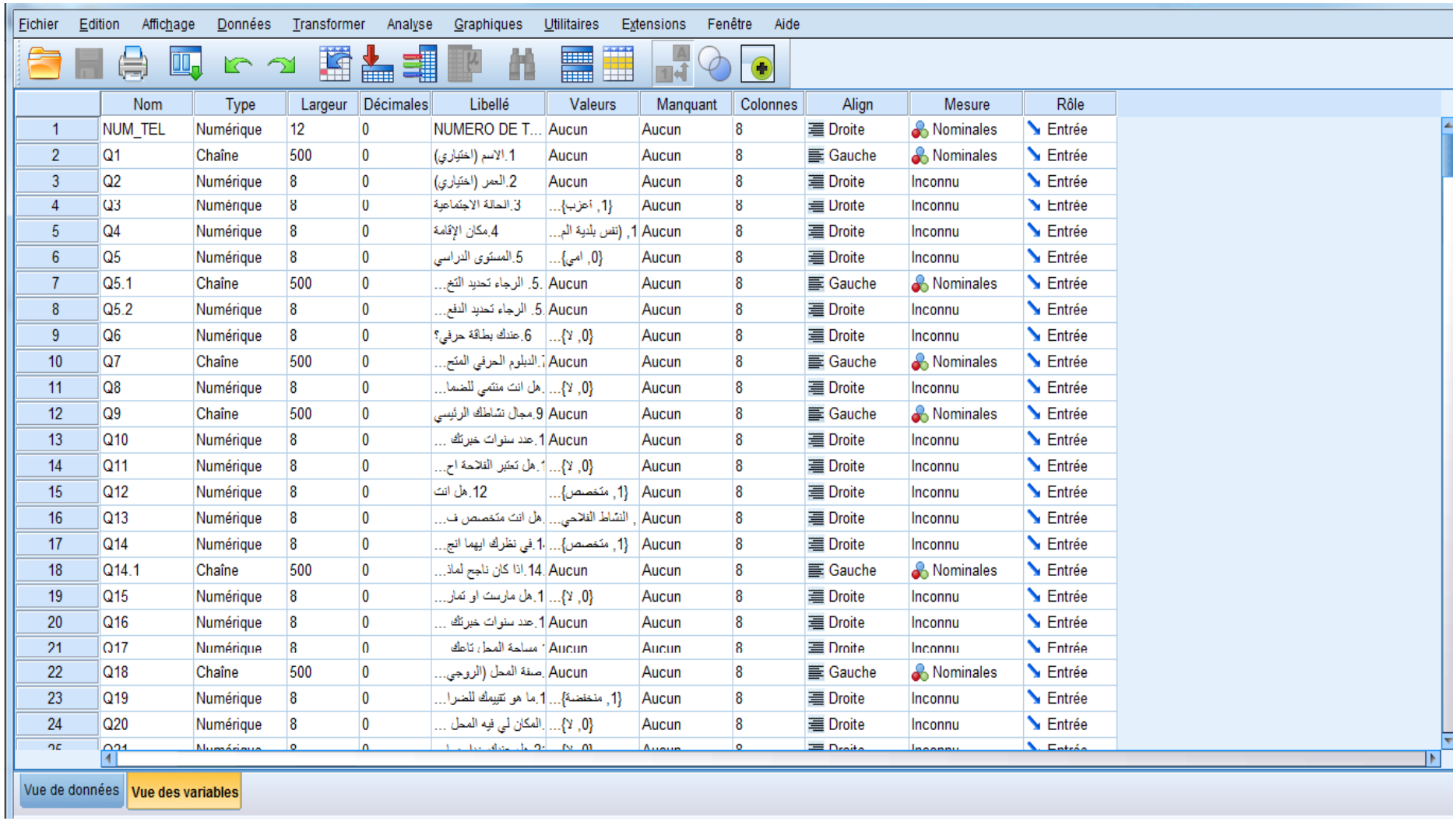
(يرجى من فضلكم اعارة هذا الجدول أهمية قصوى نظرا لأهميته في البحث)

Annexe 04 :



	Nom	Type	Largeur	Décimales	Libellé	Valeurs	Manquant	Colonnes	Align	Mesure	Rôle
1	Q1	Chaîne	500	0	...مؤسسة المنتمي لها ال	Aucun	Aucun	33	Gauche	Nominales	Entrée
2	Q2	Chaîne	500	0	2.عنوان المؤسسة	Aucun	Aucun	8	Gauche	Nominales	Entrée
3	Q3	Chaîne	500	0	...وظيفة المشغولة حالي	Aucun	Aucun	23	Gauche	Nominales	Entrée
4	Q4	Numérique	8	0	...عدد سنوات خبرتك ف	Aucun	Aucun	8	Droite	Echelle	Entrée
5	Q5	Numérique	8	0	...5.هل مارست او تمار	{0, NON}...	Aucun	8	Droite	Ordinales	Entrée
6	Q6	Numérique	8	0	...ا.اذا كنت مارست ولا	Aucun	Aucun	8	Droite	Echelle	Entrée
7	Q7	Numérique	8	0	...كوين المستمر: هل ت	{0, NON}...	Aucun	8	Droite	Nominales	Entrée
8	Q8	Numérique	8	0	...هل واصلت تكوينك ف	{0, NON}...	Aucun	8	Droite	Ordinales	Entrée
9	Q9	Chaîne	500	0	... اذا نعم وناه التخصص	Aucun	Aucun	8	Gauche	Nominales	Entrée
10	Q10	Numérique	8	0	... الدبلوم اللي تخرجت.	{1, TS}...	Aucun	8	Droite	Ordinales	Entrée
11	Q11	Numérique	8	0	...1.هل تعتبر ولاية الوا	{0, NON}...	Aucun	8	Droite	Nominales	Entrée
12	Q12	Numérique	8	0	...1.هل تعتبر ولاية الوا	{0, NON}...	Aucun	8	Droite	Nominales	Entrée
13	Q13	Numérique	8	0	...1.هل للديناميكية الفلا	{0, NON}...	Aucun	8	Droite	Nominales	Entrée
14	Q14	Chaîne	500	0	...ما الذي يدعم هذا الر	Aucun	Aucun	8	Gauche	Nominales	Entrée
15	Q15	Numérique	8	0	...1.هل ديناميكية الابتكا	{0, NON}...	Aucun	8	Droite	Nominales	Entrée
16	Q16	Numérique	8	0	... بصفتكم أحد الفاعلين.	Aucun	Aucun	8	Droite	Nominales	Entrée
17	Q16_1_1	Numérique	8	0	...16 عوامل انتاج جدي	{0, NON}...	Aucun	8	Droite	Nominales	Entrée
18	Q16_1_2	Chaîne	500	0	...16 عوامل انتاج جدي	Aucun	Aucun	17	Gauche	Nominales	Entrée
19	Q16_1_3	Numérique	8	0	...16 عوامل انتاج جدي	Aucun	Aucun	8	Droite	Echelle	Entrée
20	Q16_1_4	Chaîne	500	0	...16 عوامل انتاج جدي	Aucun	Aucun	8	Gauche	Nominales	Entrée
21	Q16_1_5	Numérique	8	0	...16 عوامل انتاج جدي	{1, ENTREP...	Aucun	8	Droite	Ordinales	Entrée
22	Q16_1_6	Chaîne	500	0	...16 عوامل انتاج جدي	Aucun	Aucun	8	Gauche	Nominales	Entrée
23	Q16_1_7	Chaîne	500	0	...16 عوامل انتاج جدي	Aucun	Aucun	8	Gauche	Nominales	Entrée
24	Q16_1_8	Chaîne	500	0	...16 عوامل انتاج جدي	Aucun	Aucun	8	Gauche	Nominales	Entrée

Annexe 05 :

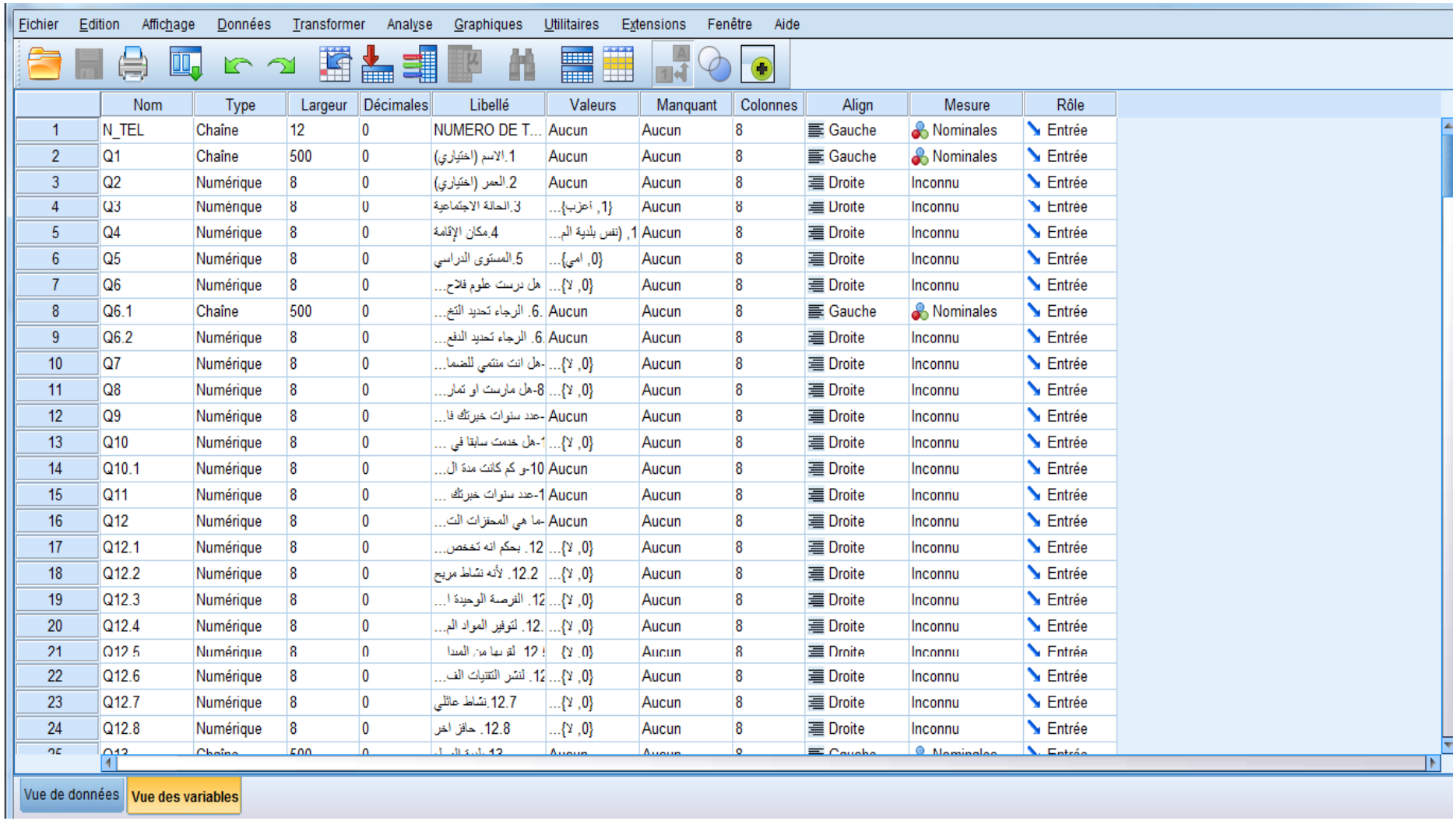


Fichier Edition Affichage Données Transformer Analyse Graphiques Utilitaires Extensions Fenêtre Aide

	Nom	Type	Largeur	Décimales	Libellé	Valeurs	Manquant	Colonnes	Align	Mesure	Rôle
1	NUM_TEL	Numérique	12	0	NUMERO DE T...	Aucun	Aucun	8	Droite	Nominales	Entrée
2	Q1	Chaîne	500	0	1.الاسم (اختياري)	Aucun	Aucun	8	Gauche	Nominales	Entrée
3	Q2	Numérique	8	0	2.العمر (اختياري)	Aucun	Aucun	8	Droite	Inconnu	Entrée
4	Q3	Numérique	8	0	3.الحالة الاجتماعية	...{1, أعزب}	Aucun	8	Droite	Inconnu	Entrée
5	Q4	Numérique	8	0	4.مكان الإقامة	...{1, (نفس بلدية الم	Aucun	8	Droite	Inconnu	Entrée
6	Q5	Numérique	8	0	5.المستوى الدراسي	...{0, امي}	Aucun	8	Droite	Inconnu	Entrée
7	Q5.1	Chaîne	500	0	5. الرجاء تحديد التخ...	Aucun	Aucun	8	Gauche	Nominales	Entrée
8	Q5.2	Numérique	8	0	5. الرجاء تحديد الدفع...	Aucun	Aucun	8	Droite	Inconnu	Entrée
9	Q6	Numérique	8	0	6.عندك بطاقة حرفي؟	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
10	Q7	Chaîne	500	0	7.الدبلوم الحرفي المتح...	Aucun	Aucun	8	Gauche	Nominales	Entrée
11	Q8	Numérique	8	0	8.هل انت منتمي للضما...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
12	Q9	Chaîne	500	0	9.مجال نشاطك الرئيسي	Aucun	Aucun	8	Gauche	Nominales	Entrée
13	Q10	Numérique	8	0	10.عدد سنوات خبرتك ...	Aucun	Aucun	8	Droite	Inconnu	Entrée
14	Q11	Numérique	8	0	11.هل تعتبر الفلاحة اح...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
15	Q12	Numérique	8	0	12.هل انت	...{1, متخصص}	Aucun	8	Droite	Inconnu	Entrée
16	Q13	Numérique	8	0	13.هل انت متخصص ف...	...{, النشاط الفلاحي	Aucun	8	Droite	Inconnu	Entrée
17	Q14	Numérique	8	0	14.في نظرك ايهما انج...	...{1, متخصص}	Aucun	8	Droite	Inconnu	Entrée
18	Q14.1	Chaîne	500	0	14.اذا كان ناجح لماذ...	Aucun	Aucun	8	Gauche	Nominales	Entrée
19	Q15	Numérique	8	0	15.هل مارست او تمار...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
20	Q16	Numérique	8	0	16.عدد سنوات خبرتك ...	Aucun	Aucun	8	Droite	Inconnu	Entrée
21	Q17	Numérique	8	0	17.مساحة المحل تاعك	Aucun	Aucun	8	Droite	Inconnu	Entrée
22	Q18	Chaîne	500	0	18.صفة المحل (الروجي...	Aucun	Aucun	8	Gauche	Nominales	Entrée
23	Q19	Numérique	8	0	19.ما هو تقييمك للضرا...	...{1, منخفضة}	Aucun	8	Droite	Inconnu	Entrée
24	Q20	Numérique	8	0	20.المكان لي فيه المحل ...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
25	Q21	Numérique	8	0	21.هل عندك ...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée

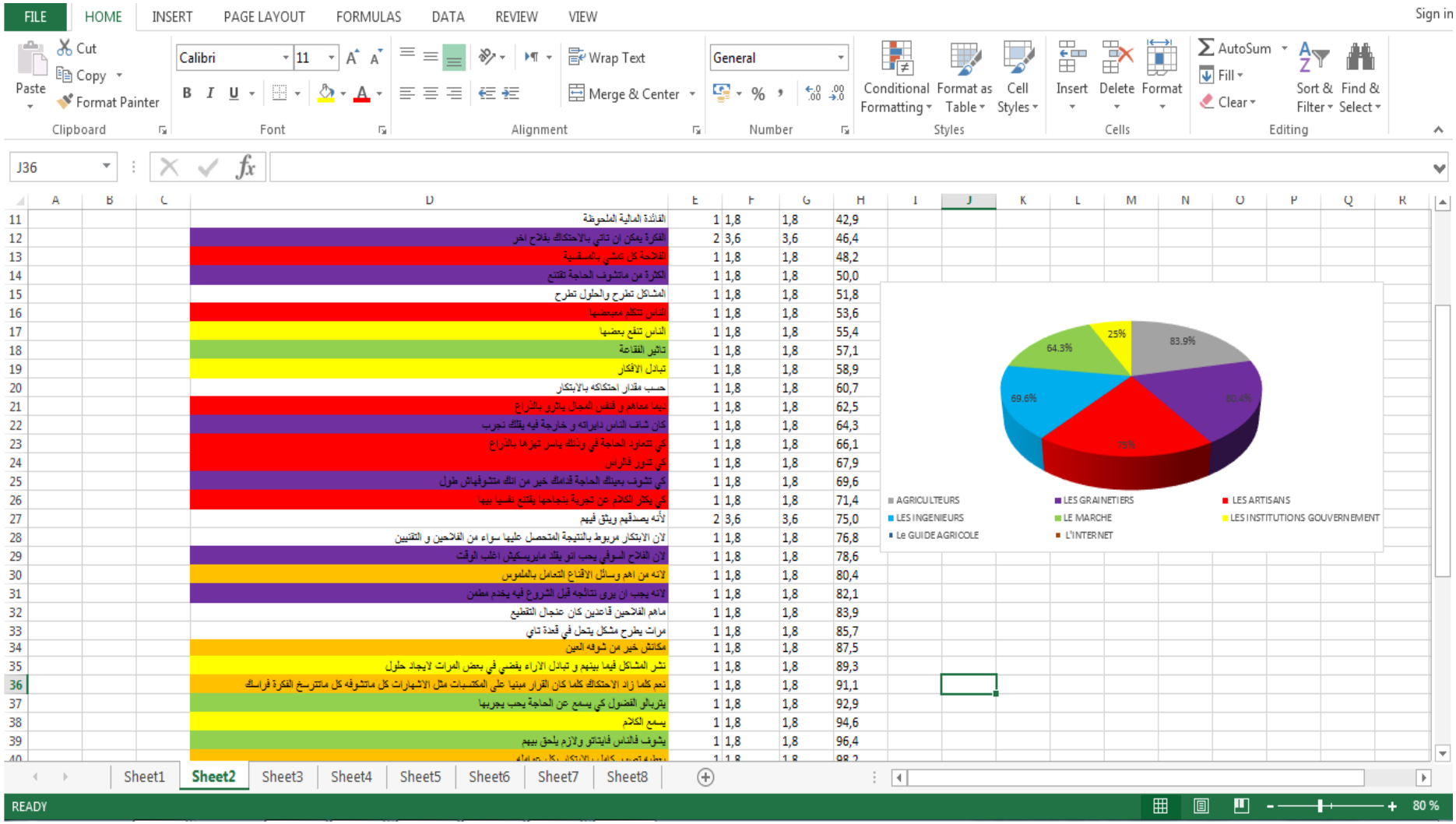
Vue de données | Vue des variables

Annexe 06 :



	Nom	Type	Largeur	Décimales	Libellé	Valeurs	Manquant	Colonnes	Align	Mesure	Rôle
1	N_TEL	Chaîne	12	0	NUMERO DE T...	Aucun	Aucun	8	Gauche	Nominales	Entrée
2	Q1	Chaîne	500	0	1.الاسم (اختياري)	Aucun	Aucun	8	Gauche	Nominales	Entrée
3	Q2	Numérique	8	0	2.العمر (اختياري)	Aucun	Aucun	8	Droite	Inconnu	Entrée
4	Q3	Numérique	8	0	3.الحالة الاجتماعية	...{1, أعزب}	Aucun	8	Droite	Inconnu	Entrée
5	Q4	Numérique	8	0	4.مكان الإقامة	...1, (نفس بلدية الم	Aucun	8	Droite	Inconnu	Entrée
6	Q5	Numérique	8	0	5.المستوى الدراسي	...{0, امي}	Aucun	8	Droite	Inconnu	Entrée
7	Q6	Numérique	8	0	هل درست علوم فلاح...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
8	Q6.1	Chaîne	500	0	6. الرجاء تحديد التخ...	Aucun	Aucun	8	Gauche	Nominales	Entrée
9	Q6.2	Numérique	8	0	6. الرجاء تحديد الدفع...	Aucun	Aucun	8	Droite	Inconnu	Entrée
10	Q7	Numérique	8	0	-هل انت منتمي للضما...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
11	Q8	Numérique	8	0	8-هل مارست او تمار...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
12	Q9	Numérique	8	0	-عدد سنوات خبرتك فا...	Aucun	Aucun	8	Droite	Inconnu	Entrée
13	Q10	Numérique	8	0	1-هل خدمت سابقا في ...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
14	Q10.1	Numérique	8	0	10-و كم كانت مدة ال...	Aucun	Aucun	8	Droite	Inconnu	Entrée
15	Q11	Numérique	8	0	1-عدد سنوات خبرتك ...	Aucun	Aucun	8	Droite	Inconnu	Entrée
16	Q12	Numérique	8	0	-ما هي المحفزات الت...	Aucun	Aucun	8	Droite	Inconnu	Entrée
17	Q12.1	Numérique	8	0	12. بحكم انه تخخص...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
18	Q12.2	Numérique	8	0	12.2. لأنه نشاط مربح	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
19	Q12.3	Numérique	8	0	12. الفرصة الوحيدة ا...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
20	Q12.4	Numérique	8	0	12. لتوفير المواد الم...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
21	Q12.5	Numérique	8	0	12 لقربها من المدا	{0, لا}	Aucun	8	Droite	Inconnu	Entrée
22	Q12.6	Numérique	8	0	12. لنشر التقنيات الف...	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
23	Q12.7	Numérique	8	0	12.7.نشاط عائلي	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
24	Q12.8	Numérique	8	0	12.8. حافز اخر	...{0, لا}	Aucun	8	Droite	Inconnu	Entrée
25	Q13	Chaîne	500	0	13. بأية الم...	Aucun	Aucun	8	Gauche	Nominales	Entrée

Annexe 07 :


FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
REVIEW
VIEW
Sign in
Cut
Copy
Format Painter
Paste
Clipboard
Calibri
11
Font
Wrap Text
Merge & Center
Alignment
General
Number
Conditional Formatting
Format as Table
Cell Styles
Styles
Insert
Delete
Format
Cells
AutoSum
Fill
Clear
Sort & Filter
Find & Select
Editing
J36
A B C D E F G H I J K L M N O P Q R
11 الفائدة المالية الملحوظة 1 1,8 1,8 42,9
12 الفكرة يمكن ان تاتي بالاحتكاك بفلاح اخر 2 3,6 3,6 46,4
13 الفلاحة كل تمشي بالسقية 1 1,8 1,8 48,2
14 الكثرة من ماتشوف الحاجة تقتنع 1 1,8 1,8 50,0
15 المشاكل تطرح والحلول تطرح 1 1,8 1,8 51,8
16 الناس تتكلم معبعضها 1 1,8 1,8 53,6
17 الناس تنفع بعضها 1 1,8 1,8 55,4
18 تاثير الفقاحة 1 1,8 1,8 57,1
19 تبادل الافكار 1 1,8 1,8 58,9
20 حسب مقدار احتكاكه بالابتكار 1 1,8 1,8 60,7
21 ديما معاهم و فنفس المجال يثرو بالذراع 1 1,8 1,8 62,5
22 كان شاف الناس دايراته و خارجة فيه يقلك نجرب 1 1,8 1,8 64,3
23 كي تتعاود الحاجة في وذنك ياسر تيزها بالذراع 1 1,8 1,8 66,1
24 كي تدور فالراس 1 1,8 1,8 67,9
25 كي تشوف بعينك الحاجة قدامك خير من انك متشوفهاش طول 1 1,8 1,8 69,6
26 كي يكثر الكلام عن تجربة بنجاحها يقتنع نفسيا بيها 1 1,8 1,8 71,4
27 لأنه يصدقهم ويثق فيهم 2 3,6 3,6 75,0
28 لان الابتكار مربوط بالنتيجة المتحصل عليها سواء من الفلاحين و التقنيين 1 1,8 1,8 76,8
29 لان الفلاح السوفي يحب انو يقلد مايريسكيش اظلب الوقت 1 1,8 1,8 78,6
30 لانه من اهم وسائل الاقناع التعامل بالملموس 1 1,8 1,8 80,4
31 لانه يجب ان يرى نتائجه قبل الشروع فيه بخدم مظمن 1 1,8 1,8 82,1
32 ماهم الفلاحين قاعدين كان عنجال التقطيع 1 1,8 1,8 83,9
33 مرات يطرح مشكل يتحل في قعدة تاي 1 1,8 1,8 85,7
34 مكانش خير من شوفه العين 1 1,8 1,8 87,5
35 نشر المشاكل فيما بينهم و تبادل الاراء يفضي في بعض المرات لايجاد حلول 1 1,8 1,8 89,3
36 نعم كلما زاد الاحتكاك كلما كان القرار مبنيا على المكتسبات مثل الاشهارات كل ماتشوفه كل ماتترسخ الفكرة فراسك 1 1,8 1,8 91,1
37 يتربالو الفضول كي يسمع عن الحاجة يحب يجربها 1 1,8 1,8 92,9
38 يسمع الكلام 1 1,8 1,8 94,6
39 يشوف فالناس فايتاتو ولازم يلحق بيهم 1 1,8 1,8 96,4
83.9%
80.4%
75%
69.6%
64.3%
25%
AGRICULTEURS
LES GRAINETIERS
LES ARTISANS
LES INGENIEURS
LE MARCHE
LES INSTITUTIONS GOUVERNEMENT
Le GUIDE AGRICOLE
L'INTERNET
Sheet1
Sheet2
Sheet3
Sheet4
Sheet5
Sheet6
Sheet7
Sheet8
READY
80 %

Abstract :

The aim of this study is to make an inventory of agricultural innovations in El Oued region, classify them, and understand the determinants of their adoption. And examinate the level of diffusion of innovations while highlighting the crucial role of field actors in farmers' access to these new practices and technologies. By analysing the interactions among actors, we identified the social, economic, and institutional factors that influence innovation, as well as the obstacles and opportunities to exploit. The methodology based on a field survey, including questionnaires and interviews with 150 agricultural stakeholder, such as administrative agents, associations, cooperatives, agricultural input dealers, and artisans. The main results reveal the existence of about thirty artisanal machines, ten technical innovations, and six organizational innovations in use. Farmers and artisans revealed to be the main drivers of agriculture development, while input suppliers play a significant role. The availability, demand, and increasing use of the Internet to promote innovations are essential factors for their innovation adoption and dissemination.

Résumé :

L’étude a pour objectif de recenser les innovations agricoles dans la région d’El Oued, de les classifier et de comprendre les déterminants de leur adoption. Et à examiner le niveau de diffusion des innovations tout en mettant en lumière le rôle crucial des acteurs de terrain dans l'accès des agriculteurs à ces innovations. En analysant les interactions entre acteurs, nous chercherons à identifier les facteurs sociaux, économiques et institutionnels qui influencent l'innovation, ainsi que les obstacles et opportunités à exploiter. La méthodologie repose sur une enquête de terrain, incluant des questionnaires et des entretiens avec 150 acteurs clés, tels que des agents administratifs, des associations, des coopératives, des vendeurs d'intrants agricoles et des artisans. Les résultats principaux révèlent l'existence d'une trentaine de machines artisanales, dix innovations techniques et six innovations organisationnelles en usage. Les agriculteurs et artisans se révèlent d’être les principaux moteurs du développement, tandis que les fournisseurs d'intrants jouent un rôle significatif. La disponibilité, la demande et l'utilisation croissante d'Internet pour promouvoir les innovations sont des facteurs essentiels pour leur adoption d’innovations et leur diffusion.

الملخص:

تهدف هذه الدراسة إلى جرد الابتكارات الزراعية في ولاية وادي سوف وتصنيفها وفهم محددات اعتمادها. ودراسة مستوى نشر الابتكارات مع تسليط الضوء على دور الجهات الفاعلة في الميدان الفلاحي في وصول المزارعين إلى هذه الممارسات والتقنيات الجديدة. من خلال تحليل التفاعلات بين الجهات الفاعلة، حددنا العوامل الاجتماعية والاقتصادية والمؤسساتية التي تؤثر على الابتكار، فضلا عن العقبات والفرص التي يمكن استغلالها. استندت المنهجية البحث إلى مسح ميداني ، بما في ذلك استبيانات ومقابلات مع 150 من الناشطين في الميدان الفلاحي ، مثل الاعوان الإداريين والجمعيات والتعاونيات وتجار المدخلات الزراعية والحرفيين. من اهم النتائج المحققة وجود حوالي ثلاثين آلة حرفية وعشرة ابتكارات تقنية وستة ابتكارات تنظيمية قيد الاستخدام. كذلك تبين أن المزارعين والحرفيين هم المحرك الرئيسي للتنمية الزراعية ، بينما يلعب موردو المدخلات دورا مهما. كما يعتبر استخدام الإنترنت المتزايد من اهم العوامل أساسية لاعتماد الابتكارات ونشرها في أوساط الفلاحين.