SUSTAINABILITY AND THE CONTRIBUTION OF INNOVATION

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Abstract: The development of innovation should support the solution of social and ecological problems. For instance, in agriculture, innovative technology should tackle the loss of biodiversity, the abandonment of farming, and the use of agrochemicals. These goals should be in addition to the existing goals of production capacity, efficiency, and market orientation. The partnership among diverse local players for the generation and transfer of new ideas and products should promote or enhance sustainability, as well as the economic development of local communities. Learning interactions for sustainability and innovation can change both the collaborative and production processes. The interaction of local players can enhance innovation for sustainability. This paper explores multiple perspectives, beliefs, and actions of stakeholders on the issue of how innovation can support sustainability. This is an opportunity to highlight the significant role that innovation plays achieving sustainability, the consequences of developing (un)-sustainable technology and non-technology, and provides policy makers with an introspective approach when considering better innovative practices for sustainability.

Keywords: Agriculture, Innovation for Sustainability, Learning Interactions, Local Innovation Systems, Sustainability.

INTRODUCTION

Sustainability has become synonymous with quality of life and nature preservation. In this sense, innovation is a necessity for sustainability through the development of technology, as well as new processes or ideas for the improvement of production and ecological and social systems. Innovation is often described in terms of market orientation, radical change, and higher revenue. However, economic benefits should not be the only result or concern of innovation, the social and ecological welfare of people and local communities should also be considered. Sustainability and innovation are complex concepts that can be studied from different perspectives. Economic development is a common and conflicted approach by which both terms are studied. A system approach can be another way of analyzing these concepts. In this sense, sustainability and innovation are important and complementary features in local and regional economies. Innovation is associated with knowledge generation and learning interactions among local players. Sustainability involves three principles (economic, social, and ecological) which are interrelated with economic principles and innovation processes. Thus, innovation contributing to sustainability in agriculture should be approached in terms of increasing the quality of local food production, improving the quality of the environment, having monetary benefits, and avoiding the loss of biodiversity and the abandonment of farming.

Local innovation systems in agriculture include learning interactions among diverse local players. These local players involve universities, industries, government, and farmers who interact and learn for the improvement and diffusion of technology and new knowledge. In this sense, the creation of new knowledge should impact the three principles of sustainability (ecological, economic, and social). However, structural barriers and functional problems (for example, public policies, better initiatives and mechanisms, and improved attitude and will of players) need to be addressed. As well, a new scenario for building local knowledge communities to address community problems and needs is desired. This paper analyzes the contribution of innovation to sustainability in farming practices by exploring multiple perspectives, beliefs, and actions related to this topic. First, a basic understanding and relationship between sustainability and innovation is presented, examining the economic and system perspective, as well as learning theory. Second, the methods used are described. Third, the results and discussion are stated, including the concepts of sustainability and innovation for sustainability, as well as the benefits of learning interactions. The paper ends with conclusions. This research is part of a doctoral dissertation that is in the approval.

Sustainability and Innovation

Sustainability includes social, ecological, and economic principles, which are connected to the quality of life of society, ecological and social justice, and economic opportunities. Technology and innovation have benefits related to such quality of life through the development of knowledge, products, and services. Quality of life refers to human development, social and ecological justice, as well as welfare economics. In this sense, new products and services introduced to society should cover a social, ecological, and economic benefit for users. Progress is based on the potential that technological development and innovation can bring to society, increasing the standard of living and resulting in less damage to the environment. However, technological innovation has also shown negative consequences such as water pollution and loss of biodiversity and culture. The creation and diffusion of scientific knowledge and technologies can have relevant implications for socio-ecological systems [1]. For this reason, institutions and governments must address policies involving research, development, social learning, and the transfer and commercialization of technology and knowledge. These policies can help improve ecosystem services, including clean water, food, biodiversity, and so on.

(a) Economic perspective

Sustainability from an economic perspective highlights the importance of preserving nature from human activity and having enough resources for production and consumption. In this sense, livelihoods and resources for present and future generations should be provided by natural and human capital as part of economic systems. Hence, sustainability can be understood as an evolving concept of ecological, social, and economic dimensions to ensure the continuity and quality of life. There are two perceptions about sustainability and the connection of its dimensions: strong and weak. Strong sustainability refers to the protection of the environment as a precondition for economic development [2]. This perception has a direct relationship with the precautionary principle, which refers to avoiding irreversible damage to the environment. The replacement of natural capital by another similar capital is part of strong sustainability. The reduction of a certain amount of natural capital is weak sustainability [3]. This natural capital can be substituted by another capital including human and technological advances. Innovation means disruption and discontinuity, through the introduction of new ideas and methods inside organizations and markets. Schumpeter [4] identified five types of innovation: a) new production processes, b) new products, c) new materials or resources, d) new markets, and e) new forms of organization. The commercialization of inventions and ideas is the end of an innovation; however, innovation is not only technological change and marketing, but also changes in processes and structures. For instance, social innovation can support sustainable actions through the creation of new strategies and initiatives towards the solution of social and ecological problems. In this way, innovation can contribute to economic development and can benefit producers (profits) and users (needs) of those innovations. Innovation can also have a negative impact on economic development; for example, through unemployment and a decrease in natural resources. Thus, innovation should reduce the risks of environmental depletion and pollution caused by a new technology or service. The link between sustainability and innovation in economy when creating new knowledge and ideas on large scale should consider that ecosystems are limited and that unsustainable issues need to be addressed, especially those affecting the environment.

(b) System perspective

Sustainability and innovation are complex systems for complex issues. A system is the interconnection of different elements that work together towards a common goal. A change in the system provokes adaptation and transformation. Spedding [5] tells us that a system is a set of interacting elements for achieving a common purpose, and that it is capable of responding to external factors including significant feedbacks. A sustainability system refers to the interrelation of three pillars (society, ecology, and economy) that are mutually dependent and include elements such as ecosystem goods and services, education, health, employment, and fair incomes. Also, it includes multiple stakeholders at different levels, policies and rules, as well as behaviors. Innovation systems are vibrant networks and links among the diverse players that are involved in knowledge generation and transfer of technology. Lundvall [6] describes national innovation systems as a social and dynamic system that involves searching, exploring, and learning among public and private organizations. Although, there is not an agreed upon definition for the local innovation system, it can be defined as a learning, dynamic network where diverse local players generate and disseminate knowledge for community improvement. In agriculture, both sustainability and innovation systems should be approached to support agricultural development toward continuous farming, healthy food production, and pest management practices. In this way, agricultural development is supported by technological and social innovation, involving not only better techniques and methods, but also the link between farmers and other stakeholders for the improvement of the environment, natural resources, and the quality of life of producers. Sustainability and innovation systems are dynamic and complex. Adaptability, transformability, and resilience are

features of these systems that can be similar, but dissimilar at the same time. This means that changes are inevitable and diverse elements inside these systems need to learn to change, adapt, learn, and transform. It is a constant evolution toward transitions. Geels et al. [7] state that co-evolution theory is related to transitions. These transitions are related to a cycle of dynamic shifts from one paradigm to another and the interface of a variety of levels and components inside systems. Thus, local sustainability and innovation systems should be intrinsically interconnected for the enhancement of practices and deal with crises and harmful problems in local farming communities.

(c) Learning theory

Individuals participating in dialogue and cooperating within different structures and communities can lead to change and learning [8]. Learning communities involves a multitude of different ways of knowing and learning from multiple perspectives and places. Learning is described as an active and social process that integrates participation, knowledge, and the creation of new practices, actions, and beliefs. The repetition of interactions and the interrelation of learning by doing, learning by using, and learning by interacting are elements of learning processes for the social, economic, and ecological benefits of communities. Formal and informal ways to share information, perceptions, and experiences to increase knowledge are learning interactions. The interaction of different players with diverse skills and knowledge at different levels increases experimental activities and expertise [6, 9, 10]. In agriculture, the integration of modern, empirical, and traditional techniques can be complementary and can enhance productivity and resilience. Local innovation systems are the ideal set of connections to interact, learn, and disseminate knowledge, values, and point of view for innovation and sustainability in the farming sector. Thus, learning is an interactive and iterative process that includes diverse players, multiple ways of knowing, and a decision-making process for sustainability and innovation systems.

METHODS

This research was conducted based on a qualitative case study with a multi-methods approach to explore sustainability actions and beliefs, innovation for sustainability, and learning interactions of key stakeholders. My case study used both a bottom-up and top-down methodology, with the goal of identifying the perceptions, benefits, and problems of the stakeholders involved. The field study was conducted in the Yucatán Peninsula of México in the communities of Conkal and Merida over a period of three months in 2013. The selection of this participant community as part of this research was due to the nearby location of the Technological Institute of Conkal (TIC), which is surrounded by local vegetable farming communities. This institute has strong linkages with multiple other local stakeholders (agro-industries, farmers, and government authorities) involved in joint projects, education, extension projects, and local business.

In-depth interviews with key players were conducted. The sampling was established by identifying position, the group to which stakeholders belong, and their engagement in the research and production of habanero chiles. This analysis involved personal interviews with ten executive stakeholder interviewees, including governmental and institutional top-level representatives, four interviews with farmers (two Mayan smallholders, one small, and one intermediate farmer), 10 researchers, and 3 alumni. Two focus group interviews with alumni and intermediate farmers were also conducted (four people in each group) using a non-random and snowball sampling technique. As well, a strengths, weaknesses, opportunities, and threats (SWOT) analysis was conducted to complement the data collected through the interviews. Four previous interviewees were invited to participate in this analysis. A total of 36 key players participated in this study.

Open questions (about 10 questions) were administered during personal and group interviews. These questions were derived from literature review and address strong sustainability, innovation systems, and agro-ecological principles. The SWOT analysis was conducted in two sections via a presentation with a description of the local innovation system and the current development of innovation in the realm of sustainability. The analysis of data was performed using coding in NVivo 10 software based on themes and categories identified from the literature review and participant responses that were grouped together for this purpose. The SWOT analysis was analyzed manually to organize the answers by themes and categories.

RESULTS AND DISCUSSION

This section reports on the data analysis by examining multiple perspectives of sustainability and innovation for sustainability, as well as the benefits of learning interactions. The main themes from exploring personal and group interviews are indicated, and the frequency of responses is in accordance with the number and type of stakeholders.

Sustainability

This section addresses what sustainability means and how it fits within a local innovation system in agriculture by examining the responses of each stakeholder.

(a) Alumni
Alumni considered environmental concerns and quality of life to be synonymous with sustainability. They described environmental concerns as avoiding harm to nature and not contaminating water and groundwater. Quality of life was described as the enhancement of social conditions. The most frequent responses were as follows: (1) Respecting the environment and the coexistence between nature and humans (86%). (2) Improving the quality of production and the quality of life of people (57%). (3) Having enough and healthy food (42%). (4) Working well with good results without harming nature (28%). (5) Keeping profitable plots (28%). (6) Sustainability is synonymous with self-sufficiency (28%).

An alumnus indicated that sustainability is related to the market through the fulfillment of quality standards and production capacity. Another alumnus pointed out that sustainability includes respecting local farming traditions because the traditions are assertive and experiential. In general, most alumni are from agricultural families and many of their beliefs and actions are oriented to share and respect diverse knowledge with small and intermediate farmers.

(b) Researchers
Most researchers defined sustainability as the rational use of natural resources without affecting ecosystems. Researchers mentioned two sustainability considerations: how people use natural resources, and how to protect the environment in order to preserve agro-systems for many years to come. The responses of researchers were as follows: (1) Better use of natural resources without affecting the ecological balance. Sustainability means achieving the ultimate in quality and performance by using needed natural resources without the abuse of agrochemicals (40%). (2) Something that endures through time and space; it is sustainable because it does not deteriorate ecological and human conditions. For instance, a crop should be used rationally and kindly with regard to the environment and humans (20%). (3) Social, ecological, and economic benefits impacting production and consumption. This has to do with working together with local communities. Every individual is involved in the process of being, behaving, and making decisions (20%).
A researcher described sustainability as a process or activity that can be maintained for a long time and by natural cycles. If there is an agricultural production system that is permanent, then sustainability means to not use it to its fullest because soil fertility can be lost and an increase of the use of agrochemicals can arise. These agro-systems would not have the highest productivity, but they can be used for 200 or 300 years.

(c) Executives
More than 50% of executives stated that financial feasibility should be the basis of sustainability, meaning monetary return and investment. However, they recognized the importance of using natural resources appropriately and practicing new and better ways of farming. Their opinions are described below: (1) An activity that allows long-term survival. It is synonymous with the term resilience, which is the ability of an ecosystem, when a factor is altered, to recover and reach a degree of balance, although this ecosystem may not necessarily be identical to the original. (2) Protecting the environment and ecosystems by reducing the use of toxic products. (3) Rational and appropriate use of environmental elements such as water, soil, vegetation, and climate.
Most executives pointed out that a production system is sustainable when there is the possibility of having extra money to reinvest in production and to get the product to market. However, one executive mentioned that the protection and preservation of natural ecosystems is also important.

(d) Farmers
Farmers were divided into small and intermediate producers because of their different education, experience, and production capacity. For small farmers sustainability meant the preservation of the environment without causing soil erosion. One of them said, “If I sow habanero chiles, I have to take care of the land using an organic fertilizer such as the manure of sheep, turkeys, and chickens.” Another small farmer said that with a few square meters you can feed the family, and the remainder can be sold to the community. They are in favor of polyculture because the products can be consumed by the family and community, and as a result they generate production diversity and self-sustainability. For intermediate farmers, sustainability meant building a model that allows producers to be reliable suppliers 365 days a year in terms of return on investment, market conditions, and production systems. Nevertheless, more than 50% of intermediate farmers stressed that sustainability is a system that can be functional and reliable over time, useful, and friendly to the environment. An intermediate farmer described sustainability as identifying and solving problems through the implementation of ideas and solutions resulting in a sustainable model that involves all stages and links of the production and market system. The goal should be the economic benefit for the primary, secondary, and tertiary sector.

Sustainability Review

The three principles of sustainability (social, ecological, economic) were considered as part of the analysis. The breadth of sustainability themes involved farming communities as part of society, financial stability as part of

economy, and biodiversity preservation as part of ecology. A synopsis of sustainability beliefs and actions of stakeholders are presented in table 1.

Table 1: Overview of Sustainability

Stakeholders	Sustainability Beliefs / Actions
Alumni	*Beliefs:* - Respecting for traditional knowledge. - Improving environmental and societal conditions. *Actions:* - Sharing knowledge with small and intermediate producers.
Researchers	*Beliefs:* - Agro-systems that last longer than 200 or 300 years. - Little use of natural resources for analysis in labs. - Respect for the local culture. *Actions:* - Learning from people's traditional. - The test of sustainable crops.
Executives	*Beliefs:* - Financial feasibility, with the possibility of including social and ecological impacts. *Actions:* - Monitoring a fair income for the producer.
Small farmers	*Beliefs:* - Interest for preserving biodiversity. - Survival benefits. *Actions:* - Use of organic fertilizers. - Use of plants and trees to control pests.
Intermediate farmers	*Beliefs:* - Respect for traditional knowledge. - Interest in healthier products. - Interest in preserving biodiversity. *Actions:* - Reduction of agrochemical use. - Use of organic fertilizers.

Sustainability can be difficult to define because the concept implies complexity, ethical values [11, 12], and it is highly contested (human values, perceptions, and interests) [13]. The different perspectives on this concept are derived from personal experiences, local and institutional issues, and personal interests. In general, the most relevant findings derived from the analysis are: a) the improvement of quality of production and the quality of life of people by protecting nature; b) an activity that allows sufficient and healthy food and long-term survival; and c) a sustainable model in terms of return on investment. In this sense, the strong sustainability concept is being supported by most stakeholders. Baker [2] says that strong sustainability promotes the preservation of nature for better economic development outcomes. For this reason, ecology, society, and economy are interconnected and complementary; as a result, they cannot be replaced. Daly and Farley [14] indicate that ecology is the dimension that embraces economy and society by providing the needed resources for production and consumption. Figure 1 shows the categories involved, integrating them into a unique concept of sustainability in agriculture. This concept is the interrelation of ecology, economy, and society as a sustainability system, meeting basic needs and living standards, financial security and stability, and the will to protect nature to ensure economic and non-economic wealth for all.

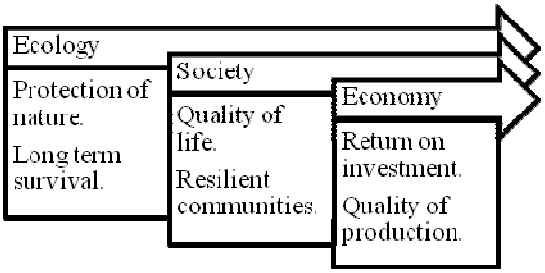

Figure 1: Sustainability concept in agriculture

Innovation for Sustainability

The results of interviews provided stakeholder insights on innovation for sustainability.

(a) Alumni

Innovation for sustainability is understood as the introduction of new knowledge and ideas to recover production systems that do not damage the environment. This response may be linked in two ways to sustainability perspectives: the improvement of the quality of production and the protection of the environment. In fact, an alumnus commented that we need to innovate in order to improve living standards and survive. Other points of view are as follows: (1) New techniques and ideas for the production process that do not damage the environment. This means changing current production systems, which may not require advanced technology, but might include adopting or developing more natural approaches (42%). (2) It is the application of knowledge for survival, understanding that it is not exploitation, but protection of natural resources (28%). (3) The generation of new technology for the production of healthy and organic products (28%).

(b) Researchers

These stakeholders describe innovation for sustainability as a new method, process, or product that avoids damaging the environment while increasing productivity. Also, 30% of researchers highlighted that innovation should consider the needs and problems of rural actors and producers. In this way, the relationship of innovation with sustainability is the preservation of agro-systems for many years through the acceptable use of natural resources and the environment, and the solution of a social or ecological need through new methods and techniques. The percentage of respondents who addressed a particular issue in this regard is shown as follows: (1) Development of new processes and more efficient procedures by reducing impact on the environment (water, air, and biodiversity) and producing long-term benefits (40%). (2) Having more tolerant, yield worthy, and better varieties of plants adapted to climate, pests, and diseases. As a result, use no or fewer agrochemicals use them with the goal of obtaining a more productive crop (20%). (3) The generation, introduction, and adoption of new methodologies (10%). (4) The consideration of rural actors and their needs should be important to innovation. An abrupt innovation may mean that local producers are not going to implement it. Libraries are full of research that does not reach the area where it is required, so it is important to integrate producers into the research process (10%).

(c) Executives

The majority of executives defined innovation as including improved processes, ideas, or products that can be successfully taken to market, although some executives mentioned that innovation does not need to get to market. They see innovation for sustainability as the generation of higher technology applied to farming with the aim of preserving nature and increasing food production. In this way, these stakeholders said that certain political and market conditions are necessary to set on innovation for sustainability. Some of their perspectives are stated as follows: (1) Something that allows the producer to obtain products that can achieve success in the global market (18%). (2) A number of practices aimed at improving processes, services, and products that reach the market, but also enable the survival of society in the long term (18%). (3) Generate new technology for the transformation of healthy and organic products, respecting the three sustainability dimensions (social, economic, and environment). The goal is for producers to sell their products and make money, but also to ensure continuous cropping (18%). (4) Many institutions are creating innovation, but not for sustainability. It is economically profitable, but not sustainable. It is important to link one with the other, but not necessary to fulfill this link in all instances (9%) (5) The application of an innovation for sustainability is obviously having enough information that allows the creation of sustainable production that lasts over a long time (9%). (6) An innovation can come from anywhere; for example, the use of vermiculture, a good fertilizer that came from California (9%).

(d) Farmers

For small farmers, this concept was confusing. One of them said that farming requires special techniques and the ability to deal with uncertainty, and this is probably innovation for sustainability. Another small farmer mentioned that innovation for sustainability is about practice, and ethical and social order. For intermediate farmers innovation for sustainability is the application of techniques and how to use technology to produce and maximize plant yield. An intermediate farmer emphasized that applying better farming practices and knowledge to maximize crop yield and reduce pollution levels may help producers to have efficient and sustainable agro-systems. For both small and intermediate farmers, the innovation link with sustainability can be seen through reducing agrochemical use and increasing the rational use of natural resources, polyculture and healthy products, and preserving efficient agro-systems.

Innovation for Sustainability Review

The creation and the improvement of processes, methods, or products supporting sustainability should be the purpose of innovating. The end of innovation is to commercialize an idea, knowledge, or product, but its contribution to sustainability would be to ensure the continuity of farming over time, considering social and ecological needs, the solution of harmful problems, and ethical and social considerations. The main findings regarding innovation for sustainability are summarized in table 2.

Table 2: Overview of Innovation for Sustainability

Stakeholders	Innovation for Sustainability
Alumni	- A shift in production systems. - The generation of new technology for the production of healthy and organic products. - The application of knowledge for surviving by understanding that innovation is not exploitation, but protection of natural resources.
Researchers	- The generation and improvement of seed varieties and products. - The development of new procedures that have less impact on the environment. - Innovation should be in accordance with the needs and acceptance of rural producers.
Executives	- Marketable capacity of new ideas and products. - Using higher technology to produce a crop capable of distributing the product, but also ensuring continuous cropping.
Small farmers	- Ethical and social order of what is going to be offered to society. - The creation of productive diversity for community consumption. - Special techniques and dealing with uncertainty.
Intermediate farmers	- Marketable capacity of new ideas and products. - The generation of new technology and methods for better production of healthy and organic products.

The generation of new knowledge for the solution of social and ecological issues and the generation of new methods or new ideas for the improvement of production processes affecting the environment are perceived by stakeholders as innovations contributing to sustainability. The market is another important aspect of innovation for most stakeholders. However, the multiple perspectives revealed an ideal scenario of innovation for sustainability, but not a current one. Indeed, two stakeholders stated that technological innovation cannot contribute to sustainability, but only promote social innovation. For this reason, social, technological, and institutional changes need to occur in order to impact innovation on sustainability [15]. Thus, innovation for sustainability should be seen as the creation and application of new knowledge to the social, economic, and ecological improvement of local communities toward prosperity. The question is how to achieve that innovation so that it truly contributes to sustainability.

Learning Interactions

Studying the benefits of learning interactions for the generation of technological and social innovation can help us to understand the necessity of innovation in sustainability actions. Here, I summarized this analysis from the stakeholder perspective.

(a) Alumni

One of the learning interaction benefits that alumni mentioned is to know what need or problem is being investigated, and to bring new information to key players to create and implement better tools, identify problems, and propose possible solutions. The importance lies in updating and connecting all actors to support every element in the production system, especially farmers. Another benefit is that interacting with researchers and technicians is important, but collaborating and learning from producers is crucial because they have a lot of experience farming. For alumni, the integration of scientific and traditional knowledge is important because it can result in improved outcomes for the local community.

(b) Researchers

For researchers, collaborating on and interacting with joint research for solving the needs and problems of producers is one benefit of learning interactions. Most researchers highlighted that interaction and collaboration make the system stronger. The common vision of many people is very different from a single vision because methods and strategies can be managed more proficiently. Two researchers indicated that a knowledge network would be another benefit because it might be moving in different directions through those who are generators, those who are transferors, and those who are engaged in the process. They see that integrating the modern and the traditional can be difficult, but it can be interesting because farming management can be integrated for better farming techniques and to deal with complex issues.

(C) Executives

For executives, the introduction of diversified products to the market with good quality, high competitiveness, the return of dividends, and greater social impact are learning interaction benefits. They said that the collaboration with agribusiness and intermediate farmers is more common, and this is usually achieved by identifying some need or specific technological opportunity. An executive indicated that they collaborate with an NGO under the format of learning communities. Their interaction includes the analysis of diverse topics and different views to deal with a problem. Other executives commented that the benefit of learning interactions for innovation would be to have greater social impact, and greater competitiveness; for sustainability, it would include the improvement of the environment, and the trade of products in compliance with quality standards. As a result, learning and absorbing knowledge should be approached from multiple directions. Executives see the combination of modern and traditional knowledge as difficult to articulate because, in agribusiness, most scientific knowledge is applied to production processes. Maybe through joint demonstration and validation of crops, scientists and traditional farmers can combine knowledge for better results.

(d) Farmers

Farmers stated that sharing experiences and practices is important and necessary. A small farmer said that an individual never stops learning and sharing, and that it is important to share information and experiences with other communities and experts to develop a better solution for planting. Another small farmer mentioned that some years ago they formed cooperatives to learn planting techniques and to consume what they produced in the experimental crops, but now, with the introduction of new technology, this model has almost disappeared. For small farmers, daily practice is the best school, but they recognized that scientific knowledge is also important. Intermediate farmers pointed out that the benefit is associated with improved production efficiency, less and better use of natural resources, and greater depth of knowledge for sustainable development. An intermediate farmer indicated that the integration of all players is the key to a stronger system, especially when competing for a new market with new demands, it is better to work together through formal or informal learning processes. These farmers concluded that it is not possible to collaborate with traditional farmers because they do not think and act like agricultural entrepreneurs.

Learning Interactions Review

The creation of inter- and -multidisciplinary groups, networking of knowledge, and the integration of scientific and traditional knowledge are the three broad areas that represent the benefits of learning interactions. Table 3 summarizes the most frequent responses of stakeholders in these three areas.

Table 3: The Benefits of Learning Interactions

The creation of inter-multidisciplinary groups	Networking of knowledge and learning	The integration of scientific and traditional knowledge
Participating and contributing to generate new knowledge. Interaction allowing a broader and deeper knowledge of production. Efficiency in term of quicker and better use of resources through the use of institutional efforts, knowledge, and infrastructure. Increasing the performance and competitiveness of producers. Working with different institutions and people allows holistic crop management. Greater social impact and better results. Efficiency in terms of production, less and better use of natural resources, and greater depth of knowledge for sustainable development.	Identifying real situations, problems, and possible solutions through greater sharing of experiences, knowledge, and resources. Diffusing and applying technology generated by this network. A vision of partnership and alliances in order to leverage resources and market supply, resulting in benefits to the producers and farming communities. Sharing the same mission and vision. A perfectly articulated network. The development and transfer of knowledge should be in multiple directions (from industry to researcher, from producer to industry or researcher, etc.). Formal and informal means of gathering and sharing information.	The sum of wills and strengths of stakeholders would help to integrate the scientific and traditional knowledge. This fusion is important for sustainability respecting the culture and the environment. This is not about money or to get rich; it is about being more efficient with the use of our resources and how we rescue our values for feeding. Traditional and scientific knowledge cannot be separated because traditional knowledge is an accumulation of information and experience.

It can be noted that several benefits to building knowledge and learning network in local communities are shown. However, numerous problems need to be overcome to make local innovation systems stronger and more efficient. The main learning problems that participants reported are lack of willingness, lack of a positive attitude, and lack of resources. The perception of stakeholders is that there is little interest in learning interactions inside this sector, and the link among diverse players is disjointed. There are opportunities to build a local innovation system for sustainability, including the union of small and intermediate producers, HEIs, research centers, industry, and government to join strengths and support the production system. However, not many stakeholders are interested in legislation, policy development, system alignment and learning outcomes. Thus, it would be necessary to establish the conditions and strengthen the opportunities for innovation that better contributes to sustainability.

The contribution of innovation to sustainability

Innovating for sustainability is related to knowledge, experiences, beliefs, and actions. Not all innovations are based on advanced technology; innovation occurs also in structures, procedures, programs, and policies. In this way, a new method, process, strategy, or technology is part of innovation contributing to sustainability. Learning and knowledge interactions can help to create appropriate technological and social innovation. High skills, training, and the production of continuous knowledge are important components for the development of technology [16]; social innovations are immersed in local communities, which have the capacity to learn, transform, and adapt by building skills, finances, and institutional resilience [17]. Thus, with an improved shift of focus and a common vision of all local players, including the government (with better and more appropriate policies and public programs) and society

with more active participation and engagement regarding social, economic, and ecological welfare, there may be a reorientation of innovation towards sustainability. Technological and social networks can learn, innovate, and share new information and knowledge for improving quality of life and reaching sustainability.

CONCLUSIONS

This research discovers insights regarding how innovation can contribute to sustainability in the context of agriculture. The findings reveal that innovation for sustainability is not a common thought and initiative for most stakeholders. The exploration of the sustainability and innovation concepts allows another conception of sustainability through the lens of innovation. Sustainability and innovation are complex sub-systems that belong to a whole system that is difficult to describe. Sustainability is related to enhanced living standards, economic stability, and access to ecosystem goods and services. Innovation in this study refers to not only the creation of new knowledge, strategies, or initiatives that can be applied to solve problems and needs, but also the opportunity to commercialize that knowledge or idea. In this way, innovation supporting sustainability should ensure the permanence of farming, consider social and ecological needs or problems, ethical and social considerations, protect the environment and biodiversity, and support economic benefits. Learning interactions and knowledge networks at the local level can develop and disseminate technological, non-technological, and social innovation, especially in agriculture where continuous change and uncertainty occur all the time. However, there are many challenges and barriers to overcome such as the consolidation of local innovation systems for sustainability, the integration of diverse knowledge to solve harmful problems in farming, and the reorientation of innovation policies towards sustainability. Additionally, this research contributes to a better understanding of the current practice of innovation and how it should support sustainability, and provides policy makers and society with a different perspective from which to analyze both sustainability and innovation. The questions applied have had some impact among stakeholders because they have had the opportunity to reflect at a deeper level what sustainability and innovation for sustainability means, causing them to consider thoughts and insights regarding their beliefs and actions. For the academic community, this represents potential dialogues and conversations about what the role of innovation should play in sustainability actions.

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