# Innovation Systems and Sustainability in Agriculture: Learning Interactions at Local Space

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**Abstract**

Agricultural activities are interconnected with knowledge networks, production systems, and the creation of innovative technology to tackle sustainability issues including loss of biodiversity and food safety. Learning interactions and local innovation systems in agriculture should generate and transfer innovative agricultural technology with a goal of implementing sustainable actions. However, the interaction among diverse stakeholders involves uncertainty and disagreement. A case study targeting to the agricultural sector and sustainability is analyzed. The aim is to address barriers and opportunities for the creation of local innovation systems in support of sustainability. As well, how location, proximity and production capacity of producers and other stakeholders are related to such system. This project is in process and results are preliminary.

## Background and Relevance

### Introduction

Learning interactions play a role in economic systems and can alter collaboration and knowledge generation (Lundvall, 1992). Learning interactions are formal and informal ways to share information, perceptions, and experiences to increase knowledge; in the case of agriculture, such knowledge can be applied to improve productivity and maintain sustainability. This is particularly true for agriculture in places where traditional and modern techniques are used side-by-side. The generation and diffusion of knowledge is not limited to scientific facts; experience and traditional practices can also be diffused to improve agricultural practices. The opportunity to learn is in all people, either scientist or the general worker (Lundvall, 1996).

Local places should be seen as spaces of knowledge for innovation and sustainability growth. Sustainability is understood as the maintenance of the current environmental conditions (if not an improvement), the improvement of local livelihoods, and respect for local culture and traditions. In this sense, local places can offer a competitive and comparative advantage in the economy. Porter (1998) states that knowledge, interactions, and interests in local places can indicate or represent competitive advantages and innovation. Innovation in sustainable agriculture does not necessarily imply the application of modern science and technology, but will often include the application of local knowledge. Thus, a local community should be the place where innovation systems solve problems and needs to boost sustainable agriculture. In this way, local innovation systems for sustainable agriculture are integrated in different ways including multiple players coming together at different scales and locations, partnerships, all forms of

knowledge, learning capacity, and proximity (Asheim & Isaksen, 2002). However, these aspects are in their infancy for most developing countries. One of the biggest problems is that a lack of overall alignment of programs and mechanisms results in many practitioners who could benefit being left out of the process. In this sense, face- to-face interaction and mutual learning should be incorporated into local innovation systems to build competencies and help strengthen the larger network (Pietrobelli & Rabellotti, 2011).

The purpose here is to examine how learning interactions and local innovation systems generate and transfer innovative agricultural technology on agriculture practice and sustainability. Our focus is how proximity is an important element to create local innovation systems, and how local players can interact for learning and innovating. As a result, a cluster is emerging where diverse local players are associated to generate and transfer technology and innovation for agriculture and sustainability. To achieve the general purpose, three specific objectives are proposed:

- Analyze barriers and opportunities in building local innovation systems.
- Observe how proximity of local stakeholders is related to the generation and transfer of knowledge and how the location of producers is linked to production (type and capacity).
- Develop policy recommendations oriented to strengthen knowledge networks at the local level that impact farming and sustainability.

## Innovation Systems

Innovation systems are the different elements to produce, diffuse, and use new knowledge and technology for economic benefit (Lundvall, 1992). Lundvall (1996) suggests that local networks that include research institutions and producers can increase innovation. In addition, Carlsson et al. (2002) focus on technological innovation systems, as they consider this as a whole system, one that is both dynamic and global. To this end, Bergek et al. (2008) and Wieczorek and Hekkert (2012) propose an analysis that addresses a systematic approach to innovation systems including their characteristics, structures, and functions. This study represents an analytical framework to identify policy issues or system failures in technological innovation systems. In this way, multiple players in local communities can orient their efforts towards developing innovative technology for sustainable agriculture. The aim of these local systems is to generate and disseminate knowledge and collaborate with multiple actors at different scales integrating dissimilar perspectives, agreements, and disagreements in a cordial context (OECD, 2004; Heinzl et al., 2012; Lijmbach et al., 2002).

## Sustainability in Agriculture

Sustainability is a complex concept that crosses scale and space, which includes social, ecological, and economic dimensions (Avelino & Rotmans, 2011). This concept has been defined in many ways. However, the analysis of the behavior and relationships between humans and nature and the results of such interaction

results in sustainability (Frodeman, 2011). Sustainability in the agricultural sector is generally associated with less intensive agriculture, new practices and learning, long term benefits, and the adaptation and resilience of farmers. Innovative technology for agricultural sustainability plays a critical role in facing these complex conditions through learning processes to generate new knowledge. This new knowledge generated by local innovation systems allow institutions and farmers to learn and change. Pietrobelli and Rabellotti (2011) emphasize that innovation and learning are vital for economic growth, particularly for developing and less developed countries.

### Learning Interactions

Lundvall (1992) analyzed the capacity of learning by doing, learning by using, and learning by interacting for knowledge and innovation production. These types of learning are related to experimental activities and are based on repetition, increasing the level of expertise, and cognitive processes (Amin & Cohendet, 2004; OECD, 2004). In this sense, the interaction of different actors with various skills and knowledge at different scales and spaces can lead to learning for innovation (Lundvall, 1992). Proximity and location between multiple players allow for social connections and networking, the sharing of production capacity, and learning processes in building local innovation systems (Asheim & Isaksen, 2002). Sol et al. (2012) highlight that learning is an interactive process that is visible to many ways of knowing, seeing, and understanding. The idea is to interchange knowledge and use the opportunity to change opinions, perceptions, and behaviors. In this sense, the partnership between government, public and private institutions, and individuals with different education, values, and competences can interact to generate new knowledge and implement innovation for agricultural sustainability (Lundvall, 1992).

## Methods and Data

The field study was conducted in the Yucatán Peninsula, in the community of Conkal over a period of three months in 2013. The data was collected through formal and informal individual and group interviews. To supplement data we also carried out a document analysis, observation, and a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis with the participation of four key players. Our case study is based on a holistic approach using both a bottom-up and top-down methodology. The Technological Institute of Conkal (TIC) was our case study due to its orientation to farming sector and links with agro-industries, farmers, and government authorities.

In-depth interviews were conducted with a sample of 7 alumni, 8 farmers including 2 Mayan farmers, 8 researchers, 3 policy makers including the municipal authority, an executive of the industry, and the technological liaison chief at the TIC. The 26 individual and group interviews were carried out face-to-face, lasted 50-80 minutes, and consisted of open questions. The sample size is small because we only approached people who were engaged in research and production of habanero chile

in the community. The interviews focused on gathering perspectives of local innovation systems, sustainability, understanding the interaction of learning and the role of location regarding production and know-how capacity.

SWOT analysis was conducted to complement the data collected through interviews. The aim was to identify barriers and opportunities in building local innovation systems for strengthening knowledge networks. Four people participated in this analysis: the technological liaison chief of the institution, an alumnus, an external researcher, and the leader of habanero chile producers association. Although the SWOT analysis has not been completed, we present some initial outcomes. Also, this study shows some observations on how the grade of expertise and production capacity of producers relates to location, the level of interaction, and sustainability actions, illustrated in Table I.

## Preliminary Results

The production chain of the habanero chile of Yucatán is a good example of learning connections among farmers, government, the academic sector, and industry, all towards innovation and sustainability goals. As a result, the TIC has been concerned with how to improve production through knowledge generation, sustainability issues, and collaboration with other local actors. This institute is committed to training professionals in agronomy to solve problems regarding agricultural goods and sustainable development. In 2003 the Technological Institute of Conkal (TIC) participated in the creation of a production network for the development of Yucatecan agribusiness. One of the goals was to leverage the resources through a well-coordinated network of public and private institutions. Following 2005 this institute joined a project titled “The Original Certification of Habanero Chile” where more than thirty five researchers, one industry group, and local government were working together to achieve the first certification and definition of an official global and Mexican standard.

These initiatives have motivated the redirection of some innovation policies and learning processes in Mexico and Yucatán. In fact, TIC has been developing action and participatory learning as an active player in local innovation systems, with a goal to generate and transfer knowledge to the agricultural sector. However, because of structural and functional problems, innovation systems for agriculture have not worked well. Generally speaking, this can be attributed to a lack of interaction among different players, expertise of farmers and researchers, production capacity, strong and powerful actors, and the lack of articulated mechanisms for learning.

The production of most smallholders is primarily subsistence with some small scale production for the local community. Their interaction with industry is minimal and they do not have commercial relationships. They state that they usually use their own knowledge and receive training from TIC only occasionally because of a lack of resources. TIC and industry cooperate more with intermediate-scale producers for learning, sustainability, and agricultural innovation. Four of the producers are

alumni of TIC, which implies higher skills, collaboration, and business vision. These types of producers are located beyond the boundaries of the municipality of Conkal, mainly to the north and east of the local community, as indicated in Figure 1. This geographic arrangement appears to be a result of a need and capacity for greater land to produce and supply habanero chile to regional industries. They seek alliances with small producers, but have faced difficult due to dissimilar knowledge, different perspectives, collaboration, and end goals as farmers. The major problem is a disaggregation inside the producers association of habanero chile of Yucatan due to the lack of trust and political forces. As well, another problem is the decrease of farmers in this community due to cultural changes associated with different generations of farmers.

For this reason, different perspectives on innovation and sustainability are being analyzed to understand the realities that each actor faces in their workspaces. In this way, the involvement of all sector stakeholders to open dialogue and discussions will support the development of mechanisms that can solve current agricultural problems. Establishing a common sustainability vision of innovation in agriculture will be crucial; as is regularizing the flow of information and knowledge to better governmental programs and incentives will be important.

Table I
Observations of the producers regarding location, learning interaction, and sustainability

| Type of producers | Capacity of production | Location | Level of interaction for learning and innovation | Other players | Sustainability actions |
|---|---|---|---|---|---|
| Small farmers (2 Mayan farmers, farmer 1) | >3,000 m<br><br>Different products in one plot | Center and South | Low<br><br>Same social and cultural aspects<br><br>Share experiences<br><br>Lack of organization | Based on trust: Municipality authority<br><br>President of horticulture committee | Interest for preserving biodiversity<br><br>Survival benefits<br><br>Use of organic fertilizers<br><br>Use of plants and trees to control pests |
| 5 intermediate farmers | 5,000 – 10,000 m | North and East | High<br><br>Same education and vision<br><br>Planned interaction and activities for sharing knowledge and experiences | As network: Local government<br><br>Industry<br><br>TIC and other HEIs | Respect for traditional knowledge<br><br>Reduction of agrochemicals<br><br>Use of organic fertilizers<br><br>Interest in more healthy products |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Interest for preserving biodiversity |

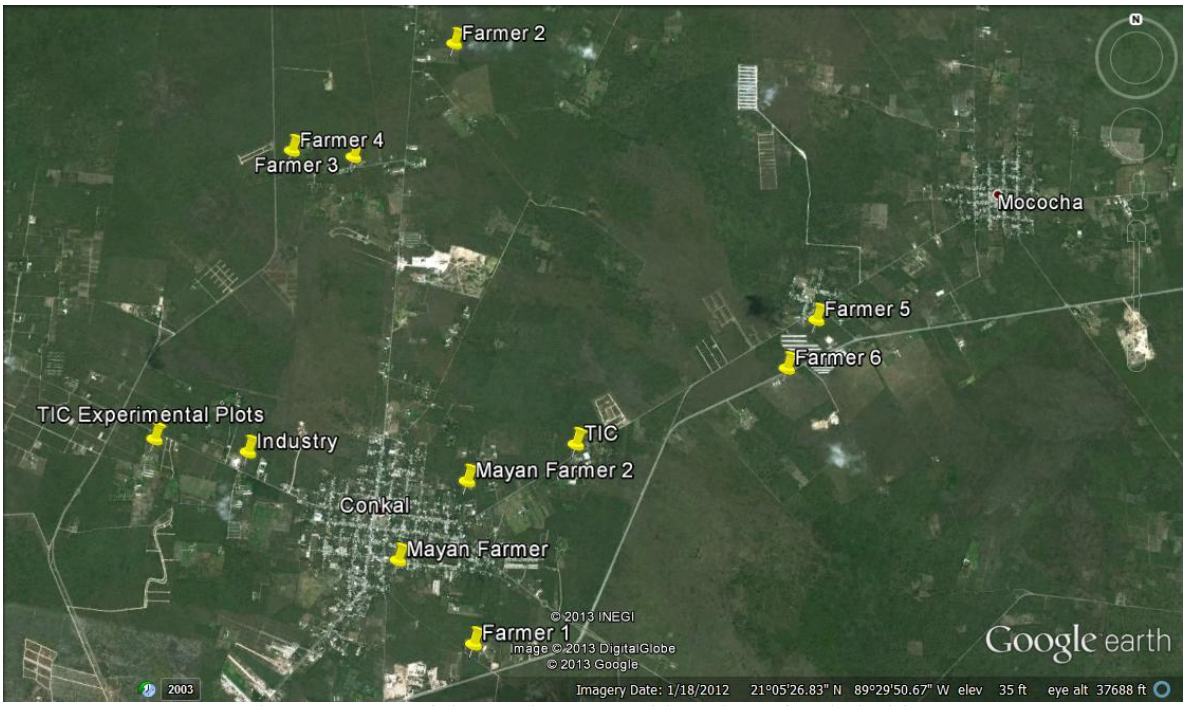

Figure 1: Map of the study area and location of stakeholders

## Conclusions

The case study indicates that local innovation systems and sustainability in agriculture reveal barriers and opportunities for learning interactions among multiple players at local scales. Local communities have started to create innovation through education, training, research, and knowledge networks. In fact, the national and provincial governments of Mexico have made great strides creating opportunities for knowledge generation and learning at local levels. In addition, intermediate producers have shown progress in creating synergy and collaboration for sustainability in agriculture. Then, a new perspective to analyze an innovation system in local spaces was explored to understand learning interactions, proximity, production capacity, and sustainability. The problem is the operation of such spaces, the implementation of programs, the need for a local coordinator entity, and monitoring agricultural systems for the integration of innovation towards sustainability. Hence, there are challenges such as the consolidation of effective knowledge and learning networks, the inclusion of all kinds of knowledge from different spaces, the creation of a new vision of innovation systems for sustainability, and the formulation of new policies oriented to support local knowledge for innovation and sustainability.

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