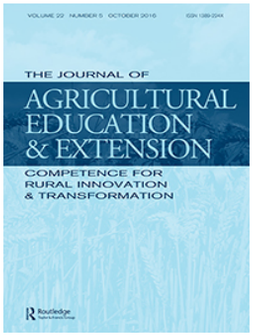

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The evolution of the MasAgro hubs: responsiveness and serendipity as drivers of agricultural innovation in a dynamic and heterogeneous context

Tania Carolina Camacho-Villa[a], Conny Almekinders[a,b], Jon Hellin[a], Tania Eulalia Martinez-Cruz[b], Roberto Rendon-Medel[c], Francisco Guevara-Hernández[d], Tina D. Beuchelt[e] and Bram Govaerts[f]

[a]Socio-economics Program, International Maize and Wheat Improvement Center (CIMMYT), Mexico, D.F., Mexico; [b]Knowledge Technology and Innovation, Social Science, Wageningen University, Wageningen, The Netherlands; [c]Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y la Agricultura Mundial (CIESTAAM)-Universidad Autónoma Chapingo, Chapingo, Estado de México, Mexico; [d]Facultad de Ciencias Agronómicas, Universidad Autónoma de Chiapas, Tuxtla Gutiérrez, Chiapas, México; [e]Center for Development Research (ZEF), University of Bonn, Bonn, Germany; [f]Sustainable Intensification Program, International Maize and Wheat Improvement Center (CIMMYT), Mexico, D.F., Mexico

ABSTRACT

Purpose: Little is known about effective ways to operationalize agricultural innovation processes. We use the MasAgro program in Mexico (which aims to increase maize and wheat productivity, profitability and sustainability), and the experiences of middle level 'hub managers', to understand how innovation processes occur in heterogeneous and changing contexts. *Design/methodology/approach*: We use a comparative case study analysis involving research tools such as documentary review, key informant interviews, focus group discussions, and reflection workshops with key actors. *Findings*: Our research shows how a program, that initially had a relatively narrow technology focus, evolved towards an innovation system approach. The adaptive management of such a process was in response to context-specific challenges and opportunities. In the heterogeneous context of Mexico this results in diverse ways of operationalization at the hub level, leading to different collaborating partners and technology portfolios. *Practical implications*: MasAgro experiences merit analysis in the light of national public efforts to transform agricultural advisory services and accommodate pluralistic agricultural extension approaches in Latin America. Such efforts need long-term coherent macro level visions, frameworks and support, while the serendipitous nature of the process requires meso-level implementers to respond and adapt to and move the innovation process forward. *Originality/value*: This paper contributes to the debate on how to operationalize large programs by showing that the innovation support arrangements enacted in the field should allow for diversity and have a degree of flexibility to accommodate heterogeneous demands from farmers in different contexts as well as continuous changes in the politico- institutional environment.

KEYWORDS
Agricultural innovation; Mexico; heterogeneity; MasAgro; adaptive management

CONTACT Tania Carolina Camacho-Villa c.camacho@cgiar.org Socio-economics Program, International Maize and Wheat Improvement Center (CIMMYT), Apdo. Postal 6-641 06600, Mexico, D.F., Mexico

1. Introduction

In recent years, interest has grown in 'Agricultural Innovation Systems' (AIS) as a concept to understand and analyze change (or the lack of it) in the agricultural sector (World Bank 2007). AIS thinking evolved from previous approaches including: Transfer of Technology, Farming Systems Research and Agricultural Knowledge and Information Systems (Röling 2009; Klerkx, Van Mierlo, and Leeuwis 2012). AIS departs from the principle that innovation is based on interactive learning between actors that are part of the system (Hall 2007) and implies changes in technologies (hardware), knowledge (software) and organization (orgware) as a result of actors' capacity to innovate (Leeuwis et al. 2014). The term innovation, however, can be interpreted in many different ways, it has multiple dimensions and it can take different shapes and forms depending on local circumstances (Vamsidhar Reddy, Hall, and Sulaiman 2012).

Several AIS studies have shown that agricultural innovation is 'the result of multiple interactions between components of farming systems, supply chains and economic systems, policy environments, and societal systems' (Klerkx, Van Mierlo, and Leeuwis 2012). This highlights the fact that innovations can 'follow path-dependent, contextually-shaped trajectories that unfold over time' resembling 'a process of muddling through, using the best ideas available at a given point in time and trying to move forward in a way that addresses certain social, economic and, increasingly, environmental aspirations' (Vamsidhar Reddy, Hall, and Sulaiman 2012). In other words, the evolution of agricultural innovation is more often one of metamorphosis, with the pace and direction of change dictated by the differing contexts in which agricultural transformation takes place (Klerkx, Aarts, and Leeuwis 2010; Triomphe et al. 2013). Hence, Klerkx, Aarts, and Leeuwis (2010) refer to adaptive management to point out the need for innovating actors to react constantly to their context which they try to modify in their favor. This notion of adaptive management can cause some tension when confronted with linear frameworks that do not allow for flexibility in innovation support programs (Kilelu, Klerkx, and Leeuwis 2014).

A range of studies has looked at agricultural innovation in different contexts. (Klerkx, Aarts, and Leeuwis 2010; Vamsidhar Reddy, Hall, and Sulaiman 2012; Triomphe et al. 2013; Kilelu, Klerkx, and Leeuwis 2014; Totin et al. 2015; Schut et al. 2015). Some of these studies take a micro-level perspective by focusing, the interactions at the farmers level: on the demand-articulation (Kilelu, Klerkx, and Leeuwis 2014), or how intermediaries or brokers play a role in connecting the demand-side to the supply-side (Klerkx, Hall, and Leeuwis 2009; Kilelu, Klerkx, and Leeuwis 2014). Others take a macro-level perspective by looking at the (re)configuration of AIS and the (changing) roles of different stakeholders in them (Birner et al. 2009; Christoplos 2010; Klerkx and Leeuwis 2008; Parkinson 2009; Swanson and Rajalahti 2010; Turner et al. 2016) as well as efforts to find a 'best fit' mode for countries in providing and financing agricultural advisory services (Birner et al. 2009). There is less empirical evidence on meso-level innovation support arrangements in AIS and how they come about. We consider this level where multi-stakeholder processes are playing out, in spaces that are virtual or real innovation platforms (Schut et al. 2015), with different type of brokers or innovation intermediaries playing different roles. Like for example Madzudzo (2011) and Minh et al. (2014), we look at how brokers at this level operationalize their role. Whereas Madzudzo (2011)

presents two cases in which the brokers represent an external actor with an own budget and clear mandate to deal with bottlenecks, and Minh et al. (2014) report on the efforts to institutionalizing demand-driven approaches to public service delivery, we look at brokers that are part of a public institutional effort with a short and medium term objective and subject to a political agenda for the orientation of their efforts to support farmers. In this paper we describe the innovation processes taking place in and around the MasAgro (*Modernización Sustentable de la Agricultura Tradicional*) program in Mexico, through its operational meso-level interface of 'hubs'. Mexico shares with other Latin American countries the heterogeneity of their agriculture sector in relation to farmers and farming systems, different type of public, private and social stakeholders, and how they are affected by the volatility and inconsistency of agricultural public policies (IAASTD 2009; Aguirre 2012; Barrantes et al. 2013).

Over the last 50 years, Mexico has experimented with different models of agricultural research and development. A transfer-of-technology approach predominated from the 1950s until the early 1980s. There were positive results, mostly in parts of the country characterized by commercial large-scale agriculture. This model, while criticized for not addressing the needs of more subsistence-oriented farmers (Fitzgerald 1986), largely persists (Fox and Haight 2010; Hellin 2012). During the 1980s and 1990s, and mirroring global trends, non-governmental organizations and government institutions in Mexico favored more farmer participatory approaches (Diego-Quintana 2004). As a consequence, there is now a plethora of public and private extension agents: private companies, research and academic organizations, state governments and NGOs. Among them are private extension agents who depend for their existence on the implementation of public agricultural development programs. These *prestadores de servicios profesionales* (PSPs) are often organized into small agencies called 'despachos'. These extension services, however, achieved relatively little because of constant policy changes (Muñoz-Rodríguez and Santoyo-Cortes 2010; McMahon and Valdés 2011).

MasAgro started in 2010 as a joint effort between the International Maize and Wheat Improvement Center (CIMMYT) (an international research institute with its headquarters in Mexico) and the Mexican Government's *Secretaria de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación* (SAGARPA) (Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food). MasAgro is implemented through a collection of 'hubs' that cover much of Mexico. In MasAgro, a hub is seen as a network of value chain actors from a particular agro-ecological region who work together on sustainable solutions in maize- and wheat-based farming systems. The hub envisions the fostering of innovation processes at regional level, taking into account the different contexts (Hellin et al. 2014). Similar to other experiences using the same concept, MasAgro hubs have become innovation platforms or nodes at the meso-level that connect various collaborating actors (Schut et al. 2015; Kilelu, Klerkx, and Leeuwis 2016) and where innovation processes are operationalized. The way these hubs have been developed and how the managers of these hubs have addressed emerging challenges and opportunities sheds light on the reality of shaping innovation approaches in the heterogeneous contexts of Latin America. More broadly, the paper aims to contribute to the ongoing debate on how pluralistic systems of advisory services and innovation support may deal with heterogeneity in farmers' situations and needs (Kilelu, Klerkx, and Leeuwis 2014), move from linear technology oriented to adaptive management and innovation-system approaches (Klerkx,

Aarts, and Leeuwis 2010; Triomphe et al. 2013), and what this implies for the multiple stakeholders involved in terms of competences, stakeholder identities and institutional settings to enable demand-driven and adaptive innovation approaches (Nettle, Brightling, and Hope 2013; Landini 2015; Minh et al. 2014; Schut et al. 2015).

The structure of the paper is as follows. After a section on materials and methods, we include a brief background history of MasAgro, describing how it evolved from a program focused on technology to one moving forward an innovation-system approach. This is followed by a section that describes how individual hub managers (essentially innovation brokers operating at a meso-level and being part of a larger program) responded to specific and changing conditions. We show how these specific conditions arose from emerging opportunities and limitations which, in turn, were determined by different agro-ecological and socio-economic conditions. The result was the 'serendipitous' coming together of different actors at the hub level. We draw on the experiences of the hub managers to identify lessons for fostering innovation processes. In the last section we discuss the experiences of the MasAgro hubs and reflect on the way adaptive management can support transformation of agricultural advisory services in the heterogeneous context of Latin America.

2. Materials and methods

This paper presents the lessons from what is essentially a comparative case study analysis of a series of innovation journeys (Klerkx, Aarts, and Leeuwis 2010). It describes and interprets the process of the construction of eight hubs and focuses on the roles of the hub managers in charge of these hubs. In addition to observations and discussions as part of our daily involvement in the program over the last six years (2010–2016), we use the following sources of information and data collection methods:

(1) Review of progress reports, notes of discussion meetings, concept notes and project presentations about MasAgro hubs from 2006 to 2014.
(2) Key informant interviews with three CIMMYT researchers who developed and operationalized the hub concept. The three are senior researchers working in projects in Asia and/or Mexico. Two of them were interviewed between March and June 2014 about their experiences with the innovation and hub concept stemming from research-for-development projects in Asia. The third researcher has been leading the efforts to operationalize the MasAgro concept since 2006. He was interviewed in August 2014 and again in June 2016.
(3) Four workshops with hub managers: June 2014 and November 2014 in CIMMYT headquarter in Texcoco, April 2015 in San Juan Teotihuacan and in April 2016 in Oaxaca City. These workshops were used to encourage the hub managers to share experiences and to reflect collectively on achievements and challenges at the hub level. Brainstorm sessions, individual and paired deeper reflection sessions were used for information collection, essentially, answering the questions 'what worked well?' and 'what did not work so well'? The resulting information was usually presented on cards which were subsequently clustered by the participants into thematic issues. These thematic issues form the basis of the sources of variation that affected the innovation processes at the hub level (see Table 2 and section 3.2). Individual and paired reflection sessions were also used to produce visual representations and

timelines of the hubs. Plenary group discussions among participants served further deepening these results, to distill lessons.

(4) Four focus groups and two interviews with hub managers, their teams and partners in Texcoco (June 2015), Ciudad Obregon (September 2015), Irapuato (February 2016), Berriazabal (March 2016), Oaxaca and Morelia (both in April 2016) with the participation of 28 persons in total. These were designed to capture the collective hub histories based on the actors' experiences.

3. Evolution of the hubs

3.1. Variation in the program level direction

CIMMYT researchers started using the hub concept in wheat production systems in Asia in 2006 (Sayre 2006). In 2007 they brought the approach to Mexico to support the development and promotion of conservation agriculture (CA). In the initial years, and in response to the need to secure donor funding, CIMMYT researchers proposed the hub as the tool for linking research findings from long-term on-station CA trials to farmers' fields. With the first donor support from private and public sector, researchers further developed and operationalized the hub concept and established CA testing plots in farmers' fields (named modules) and experimental plots (named experimental platforms).

In October of 2010 SAGARPA signed the MasAgro agreement with CIMMYT. MasAgro funds provided the opportunity to increase the number of hubs in order to target more agro-ecological regions in Mexico. Meetings with key national actors led to a broadening of the technology basis so as to include: improved maize and wheat varieties, fertilization diagnostic tools, integrated fertility management, post-harvest technologies and crop diversification. CIMMYT researchers hired four hub managers to be in charge of the growing numbers of hubs. Partnerships were established with academic institutions and with 'despachos'. CIMMYT also implemented an annual training course for farm advisors in CA known as 'Curso de Tecnico Certificado en Agricultura de Conservacion'.

In 2012, SAGARPA, the Mexican Ministry of Agriculture, decided to duplicate MasAgro's budget and to present the program as the national strategy that would integrate the work of various institutions and dispersed agricultural development programs of the Federal government. This included the program to support maize and bean production chain named PROMAF (Programa Estrategico de Apoyo a la Cadena Productiva de Productores de Maiz y Frijol). Researchers and SAGARPA officials met with officials of the different state governments to establish agreements for promoting MasAgro at the state level. Extension training courses were developed to better equip the PSPs in supporting farmers. As part of the Federal government's policy to coordinate agricultural throughout the country, these PSPS became the extension agents within MasAgro.

In 2013 the presidential elections brought a different political party to power. New political appointees in SAGARPA adopted a different perspective in relation to MasAgro. SAGARPA asked CIMMYT to align MasAgro with a new key governmental program, *Cruzada contra el Hambre.* The *Cruzada* was designed specifically to reduce hunger in the most marginalized parts of Mexico. In response, MasAgro reoriented its activities to include marginal parts of the country and the poorest farmers. The result was additional new alliances with organizations and programs that were already working with marginal

farmers mainly NGOs and academic institutions. MasAgro became more involved in pro-poor technologies and participatory approaches. Uncertainties around SAGARPA funding continued to create challenges and opportunities: in 2014 and 2015, the different MasAgro hubs started to seek complimentary funding from the private sector, different state governments and NGOs.

3.2. Similarities and differences between hubs

3.2.1. Hub activities and status

Some hubs had started up with CA trials as early as 2007. In 2012, CIMMYT researchers had defined 12 hubs that would eventually cover all agro-ecological regions in Mexico with relevant maize and wheat-based farming systems. The activities to develop these hubs started in different points in time (see Figure 1), depending on the funding priorities and the potential or existing partnerships. To date, eight hubs are operational and four are in the process of development.

Hub managers developed their respective hubs by collaborating with local research and extension actors in the establishment of an increasing number of experimental platforms and different type of demonstration plots where different technologies were tested and adapted with farmers (see Table 1). They put a team of technicians and office support in place with whom they organized field days and farmers exchange visits. These events brought together farmers, local authorities, farmers' leaders, local representatives of programs, state officials, academic organizations and input suppliers. Hub managers also have been implementing an increasing number of training events with the one named 'Tecnico Certificado en Agricultura Sustentable' as well as more specialized courses on particular technical topics. They also established and ran pools of machinery that were necessary to support the farmers in the implementation of CA practices. In addition they have been constantly identifying, contacting and meeting with key local stakeholders such as state governments, regional implementers of public agriculture and social programs, local representatives of private or social initiatives. As a result the number of strategic alliances have increased, giving shape the network that the MasAgro hubs were envisioned to be. While starting from the same premises and similar activities, the hub managers have shaped their hub in response to the differences in context and the plethora of opportunities and challenges throughout the MasAgro program. As a result the hubs have evolved in different ways.

3.2.2. Varied agricultural context

An important difference between the hubs is the variation in agricultural contexts (Table 2). In the northern part of Mexico, Pacifico Norte hub works with farmers who manage irrigated commercial farms of on average 70 ha. There farmers are highly mechanized and their farms are input-intensive and highly productive. In addition, farmers in the Pacifico Norte hub are well organized and are able to negotiate maize subsidies with government and wheat prices in international markets. In contrast, the hubs in southern Mexico find themselves working predominantly with smallholder farmers producing in rain-fed conditions with varying degrees of diversification, mechanization, use of inputs and commercialization. In these regions, smallholders are producing maize on farms of 5 ha or less, for home consumption and/or local or regional markets.

Figure 1. Location and status of MasAgro hubs in 2016.

There is also major presence of indigenous smallholders from different ethnic groups who intercropping maize with beans and squash in the Pre-Colombian *milpa* farming system. Farm households increasingly have family members working off-farm and for whom remittances are an important component of farm households' income.

3.2.3. Different previous institutional experiences

CIMMYT has been in Mexico since 1966, working in different regions of the country, creating a different institutional history for each of the hubs (Table 2). In the Pacifico Norte, CIMMYT has a long-standing relation with local stakeholders that goes back to wheat breeding by CIMMYT in the 1960s. It was among the two first hubs that CIMMYT researchers established in 2007. The appointed hub manager was previously a research assistant in the local CIMMYT research station in Obregon. In the Bajio hub, CIMMYT presence has been intermittent as of the 1970s when the center got involved in research and promotion of CA practices. This promotion continued with the support of other organizations that trained local actors (such as farm advisors and farmers) and facilitated the availability of CA machinery until CIMMYT came back with MasAgro. The first hub manager was involved in these previous efforts, so when she started in 2011, she could build on a network of earlier collaborators.

Table 1. Hubs indicators of their main activities until 2015.

Hub components	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hubs in operation	2	2	2	2	5	5	5	6	7
Experimental platforms				2	17	21	55	50	43
Modules from collaborations		30	47	47	126	327	225	243	452
Modules from alliances						2497	2712	1195	805
Adoption areas (ha)						28,957	69,357	37,011	40,982
Machinery pools						9	9	11	14
Training events for farmers					3	153	301	383	384
Training events for farmers' advisors				5	183	38	102	49	58
Annual Training Course (certified persons)				4	32	45	181	67	46

Hub managers who cover the states of Chiapas and Oaxaca were in a very different position The Chiapas hub manager counted with previous experience on CA but he was both new in the area (coming from elsewhere in the country) and could not build on previous CIMMYT work in the area. Establishing an office, a team and a pool of machinery was the first step, but more challenging was developing partnerships. He also had to implement the technology in off- and on-farm trials to see how the technologies were performing, what adaptations were needed and eventually to convince collaborating farm advisors and farmers that MasAgro technologies work. The hub manager working in Oaxaca found himself in a similar situation to that of the hub manager in Chiapas: he had to show how the MasAgro technologies performed, but in addition he found the doors of local government closed for collaboration. They saw with mistrust the presence of a research center that had previously only 'taken information away'.

3.2.4. Variation in partnerships and alliances

From its inception, MasAgro had to build partnerships and alliances. A distinction was made between partnerships, whereby CIMMYT largely defined the agenda, and alliances in which joint research and development agendas arose from activities alignment between CIMMYT and other stakeholders. SAGARPA expected MasAgro to implement its program through collaboration and set aside money to build partnership and alliances to integrate the scattered extension efforts in the agricultural sector. Moreover, in 2014 and 2015 when Federal government funding was late because of the delay in budget approval, MasAgro made a concerted effort to establish links with strong regional and local collaboration to reduce financial exposure and ensure survival of the program.

Given the Mexican federal structure, it meant that in each hub, as well as engaging with the national government (represented by SAGARPA), the hub manager had to work with a state government and with different agricultural policies and subsidy programs. These often changed when after state elections the power passed from one political party to another. This created follow-up challenges but also opportunities. Also the extension and advisory services represent a scattered landscape in which hub managers had to navigate through and form strategic alliances with different extension actors.

Depending on the state, hub managers have established key alliances with farmers' organizations (Pacifico Norte), local authorities (Chiapas), research and academic centers (Oaxaca), state governments (Bajio and Guerrero) and/or environmental NGOs (Yucatan) (Table 2). The variation of hubs partners reflects the difference on key stakeholder in each region. These variations explain why the hub managers supporting

Table 2. Elements that differ between hubs.

Hub name	Agricultural context	Previous experience	Key hub partners and allies	Technologies portfolios
Pacifico Norte	High input and mechanized irrigated maize and wheat farming system. Large-scale commercial organized farmers selling to national and international markets	CIMMYT with station and long-standing relation with local actors. CA and other technologies previously researched and promoted by other institutions. Previous experience of hub manager as a research assistant	Private extension services Farmers organizations Financial organizations	CA and fertility practices continue being the main technologies
Valles Altos Maiz	Low to medium input and mechanized rain-fed and irrigated farming systems. Medium-scale semi-commercial farmers selling to regional markets	CIMMYT with HQ and long standing presence in the region. Long-term CA trials and on farm research. Previous experience of hub manager as development practitioner	Private and public extension services Individual farmers	From only CA to also fertility practices and maize varieties
Bajio	High input and mechanized irrigated maize, sorghum, wheat and barley farming systems. Large and medium-scale commercial farmers selling to national and regional markets	Intermittent CIMMYT presence related to CA research and development. Previous CA experience for capacity building and infrastructure. Previous experience of hub manager as public official	Private extension services State Governments (like Guanajuato)	From only CA to also fertility practices and Integrated Pest Management
Chiapas	Low to medium input and mechanized rain-fed maize farming systems. Small-scale self-consumption farmers and medium-scale semi-commercial farmers selling to local markets	Intermittent CIMMYT presence since 1980s related to research. Limited CA experience promoted by other institutions. Previous experience of hub manager as private extension agent	Different advisory and extension schemes Local authorities	From only CA to also fertilization and Post-harvest technologies
Valles Altos Grano Pequeño	Medium input and mechanized rain-fed barley and wheat farming systems. Medium-scale commercial farmers selling to national markets	CIMMYT has a long-standing relation with local stakeholders. Long-term CA trials. Previous experience of hub manager as development practitioner	Private extension services Buyers	From only CA to also integrate topological arrangements
Pacífico Sur	Low to medium input and mechanized rain-fed maize farming systems. Small-scale self-consumption farmers and medium-scale semi-commercial farmers selling to local markets	Intermittent CIMMYT presence since 1990s related to research projects. Limited CA experience promoted by other institutions. Previous experience of hub manager as development practitioner	Different advisory and extension schemes	From CA to integrate Post-harvest technologies, MIAF and use of manual tools
Pacifico Centro	Low to medium input and mechanized rain-fed maize farming systems. Small-scale self-consumption farmers and medium-scale semi-commercial farmers selling to local markets	Limited CIMMYT presence with research. Limited CA experience promoted by other institutions. Previous experience of hub manager as public official	Public extension services State governments	Fertilization practices and post-harvest technologies
Peninsula de Yucatan	Low to medium input and mechanized rain-fed maize farming systems. Small-scale self-consumption farmers and medium-scale semi-commercial farmers selling to local markets	Inexistent CIMMYT presence in the region. Limited CA experience promoted by other institutions. Previous experience of hub manager as private extension agent	Different advisory and extension schemes Environmental NGOS	Starting with CA as eco-friendly technology

medium or large-scale commercial farmers, mainly established collaborations with 'despachos' and input suppliers as in Sonora and Sinaloa. The Bajio hub manager took advantage of the political transition in the state of Guanajuato in 2012 and was able to develop an alliance with the new state government to scale MasAgro to cover the entire state of Guanajuato. State governments are key stakeholders in this region due to the regional relevance on national cereals markets. In contrast, hub managers in the southern part of Mexico (Chiapas, Oaxaca, Guerrero and Yucatan Peninsula states) have had to find ways to support poor small-scale farmers (as part of MasAgro contribution to pro-poor policies) as well as medium-scale semi-commercial farmers. Thus, hub managers have worked through 'despachos' to reach medium-scale farmers who tend to follow a technology transfer approach. In contrast, they support small-scale and indigenous communities via NGOs who work with participatory and systemic approaches moving the focus from plot to a farm, livelihood or watershed level. As these organizations normally have their own approaches and on-going processes they bring alternative methods and technologies to MasAgro.

3.2.5. Different technology portfolios

As hubs started out as mechanisms to promote CA, this technology was the entry point for most of them. The adoption/adaptation of this technology to the different type of farming systems has been challenging (Ramírez-López, Beuchelt, and Velasco-Melchor 2013) and has resulted in varying technology portfolios (Table 2). For instance in Pacifico Norte where the promotion of CA in flat irrigated and mechanized plots is central, the hub manager has been negotiating with financial organizations to create enabling environments. In the hubs in the central regions of Mexico where crop residue has an economic value as fodder (Beuchelt et al. 2015), CA has been complemented by other locally relevant technologies such as maize varieties and fertilization. In hubs covering the heterogeneous landscape of Southern Mexico, hub managers have learned about the diversity of farmers' demands/problems and on the various solutions that are already available. Chiapas hub manager now sees CA as a set of practices that can only be successfully promoted when other farmers' demands have been addressed. Currently, the Chiapas hub gives considerable attention to improve fertilizers management and post-harvest technologies. The hub manager in the Oaxaca states that CA cannot be a rigid application of 'rules' or 'principles'. He recognizes the value of CA to control soil erosion. However, he considers that it needs a long-term investment for its adaptation in the different farming system contexts. He has incorporated in the technological menu practices that have been developed in the region like the agroforestry system that intercrop *milpa* with fruit trees known as MIAF. In recently activated hubs like Pacífico Centro and Yucatan, hub manager started with other technologies (such as fertilization) or other reinterpretations of CA as environmentally friendly practice.

3.3. Moving forward and looking back

In the course of 2013, hub managers started to discuss the need to reflect on their diverse experiences in a more systematic way. This was the start of a series of reflection workshops that now take place once or twice a year. These workshops have become a space in which the hub managers exchange their experiences: problems, successes, errors, strategies,

achievements and lessons. They identified changes in the MasAgro focus from CA to technological menu and a system approach. They also identified the changes in their hub-level strategies because of changes in program orientation as driven by federal or state policies. In the first workshop, the hub managers shared the feeling that there was a need for a manual on how to best establish strategic alliances with key actors, one of the main challenges they saw themselves confronted with. However, after some discussion, they realized that such a manual would very likely not be useful, as it could not adequately describe how to deal with the particularities and contingencies of their everyday experiences. In the last workshop in April 2016, the hub managers reflected on the way that their hubs had evolved since their start. The hub managers agreed that each hub is unique in terms of its different agro-ecological, socio-economic, cultural and political characteristics. These differing contexts meant that individual hub mangers had to, in their own unique way, negotiate, identify and create opportunities for collaboration. The hub mangers concluded that there is not one route to success but a myriad of routes. They identified some key lessons for fostering innovation processes in heterogeneous contexts:

- Be sure you know the agricultural systems in your region;
- Show evidence in the field of the value of what you have to offer;
- Develop capacity in partners for undertaking various activities like resolving technical problems, training extension agents and/or for convincing more actors;
- Identify which farmers can play an important role, not only as adopters, but also as active promoters, who can convince others and position the program in the region;
- Find out which actors can be useful to advocate, the doors and give you access to the state government authorities;
- Study what actors want to participate and identify their strengths and weaknesses in relation to one's own;
- Take advantage of political changes and changes on actors discourses to turn them in opportunities

Hub managers agreed that since the evolution of each hub was unique in context of time and space, the development of a hub cannot be easily replicated as a pre-planned, step-by-step process. Sometimes, unexpected situations or encounters were the ones that made the difference. For one hub manager, it was a chance meeting in a bar with a local politician, who turned out to also be a farmer with an interest in CA. For another, it was a lucky encounter with a dentist, who was also the leader of a farmers' organization. A good example of active looking for opportunities is the recent experiences of the new hub manager in Yucatan: at the start of building the MasAgro hub he found his entry points with the NGOs that have environmental protection as their highest priority. CA as environmentally friendly technology was an important reason for the collaborators in Yucatan to engage with MasAgro. Therefore, hub managers highlighted that it is fundamental to be open to the fact that the process is changing all the time.

4. Discussion and conclusion

The Mexican Federal government's support of MasAgro was seen as recognition of CIMMYT's agricultural research-for-development track record. From the moment

that MasAgro was conceived, there were high expectations of what it could and would achieve. Meeting the goals of the program represented, and continues to represent, a huge challenge, more so in the context of Mexico's complex and heterogeneous agricultural and socio-political landscape. The conception of MasAgro was rooted in applied research around technologies, and with its progressing engagement with agricultural development in the Mexican context, it broadened its focus, developing into a program with an innovation-system approach. We saw that as the program progressed and its goals became increasingly more innovation-system oriented, the emerging challenges and opportunities drove the evolution at the hub level. These challenges and opportunities generated responses of the meso-level hub managers in which changing farmers' demands at micro level were articulated with socio-political demands at macro level. In fact, changing policies by Federal government opened the door to include new actors' demands like those of more marginalized farmers after 2013. In this continuing changing context, individual hubs evolved in opportunistic ways. There was no 'right' way: the evolution process specific to each hub was a mix of opportunity and planning.

The potential collaborators, their character and organization, were unique to each hub, as were the portfolios of successful technologies they could promote. This uniqueness is explained by previous histories on CIMMYT partnerships (in a similar way to those documented by Schut et al. 2015) and by longer technology timelines which brought other collaborators (as considered by Triomphe et al. 2013). It also explained by the heterogeneous stakeholders' landscape present in each region. This is illustrated by how Mexican pluralistic extension services defined different type of partners depending on each region and farmer type. Similar to the process documented Totin et al. (2015), in Mexico partners have interpreted MasAgro in their own way. The program has become for them the opportunity to continue their own innovation and development projects. Taking into account the diversity of actors, approaches and projects under the umbrella of MasAgro, we question whether there was any alternative to the approach taken by the hub mangers, an approach characterized more by opportunistic advances rather than a following a single best-fit design at the overall program level.

Although responsiveness and adaptiveness in a highly dynamic and heterogenous context have been important factors accounting for the growth and differentiation of the MasAgro hubs, opportunity and serendipity have also played a relevant role. This has made every hub unique context in time and space, and confirms that a 'one size fits all' or 'single best-fit' approach will not work (Kilelu, Klerkx, and Leeuwis 2014). Every hub requires an adaptive management approach: responding to the varying challenges and opportunities that present themselves. The repetition of an earlier used sequence of steps would have a great risk of failure, because it suggests that each new situation is the same as the preceding ones. This realization has also implication for the concept of 'scaling'. In the last workshop, the hub managers reflected on the issue of scaling within MasAgro and how this can best be achieved. Most of them see the growth of MasAgro from four hubs in 2010 to eight hubs in 2016 as an expression of scaling. More specifically it can be seen as a form of scaling-out or horizontal scaling (Wigboldus and Leeuwis 2013). However, if every hub is unique, requiring its own approach, its own size and combination of 'best fits' there is no such thing as scaling or mainstreaming in the form of 'growth through repetition'.

The evolution of MasAgro hubs shows that because of the heterogeneous Mexican contexts, the different innovation processes do not have trajectories that can be mapped out beforehand, but require adaptive management, as used by Klerkx, Aarts, and Leeuwis (2010), and hence also an adjustment of the innovation support offered as found earlier by Kilelu, Klerkx, and Leeuwis (2014). In these contexts adaptive management shapes agricultural innovations processes resembling more a 'muddling through' (Vamsidhar Reddy, Hall, and Sulaiman 2012) to meet and accommodate macro and micro level requirements, and negotiate institutional change to be able to embed demand-driven and flexible innovation support arrangements (cf. Nettle, Brightling, and Hope 2013; Minh et al. 2014; Schut et al. 2015). In the case of MasAgro, an initiative of public national and international partners, there were no standard proto-types or recipes for supporting the process, but there was a continuous thread of strategic analysis and decision-making with opportunistic alliances made and new directions taken. It has transformed the program from a technology transfer-oriented one to a program with an participatory innovation approach, covering the heterogeneity of the Mexican agricultural sector. It is this same heterogeneity that drove the transformation: it required adaptive responses of the meso-level hub managers in which diversity in farmers' technology needs and collaborators approaches at micro level had to be accommodated with socio-political demands at macro level. These experiences merit consideration in the light of national public efforts to transform the agricultural advisory services and accommodate pluralistic agricultural extension systems in Latin America, and requires that heterogeneity is well considered in the array of programs available (see e.g. Namdar-Irani and Sotomayor 2011). Such efforts need long-term coherent macro-level visions, frameworks and support, while the serendipity and opportunistic elements of the process in the dynamic and heterogeneous context ask for space and capacity of meso-level implementers to respond and adapt, and move the innovation process forward.

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Notes on contributors

Tania Carolina Camacho-Villa is a Post-doctoral research fellow in the Socio-economics Program of the International Maize and Wheat Improvement Center (CIMMYT). Her research topics are innovation processes, agrobiodersity conservation and social inclusion.

Conny Almekinders is an Associate Professor on the Knowledge Technology and Innovation, Social Science at Wageningen University and a associate researcher at CIMMYT. She focuses on sociological aspects of agricultural technology development in general and on plant breeding and seed production more specifically.

Jon Hellin is a Senior Scientist in the Socio-economics Program of the International Maize and Wheat Improvement Center. His research focuses on farmers' access to markets, livelihoods and innovation processes.

Tania Eulalia Martinez-Cruz is a PhD candidate from the Knowledge Technology and Innovation, Social Science at Wageningen University. Her doctoral research is on processes on continuity/discontinuity and inclusion/exclusion in agricultural development projects.

Roberto Rendon-Medel is a Professor in the Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y la Agricultura Mundial (CIESTAAM) at Universidad Autónoma Chapingo. He is an expert on innovation networks and agricultural extension approaches.

Francisco Guevara-Hernández is a Professor of the Facultad de Ciencias Agronómicas in the Universidad Autónoma de Chiapas. His research focuses on traditional farming systems, agricultural extension and M&E.

Tina D. Beuchelt is a Senior Researcher at Center for Development Research (ZEF) of the University of Bonn. Her research themes are land use, food security, growth, inequality, poverty and sustainable use of biological resources.

Bram Govaerts is the Latin America representative and strategic leader of International Maize and Wheat Improvement Center (CIMMYT). He is leading MasAgro program in Mexico and other Sustainable Intensification Projects in other Latin American countries.

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