On continuities and discontinuities

Tania Eulalia Martinez-Cruz

On continuities and discontinuities:

The making of technology-driven interventions and the encounter with the MasAgro Programme in Mexico

Tania Eulalia Martinez-Cruz

INVITATION

You are cordially invited to attend the public defence of the dissertation entitled:

On continuities and discontinuities:
The making of technology-driven interventions and the encounter with the MasAgro Programme in Mexico

Wednesday
22 January 2020
at 4 p.m.
in the Aula of
Wageningen University,
General Foulkesweg 1a,
Wageningen

A reception will follow after the ceremony in the Aula

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Paranymphs

Julissa Galarza Villamar

Chaniga Laitae

Propositions

1. Continuity of research collaboration beyond a single project period is evidence of success. (this thesis)
2. The false dichotomy between traditionality and modernisation ignores the way people combine different elements of both in everyday life to cope with a changing world. (this thesis)
3. Encouraging learning from success reinforces the socio-economic and political inequalities that determine who wins and loses.
4. There are many alternative approaches to development that are not represented in mainstream debate because they cannot be translated into English.
5. Using intersectionality in our 'will to improve' is like dating several people at the same time: in our bid to satisfy all, we end up satisfying none.
6. As social scientists, we often do not enact our own insights from research on inclusion and exclusion in our own lives which undermines the real-world relevance of our research.

Propositions belonging to the thesis, entitled:

"On continuities and discontinuities: The making of technology-driven interventions and the encounter with the MasAgro Programme in Mexico"

Tania Eulalia Martínez Cruz

Wageningen, 22 January 2020

On continuities and discontinuities:

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Thesis

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Table of contents

Tables and Illustrations

Tables

Figures

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Summary

Most of our work and knowledge as researchers in agriculture is taken to farmers in the form of technology-driven interventions. The central assumption behind these projects is that farmers can improve their livelihoods by increasing their crop yields and crop productivity. Over time, due to the criticisms on how these modern technologies failed to include the most marginalised people and the negative environmental impacts of their use, a call for participatory approaches to development, addressing the environmental agenda, and taking into account human rights and social justice and the role of a socially responsible civil society and industry has emerged. Yet there remains a need for using modern technologies to increase food production. For example, a 2017 UN report indicates that 13% of the global population is undernourished. Thus, to achieve the Sustainable Development goal of "Zero hunger", the World Bank indicates that small-holder farmers will play a crucial role in addressing hunger by increasing their yield and productivity while also using sustainable food systems. Hence, researchers have a role as key actors in developing sustainable food systems and modern technologies that fit the new challenges.

In Mexico, as elsewhere, researchers have played a central role in the framing and design of technology-driven interventions that seek to increase agricultural productivity. Researchers have offered silver bullets, i.e. technologies that promise to serve as simple solutions to complex problems, to politicians. One constant criticism to Mexican agricultural policy is how it has promoted agricultural production based on modern technologies to increase yields through several interventions, from the Mexican Agricultural Programme in the 1940's to the Sustainable Modernisation of the Traditional Agriculture (MasAgro) Programme launched in 2010. Some authors argue that this model has subsidised inequality because the winners of these policies have historically been the same group of well-endowed farmers. Most of the small farmers, subsistence farmers and landless agricultural labourers have historically been excluded from programmes to engage them as producers. Yet, the effectiveness of these interventions is often unclear, which leads us to wonder why some technologies and paradigms are dominant over others and therefore continue to be promoted and implemented, despite the uncertainty about their effectiveness. At the same time, it makes us wonder why some other technologies and approaches are discontinued or considered irrelevant in global narrative and agendas. Thus, we need to look at our work critically through the lens of political agronomy to explain how agendas are negotiated and what the underlying assumptions are. My research will focus on understanding how mechanisms are shaping processes of continuity and discontinuity in technology-driven interventions like MasAgro Programme in Mexico – reinforcing the prevalence of particular technologies and groups of beneficiaries and excluding others. In doing so, I used the case of MasAgro Programme, led by the International Maize and Wheat Improvement Centre (CIMMYT) and the Mexican Ministry of Agriculture and Rural Development (SADER formerly known as SAGARPA), to analyse processes of processes of continuity and discontinuity and

social inclusion and exclusion. These three technologies are Conservation Agriculture, native maize and a mobile-based short-message-service (SMS).

My first case study (Chapter 2) is contextual and focuses on the social life of MasAgro Programme in Mexico, i.e. the making of MasAgro. Here I explore the mechanisms that allowed the emergence of MasAgro Programme and how it gave continuity to the agricultural production paradigm as MasAgro Programme was initially portrayed as a second Green Revolution. MasAgro Programme found continuity over three different government periods, which is unusual for programmes in Mexico depending on government funds. Thus, I investigate how MasAgro Programme and other technologies and linked interventions encountered causing continuity of some of their processes but discontinuity of others. In the end, I show how there is an interdependence among actors, specifically among the government and researchers and how they converge at one point to negotiate agendas causing processes of continuity, discontinuity, social inclusion and exclusion.

The second case study (Chapter 3) focuses on Conservation Agriculture (CA) practices in the region of Bajío Mexico. I study what mechanisms enabled CA technology to find continuity through several interventions for a period of 30 years. At the same time, I look at how processes of discontinuity interacted with that apparent continuity in CA technology research. I apply the boundary concept to analyse who contributed to the making of those CA-like technology interventions, what their interests and agendas were and therefore who was included and excluded. I show how research and politics are mutually dependent and how they generate a discontinuity of project interventions which, paradoxically, represent a continuity of agendas and research processes. As CA is both a complex and flexible technology, it has been possible to make it accommodate the changing agendas of different actors.

In my third case study (Chapter 4), I explore how native maize cultivation continues to persist in Yavesía, an indigenous village in Oaxaca, despite agricultural policy in Mexico having been designed to force discontinuity on native maize cultivation. I situate this case study in the broader debate of agricultural production and traditionality paradigms for maize cultivation in Mexico. I show how, for the farmers of Yavesía, the encounter with MasAgro Programme is one of many that represent opportunities to give continuity to their 'comunalidad' linked to maize cultivation" as a mode of making a living. With this chapter I also show some of the intangible meanings of maize cultivation that cannot be captured in a productivity oriented rational but at the same time how the meaning of traditionality changes over time around maize cultivation in an attempt by farmers to adapt to a changing world.

The fourth case study (Chapter 5) focuses on a mobile phone-based SMS system called MasAgro Mobile (MVV), which provides farmers with farming information to empower them in their practice as farmers. MVV found continuity over different government periods as did the larger MasAgro Programme, but also by different institutions. Thus, I explore how it found continuity but also how learning was driven by processes of continuity and

discontinuity and what mechanisms allowed or prevented that lessons were learned. With this case study I show the political dimensions shaping how learning occurs and why some lessons are taken on board whereas others do not.

Finally, in the discussion (Chapter 6), I summarise the answer to my research question on how processes of continuity and discontinuity take place based on my empirical cases and lead to processes of inclusion and exclusion. I also present a final reflection on the practical implications of my findings and how to move forward in theory and in practice.

Abbreviations

AGRODESA	Civil Society of Integrated Agroservices for Sustainable Development
ASERCA	Support Services for Agricultural Marketing Agency Apoyos y Servicios a la Comercialización Agropecuarias
ASOSID	Association for Sustainable Agriculture Based on Direct Seeding
BEM	Electronic Field Book MasAgro
CA	Conservation Agriculture
CGIAR	Consultative Group for International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Centre
CIRAD	French Agricultural Research Centre for International Development
CONASUPO	National Company of Popular Subsistence
CT	Conservation Tillage
DDR	Rural Development District
DR	Irrigation District
DS	Direct Seeding
FAO	Food and Agriculture Organization of the United Nations
FIRA	Mexican Trust Fund for Agriculture
FRS	Farming Systems Research
FUPROMICH	Fundación Produce Michoacán
G20	Group of Twenty
GR	Green Revolution
ICT4D	Information and Communication Technologies for Development
INIA	National Institute for Agricultural Research
INIFAP	National Institute for Forestry, Agriculture and Livestock Research
IS	Innovation Systems
IUCN	International Union for Conservation of Nature
MAP	Mexican Agricultural Programme
MasAgro	Sustainable Modernisation of the Traditional Agriculture Programme
MIAF	Milpa Intercropped with Fruit Trees
MMV	The MasAgro Mobile component of MasAgro Programme
NAFTA	North American Free Trade Agreement
NGO	Non-Profit Organisation
OECD	Organisation for Economic Co-operation and Development
PAN	Partido de Acción Nacional
PIMAF	Support Programme for Small Maize and Beans Producers
PRI	Partido Revolucionario Institucional
PROAGRO	“PROAGRO” Productive Programme (Former PROCAMPO)
PROCAMPO	Programme of Direct Support to the Countryside
PROMAF	Production Chain of Mexico´s Maize and Bean Farmers Programme

SADER	Ministry of Agriculture and Rural Development (Former SAGARPA)
SAGARPA	Ministry of Agriculture, Cattle, Rural Development, Fisheries and Food
SDG	Sustainable Development Goals
SI	Sustainable intensification
SIAP	Agricultural and Fisheries Information Service
SMN	Mexican National Weather Service
SMS	Short Message Service
TRQ	Tariff Rate Quotas
TTF	Take it to the farmer (Component of MasAgro Programme, now MasAgro Producer)
UNDP	United Nations Development Programme
UN	United Nations

Chapter 1

Introduction

Researcher working on a water stress project and testing different improved varieties of sweet sorghum in 2011, University of Arizona. (Source: Slack D.)

1.1. My personal motivation

The heart of this PhD research project lies in the mountains of Chiapas, Mexico. In 2012, I was a researcher for the International Maize and Wheat Improvement Centre (CIMMYT) for the Sustainable Modernisation of the Traditional Agriculture (MasAgro) Programme. I was doing field work with other researchers to develop a mobile phone tool that would help farmers to make better decisions by providing them with the 'right information'. We, the researchers, technicians and the MasAgro hub coordinator, drove up to the mountains for about four hours to get to the village. I remember that we were fascinated by the landscapes and the villages we passed reminded me of my Oaxaca hometown. As we were getting close to the community, the goal of our trip, we saw some farmers' fields. A CIMMYT researcher asked me: *"Why do farmers use such low planting densities? Why do they plant maize every 2 meters? If we aim to increase crop yields as part of MasAgro Programme, the answer is easy: change the planting density and change the maize varieties".* I replied, *"Because it is a milpa".* He seemed puzzled but he did not ask any more.

As we arrived in the community, the children ran to welcome us. I went to a small classroom to talk to some farmers while another CIMMYT researcher went with the local technicians to visit the farmers' fields. At the end of the day, I felt frustrated because it did not make sense asking farmers how we could meet their information needs through a mobile phone app. To start there was no phone coverage, their literacy level was low, and Spanish was neither their mother tongue nor their most commonly used language. As the day ended, the CIMMYT researcher came back and he said: *"A milpa, now I get it. A farmer needs potatoes, pumpkin, squash, beans and other things he uses throughout the year. I also see that they keep their own seed from one cropping cycle to the other, so they do not need to buy seeds".* For the second time in a day, I was frustrated because I also failed to explain to an outsider why farmers cultivate maize with a low planting density and why they prefer their native maize seeds over the improved ones. I was familiar with a concept of the milpa because I grew up in a community like this one in Chiapas, but I was unable to explain why the recommendations of my colleague did not fit this context.

This experience in Chiapas was a repetition of the frustration that I have felt on other occasions whilst working with CIMMYT and on other projects, based on the inappropriateness of my own and my colleagues' assumptions and responses. As agricultural researchers and development (AR&D) practitioners, we aim to address problems such as food security, climate change and water security by promoting 'modern technologies' and focusing on yields and productivity, e.g. irrigation systems and improved crop varieties. I was puzzled to see that most of the farmers benefitting from these technologies and projects were large, wealthy and located in specific regions of Mexico. The projects were discursively framed as benefiting everyone, but in practice they only reached a few. As time passed, I started to work in regions such as the one I grew up in where, with my colleagues, we promoted these same technologies, assuming that farmers would adopt them, increase their yields and

improve their livelihoods. I was confused and uncomfortable. I had a personal and deeper connection with those regions, and I felt those technologies did not fit there: the context and rationales in those regions were different. But I could not find the words, I did not have the language to explain this. At the same time, as I interacted with social activists advocating about realities in indigenous communities such as my own, I realised there are other ways of thinking and looking at agricultural technologies that improve production, especially in contexts such as the one I grew up in. In my effort to make sense of these contradictions and confusions, I explored the literature and found out that this situation is not unique to Mexico, and that there is a critique on modern agricultural technological development that has actually been around since the Green Revolution (e.g. Harwood, 2009; Patel, 2012; Pingali, 2012). I wondered how it was possible that this situation continued to persist: that we develop agricultural technologies that are intended to benefit many farmers but in reality are not appropriate for many of them.

Looking at the Mexican context, what puzzled me was the persistence of the promotion of modern technologies with a focus on agricultural productivity in an environment that was littered with failed old and new projects. It was also evident that our work as agricultural researchers and development practitioners was drastically influenced by elections and other political changes. This generated my interest in understanding the broader context of the reality of our everyday life as research and development practitioners, hence, the 'social life' of the making of interventions. While pursuing that understanding through this study, I could not eliminate from the back of my mind the reality of my community, indigenous subsistence farmers and migrants in the mountains in Oaxaca. The discourses in Mexico, in my family, village and region have always recognised that the marginal and indigenous populations are excluded from agricultural and other policies, a phenomenon that also seemed to have the same persistence. In other words, I became particularly interested in what mechanisms might explain continuity in the type of technologies that the AR&D community offers to farmers, although these technologies often seem ill-suited to the contexts in which many smallholder farmers try to gain a livelihood. Moreover, how can one explain this continuity in what is an otherwise varied and often fragmented landscape, in which projects, new governments and policies come and go, new scientific narratives emerge and new global processes, especially climate change, influence people's food habits and migration patterns. Thus, I started my PhD journey aiming to understand the mechanisms that influence 'the making of' of agronomic research and development projects in agriculture and their outcomes in terms of continuities, discontinuities, inclusion and exclusion.

1.2. Agronomic research and the agricultural productivity paradigm in Mexico

In Mexico, as in many other regions in the world, most of our knowledge as agricultural researchers is brought to farmers through technology-based projects (Byerlee et al., 2009; Thompson and Scoones, 2009), which social scientists like to understand as 'interventions'. These interventions often aim to contribute to food security and reduce poverty (Benton, 2016; World Bank, 2008), these challenges often being framed a priori in terms of increasing agricultural productivity and yields. Throughout this dissertation, when I refer to the productivity paradigm, I refer to the focus on increasing crop yields through the promotion of modern technologies. Some examples of such technology-based interventions in Mexico are the (national) Mexican Agricultural Programme in the 1940s (Harwood, 2009), the Plan Puebla in Puebla from 1967-1984 (Cano and Winkelmann, 1972; Felstehausen and Díaz-Cisneros, 1985; Redclift, 1983); the Plan Maize in the State of Mexico from 1969-1975 (Maximiliano-Martínez et al., 2011), the Mexican Agri-food System Programme of 1980-1983 (Gates, 1988; Spalding, 1985) and the Sustainable Modernisation of Traditional Agriculture (MasAgro) Programme that started in 2010 and is ongoing.

In Mexico, the interventions and reforms framed around the productivity paradigm have meant that agricultural policy has historically subsidised inequality (Fox and Haight, 2010). The winners or beneficiaries of these policies have historically been a small group of well-endowed farmers and up to a point, some other small farmers who could be incorporated into the market oriented logic of the system (Appendini and Liverman, 1994; Fox and Haight, 2010; Gates, 1988). Most small farmers, subsistence and indigenous farmers and landless agricultural labourers have historically been excluded (Fox and Haight, 2010) and the government has, with varying levels of commitment, addressed the challenges facing them through 'social programmes' (Appendini, 2001; De Ita-Rubio, 2003; Gates, 1988) since this (large) group has been considered to have a marginal potential to contribute to food security or sovereignty. This bias against small farmers and the favouring of big farmers has created a bimodal mode of policy, which still prevails. Those farmers who fall outside the productivity paradigm are mainly engaged in native maize cultivation, which is embedded in their lives as part of their culture, identity and sovereignty (Fitting, 2011; Mullaney, 2014). These small farmers are mostly indigenous farmers, usually located in low-productivity areas, reliant upon rainfall and cultivating native maize in a traditional way (Murray-Tortarolo et al., 2018).

The work of agronomic researchers is central to reinforcing the bimodal pattern of Mexican agriculture and the agricultural policy of 'subsidizing inequality', since most of the interventions we promote are framed in technical terms and offer 'silver bullets' to politicians. The multiple criticisms of technologically-driven interventions (from Mexico and elsewhere), aimed at enhancing agricultural productivity and linked to the Green Revolution, have given rise to new approaches, that claim to embody a better understanding of the

complex and dynamic realities of smallholder farming and have produced a broader portfolio of technologies more adapted to local contexts (Patel, 2012; Pingali, 2012). The impact of technologically-based interventions has been, and still is, highly contested and debated. In general, the potential of technologies to be introduced is assessed based on criteria such as the (potential) yield increase, cost-benefit ratio, farmers' access to the required inputs and the ease of transferring the required knowledge to the farmers. However, the majority of such interventions have mixed results that are context-specific and not all of them can be predicted. These unpredicted outcomes and the unintended consequences of technologies promoted through technology-driven interventions continue to be the subject of claims and contestations about their benefits and drawbacks. Some examples of those technologies are Conservation Agriculture (CA) (e.g. Andersson and Giller, 2012; Ramírez-López et al., 2013), ICTs (Brown and Grant, 2010; Thompson, 2004), Climate Smart Agriculture (CSA) (Newell and Taylor, 2018) and GMOs (Zerbe, 2004).

Sumberg et al. (2013) place these contested technologies in the wider, and changing, context of agricultural research, which is increasingly shaped by the neoliberal project, the environmental agenda and the call for more participatory approaches (see also Andersson and Sumberg 2017). These influences result in goals, motivations and agendas of agricultural research being increasingly contested. Giller et al. (2017) speak of the need to view agricultural research through a lens of "political agronomy" that can shed light on the ways in which agricultural research is framed. In a similar vein, Li (2007) draws attention to the way that politics influences decisions to finance, design and implement different projects and shapes the approaches that are adopted in our desire to seek improvements.

Using such a political agronomy lens opens the possibility to explore the processes of continuity and discontinuity, how they shape technologically-driven interventions and how they produce social inclusion and exclusion. My entry point in this research is MasAgro Programme in Mexico, one of those technologically-driven interventions. MasAgro Programme is a joint initiative led by CIMMYT and the Mexican Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA). It was launched in 2010 to support the use of sustainable technologies in maize and wheat production (Camacho-Villa et al., 2016). The technologies that it has promoted include CA, a SMS-mobile phone based system (MasAgro Mobile, MMV) and participatory plant breeding of native maize. I use these three technologies to construct three of my case studies and describe how they emerged and were developed in MasAgro Programme. The fourth case is MasAgro Programme itself. I trace the origin of these technologies and their (linked) interventions to find out if and how they represent processes of continuity and discontinuity, and who has been included or excluded.

1.3. Research question

In pursuing an understanding of processes of continuity and discontinuity and of social inclusion and exclusion, I took the case of MasAgro Programme as a technologically-driven intervention. Studying the social life of MasAgro Programme, its origins and the actors associated with it allowed me to understand how projects are conceived, the mechanisms that shape them, and how they come to represent a blend of continuity and discontinuity of interventions, engagement of actors, and associated practices (such as technologies, discourses and narratives). Finally, I wanted to see how the outcomes of those mechanisms of continuity and discontinuity explain social inclusion and exclusion. The overarching research question that this thesis raises is how mechanisms shape the processes of continuity and discontinuity in technologically-driven interventions such as MasAgro Programme in Mexico – reinforcing the prevalence of particular technologies and groups of beneficiaries and excluding others. In each of the cases presented in this thesis this research question is addressed and framed differently, focusing the lens on a particular aspect, technology and intervention. These differences are elaborated in section 1.6.

1.4. Theoretical framework

Each of my empirical chapters has its own theoretical conceptual framework, detailed in each chapter. This section addresses the overall theoretical framework of my research question, which I position - together with the chapters - as part of the Social Studies of Technology (Sismondo, 2010) that emphasise the use of a 'political agronomy lens' (Giller et al. 2017) in order to recognise the political dimension of our work as researchers and practitioners in agricultural development.

For this thesis, I use the definition of technology from Richards (2009: 495) as "the human capacity to make or unmake", which views technology as an activity that is essentially socially embedded. Thus, technology is a situated action (Jansen and Vellema, 2011) that gets its meaning from the objectives and agendas of its creators and users. Thus, the same technology can have a different meaning and purpose to different actors, at different times and in different places. For example, while a breeder considers seed as a pool of genes resistant to a disease, a Quechua indigenous farmer sees his seeds as "his children and sisters", expressing the strong embeddedness of seeds in their culture and identity (Nazarea, 2013). This takes the definition of technology beyond technical artefacts to one that can be understood as 'different ways of making'. In this dissertation I refer to technology as 'the process of making interventions' following on from how Cordoba Blandon (2014) used it in her work about participation in Bolivia. In this research I try to understand how actors use technologies to legitimise discourses, narratives and associated practices –and vice versa- and how these vary between diverse arenas, at different times and levels. I describe and conceptualise these elements together as 'the making´ (Richards,

2000) of technologically-driven interventions. In this process of making, I also analyse the continuities and discontinuities (Long, 1989) that have occurred around these technologies, actors, agendas, narratives, discourses and linked practices.

To understand these mechanisms and their influence, I use the lens of critical realism (Sayer, 2000) to explain how the outcomes of a given mechanism are contextual and time-specific. To describe this whole process of the makings and processes of continuity and discontinuity, I use an analytical approach with a particular focus on practices and their objectives and outcomes, i.e. a technographic approach. Such an approach has mainly been used to describe the 'makings of' material outcomes (Almekinders, 2011), whereas I use it to look at how the making of technologically driven interventions can lead to the continuity and discontinuity of social processes, and more specifically to the continuation or discontinuation of social inclusion and exclusion. I use the definitions of Hinrichs and Kremer (2008) and Warschauer (2003) on social inclusion as 'the ability to participate in a process'. Thus, in my research, social inclusion refers to the actors contributing with their makings to the different technologies and technologically-based interventions. Inclusion and/or exclusion can, in some instances, be voluntarily and chosen by actors but in others it is determined by the nature of the intervention and the other factors shaping it, e.g. the hidden political or economic dimensions.

1.5. Methodology

In this section I will elaborate my positioning within this research, the selection of case studies and the methods of data collection that I employed.

1.5.1. My positioning within this research

As explained in the introductory section of this chapter, I have been engaged in AR&D as a practitioner for several years. Similarly to the other actors whose contributions to the making of the interventions described in this thesis, I also recognise that I, myself, have played several roles in the 'making of' interventions' (those described here and others) at different points of my life and career. Thus, when I use the 'we' pronoun in some sections of this thesis, I recognise myself as part of these different AR&D communities: alternately in the role of a social sciences researcher, a development practitioner or a water management engineer. But also, I am a social activist, a woman, an indigenous person and a young person. These are the communities that I identify with, all of which have certain shared values, ideas and cultural repertoires (Gutiérrez and Rogoff, 2003; Haas, 1992), which inevitably shape my understanding of the world and my practices. Finally, as a PhD researcher I also faced an additional challenge: finding a way to write about my colleagues and friends, which necessitated my drawing upon my intersectionality in order to reconcile different roles, views and practices.

The relevance of embedding myself as part of different communities in this research lies in my ongoing dialogue with several of the actors involved in MasAgro Programme. My supervisors and myself set ourselves the goal that this work would provide material for reflection for other actors engaged in the case studies we present. We also wanted to contribute to the literature on the politics of knowledge and research and how we, as researchers and practitioners in agriculture, deal with these in our daily life and practices. From our experience as researchers and development practitioners, we know that there is limited time to critically reflect on our practice and collate the lessons we are learning while interventions are unfolding. To increase the space for such reflections in this PhD project, we organised several reflection workshops with those involved in implementing MasAgro Programme and these became important inputs for this PhD dissertation. We also presented our work in seminars at CIMMYT and other arenas in Mexico and abroad in order to get feedback. Finally, every chapter was shared with some key actors actively engaged in the interventions we describe to get feedback on our findings, interpretations and analysis. In this discussion I also chose to present a reflection on myself as a researcher. In the early years of my PhD research, I read several books on the anthropology of development (e.g. Ferguson, 1990; Li, 2007; Mosse, 2005) that inspired me but also made me feel that criticising is easy. It led me to question why, if my colleagues, peers and myself are all seeking to make a positive contribution is there still this 'misfit'? A critical or missing element that we do not seem to be able to share or repair.

1.5.2. Research setting and case studies

To understand the mechanisms that shape the continuity and discontinuity of processes in the making of interventions, I have undertaken four historical and longitudinal case studies (Gerring, 2006; Yin, 2003). Three of these case studies are linked to a technology and one or several technologically-oriented interventions, each of them having a specific relation with, or representing part of, MasAgro Programme. The fourth case study is of MasAgro Programme itself.

Since one of my objectives was to look at processes of continuity and discontinuity in the 'making of' technologically-based interventions, I chose these cases because they gave me four different angles on technologies promoted through MasAgro Programme. Each of them has been contested in different ways and I also related to them in different ways. The first case was MasAgro Programme itself, as this was the beginning of my journey as a social sciences researcher and my supervisors were linked to it in different ways. This case provides a context and a broader focus: rather than looking at the interactions between researchers and farmers and local politicians, it addresses the interactions of researchers in an International Research Centre with their collaborators, funders and the issues and contestations that emerged as a result of these. From here, my interest in the other case studies, all of them linked to MasAgro Programme, emerged. The second case study I chose was Conservation Agriculture (CA), a technology that has been promoted by CIMMYT and

other organisations in Mexico since the 1980s, but which is a highly contested technology, not only in Mexico but worldwide (Andersson and Giller, 2012). When I joined MasAgro Programme in 2012, we were encouraged to learn the key messages promoting CA as a technology that could fit every context. I wanted to further explore the mechanisms that allowed the continuation of CA technology in MasAgro Programme, and whether there had been any internal debates about the effectiveness of CA at CIMMYT, which has been promoting the technology for many years. The third case study I chose was native maize, on the grounds that it does not fit the agricultural productivity paradigm and yet is highly valued by farmers, especially indigenous farmers. Through my practices as a social activist I realised that many of my peers had romantic and essentialist views around native maize cultivation and what we call 'traditionality'. I myself grew up seeing maize not only as a seed but also as having many intangible meanings as part our life in my Mixe community. However, as time passed, I also realised that maize cultivation and associated practices had changed over time within my community. Thus, I wanted to understand the factors that contributed to the continuity of native maize in a dynamic context and the mechanisms involved. Lastly, I chose the SMS-mobile phone-based service as a case study because I had extensive experience as a practitioner in this intervention. Thus, the empirical material from this case study would allow me to elaborate on learning as part of the process in the making of interventions, reflect on the continuities and discontinuities that lead to learning and whether learning in itself is a mechanism that leads to continuity. This fourth case study allowed me to reflect on the findings from the perspective of a development practitioner.

1.5.3. Methods

To gather the data and analyse and construct the four cases in this PhD research, I used several data collection methods over a period of three and a half years, the details of which are reported in the chapters describing each case study. They are principally in-depth formal and informal interviews with farmers, technicians, researchers and politicians who were involved in the four interventions. I also tried, where I could, to interview authorities, politicians and those who were excluded. In addition, I gathered important parts of my information from participating in field days, workshops and meetings: these provided observations and opportunities to talk with participants. Together, the information served as the basis for describing how the actors involved made and created images of the social life of these interventions.

The literature was also an important source of information. In addition to the regular scientific publications I also made use of many reports that I knew existed through my relations with CIMMYT researchers and the like. I also used research reports to which I had contributed as a co-author because I had participated in the events or workshops that generated them. Details of these data sources are presented in each chapter of this thesis. For MasAgro Programme (Chapter 2), which was my entry point, I collected information from 2014 to 2019 and used my own experience as researcher in the programme since

2012. I collected most of the information for the CA interventions (Chapter 3) between 2014 and 2016. In 2015-2016 I focussed on the case study on maize (Chapter 5). For the SMS-mobile phone based service (Chapter 5) I collected information from 2016 to 2017 and used my insights from my previous experience, which also date back to 2012.

The analysis of the information varied from one case study to the other. I did not record most of my interviews, but instead collected field notes in notebooks and maps/ drawings relating to each case study which later digitised. I used software (such as VISIO, Excel, Word, Eric II, AUTOCAD and GIS). This allowed me to map the patterns that emerged from the empirical material. I organised the notes in Word files that I later used as the inputs for each chapter of this dissertation.

1.6. The organisation of this dissertation

This dissertation is organised into six chapters. The first chapter is this introduction in which I describe the general context of this research, the research questions, the theoretical framework, methodology and how the thesis is organised. Chapters 2 to 5 correspond to the four case studies that I used to address my research questions.

In chapter two I start with the general background and the context of MasAgro Programme. I explore how MasAgro Programme emerged as a second Green Revolution intervention, giving continuity, at least initially, to the agricultural productivity paradigm. I describe the mechanisms that allowed its continuity over three periods of government (from 2010 to 2018) and how these mechanisms were also associated with discontinuities and produced exclusion. In this sense, I also explore how the other cases found continuity through MasAgro Programme and vice versa.

Chapter 3 focusses on Conservation Agriculture (CA) practices in the region of Bajío Mexico. I studied the mechanisms that allowed CA technology to find continuity, through several interventions, over a period of 30 years. At the same time, I explore how processes of discontinuity interacted with the apparent continuity in CA technology and research. I applied the boundary concept to analyse who contributed to the making of these CA interventions, their interests and agendas and thereby who was included (and excluded).

In Chapter 4, I explore how native maize cultivation continued to persist in Yavesía, a village in Oaxaca, despite the aim of Mexican agricultural policy to discourage the continuity of native maize cultivation. I place this case study in the context of the productivity vs. sovereignty debate and show how for Yavesía farmers the encounter with MasAgro Programme was one of several opportunities for giving continuity to their maize cultivation as a mode of making a living and preserving culture and identity, e.g. the principle of *'comunalidad'* intertwined with maize cultivation.

The fifth chapter focusses on a SMS-mobile phone initiative of MasAgro Programme. I explore how learning was driven by processes of continuity and discontinuity and the mechanisms that allowed or prevented the lessons learnt being taken on board. At the same

time, I explore how learning itself could be regarded as a mechanism that allows continuity or discontinuity of processes as the intervention unfolded.

Finally, in Chapter 6, I discuss and present a synthesis to try to answer my research question in relation to the processes of continuity and discontinuity and how they lead to inclusion and exclusion. I also present some final reflections on the practical implications of my findings.

Chapter 2

The making of a technology-driven intervention: MasAgro Programme

Martinez-Cruz, T.E., Camacho-Villa, T.C., Almekinders, C.J.M. and Govaerts, B.

Farmers, technicians and researchers doing Participatory Maize Breeding in Oaxaca, Mexico in 2016. (Source: Martinez-Cruz, T.E.)

Abstract

In Mexico, from the times of the Green Revolution, most of the programmes implemented in agriculture and the agricultural policy have focussed on agricultural production and embraced modern technologies and the agricultural productivity paradigm in doing so. However, similar to the outcomes of the Green Revolution, many of these interventions in Mexico have been criticised due to their mixed outcomes: while they have socially included and benefitted some farmers, they have excluded others. The key goal of this chapter is to investigate the mechanisms that shape the making of technology-driven interventions. Specifically, how the agendas, narratives, goals, target groups and collaborations are set as the interventions unfold. I argue that the entire process is not just about research and technology, but it is a politicized process in which the agendas, narratives, etc. of the many different actors evolve, and that we, as researchers, contribute to this process. To answer this question, I focus on the making of a technology-driven intervention and particularly on the making of MasAgro Programme in Mexico to understand the mechanisms that lead to continuity/discontinuity of processes and therefore to the inclusion/exclusion of different actors and technologies.

2.1. Introduction

"MasAgro Programme is only from yesterday; we have been doing Conservation Agriculture for many years" (F-B1). This quotation resonated in our minds every time we, the authors of this paper, found more actors like the farmers in Indaparapeo. They used that expression to explain that the technologies included in the menu of technologies provided by MasAgro Programme were not new to them and that they learned to use them before they started collaborating with MasAgro Programme. They explained that for them, collaborating with MasAgro Programme was a strategic move to find continuity in their personal agendas. Similarly, we found a number of researchers, technicians and politicians involved in MasAgro Programme that used technology-driven interventions to find continuity in their own agendas.

MasAgro Programme is run by the International Maize and Wheat Improvement Centre (CIMMYT) and the Mexican Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA[1]). MasAgro Programme can be seen as one of several interventions promoted in Mexico that have fit within the agricultural productivity paradigm as a means to improve farmers' lives and achieve food security. These productivity-oriented interventions have been promoted from the times of the Green Revolution (GR) and the Mexican Agricultural Programme (MAP) (Harwood, 2009) that is linked to the origins of CIMMYT. While CIMMYT, as one of the Consultative Group for International Agricultural Research (CGIAR) centres, initially focussed on research and technology production for development, the donors on whom they rely have pushed the agenda into how funds can achieve higher impacts in the specific goals targeted by the donors. Therefore, while in the past, national research centres had the role of transferring those technologies, now international institutions like CIMMYT have engaged more in development practices, such as transferring technologies directly to farmers and showing short-term successes or 'quick wins' in order to get more and continued funding (Roo et al., 2017). One particular example of this push towards development goals is CIMMYT's MasAgro Programme in Mexico.

We first encountered MasAgro Programme in 2012, two years after it emerged. MasAgro Programme has four components: 1. MasAgro Biodiversity; 2. MasAgro Producer; 3. MasAgro Maize; and 4. MasAgro Wheat. In this paper we will focus on 'MasAgro Producer' and therefore, when using 'MasAgro Programme' we will be referring to this specific component of the project. We were especially interested in understanding how MasAgro Programme was framed as a second Green Revolution that promised to be 'greener' and 'inclusive' of different realities (Camacho-Villa et al., 2016), embracing maize at the heart as a symbol of food security in Mexico. We were intrigued to see how MasAgro Programme was planned to last 10 years and through three different government periods at the

[1] The SAGARPA was renamed SADER since it was restructured in 2019 with the new president coming into power at the end of 2018. For this paper, we will use SAGARPA as such since most of the historical reconstruction presented links to this former institution.

federal level, which is unusual for projects in Mexico. As changes in governments usually mean changing goals and narratives, many projects are often discontinued at the end of a government period with new projects emerging, and only some of the old projects being maintained by revamping narratives, goals, discourses, and intervention strategies, among others (Martinez Cruz et al., 2019).

Since CIMMYT, as an international research centre, was new in leading development projects such as MasAgro Programme, actors contributing to the 'making of MasAgro Programme' had a lot to learn. For example, we organised periodic meetings with the hub managers of MasAgro Programme and they repeatedly expressed their struggles and insecurities as implementers:

> *Hub managers:* "Conny [one of the authors of this paper] but you who has a lot of experience and who has seen other projects around the world, don´t you have a manual or anything similar that we could use to guide us? It is just that we get the feeling that we are lost many times as we are implementing MasAgro Programme. We have to make decisions and judge based on what we have available but there is a lot of uncertainty in the whole process and we are never sure of what is the right answer".
>
> *Conny and Carolina [two authors of this paper]:* "There are no manuals, don't you think we could instead describe your process and share it with the rest of the world? Your experiences are rich and diverse because the landscape where you implement your project is complex and dynamic. We could share your learning and lessons" (M, W, 2017)

Thus, in this paper we collate several of those lessons described above and analyse historically the different mechanisms that shaped MasAgro Programme to find continuity through three different government periods at the national level in Mexico. This chapter presents the background that explains how the other technologies and linked interventions came to be part of MasAgro Programme. To analyse the mechanisms of continuity/discontinuity along the unfolding of MasAgro Programme, we use the concept of 'the making of' (Richards, 2000) assuming that in the process of making MasAgro Programme, several actors came together with their own agendas, e.g. a MasAgro Programme farmer cultivating maize in her field, a researcher adapting technologies to local contexts, a technician providing technical assistance to the farmers, etcetera. We do this analysis at a macro-level by reviewing the life and developments of MasAgro Programme to show that the life of a project is affected by a dynamic socio-political context that causes continuity/discontinuity (Long, 2001) of actors and agendas over time. With our work, we contribute to the debate on the political dimensions of our work as researchers and how technology-driven interventions are conceived in revamping narratives and discourses at local and global scales in an aim to find continuity.

2.2. Methodology

Our historical case study (Gerring, 2006) investigates the experience of MasAgro Programme and its evolution from 2010 to 2018. MasAgro Programme operates using the concept of a hub (Figure 2.1) and therefore, the hub is our unit of analysis. Within MasAgro Programme, a hub is 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' (Camacho-Villa et al., 2016). These agroecological regions do not necessarily overlap with the administrative division of Mexico into states[2], which as we will see in our paper also has implications on how the project unfolded over the time.

Data was collected from 2012 through 2019 used a variety of methods, which are presented below.

- Content analysis of reports, notes of discussion meetings, project presentations, articles published in scientific journals, media notes in magazines, newspapers, videos released in social media, and the websites of MasAgro Programme. Several of these reports are CIMMYT internal reports and can be accessed upon request.
- A total of 27 semi-structured interviews with key actors to construct a timeline of the evolution of MasAgro Programme, with some actors affiliated with CIMMYT, researchers linked to Mexican research institutions, actors collaborating in Mexican environmental organisations, and government officers and actors engaged at the early stages of the project drafting and implementation. The initial sample of potential interviewees was identified through an interview with the leader of the project in 2016 and through several workshops and meetings with MasAgro Programme collaborators using 'the snowball method'.
- Participatory observation from attending workshops, training events and field demonstrations involving farmers and technicians participating in MasAgro Programme in different hubs from 2012 to 2018 as some of the authors were then engaged actively in several hubs as implementers, facilitators, observers or collaborators.
- Five workshops with hub managers: two in 2014, one in 2015, one in 2016 and one in 2017. These workshops were used to collate learned experiences among the hub managers, the challenges they faced in the implementation of MasAgro Programme, and priorities and future project plans. A detailed report was made of each of these workshops and used as input for this paper. In the first two workshops only hub managers participated and in the last three, leaders of other components of MasAgro Programme also joined the sessions. The outcomes of these reports are internal CIMMYT information and can be accessed upon request.

[2] Administratively, Mexico is a federal republic composed of 32 states.

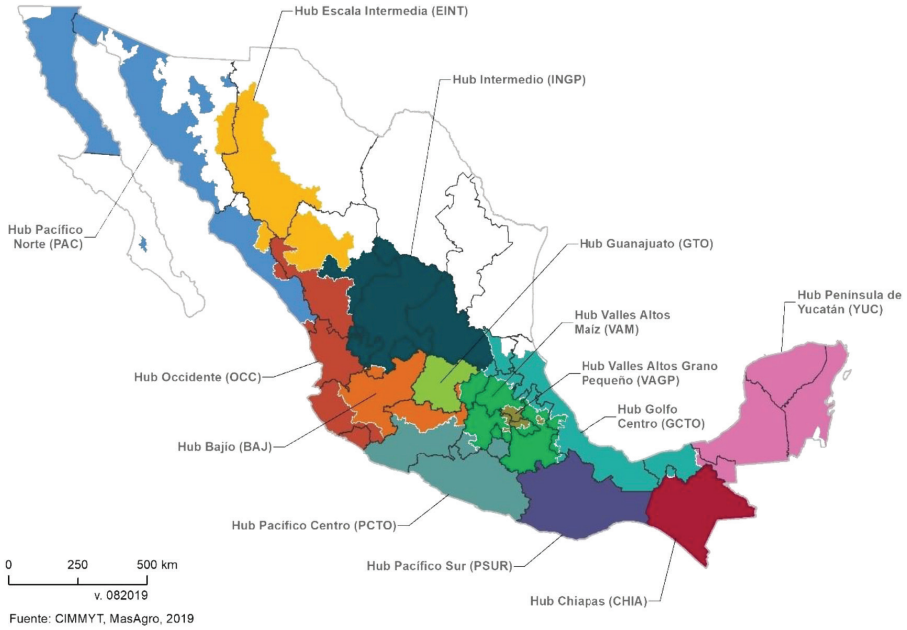

Figure 2.1 MasAgro Programme hubs in 2018 (Source: CIMMYT and MasAgro Programme, 2019).

2.3. Background

2.3.1. Maize at the heart of early interventions in Mexico.

To understand how MasAgro Programme originated, we need to understand the history of agricultural interventions in Mexico and also the status and politics of maize production in Mexico. Tracing back the history of agricultural interventions in Mexico also takes us back to the times of the Office for Special Studies (OSS) in Mexico linked to the Rockefeller Foundation in 1943. The OSS was a pilot research programme that aimed to support research on maize and wheat as staple crops. In the case of wheat, for more than 20 years Norman Borlaug and a group of researchers worked on improving wheat varieties (Deschamps-Solorzano, 2016) which later would lead to a series of international interventions aiming to eradicate hunger and poverty, i.e. the GR. Similarly, high yielding varieties of maize and so-called modern technologies were promoted through the MAP in the 1940s. As the GR in other parts of the world, the MAP was heavily criticised due to claimed negative environmental and social exclusion effects (Harwood, 2009). Despite these criticisms, the model of transferring modern technologies to farmers continued through several interventions in Mexico, e.g. the Plan Puebla[3] in 1968 (Cano and Winkelmann, 1972; Felstehausen and Díaz-Cisneros, 1985;

[3] The Plan Puebla was a project developed by the end of the 70s in the state of Puebla and promoted the use of High Yield Varieties (HYV), credits for farmers, inputs and commercialization. The idea was to help the small farmers that were left behind in the GR times (Brush et al., 1988; Gómez-Oliver, 1995; López González, 1990).

Redclift, 1983), and Plan Maíz in 1969 (Maximiliano-Martínez et al., 2011), among others.

Mexico has a long-standing history of technology-based interventions around maize because it is a staple crop linked to the biocultural diversity of Mexicans. These interventions have historically promoted the use of modern maize varieties and other 'modern' inputs adapted mainly to irrigated conditions. Despite these efforts to modernise and increase yields in agriculture, figures indicate that in recent years, 40% of the maize that is consumed in Mexico is imported (Juarez and Harrison, 2019). Yet, rainfed maize fields account for 60% of the agricultural land in Mexico and at least 50% of these lands are in the hands of indigenous populations (Murray-Tortarolo et al., 2018) who cultivate maize as part of their culture, identity, biculturality and enacting their right for self-determination.

The productivity paradigm promoted constantly through different interventions in Mexico has aimed to increase the yields, because, according to policy makers and researchers, most of the farmers in Mexico only use 50% of their yield potential (Turrent Fernández et al., 2014). Thus, the goal of several interventions has been converting the 'non-productive' maize-based agriculture into a 'productive' one by using improved maize varieties and other 'modern technologies' such as fertilisers, irrigation, etcetera. Usually those farmers with the capacity to increase their potential are referred to as transitional farmers (SAGARPA, 2012). This productivity-oriented approach has been key in the agricultural policies implemented in Mexico, benefiting a few farmers and excluding a great majority of small farmers in the country (De Ita-Rubio, 2003), which is referred to as the bimodal agricultural policy separating those who are market-oriented from not those who are not with assistance and subsidies going to those with market potential. Fox and Haigh (2010) indicate that this bimodal policy has produced systematic inequity.

2.3.2. Types of maize in Mexico

In the literature, two main types of maize are recognised in Mexico: white and yellow maize. These two types of maize have been mainly defined from the perspective of agricultural policy and research where white maize is linked to human consumption while yellow maize is linked to industry. Within white maize, authors include native maize varieties (Eakin et al., 2014; Turrent Fernández et al., 2012). In recent years, the term 'special maize' has also emerged (López-Torres et al., 2017) to refer to some maize native varieties that are in demand for specialised markets (Donnet, 2015; Hellin et al., 2013) e.g., popcorn, pozole. According to Hellin et al. (2013) the special maize can sell for up to twice the price of 'white maize' in the market and recently, this added value has been linked to identity, culture and traditional farming of indigenous peoples in Mexico. In this paper when we refer to white maize, we refer to all white maize varieties whether they are improved or not, as well as native seeds. When we refer to native maize, however, we are referring to all native maize including the 'special maize' unless expressed otherwise.

White maize represents 87% of the maize produced in Mexico (SAGARPA, 2017). Linking this to the bimodal policy mentioned before, agricultural policy has benefited

mostly commercial agriculture and has targeted transitional farmers with the potential to be converted into a productivity rationale (Brush et al., 1988; De Ita-Rubio, 2003; Gates, 1988). In several interviews with policy makers, they express that since Mexico imports approximately 70% of yellow maize and is nearly self-sufficient in white maize (SAGARPA, 2017), the ideal conversion of farmers should be from white to yellow maize cultivation. However, farmers still prefer cropping white maize as they feel they have a secure market if the industry does not take their maize. Since the bimodal agricultural policies have promoted improved maize varieties, they have also excluded the mainly indigenous farmers who crop maize under a logic other than the productivity paradigm. Instead, from the lens of agricultural policies, those 'non-productive' farmers have been approached through social development programmes (Aguilar et al., 2003). Thus, when MasAgro Programme emerged, it also followed the same logic oriented towards productivity and initially neglected the native maize farmers and their rationale. In 2019, MasAgro Programme has also incorporated native maize farmers and in the following sections I will explain what mechanisms drove this change and its implications.

2.4. The making of MasAgro Programme

In figure 2.2, we present a timeline of critical events that have affected and shaped the making of MasAgro Programme. In the coming sections we will elaborate on it as follows: a. Emergence of MasAgro Programme; b. Building the MasAgro Programme house; c. Keeping the MasAgro Programme house; d. Preparing to conquer new territories; and e. Conquering new territories. The labels we have chosen emerged from reflection workshops and interviews with MasAgro Programme implementers and reflect how interveners looked at their own work and its scaling.

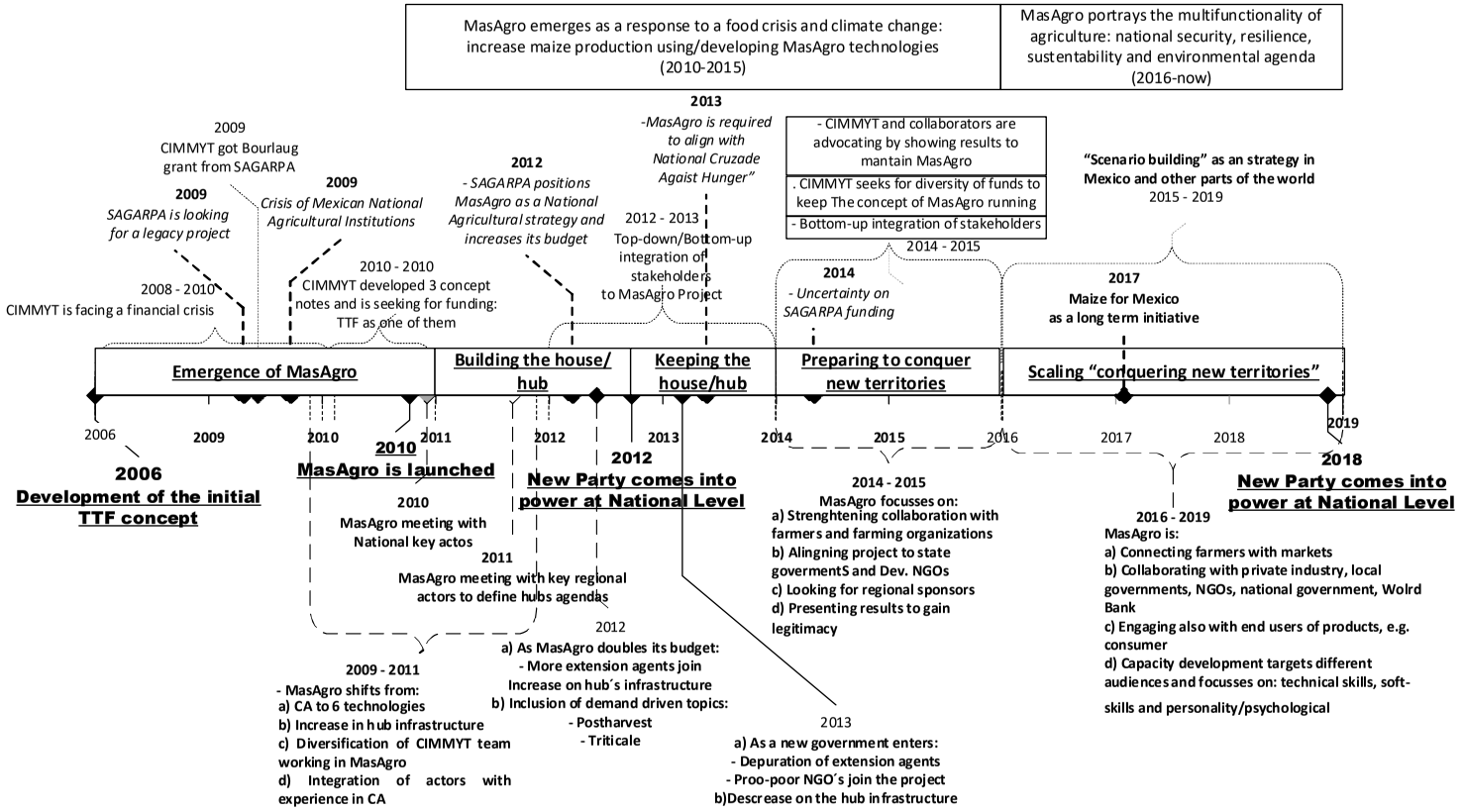

Figure 2.2. Timeline of critical events of MasAgro Programme from 2010 to 2018

2.4.1. The emergence of MasAgro Programme (Before 2010)

Two factors were crucial for the emergence of MasAgro Programme: the long-standing relationship between CIMMYT and the SAGARPA, and the collaboration between CIMMYT and Mexican institutions in wheat and maize research.

In 1907, Mexico officially created the first agricultural research institutions led by the ministry of agriculture. After World War II, wheat research was considered globally to be crucial in providing sufficient food to combat hunger. Mexico had the ideal climatic conditions for wheat research because it allowed for two cropping seasons in a single year. In 1943 the OSS emerged as a joint collaboration of the Mexican Government and the Rockefeller Foundation to run a pilot programme to support wheat research (Garcia Garcia et al., 2006). The OSS had national and international researchers. In 1966 the OSS pilot programme came to an end but the Mexican government proposed the creation of the CIMMYT to focus on maize and wheat at the international level (Deschamps-Solorzano, 2016) and a national research system called National Institute for Agricultural Research (INIA for its acronym in Spanish and which later turned into the National Institute for Forestry, Agriculture and Livestock Research or INIFAP). From that day onwards, the Mexican government committed itself to contribute $50,000 USD annually to CIMMYT (Implementer C1-2017).

As time passed, CIMMYT and INIFAP collaborated mainly on wheat research with some maize research on the side. However, in 2001 the discovery of GMO maize in Mexico (Quist and Chapela, 2001) endangered this collaboration because this discovery led to suspicion that CIMMYT was involved in bringing GMO maize to Mexico and a series of claims and discussions around GMOs and the perceived dangers they posed (Hodgson, 2002). Because maize plays a key role not only in food security but also in identity and culture of the Mexican population, the discovery of GMOs and the suspected connection with CIMMYT motivated SAGARPA to end its relationship with CIMMYT and suspend the $50,000.00 USD yearly economic contribution agreement.

In late 2009 CIMMYT and SAGARPA were facing challenges that necessitated the rebirth of their collaboration and led to the emergence of MasAgro Programme. CIMMYT had been facing a financial crisis in the 2000s (similar to financial crises in other contexts of international research in the 90s and 2000s (see Anderson, 1998 and Gagnon-Lebrun, 2004). The ceremony paying homage to the legacy of Norman Borlaug, the father of the GR who passed away in 2009, was a key moment in rebuilding the relationship between CIMMYT and SAGARPA. The recently appointed CIMMYT director invited the Mexican minister of agriculture to attend a ceremony in honour of Borlaug at the Norman Borlaug Institute in the U.S. After this ceremony, the SAGARPA officers learned about the agreement with CIMMYT (the economic support the Mexican support was supposed to provide at the emergence of CIMMYT) and gave CIMMYT a 2-year grant of $2,000,000 USD to show a commitment to restart the institutional relationship. Additionally, from the perspective of SAGARPA, Mexico had encountered several episodes that highlighted the risks of a maize crisis and necessitated research into maize. First, in the 2000s, Mexico was importing at least one

third of the maize demand from the U.S. (Turrent Fernández et al., 2012). Second, the boom of biofuels in the U.S. and different climatic shocks affecting maize production worldwide led to the 'tortilla crisis' of 2007 and subsequent rises in maize prices (Ogle, 2009; Thomaz and Carvalho, 2011). Third, within Mexico the local maize production was affected by the severest drought in 60 years and the year after by unusually high rainfall (Caballero, 2012; Seager et al., 2009; Tirado and Cotter, 2010). These factors together set the focus on maize production as a problem of food security linked to climate change in Mexico.

Some CIMMYT researchers took advantage of the window of opportunity offered by the recently restarted collaboration and presented three concept notes[4] in 2010 addressing food security and climate change issues to SAGARPA: a. Take it to the farmer, b. Seed of discovery and c. Wheat. SAGARPA responded positively to these programme suggestions but requested that CIMMYT also develop a concept note for maize since the food security issue in Mexico was linked specifically to maize. Generating such a programme was important because a common practice in Mexico at different levels is that incoming government leaders either discontinue or re-shape the projects of previous governments to be able to present a new project which would be the unique 'project legacy' for which its government would be remembered (Martinez Cruz et al., 2019). The president of Mexico in 2010 also wanted to invest in a 'legacy project' (Several interviews, 2016) and invited all the ministries to present proposals for such a project. Given the current maize crisis, the president welcomed the proposals from CIMMYT and SAGARPA which together emerged as the MasAgro Programme. The programme was portrayed as a legacy not only for Mexico but also for the world. MasAgro Programme would be a second Green Revolution in terms of impact but would be more inclusive and greener (Implementer C1, 2016 and 2019). Knowing the dynamics of the political context in Mexico (continuities and discontinuities, see Martinez Cruz et al., 2019) and that projects need some time to yield outcomes, the agreement was that MasAgro Programme would run from 2010 to 2020 to have sufficient time to achieve its initial objective of increasing productivity by 8-40% for small famers and reach 1.3 million families (CIMMYT, 2010).

One of the key features of MasAgro Programme, which was also the most attractive one for SAGARPA, was the broad agreement on capacity building (Several interviews, 2016). SAGARPA leaders agreed that historically, agricultural policy had reinforced a culture of paternalism which had not led to positive outcomes in several interventions in Mexico. For example, when technologies are promoted through financial incentives rather than developing capacities of farmers on the usefulness and function of these technologies, farmers tend to revert to their old farming practices once the incentives are gone, undermining the long-term benefits of such technologies (den Broeck et al., 2013). Thus, ensuring investment in capacity building seemed promising for SAGARPA as the knowledge

[4] Interviews revealed that these concept notes were drafted in a general way because CIMMYT was looking for funding and was presented to a broad range of actors that might be interested in financing any of them.

and learning would remain with the farmers and help them in their production process (N-Officer 1, 2016).

In the early years after launching MasAgro Programme, there were tensions among some INIFAP researchers and SAGARPA because of the budget reduction that INIFAP had undergone in the last years. Since 1995, the Mexican government had reduced INIFAP's budgets and redesigned the national agricultural research from a supply-driven to a demand-driven system; meaning that rather than researchers identifying the research agenda with government funds, farmers had to set the research agenda in collaboration with researchers and also had to fund INIFAP's research (Ekboir et al., 2006). With the economic crisis of 2009, the agricultural sector in Mexico struggled (Basurto and Escalante, 2009), affecting the Mexican research institutions. Thus, in 2010, Mexican researchers criticised the Mexican government for funding a project proposed by CIMMYT, an international institution, and refusing to fund Mexican institutions. Policy makers, SAGARPA government officers and a few INIFAP researchers justified the decision to support MasAgro Programme through CIMMYT. CIMMYT was perceived as a neutral broker with a good reputation for delivering on their research goals as well as making good use of the resources provided and having a solid research base; and therefore, capable of bringing different actors together, and increasing transparency and accountability. Furthermore, since the government was pursuing a global legacy project, this was easier to achieve using the name of an international organisation than a national one.

2.4.2. Building the MasAgro Programme house (2010-2012)

2.4.2.1. Objectives

MasAgro Programme started on October 15th, 2010 with a government-agreed budget of 138 million USD for a 10-year period (for the fours components). Prior to the launching of MasAgro Programme, researchers from national research institutions and universities, and government officials from SAGARPA and CIMMYT reunited to contribute to the design of the project and to connect CIMMYT to other national institutions. As explained in the introductory section, MasAgro Programme emerged with four components and we focussed on the "Take it to the farmer" (TTF) component which later turned into "MasAgro Producer".

The objectives of MasAgro Programme at this stage were as follows:

> "The Initiative is targeted towards poor maize and wheat farmers, smallholders with low productivity. It is a long-term initiative focusing on major structural and environmental problems such as soil erosion, water scarcity, low input (phosphorus) use, and climate change. It aims to increase the food supply to satisfy the needs of the growing population (maize and wheat self-sufficiency). It also aims to have

> major impacts on livelihoods and employment, as well as on keeping people, especially the poorest farmers, in their rural communities.
>
> The Initiative will establish a technology innovation platform to share with the international community knowledge of biodiversity as a universal public good, before private interests monopolize its genetic components" (CIMMYT, 2010).

MasAgro Programme aimed to integrate different actors along the value chain, and the farmer was portrayed at the centre of the process evaluating and adapting the proposed technologies. In the early days of the project, the main focus was on adapting and adopting technologies for different regions of Mexico enclosed in the so-called hubs and reaching the 'transitional farmers' who were producing at 50% of their capacity and had the potential to increase their yields by using modern technologies. In the words of the hub managers (Ramirez-Lopez et al., 2017), their initial task was to 'build the MasAgro Programme house'. As part of building the house, the hub managers needed to build the physical infrastructure and the network of actors and collaborators.

2.4.2.2. The strategy to build the house

According to Camacho-Villa et al. (2016) '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 operationalised the hub concept and established CA testing plots in farmers' fields (named modules) and experimental plots (named experimental platforms). Thus, the hub served as a physical infrastructure composed of experimental platforms, modules, extension and impact areas; a network of actors linked to the infrastructure and key processes in the hub (Figure 2.3).

Building the house was partially about the making of a physical infrastructure. In 2010, the MasAgro Programme leaders focussed on linking the new project to the existing CIMMYT conservation agriculture (CA) research in Mexico so that they would not have to start from zero. The MasAgro Programme leaders undertook the research that CIMMYT had ongoing in the headquarters based in the central valley of Mexico (Texcoco) and the experimental station in Ciudad Obregón, Sonora, giving birth to three of the early hubs: Hub Valles Altos Maize (High lands Maize, VA-Maíz), Valles Altos Grano Pequeño (High Lands Small Grain, VA-GP) in the Texcoco area, and Hub Pacific (Hub Pacific, PAC) in Sonora. In the beginning of the project, the model of technology transfer was supply driven (Camacho-Villa et al., 2016). While CIMMYT provided a menu of technologies they were familiar with, e.g. post-harvest, improved maize varieties adapted to local conditions, use of sensors for nitrogen, diagnostic tools for phosphorus and potassium; and crop diversification (ibid.), they focussed on promoting the CA technology that they were most familiar with. CIMMYT had a long history of CA-related research in Mexico and they could more easily explain

how it could contribute to food security by increasing (specifically) maize yields and help mitigating the effects of climate change (Martinez Cruz et al., 2019) compared to the other non-CA technologies that CIMMYT had not explored as deeply. CIMMYT also looked for collaborations in other regions and restarted previous collaborations in the Bajío region (hub BAJ) as portrayed in Chapter 3 and Chiapas (Hub CHIA) using CA-related technologies. This led to the consolidation of five hubs in 2012: VA-Maíz, VA-GP, PAC, BAJ and CHIA; and the promise of three more hubs to come.

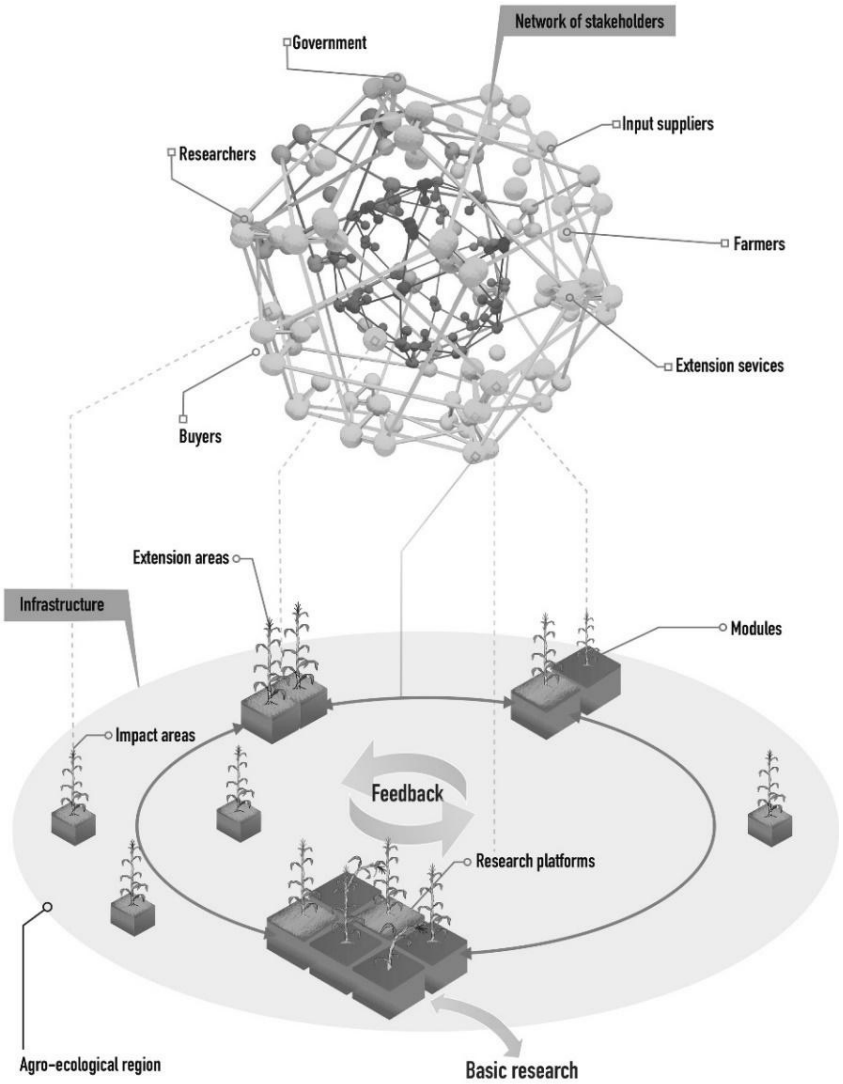

Figure 2.3. The structure of a MasAgro Programme hub (Gardeazabal-Monsalue, 2019)

From 2010-2012 the hub managers also focussed on extending the infrastructure by engaging with local actors, promoting the potentially positive effects of CA and aligning with other existing programmes at national level. At this stage, some of the hub managers were more concerned with the quantity rather the quality of infrastructure and collaborations, which later became an issue and their later collaborations focussed also on the quality of the collaborations that they developed.

One of the key elements through the project was capacity building at different scales, with farmers and technicians being the main target groups. To do so, MasAgro Programme opened calls to train certified technicians in CA and also organised training event with farmers in the different hubs. Aiming to have a bigger scope, MasAgro Programme brought on board several of the technicians working with SAGARPA in other programs such as PROMAF (Production Chain of Mexico´s Maize and Bean Farmers Programme). These technicians were required to train farmers and have field trials called 'modules' (see Figure 2.3) to validate MasAgro Programme technologies as part of the training.

Additionally, aiming to monitor the performance of the technologies and the potential outcomes of MasAgro Programme, a first socioeconomic study was performed in the region of VA (VA-Maiz and VA-GP) in 2012, with general reports of the numbers of drivers of adoption of CA and general data linked to yields, production costs and characterising the farmers and their field.

2.4.2.3. Successful stories to build the house

One key element that attracted several collaborators and that is present throughout the evolution of the programme, are the awards and recognition MasAgro Programme received for their work from other national and international institutions. For example, in 2012, MasAgro Programme was recognised by the Vice Ministers of Agriculture in the G20 summit as a model that could serve as reference for other low income countries to coordinate research and development, innovation, technology transfer and public-alliances to increase crop yields.

2.4.3. Keeping the MasAgro Programme house (2013-2014)

2.4.3.1. The objectives and the context

While in the early years of MasAgro Programme the narrative to justify its emergence had been around maize production as a symbol of food security and increasing resilience due to climate change, in 2013 the rise of the environmental agenda and social inclusion reshaped these narratives which is captured with the paradigm of Sustainable Intensification (SI) that has come to be dominant in the world of agricultural development (Pretty and Bharucha, 2014). SI also promoted increased crop yields and productivity, but with a focus on maintaining environmental sustainability while doing so. The SI paradigm was more abstract, as it did not come with clear targets, but at this stage, it was needed since internals contestations at

CIMMYT pointed out that the increases in yields targeted in the initial programme might not be reachable. The adoption of SI narrative was one of the major reframings within MasAgro Programme. Another reason to keep the objectives in an abstract way was the need to keep them flexible as a new government had come into power by 2012. Although the programme was planned for a 10-year period, its continuity was at risk because, as showed by Martinez-Cruz et al. (2019), changes in power often lead to the discontinuation of previous projects and efforts since new governments pursue legitimisation through adopting new projects. In this case, MasAgro Programme was a legacy project linked to the previous government and another party in power. At this stage, by 2013, ten hubs were already running.

2.4.3.2. The strategy to keep the house

MasAgro Programme, in its efforts to succeed and find continuity, played and readjusted to the requirements of the new government. Therefore, MasAgro Programme moved from a technology supply-driven approach, where CA was postulated to be a 'one size fits all' solution, to a demand-driven one. The demand-driven approach was also partially set by local collaborators in the different hubs who also were looking forward to finding continuation to their own strategies, e.g. post-harvest, pest-management, Milpa Intercropped with Fruit Trees (in Spanish MIAF) systems, among others (Camacho-Villa et al. 2016). One of these strategic adjustments was aligning with the 'National Crusade Against Hunger' in 2013 and the expanding of target groups to include subsistence and indigenous farmers cultivating native maize. Initially these farmers were not an explicit target of MasAgro Programme because they did not fit into the 'transitional category'. However, in regions like hub CHIA some collaborators were already working with subsistence and indigenous farmers. This meant that some other strategies such as the MIAF in Oaxaca and Chiapas promoted by previous projects and organisations came to be part of MasAgro Programme. In the same way other strategies linked to native maize farmers such as the collaboration exemplified in Chapter 4 came to be crucial. Thus, MasAgro Programme adapted to the needs of the new government by converging different agendas, interests and actors to find continuity. Hub managers recognised that they had to move beyond the productivity paradigm and adopt different goals and agendas, e.g. improving the well-being of farmers and also looking at family-based units in some cases. MasAgro Programme broadened its narrative and target groups to also turn the subsistence farmers into producers, e.g. producing special maize. Since then, several market niches have been explored nationally and internationally arguing that 'producers' of native maize can gain more by selling to external markets that can pay a better price for their maize by making use of the concept of 'identity, culture, and tradition'.

Another component that changed with the new government was the extension service linked to MasAgro Programme. With the changes in government, the PROMAF programme was discontinued, and with it also all of MasAgro's collaborations with PROMAF-paid technicians and farmers. Hub managers mentioned that they ended collaborations with partners whose goals were inconsistent with those of MasAgro Programme and kept

a few ones that they considered crucial. This is consistent with the idea of keeping quality of collaborations versus quantity, e.g. people sharing the MasAgro Programme's objective. MasAgro Programme had to align its strategies to the new National Development Plan (PND) and this led to the renaming of its components, including TTF turning into MasAgro Producer. The government also decided to create a separate subsidy programme linked to MasAgro Programme beneficiaries and exclusively operated by SAGARPA called "MasAgro Productivo". This shows, as documented by Martinez-Cruz et al. (2019), how rebranding can serve to give continuity to some processes, in this case to MasAgro Programme, and link it to a new leader and government that wants to demonstrate their legitimacy. The creation of MasAgro Productivo exclusively operated by SAGARPA caused chaos especially for farmers who had been collaborating with MasAgro Programme for years. In theory, all MasAgro Programme farmers would benefit from this programme and new farmers would also be part of the programme. The reality was that, despite promises to the contrary, not all the previous MasAgro Programme farmers benefitted from the subsidies. At the same time, many new farmers that signed up for MasAgro Programme in order to access MasAgro Productivo stopped participating once they received the subsidies. When talking to early MasAgro Programme farmers, they would talk about two MasAgro Programmes and one farmer in the Bajío region expressed his feelings as follows:

> "We want the old MasAgro Programme to be back, we want the MasAgro Programme from CIMMYT, we do not want the MasAgro Programme from the SAGARPA. We like the MasAgro Programme from the CIMMYT, they are constant. The MasAgro Programme from the government is the same old thing, we already know how it will end" (Farmer 1, BAJ, 2015).

In 2016, a newly appointed leader of SAGARPA discontinued MasAgro Productivo because of the limited impact of the strategy and new agendas.

2.4.3.3. Successful stories to keep the house

Another strategy that MasAgro Programme used to find continuity with the incoming government was to share the impacts of the programme with a broader audience and share the recognition and awards gotten. These vary from the celebration of technicians' graduations to inviting donors or government officers to learn about the role of CIMMYT and MasAgro Programme in contributing to global challenges such as food security and climate change, e.g. the visits of Carlos Slim and Bill and Melinda Gates in 2013. Other examples are the recognition given by donors such as Bill Gates expressing in his blog that MasAgro Biodiversity was one of the most innovative projects in genetics research. Social media and communication strategies appeared to be crucial elements to share successes. Throughout the implementation of MasAgro Programme, hub managers have continuously indicated that showing results is a good way to engage more collaborators. One of the hub managers

calls this *"the technique of the puppy, you first engage the child and then you engage the parents"* meaning that you first attract as many actors or farmers as possible and then you move up to higher levels such as governments or organisations that are willing to invest and collaborate with the project.

2.4.4. Preparing the territory (2014-2016)

2.4.4.1. Objectives

The objectives of MasAgro Programme continued moving away from the explicit figures provided in 2010 in the original project, at least in the way the programme was presented. The emphasis continued to be on higher and stable crop yields but now also included promoting resource conservation. This also led to the inclusion of key NGOs (Non-Profit Organisations) such the Nature Conservancy, Fundación Haciendas del Mundo Maya in Yucatan for native maize projects, among others that looked beyond the productivity paradigm and focussed also on biodiversity, sustainability and social inclusion. Also, a higher emphasis was placed on increasing the connections and collaboration among several stakeholders in the small grains (e.g. wheat, barley and sorghum) and maize value chains. Supporting the maize seed sector became crucial and the adoption of specific native maize participatory plant breeding strategies was explicit. The focus nevertheless broadly remained on increasing crop yield by using modern technologies. By 2015, 12 hubs were fully operating, and 246,482 impact areas were reported for the Fall-Winter season and 970,419 has in Spring-Summer (SAGARPA, 2018).

2.4.4.2. Strategy in preparation to conquer other territories

The government transitions, in the words of the hub managers, can be seen as both challenges and opportunities. The experience with the transition in 2012 taught the MasAgro Programme leader and hub managers to diversify their options or in their own words *"to not place all the eggs in one single basket"* and several attempts to find local donors started. From 2014-2016, hub managers and leaders explored different financial options. One of the most successful ones was the experience of MasAgro Guanajuato. MasAgro Guanajuato is part of the hub Bajío but has a history with CIMMYT that dates back to the 2000s and experiences with the Direct Seeding technology (See Chapter 3). A new local ministry of agriculture came into power in 2012 in Guanajuato and that led to the local government investing in the local MasAgro Guanajuato programme. Other MasAgro Programme leaders explored and partially succeeded in replicating the Guanajuato experience for some time in regions like Queretaro, Zacatecas and Guerrero. In other cases, such as in Sinaloa, farming organisations have played a key role in supporting MasAgro Programme. In yet others, private industry came to be a key collaborator by appealing to the sense of social responsibility with the emergence of the environmental agenda worldwide. For example, Heineken collaborates with MasAgro Programme using the rationale that for every single dollar invested, they are

not only contributing to improving the lives of farmers but also to reducing water use and environmental impacts.

A crucial part of the process, besides expansion of the portfolio of technologies adapted to local contexts and the shift to a technology demand-driven process (Camacho-Villa et al., 2016), was to increase the traceability and accountability of the strategy through the use of an Electronic Field Book (BEM). The BEM is fed by different collaborators of MasAgro Programme such as some farmers, technicians, researchers and collaborators who would register data on their fields, trials, and training events, among others. The information gathered would help to set metrics and variables that could be translated into indicators, e.g. potential yields, a situation that leads to specific outcomes, number of farmers using postharvest, average age of farmers in a region, types of soils, etc. The BEM is part of a bigger information and communication technology for the agriculture unit (ICT4Ag) and links to MasAgro Mobile (MMV) as presented in Chapter 5. The assumption behind creating the BEM, MVV and ICT4Ag was that having more information about the agricultural context can help people make better decisions, e.g. a specific set of practices that lead to a great yield increase or loss and sharing information on the potential of a region or qualities of the farmers/clients in a region. The ICT4Ag unit aims to serve the needs of farmers, technicians, decision makers, governments, researchers, private industry, NGOs and any other interested actors.

2.4.4.3. Successful stories in preparation to conquer new territories

Hub managers argued that one of their bottlenecks in finding alternative sources of funding was how to show the impact of their programs because donors and investors want numbers, such as how much impact their money can yield and what the future projections with their investment are. Hub managers indicate the "puppy strategy" of showing their field trials, results, and successful cases on an individual basis was effective, but not in the long term, necessitating alternative ways of promoting the impact of MasAgro Programme. Thus, analysing the data of the effectiveness of MasAgro Programme became crucial and some studies within CIMMYT have started to evaluate the results of the interventions. Hub managers and some CIMMYT researchers agree that measuring impact is a complex topic. First, many of the impacts are hard to measure, such as the impacts on diets or the feelings linked to preserving native seeds as part of culture and identity. Second, drawing the line on what can be attributed to MasAgro Programme rather than previous projects or interventions is complex given that several of the collaborators were already working on their interventions and then joined MasAgro Programme as an ideal platform for them to keep on funding their strategies, e.g. the MIAF systems, Participatory Plant Breeding strategies linked to maize in Oaxaca, post-harvest techniques, among others. At this stage, the results from the BEM are used to show the impacts of the MasAgro Programme strategy and attract more donors by presenting data on the successes of the methodology while recognizing this is the result of an innovation network and therefore attribution is complex.

Additionally, the use of social media and sharing successful stories continued to be an effective means of attracting collaborators. For example, in 2014, the leader of MasAgro Programme was awarded the Norman Borlaug Award for Field Research and Application — endowed by the Rockefeller Foundation and awarded by the World Food Prize. He used this award to promote MasAgro Programme and attract more collaborators and donors. In 2014, the Interamerican Development Bank also recognised MasAgro mobile as one of the most promising tools that can take knowledge and extension services to farmers.

2.4.5. Conquering other territories (2016-present)

2.4.5.1. Objective

In 2016 MasAgro Programme's focus was on conquering other territories, i.e. escalating horizontally and vertically. Having learned how to deal with uncertainty surrounding funding and how to position MasAgro Programme to attract more donors and collaborators, the leaders used BEM as a key component because it allowed the use of data to create successful stories and scenarios to attract more donors and collaborators.

The narrative of the MasAgro Programme in 2018 now portrays an agenda of environmentalism and social responsibility; in which we all have to play a role. In the words of the MasAgro Programme leader, in 2010 MasAgro Programme was a response to a food crisis but in 2018 the focus is different:

> "Now, there is a need to increase awareness in the society, with the civil society, the communities, and other actors on why it is important to take a position and take care of natural resources. We will use the same methods but for a different purpose, to reduce risks, to increase resilience, to play with future scenarios. Let us dream and think where we want to be and what we need to get there" (Leader C2, 2018).

MasAgro Programme's leader argues that now agriculture has a multifunctional role and needs to move beyond food security because the problems have changed. The MasAgro Programme leader uses the narrative of the multifunctionality of agriculture to fit several contexts and different social problems. The strategy to conquer other territories.

2.4.5.2. Strategy to conquer other territories

Using the concept of agriculture as a multifunctional activity, the MasAgro programme leader also portrays maize cultivation as an activity that can fulfil several roles. Thus, for the incoming government, he presented a new initiative that is called "Maize for Mexico" which focuses on scenario building of how Mexico should look like in terms of maize production by appealing to the concepts of national security and self-sufficiency which align with the current government vision of "sovereignty, autonomy and independence". The MasAgro

Programme leader has taken this idea to other regions of Latin America and the expectation is that other collaborations will arise.

As a strategy to find continuity, MasAgro Programme continues engaging with other strategies. For example, a new collaboration with the Support Programme for Small Maize and Beans Producers (PIMAF) yielded a collaboration with 35,000 farmers. This strategy of collaboration with several programmes and actors from the beginning, in the words of the hub managers, allowed MasAgro Programme to expand their hubs and their technologies, and to replicate the model of MasAgro Programme.

2.4.5.3. Successful stories to conquer new territories

In discussions with MasAgro Programme implementers, a debate repeatedly arises as to who needs whom in the MasAgro Programme system. Do farmers need MasAgro Programme? Do collaborators need MasAgro Programme? Do MasAgro Programme and CIMMYT need the farmers and collaborators? It appears that they all need each other, and all come together to be part of MasAgro Programme pursuing their individual agendas and at the same time working on a common one. In our perspective, MasAgro Programme collaborators have come together to advocate for each other, pursuing their personal agendas but also pursuing a common one. For example, an indigenous Mixe woman from Oaxaca who collaborates with MasAgro Programme has participated in several events portraying to donors her positive experiences cultivating her native maize using the MIAF systems in marginalised mountain communities. She has become the spokesperson of the minorities at MasAgro Programme events, and other actors have also played a similar role. She advocates for herself and her farming group but also for other realities. At the same time, she advocates for MasAgro Programme and CIMMYT. CIMMYT on the other hand portrays her as a success story that can be replicated in other regions and in this way researchers and actors can also find continuity in their agendas.

The MasAgro Programme leader and MasAgro Programme have gotten a long list of awards and referrals from well-known institutions that present the MasAgro model and its technologies as key to address global problems in the developing world. Some of the institutions recognising the potential of MasAgro as a model are the G20 (Group of Twenty), IUCN (International Union for Conservation of Nature), UNDP (United Nations Development Programme), OECD (Organisation for Economic Co-operation and Development), the World Economic Forum, Cornell University, and others. These awards legitimise what MasAgro Programme has accomplished and enables the expansion of the MasAgro Programme model to other regions.

2.4.6. The future of MasAgro Programme

Two years are left for MasAgro Programme and it is unclear what might happen after. Hub managers indicate that they expect that farmers and technicians will graduate and run their process independently and that the MasAgro Programme hub will become an incubator

where different actors still can meet but that can sustain itself without the need of main donors such as the government programs, which will enable the MasAgro Programme goals to be pursued even once government funding ends.

At the same time, whether or not MasAgro Programme achieves its objectives remains unclear. First, measuring impact is still debated given that many of the technologies and interventions were not new in the MasAgro Programme implementation areas. "MasAgro is only from yesterday, we had been making Conservation Agriculture for many years" (Chapter 3) resembles the long history of many of those technologies and linked interventions. Many of the collaborations of MasAgro Programme were before part of other interventions that learned to find continuity in a dynamic political context.

2.5. Discussion

Through studying the history and evolution of MasAgro Programme, we can elaborate on several factors that shape the making of an intervention and that at the same time influence who falls in and who falls out from the intervention at different times. This analysis will help us understand continuity and discontinuity and how a long-running technology intervention programme is made.

2.5.1. Agenda setting and the role of donors and collaborators

Through different elements in the historical reconstruction of MasAgro Programme, we identified how agendas and priorities were negotiated. Although we, as researchers, claim a neutrality in our work, similarly to how several authors have shown (Andersson and Sumberg, 2017; Martinez Cruz et al., 2019), our work is not isolated from politics. The CIMMYT researchers found themselves playing and engaging with dominant narratives to be able to fund their work, just as they offered different technology options to farmers and hubs, they could offer to fit the agendas of particular donors. For example, in 2010 MasAgro Programme was portrayed as a crisis response to food security and climate change and proposed CA as a central technology to face those challenges. With that goal, the target farmers were those with the potential to convert and increase their maize production and subsistence or native maize farmers were excluded. However, as a new party came into power with new goals and more collaborations added to the project, the target areas broadened and ended up also including indigenous farmers cultivating native maize and not only looking at increasing productivity but also other values such as the social inclusion of marginalised groups. In the case of the inclusion of private companies, MasAgro Programme also had to adapt to the particular demands of donors to fit the narratives that those donors were interested in. For example, Heineken used the positive social image of MasAgro to present itself as socially responsible by highlighting how each peso they invest in MasAgro Programme can save water, reduce environmental impact, increase production and improve the well-being of families.

We also see how MasAgro Programme came to negotiate with a wide range of collaborators. MasAgro Programme became like a magic box that readjusted and adapted to the needs of each specific context. This allowed the people involved in the program to work with farmers both at a commercial scale and also with subsistence farmers. This is also reflected in the MasAgro Programme collaborations with the environmental NGOs in Yucatan or pro social equity NGOs in Oaxaca.

2.5.2. Interventions are based on assumptions that are constantly reviewed

Some of the contestations through the history of MasAgro Programme have been the assumptions behind the interventions and the theory of change. On the one hand, MasAgro Programme has been accused of affecting biodiversity loss by promoting productivity-oriented approaches and of not consulting local populations in the intervention areas on the ways the population wanted to be 'included' or even if they wanted to be included in the intervention. This argument has been particularly important in regions were native maize is cultivated that could be cross pollinated with other non-native maize plants. This has become a matter of human rights, as several NGOs portrayed the promotion of other technologies and improved maize as going against the right to self-determination of indigenous populations (Martinez-Mendoza et al., 2016). In raising this criticism, it is important to note that the intervention approach of MasAgro Programme is similar to that of several if not most other agricultural interventions in Mexico in the sense that the way these programmes want to improve agriculture may have led to the exclusion of particular groups. Yet, it is important that those topics are brought up because, in this way, we can work on creating more inclusive approaches and consider a social justice perspective that is usually lacking in the implementation of interventions. Through the development of this research project, some concepts were unclear and yet were used to fit a broad audience, for example, "we target small farmers". But who is a small farmer? How do you define it? Less than 5 hectares? Rainfed or irrigated agriculture? Almekinders et al. (2019) explain that those different understandings of the reality can be attributed to the partial snap-shots we, as researchers, make from reality at a given time and space. These partial snap-shots, which don't capture the broader situation, limit our methodology and therefore our understanding of the bigger picture and real contexts.

As interveners we need a departing point and this departing point, despite running exploratory research, will always be based on our assumptions and our understanding of those particular contexts. Additionally, we never intervene in a vacuum and the current and past processes will always have an effect on the outcomes of the intervention plus the uncertainty of the future. It was surprising to us that the hub managers in every workshop expressed the need to have a manual on how to operate their hubs and at the same time they recognised that the contexts were so diverse and different that there were no 'one size fits all' answers. The hub managers always had to make decisions based on their instinct and the tools they had available. We can see MasAgro Programme as one of the interventions

that has learned to deal with the uncertainty and has increased its resilience capacity over time by not 'placing all the eggs in a single basket' or 'using the puppy strategy' or playing with the changes in government. In the end, hub managers and MasAgro Programme collaborators are writing their own story as the project unfolds. MasAgro Programme has reinvented its own theory of change over the time to fit the dynamic landscape in Mexico. MasAgro programme is an example of what Long (2001) and Martinez-Cruz et al. (2019) show, it is rare for a planned intervention to lead to specific planned outcomes because those plans are based on assumptions and those are subject to change and lead to other outcomes. This does not mean that interventions should not have a theory of change, but we want to highlight the highly dynamic context in which we work as agricultural researchers and development practitioners and the uncertainties we deal with. In both development practice and academia, we talk about interventions in terms of successes or failures undervaluing the role learning and challenges that are overcome in 'making of interventions'.

2.5.3. Quick wins in agricultural research and development

CIMMYT and many other research organisations have shifted from their traditional role as research organisations and have jumped into what is called development oriented agronomy (Roo et al., 2017). MasAgro Programme is an example of such a project, and this has led to internal tensions in Mexico. In the early years of the creation of CIMMYT and the CGIAR, the idea was that those centres would create research, knowledge and technologies and partner with national research systems and local governments who had the role to 'take them to the farmer', thus clearly defining the boundaries and roles of the international and national organizations. However, with the changes in the funding schemes and the financial crisis in the 90s, we have seen more and more institutions like CIMMYT stepping into development oriented agronomy research (Anderson, 1998), and moving into the roles formerly filled by national organizations. This also means that solving global issues is not so crucial anymore and rather, we have been pushed as researchers to join the business of selling our expertise and adapting it to the needs of specific funding institutions and donors and showing them their desired impact. Mosse (2011) has shown in his ethnographic work on professionals of the World Bank how anthropologists play with their expertise aiming to find continuity in their agendas. In agricultural research we have learned to use quick wins (Roo et al., 2017), sell successful stories about our technologies and work (Sumberg et al., 2011) and contribute to reinforcing some dominant technologies, paths, narratives and discourses, as shown by Martinez-Cruz et al. (2019) with the aim of attracting donors and continuity in our work. This also was evident with CIMMYT: the hub managers frequently recognised that the productivity-oriented paradigm undertaken in MasAgro Programme was an abstraction of reality (the use of numbers and metrics) and the need to focus on other qualitative factors, but at the same time they recognised that although many of the impacts were qualitative, results usually needed to come up in quantitative terms and that

they needed metrics to show the impact of their work to persuade donors to participate. This focus on engaging donors also increases the focus on 'quick wins', which changes much of how the intervention might be done, such as by engaging the most innovative farmers, the ones willing to experiment more or take more risks who have been shown in much of the literature (Harwood, 2009; Röling, 2007) to have more resources and space to manoeuvre. Thus, if we are also looking at increasing social inclusion of minorities, we need to use different strategies that might not be able to yield results in the terms requested by the donors. Without a movement away from the 'quick wins' paradigm of attracting donors, many of most needy but least innovative targets of the interventions will be systematically excluded.

2.5.4. Learning as an outcome of the interventions

Throughout the history of MasAgro Programme we collected many lessons that emerged in the process of MasAgro Programme, however, learning is usually undermined and underestimated in the making of interventions as shown in Chapter 5. We have noted that MasAgro Programme and the collaborators learned to play with narratives, discourses, different actors, diversify approaches, and collaborators. Furthermore, much as MasAgro Programme did, other actors also learned how to play to achieve their goals. For example, the farmers of Indaparapeo that indicated "MasAgro Programme is only from yesterday" learned to manoeuvre through different interventions, leading institutions, narratives, discourses, donors, among others to maintain the support they wanted to improve their situations. Another example is the indigenous female farmer from Oaxaca. She participated in several events of MasAgro Programme representing the minorities and diversity included in the project, e.g. indigenous person, woman, low educational level, living in the mountains that are considered areas of low agricultural potential, and cropping native maize. She learned to use her multiple identities to convey a message but at the same time to get included in several interventions since for her, the milpa cultivation and MIAF system is not something new but by adapting to MasAgro Programme she was able to continue several of her processes.

In the end, learning in interventions is undervalued. Many interventions end as soon as they yield negative results, but MasAgro Programme has been resilient and several of its collaborators with them as well. In doing research and applied development work in Mexico, many actors came together and learned to play the rules of the game to find continuity to their agendas and which can be summarised as the "hope-generating bureaucratic machine" (Nuijten 1998). However, in this case, the winners and losers change over time and some of them have learned to sneak themselves into the new projects, increasing their resilience. In this hope-generating bureaucratic machine, it is not only the government setting the rules of the game but others also. With this we do not want to imply that there are not 'losers' of this process and rather highlight the strategies of 'continuation of our involved actors' and the social life of MasAgro Programme.

2.6. Conclusions

The making of an intervention is a complex process. Setting up the intervention and defining its goals is only the beginning of a process of change, learning, and adaptation, as many actors and factors play a role in the making of an intervention. Interventions as such are shaped by several factors, driven by donors' agendas, research interests, actors that come and can link to the interventions because there are windows of opportunities to get their own agendas whether the time span is short or long. We have shown the social life of a project and how different factors have shaped it, and how priorities, target groups and collaborators have changed over time. We also have seen that the unfolding of this messy process has led to learning, e.g. MasAgro Programme collaborators learned to recreate strategies to continue their process adapting a new narrative, adopting a new technology, etcetera. With this we want to argue that the making of development-oriented agronomic research is not a neutral activity and that we all have to play the game, orchestrate and team up with other actors. In fact, particularly in agronomic research, several of us find ourselves pulled into development and playing this game and moving beyond 'just research' and playing more in the arena of development practice. We are not independent entities and we all shape each other, one day we are part of an intervention in a given way and the other, we might not be part of it anymore. Yet, we can find ways of collaborating if we find the right ways and learn to play the rules of the game and dance to the rhythm that our collaborators want us to dance. And when we play these games, we can adapt our way into continuity of the bigger programs and the many smaller agendas contained within.

Chapter 3

Collaborative research on Conservation Agriculture in Bajío, Mexico: Continuities and discontinuities of partnerships

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Farmers in Indaparapeo, Michoacán in October 2014 (Source: Jose Luis Razo, CIMMYT, 2014).

Abstract

Agricultural technologies are debated and contested. Studying the socio-political life of agricultural research can help us to understand why some particular technologies or pathways are favoured (and others not) and eventually why expectations are maintained or not. We studied the 30-year trajectory of practices of Conservation Agriculture (CA) in the central region of Mexico. The results of our interviews and literature review show how, over the course of time, Conservation Agriculture technology has successively changed from being referred to as Conservation Tillage, Direct Seeding, Conservation Agriculture and has now, finally become integrated within Sustainable Intensification. These changes are connected with revamped narratives and the applications of the latest research and development (R&D) paradigms. They were the result of new spaces for CA projects opening up after other spaces had closed, spaces that allowed the researchers, politicians, technicians and farmers to continue to engage in CA in a reconfigured way that fit the various agendas. The opening and closure of spaces for CA projects were the result of researchers being subject to, and taking advantage of, political changes and of politicians seeking new initiatives to support their agendas. This shows how research and politics are mutually dependent and how they generate a discontinuity of project interventions which, paradoxically, represent a continuity of agendas and research processes. As CA is both a complex and flexible technology, it has been possible to make it fit to accommodate the changing agendas of different actors.

3.1. Introduction

Much agricultural scientific knowledge is brought to farmers through projects that promote agricultural technologies (Byerlee et al., 2009; Johnston and Mellor, 1961; Thompson and Scoones, 2009). These projects and technologies are usually intended to increase agricultural productivity and improve farmers' livelihoods (Benton, 2016; World Bank, 2008). When their potential is being assessed variables such as the potential yield increase, cost-benefit ratio, access to inputs and the knowledge that farmers need to adopt the technology are generally taken into consideration. However, these interventions often have mixed outcomes, some of which are not foreseen. Moreover, the impacts of technology-driven interventions continue to be subject to claims and counter-claims about their benefits and drawbacks, more recently in the case of Conservation Agriculture (CA) (e.g. Andersson and Giller, 2012; Ramírez-López et al., 2013), the System of Rice Intensification (Glover, 2011), Climate Smart Agriculture (CSA) (Newell and Taylor, 2018), GMOs (Zerbe, 2004) and ICTs (Brown and Grant, 2010; Thompson, 2004). In the literature, three important arguments emerge from these discussions around the impact of the applications of these technologies: one size does not fit all (Gatere et al., 2013; Ramalingam, 2013); technologies alone are not sufficient to solve the 'problem' (however defined) (Douthwaite et al., 2001; Glover et al., 2016) and the importance of understanding the local contexts where interventions are implemented in order to reduce unintended negative outcomes (Ferguson, 1990; Li, 2007).

Sumberg et al. (2013) place these contested technologies in the wider and changing context of agricultural research which is increasingly shaped by the neoliberal project, the environmental agenda and the call for more participatory approaches. These influences result in increasingly contested goals, motivations, and agendas of agricultural research. This points to the inherently political nature of agricultural research and the need to understand the politics of knowledge and research. Giller et al. (2017) speak of the need to view agricultural research through a lens of 'political agronomy' that can shed light on the way agricultural research is framed, and how this influences decisions to finance and implement different projects and approaches. This can help us to understand why particular technologies or pathways are favoured (or not), and why expectations are maintained (or not).

What is generally labelled as Conservation Agriculture is a prominent example of such a contested technology. Figures indicate that at least 105 million of ha in the world use zero tillage which is considered a component of CA, claiming its positive impacts to mitigate climate change (Hobbs and Govaerts, 2010) and in increasing crop yields (Hobbs et al., 2008). Research indicates that farmers in northern Mexico can reduce the water demands by 29% and increase crop yields by 10% by using CA vs conventional tillage systems (Hobbs et al., 2008). On the other hand, some authors have shown how the adoption of CA by farmers is influenced by local socio-economic complexities (Baudron et al., 2012; Ekboir, 2003; Erenstein et al., 2012) and others have addressed the political nature of CA interventions

(Andersson and Giller, 2012). Whitfield et al. (2015) have argued that the promotion of CA technology has been more a response to changing international development agendas rather than to any empirical evidence about its benefits. Westengen et al. (2018) describe how the framing of political agendas influences the way farmers eventually practice CA in their fields. In this paper we examine these claims about CA in the context of Mexico. We have analysed different CA projects in a central region of Mexico over a time span of 30 years. We studied the way actors participating in the projects needed to find a 'fit' within a dynamic political landscape and had to do so repeatedly to achieve continuity. This search for continuity in the face of the discontinuity of projects affected not only researchers but also politicians, technicians, and farmers. In our research we take 'the social life of a research project' as the focal point in order to understand how projects are conceived, what interests drive them, and how they come to represent a blend of continuity or and discontinuity of interventions and engagement of actors.

Conservation Agriculture has known a variation of labels since 1943 to describe a technology package that gives a central place to minimal soil disturbance (Kassam et al., 2009). The FAO definition of Conservation Agriculture refers to the combination of three core elements (minimum soil disturbance, crop residues mulching and crop rotation) (FAO, 2008; Kassam et al., 2019). Other authors use the CA term to portray how it is widely used to fit different sets of practices and somehow justify it is promotion whether it fits or not the three principles (e.g. Andersson and D'Souza, 2014; Kassam et al., 2009). We use Conservation Agriculture (CA) technology as an umbrella term to cover a varying, confusing and complex set of practices around minimum soil tillage, in this case for the technology-interventions over a period of 30 years in Mexico, presented in this paper. We use the term CA as a 'boundary object' (BO) to show how different actors re-arrange themselves around a shared idea (Ewenstein and Whyte, 2009; Mollinga, 2010; Star and Griesemer, 1989) i.e. CA, while having different definitions, practices and/or interests.

Our entry point of the study is the MasAgro Programme[5] (the Sustainable Modernization of Traditional Agriculture), a joint effort of the International Maize and Wheat Improvement Centre (CIMMYT) and over 150 partners, that was funded by the Mexican Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA). It was launched in 2010 to support the use of sustainable technologies, CA among them, in maize and wheat production, (Camacho-Villa et al., 2016). From there we trace back 30 years of CA-related interventions. We distinguish three groups of projects that introduced CA, in Jalisco, Guanajuato and Michoacán respectively, which we label as phase 1, 2 and 3 of the CA technology.

[5] MasAgro has four components: 1. MasAgro Biodiversity; 2. MasAgro Farmer; 3. MasAgro Maize; and 4. MasAgro Wheat. In this paper we focus on MasAgro Farmer and therefore, when we use the word "MasAgro", we specifically refer to this project component specifically (For further information: https://www.cimmyt.org/project-profile/sustainable-modernization-of-traditional-agriculture/)

3.2. Data collection and study site

Our historical case study (Gerring, 2007) focuses on three states in the region of Bajío, in Mexico: Guanajuato, Jalisco and Michoacán (Figure 3.1). Administratively, Mexico is a federal republic composed of 32 states.

Figure 3.1. the study area: Bajío region

The data were collected between October 2014 and October 2016. Three main data sources and types of analysis were used:

(1) Content analysis of literature and policy documents on projects framed around CA technology within the Bajío region, such as project reports and evaluations, articles published in scientific journals, media notes in magazines, newspapers. and, websites. Additionally, we accessed the CIMMYT repository, the Web of Science, Scopus and Google Scholar to consult the scientific publications that resulted from these projects[6].

(2) A total of 35 semi-structured interviews with key actors to construct a time-line events of the evolution of CA technology and the key actors who participated

[6] The information gathered is stored in Mendeley reference manager and can be accessed from the authors on request.

in each of the different interventions. These interviewees included project leaders, technicians, scientists, government officers and farmers implementing CA. The initial sample of potential interviewees was identified through participation in a workshop for MasAgro Programme collaborators and farmers organised in October 2014 with the aim of historically retracing actors' experiences of CA, tracking backwards from the MasAgro Programme intervention to their initial encounter with the CA technology. This workshop yielded the names of key CA actors within the region. Additional key actors were identified through the initial interviews (using 'the snowball approach') and further consultation of the literature.

(3) Participatory observation from attending workshops, training events and field demonstrations involving farmers and technicians participating in the MasAgro Programme in Michoacán and Hub Bajío. A total of six workshops was organized between November 2014 and September 2015. Two of these were aimed at technicians, collaborators and farmers and two workshops at farmers in Indaparapeo, Michoacán (where MasAgro Programme has an experimental platform. One workshop was aimed at collaborators and the last was done with farmers from Indaparapeo who were not participating in MasAgro Programme.

3.3. A brief history of the Conservation Agriculture technology

Technologies based on 'Conservation Agriculture' were known to the Egyptians and Incas (Derpsch, n.d.) although such practices were first formally documented in the U.S. by Faulkner (1943). Since then CA technology has been tried out in, and adapted to, a wide range of contexts. In the late 1970s several research institutions working on international development such as CIRAD (the French Agricultural Research Centre for International Development) and CIMMYT were running projects based on CA in tropical conditions in developing countries, Mexico among them (FAO, 2008; Friedrich et al., 2012). In Brazil CA was promoted as a response to serious soil erosion in the 1980s (Ekboir, 2003). By the end of the 1980s successful experiences with CA in Brazil and Argentina caught the attention of agricultural researches world-wide (Derpsch, n.d.).

According to Farooq and Siddique (2015) and Kassam et al. (2019), the term Conservation Agriculture (CA) has no clear origin. It was popularised in the International Congress on Conservation Agriculture in 2001 (Kassam et al., 2009). The FAO (2019) indicates that the CA combines three major components: a) Minimum soil disturbance refers to low disturbance no-tillage and direct seeding; b) Permanent soil organic cover with at least 30% of the ground covered after sowing and c) Crop rotation with at least three different crops. The potential benefits of CA include:

- improved soil water retention and drainage, as soil porosity is increased;
- less soil erosion and water losses, as mulching reduces evaporation and increases organic matter;
- increased water and nutrient availability, as a result of the higher organic matter content of the soil;
- a reduction of labour and capital requirements, because of reduced tillage (ibid).

Among the frequently reported myths of CA are an increase in weeds and the need for more herbicides (at least initially) and for specialised machinery to sow and incorporate mulch, the competition for biomass to be used as mulch or fodder, and the delayed yield impact (Andersson and Giller, 2012). In many situations these disadvantages may outweigh the benefits listed above (ibid.).

Interest in CA experienced a revival, based on its potential for delivering a more sustainable and environmentally friendly type of agriculture. CA practices have been described with a range of labels: zero, no or minimal tillage, strip-till, direct seeding, conservation tillage, conservation agriculture, blue agriculture and direct seeding mulch-based cropping systems (Kassam et al., 2009). More recently due to CA's popularity, a new paradigm emerged from the CA concept, i.e. Sustainable Intensification (Giller et al., 2015; Kassam et al., 2015; The Montpellier Panel, 2013).

3.4. Conservation Agriculture in the Bajío region, Mexico

In Mexico, CIRAD and CIMMYT researchers started CA experiments in Veracruz in 1975 under the name of Conservation Tillage (Martínez Ruíz, 2006). CA was high on the research agenda of CIRAD and CIMMYT, and their researchers were studying CA in various parts of the world. The label, Conservation Tillage, emphasized the value of the technology in combating soil erosion and coping with conditions where water was a limiting production factor.

Since then CA has been practised and studied in Mexico in one form or another, under different labels and being promoted by a variety of actors. Towards the end of the '70s, the Mexican Trust Fund for Agriculture (FIRA), CIMMYT and the National Institute for Forestry, Agriculture and Livestock Research (INIFAP) trained technicians to take the technology from Veracruz to other regions of the country (Aquino-Mercado et al., 2008; Martínez Ruíz, 2006), including the Bajío region.

Conservation Agriculture was introduced to Bajío, the area of our study, by CIRAD-CIMMYT researchers in 1987. Bajío is one of the most fertile and productive agricultural regions in Mexico. It lies 200 km away from Mexico City (Figure 3.1). Most of the region has access to irrigation and the climate allows two cropping seasons through the year. Maize is partly commercial under irrigated regimes and a staple crop in rainfed/semi-irrigated regimes. The features of CA as practiced in farmers' fields varied from one intervention to the other and are summarized in Table 3.1.

Tabel 3.1. The characteristics of the Conservation Agriculture interventions, sites, context, and practices

Project / Technology label	Conservation Tillage (1987-1992/ 1994-1999)	Direct Seeding (2000-2009)	Conservation Agriculture /Sustainable Intensification (2005-2017)
Site of implementation	Jalisco (Ciudad Guzmán and San Gabriel)	Guanajuato (Irrigation District 011)	Michoacán (Rural Development District 092)
Cropping season and main crops	Spring-summer (S-S): maize	• Spring-summer (S-S): maize and sorghum • Fall-Winter (F-W): wheat and barley	• Spring-summer (S-S): maize and sorghum • Fall-Winter (F-W): Wheat and barley
Irrigation regime	Rain-fed (400-1000 mm/year)	• S-S: 38% irrigated at least once and the rest rain-fed • F-W: 100% rain-fed	• S-S: 85% irrigated at least once, the rest rain-fed • F-W: 100% rain-fed
Approach to take CA to the farmers	Researcher controlled experimentation (on farm research and farming systems research)	Farmer controlled (innovation systems)	Farmer controlled (innovation systems/sustainable intensification)
Crop soil coverage	At least 30%, still studies on adaptation were performed	At least 30%	At least 30%
Tillage practices	One or two tillage activities through the cropping season. No ploughing	• S-S, direct seeding, and no ploughing • F-W, one or two tillage activities as required to incorporate the crop residues	• S-S, Direct seeding and no ploughing • F-W, Direct seeding and no tillage unless beds need remaking by opening the furrows
Crop rotation	Not an explicit part of the package	Not an explicit part of the package	• Wheat-Maize or Barley-Sorghum (two cropping seasons per year). • Experimented on trial fields with legumes (Only 9% of farmers use crop rotation, where possible)
Economic benefits	Not analysed	Reduction of production costs.	Reduction of production costs.
Maize yields with traditional tillage practices	1.25[a] tons/ha	11[b] ton/ha	7.7 ton[c]/ha
Maize yields with CA practices	2.2[a] tons/ha	11[b] ton/ha	7.6 -9.9[d] ton/ha
Maize production cost using conventional tillage	$2,240[a] MNX[+]	$9,490[b] MNX[+]	$11,950[c] MNX[+]
Maize production cost using CA	$2,207[a] MNX[+]	$6,550[b] MNX[+]	$9,821[c] MNX[+]
No. Farmers involved	25[e]	Up to 67[f]	Up to 100[g]

[a] Erenstein (1999, pp. 6, 26)
[b] SERpro_SC (2007, pp. 44-55)
[c] CIMMYT (2016). BEM, data base of MasAgro Programme.
[d] Fundación Produce Michoacán A.C.(2011, pp. 73-75) and (CIMMYT, 2016). BEM, data base of MasAgro Programme.
[e] Based on oral testimonies
[f] SERpro_SC (2007, pp. 24)
[g] Fundación Produce Michoacán A.C. (2011, pp. 62) and oral testimonies, data from the first intervention in Michoacán
+ MNX=Mexican pesos

3.4.1. The first introduction: Conservation Tillage technology in Jalisco (1987-1999)

3.4.1.1. On Farm CT Research in Jalisco (1987-1992)

With the first promising on-station research results from Veracruz, Mexico, and encouraged by other research in the world, CIRAD and CIMMYT researchers aimed to adapt CA to local conditions. They identified Ciudad Guzman, Jalisco, as representative of the typical varied situation in many rain-fed areas in Mexico where Conservation Tillage (CT) could address problems with soil erosion and increase water-limited maize productivity (Erenstein, 1999). From 1987 to 1992, they carried out experiments in farmers´ fields to adapt CT to local conditions, applying the On Farm Research (OFR) approach (Hildebrand and Poey, 1985; Lockeretz, 1987), studying the effects of frequency and timing of tillage activities and amount of crop residue on maize yields.

The scientific publications from this research showed that the CT treatments gave significantly higher yields (almost double) when using one or two mechanised tillages (Erenstein, 1996; Van Nieuwkoop, 1993). Researchers considered more research was needed to study the effect of the practices on production costs.

3.4.1.2. Farming Systems CT Research (1994-1999)

In 1993-1994, INIFAP developed an interest in promoting CT in Mexico, presenting CT as a technology that could increase the competitiveness of Mexican maize farmers in the international market. This argument was well received by politicians in Jalisco who were concerned about the impact of NAFTA[7] (North American Free Trade Agreement) on farmers in their state, the signing of which (in 1994) opened up Mexican markets for maize imports. This provided favourable conditions for further CT research and resulted in a second project starting in 1994, funded by the Mexican Government and implemented by INIFAP, CIRAD and CIMMYT. One component of the project was to test CT in 25 different INIFAP research stations throughout the country. The other component was to continue the research activities in Ciudad Guzmán in Jalisco. The research was fitted to the Farming System Research (FSR) approach and included economic analysis at field level (Darnhofer et al., 2012). San Gabriel was added as a new experimental site. At this stage, competition for crop residues between livestock and mulch was noted.

The shift to the Farming System Research (FSR) approach was crucial. NAFTA marked the beginning of the era of neoliberalism in which the government took a back seat and encouraged 'free market' competition. The assumption was that if FSR were successful then farmers would take it over and begin to articulate their research needs and pay for

[7] NAFTA is the "free trade agreement between Mexico, the U.S.. and Canada. It eliminated all trade and investment barriers and secure equal treatment for foreign investors in energy, telecommunications, banking and financial services and procurement" (Ramirez, 2003). It promised 15-years of phased trade liberation for vulnerable sectors, such a maize and bean producers (Yunez-Naude and Barceinas, 2002).

technical assistance (Gates, 1996). Thus, the FSR approach also aligned well with the political agenda of the time.

With the emergence of neoliberalism, and the deregulation of the national markets and international trade, agricultural policy focussed on private sector initiatives and enhancing competitiveness. New mechanisms to fund agricultural research were established, similar to those in other countries under neo-liberal agricultural regimes (Gates, 1996). In 1996, the *Fundaciones Produce* became the central funding institutions for agricultural research in each state in Mexico (Ekboir et al., 2006). One of the outcomes of these changes was that there were less funds for the CT project and by 1997 only the research activities in Ciudad Guzman continued, at a lower level than before.

3.4.1.3. The state of Conservation Agriculture after 'phase 1'

When the last funding dried up in 1999, 25 farmers were hosting on-farm trials with a range of treatments (Table 3.1). This second project period generated 16 publications, around half of which were project reports and the rest scientific articles published after the project finished. The results showed that that the adoption of CT was constrained by several factors, of which access to specialised machinery for sowing, tillage and the incorporation of mulch was perhaps the most important. The need for expertise on management of pests, weeds and mulch were also flagged as issues. In addition, because CT only had an impact on yields after several seasons, farmers lacked the incentive to adopt CT practices. The researchers concluded that Ciudad Guzman was not a 'promising environment' as envisioned initially.

3.4.2. The second introduction: Direct seeding technology in Guanajuato (2000-2009)

3.4.2.1. The emergence of the DS project

The experiences in Jalisco had made it obvious that farmers needed access to machinery in order for a new CA project to be feasible. An initial exploratory study identified suitable sites in the states of Guanajuato and Querétaro, where the political climate was also favourable. The new president of Mexico as well as the Minister of Agriculture were both from Guanajuato[8]. While PAN (the incoming government) favoured market liberalization, it had also campaigned against the previous government's unmet promises to support maize farmers to adjust to NAFTA[9]. This led PAN politicians in Guanajuato launch the state

[8] They were from PAN (Partido de Acción Nacional) which in 2000, dislodged PRI (Partido Revolucionario Institucional) after it had enjoyed seventy years in power.

[9] By 2000, six years after NAFTA was signed, it was clear that the agreement and the promises to support Mexican farmers were not working out as expected. The Mexican government had agreed to protect maize farmers for a period of 15 years through the establishment of Tariff Rate Quotas (TRQ), market price guarantees and programs such as PROCAMPO and Alianza Para el Campo. However, the TRQ were not implemented as agreed, resulting in an increase on maize imports (Sweeney et al., 2013; Yunez-Naude and Barceinas, 2002) and a reduction in the prices that Mexican farmers received for maize.

Agricultural Development Plan 2000-2006 (SERpro_SC, 2007) prioritizing access to water for maize producers who had been under increased competition for irrigation water with the industrial sector within the state.

In 2000 Chapingo Autonomous University organised a conference on Conservation Tillage, that allowed politicians, interested researchers and the private sector to meet, which led to a plan for a new CA initiative that was seen as having the potential to reduce competition for water resources between industry and agriculture and increase maize yields and productivity (SERpro_SC, 2007). Globally, CA was continuing to capture the attention of researchers and private sector partners, the later of whom had an interest promoting the machinery and herbicides needed to promote CA.

3.4.2.2. ASOSID: the formation of the multi-stakeholder platform

It took another two years of lobbying and negotiations to get the project proposal approved by the local Minister of Agriculture (SDAyR) in Guanajuato. CA was now labelled as "Direct Seeding" (DS), a reference to the experience of Monsanto in Argentina where well-organised farmers were using DS and financing their own technical assistance, a model that resonated with researchers, the Ministry and the private sector.

By 2002 Innovation System (IS) thinking, in which multi-stakeholder platforms and involving various actors as active participants plays a central role, had entered the scientific domain (Hall, 2007; Triomphe, 2012). Wishing to pioneer IS, the CIRAD-CIMMYT researchers took up the role of broker: bringing together the various stakeholders and coordinating the process. Some farmers from the Irrigation District 011 (DR011), mostly commercial ones with some access to machinery, were invited to participate. These farmers were conveniently close to the field stations of INIFAP and FIRA-Villadiego that were able to organise several training sessions on the use of the machinery. The latter also acted as a credit institution to enable farmers to get the machinery that they needed. A local machine manufacturer Sembradoras Dobladenses was invited to join in and played a key role in adapting the tractor implements for direct seeding, trimming the crops and bed-remaking at an affordable price. Monsanto also joined because of its interest in supplying high yielding seeds, herbicides and providing technical support. Finally, when a group of five technicians were hired by the SDAyR and trained, the multi-stakeholder platform "Association for Sustainable Agriculture Based on Direct Seeding" (ASOSID) was set up: *an initiative that engaged a wide range of stakeholders, each with their unique contribution and interest.*

The researchers and technicians organized five groups to do adaptive research in farmers' fields, each with around a dozen farmers and advised by a technician. These technicians were trained and supported by researchers who also followed up the farming trials recording the frequency of tillage activities and the amount of crop residue. The participating farmers purchased machinery with credits from FIRA and were trained on the practices by the technicians. The CIRAD-CIMMYT researchers coordinated and monitored

the adaptive research process and following the principles of IS, kept the farmers at the centre (Triomphe, 2012).

3.4.2.3. The disintegration of ASOSID

Soon after the project started the first differences in perspectives and expectations of the actors emerged. From the beginning some questioned the role and intentions of Monsanto and when a former Monsanto employee became the first president of ASOSID in 2003 this added to the tension. Another issue was the scale of the project's activities. The CIRAD-CIMMYT researchers wanted to work with a limited number of farming groups to establish a collective learning culture. The government wanted a large impact and expected the 23,000 farmers of the DR011 to use DS by 2006. Tensions over these two issues led to all the researchers leaving the project in 2003.

By the end of 2005, with the Guanajuato-state elections coming up, political interest in supporting ASOSID was waning. When the new government took power in the following year, it reduced financial support to ASOSID which, effectively, meant the end of the DS initiative in Guanajuato. ASOSID's president, the more recently hired technicians, and FIRA had already abandoned ASOSID. Only some of the technicians who were the first to be hired, and the farmers continued.

3.4.2.4. The state of Conservation Agriculture after 'phase 2'

An evaluation study from 2007 shows that 67 farmers were involved in ASOSID at the end of the project. We found only one report referring to the DS project and ASOSID (SERpro_SC, 2007) and a literature search yielded three scientific publications which briefly mention ASOSID and DS in Guanajuato. The results show that DS required one tillage in winter and superficial ploughing to incorporate crop residues in the spring-summer. DS did not significantly increase yields but did reduce tillage costs by around a third (see Table 3.1).

3.4.3. The third introduction: Conservation agriculture in Michoacán (2005-2017)

3.4.3.1. The first CA project in Michoacán (2006-2008)

In Michoacán, the neighbouring state to Guanajuato, government officials within FUPROMICH[10] had heard about DS technology and the ASOSID platform and arranged for a group of around 20 farmers from the Rural Development District (DDR092) to visit the DR011 farmers to see DS practices in the field. They liked the project and, at a public meeting, challenged the government officials to instigate a similar programme in their area by enouncing *"Yes, sure, we like the project we visited. But now, what are you going to do*

[10] Fundación Produce Michoacán (FUPROMICH) and Rural Development District 092 (DDR092).

so we can learn to apply the direct seeding technology as well?". Consequently, the CA technology fitted the political agenda of FUPROMICH's leaders (for much the same reasons as it had appealed to those in Guanajuato) so they took up the challenge and hired five former ASOSID technicians from Guanajuato (that later constituted an organization called 'AGRODESA'[11]) to work under the guidance of researchers from INIFAP-Michoacán. This initiative included a crop rotation with a legume in order to improve the soil and was labelled as CA project (Fundación Produce Michoacán A.C., 2011).

The initiative was officially launched in 2006, with an emphasis on adapting CA to local conditions, rather than on research. Each of the 100 participating farmers committed himself to have 'an experimental field' of one hectare under CA for at least three years, as previous experience had shown that CA would have no immediate effects on yields. The five AGRODESA technicians lived in the farming communities, so they could readily attend to farmers´ requests for support and the INIFAP researchers could be called upon when needed. The farmers would ideally need seven different pieces of machinery to implement the CA package: a tractor, a laser leveller, a mulch slasher, a sower, a threshing machine, a baler and a tractor sprayer and FUPROMICH negotiated state subsidies for small groups (of three to four farmers) to purchase at least two different machines for CA, which they could then share.

3.4.3.2. The follow up project (2008 –2010)

Two years later, in 2008, the PRD party came into power in Michoacán and reduced FUPROMICH's budget. Nevertheless, the new state government was still attracted by the CA technology and decided to fund a project under their *Sistema Producto Maiz* initiative that targeted maize-farmers in both the irrigated and the rain-fed regions of Michoacán and coordinated by the Chapingo Autonomous University. The AGRODESA technicians accepted the invitation to implement the project on condition that they could continue to work with their model of working with farmer-groups. This allowed them to continue their work with the five DDR092 farming communities and they proposed that one of the former FUPROMICH officials become their administrative coordinator.

3.4.3.3. The state of Conservation Agriculture after 'phase 3'

Since the project now also targeted rain-fed maize production and included a legume rotation element, the project was now working with increasingly diverse agro-ecological and socio-economic contexts. While the project's emphasis was on extension, rather than research, there were also knowledge gaps to fill, such as how to accommodate the practice of making beds on hill slopes. In the irrigated areas, occasional soil tillage was needed in the later years to facilitate irrigation. Reported results showed zero to significantly positive effects on maize yields, and a 20% reduction in costs of tillage (Table 3.1). Up to 100 farmers had been

[11] Agroservicios Integrales para el Desarrollo sostenible S.C.

participating in the two years of the project. We found no project reports or scientific papers relating to the project that describe the use of machinery or the adoption of CA practices.

3.4.4. The incorporation into MasAgro Programme

3.4.4.1. The encounter with MasAgro Programme

In 2010 a new government official took over the responsibility for the CA 'Sistema Producto Maiz' project, and cut the project's budget, leaving AGRODESA with just enough funds to sustain its work in Indaparapeo, one of the five initial farming communities of the DDR092. In that same year some of these farmers and an AGRODESA technician visited an agricultural fair in Sinaloa state where they attended a public presentation by the leader of the MasAgro Programme that showed the places in Mexico where MasAgro Programme was working on CA. The farmers from Indaparapeo asked: *"What about us? Why aren't we on your map? We're also doing CA! Come and see what we are doing."* This public challenging of politicians and researchers once again proved to be a very effective way for farmers to get their voices heard and led to the project in Indaparapeo becoming part of MasAgro Programme, of which it remains a part to this day (CIMMYT, 2018). In a MasAgro Programme reflection meeting in 2014, the Indaparapeo farmers recalled their long-standing experience with CA technology, saying that *"MasAgro is only from yesterday, we have been doing CA for a long time"*.

The MasAgro Programme today, like many other CA-labelled interventions, fits the broader concept and strategy of SI (CIMMYT, 2017; Curiel, 2016). As with the other CA-like interventions we have described, MasAgro Programme is framed around food security, reducing maize imports (symbolic of national sovereignty) and climate change. Three events were key to the Mexican government establishing MasAgro Programme in 2010. First, there was the price increase of maize on the world market due to the biofuel boom in the U.S. (Ogle, 2009). Mexico, importing yellow maize for poultry and industrial uses, now saw rising prices for white maize as well as it had partially replaced the use of yellow maize. This led to the 'tortilla crisis' of 2007. Then, in 2009, national maize production was affected by the severest drought in 60 years and the year after by unusually high rainfall (Caballero, 2012; Seager et al., 2009; Tirado and Cotter, 2010).

3.4.4.2. The state of Conservation Agriculture as at present

MasAgro Programme, at the time of writing, is still functioning after eight years and has expanded to many parts of Mexico. It is based on innovation system thinking, combining research and development with multi-stakeholder approaches (Camacho-Villa et al., 2016). Conservation Agriculture is an important element of the technology menu that the programme offers to Mexican farmers involved with irrigated and rain-fed maize and wheat production. Five journal papers and four working papers have thus far been published on CA-MasAgro. These papers, together with other research on CA in Mexico, show that CA has the potential to increase yields and brings economic benefits to farmers. According to the

most recent National Agricultural Census (INEGI and SAGARPA, 2015), there are 9,403,672 ha in Mexico under CA. An extrapolation of these data suggests that 1.3 million farmers (34.2% of the agricultural area in Mexico), may be using one form of CA or another.

3.5. Discussion

3.5.1. Conservation Agriculture technology as a boundary object

We have analysed different project interventions in the Bajío region over a period of 30 years by considering CA-label as a boundary object. We have shown how CA has moved from one space to another, with the principal actors re-arranging their engagement with it and changing its shape, according to research and political priorities, funding opportunities and the chance to build alliances. The changing labels given to the technology illustrate these changes: 'Conservation Tillage' became 'Direct Seeding' and then 'Conservation Agriculture'. Along with the names, there were changes in the narratives and practices. It was initially presented in 1987 as Conservation Tillage: a combination of reduced tillage and the use of crop mulches that would increase maize yields and income of smallholder maize farmers in rain-fed areas. Later it was promoted in order to make maize-farmers internationally more competitive and to use irrigation water more effectively. As time passed CA moved from experimental treatments to technologies that were applied by farmers, it became increasingly clear that variations in agro-ecological and socio-economic conditions demanded site and famer-specific adaptations. At this point the difficulties in adapting CA to smallholder farming on rain-fed hilly land became apparent. This led CA researchers to target farmers in irrigated areas, raising the need for farmers to have access to tractors and other specialised machinery. Later, in the 2000s in Guanajuato, CA was rebranded as Direct Seeding: with no tillage at all and (as yet) no crop rotation, although researchers were starting to investigate this. This form of CA required specific machinery for sowing and preparing the mulch. Later, in Michoacán, the package was promoted as Conservation Agriculture and now included crop rotation. Finally, CA in MasAgro Programme gave place to the concept of the Sustainable Intensification package in Mexico.

3.5.2. Alliances and dependency

In each of the projects we saw how CA met the agendas of researchers, politicians, technicians, farmers and sometimes agro industry and led these actors to become partners in CA projects. The alliances were relatively easily welded, because there was a flexibility in the wording of CA technology (creating a narrative that justified the project, technology and project label) and in how it was practiced that allowed it to meet the interests of the partners and to achieve their goals.

Researchers from national and international institutes teamed up in their effort to mobilize resources from the federal and state governments to advance their scientific

agenda. In addition to labelling and practising CA with the newest vocabulary, and using emerging insights from agronomic and economic research, they also wove in new approaches to technology development: on-farm research, farming systems research and innovation system thinking with multi-stakeholder platforms. These changes in labels and approaches reflect the efforts that researchers (like us) make to keep ourselves at the frontier of scientific advances; in this case responding to the evolving discussions around CA, both as a specific technology and in relation to agricultural technology development in general.

For politicians, the change of project labels was a useful way of distinguishing themselves from their predecessors, allowing them to approach the electorate with new priorities, narratives and vocabularies. The 'moldability' of the CA technology fitted very well with this picture: the new projects were able to claim different benefits from applying CA, depending on the context. It was adapted to maize and other crops, irrigated and rain-fed regimes, different types of famers and to a range of environmental, sustainability and socio-economic challenges, such as NAFTA and climate change. This made the CA projects not only relevant for the agricultural sector, but also allowed them to reflect broader political issues and for politicians to show commitment to farmers and broader societal issues. It allowed politicians to legitimately subsidise farmers to acquire machinery, which farmers saw as a strong sign of support from their governments. In other words, the researchers and politicians needed each other and in the CA initiatives they found each other working together repeatedly, in new forms, under different labels and following different narratives. In the last case, Michoacán, the technicians and farmers became important active players. They learned to play the rules of the game and were able make use of opportunities provided by a change of government, the replacement of an important government official or a public presentation by a renowned international scientist. It allowed technicians to find continued funding of their activities and farmers to access inputs and machinery.

3.5.3. Continuities and discontinuities

Because of the relationships between the actors were tied to changes in the political scenery, these alliances had a relatively short lifespan. None of the projects lasted more than five years, with the exception of MasAgro Programme, the only one that sustained changes in government. In each of the other projects, the life cycle was defined by elections and changes in political priorities that either led to the start of a new project or to the reduction of funding of an existing project to the point where it was no longer viable. This dynamic meant discontinuity for the agenda of the researchers and technicians who were always in need of more time to configure the right form for CA or integrate it into a context for specific farmers. After spending considerable time and effort in liaising with farmers, gaining their confidence and setting up participatory working modes, they were forced to look for other spaces and other potential sources for funding. In some instances, such as Michoacán, they

were successful and the same technicians were able to continue working with farmers from the same farming community. In other cases, they had to start a new configuration, which happened in Guanajuato, Jalisco and even Michoacán (in the FUPROMICH and Chapingo interventions). This said, it was not so difficult to find farmers interested in participating because CA training came with a range of benefits: inputs, advice and support in getting machinery. Thus, these projects had clearly time-defined boundaries, set by the start and end of funding, which created discontinuities. Yet the boundaries between these interventions were vague and there was continuity in the process of researching and promoting CA technology. Long (2001:34) has highlighted the linkages between series of interventions, with later ones carrying the history and experience of earlier events and actors. In our case, the researchers were the main drivers of the continuity, taking the legacy of CA from one area to another. In Michoacán, this led to a situation where the MasAgro Programme researchers were able to build on the earlier CA experiences of technicians and farmers, derived from other projects.

3.6. Conclusions

We have studied a technology development trajectory that consisted of multiple project interventions creating a lengthy process of apparent discontinuities, underpinned by an invisible continuity of actors organising themselves around CA projects. By analysing the social life around the technology, we have been able to answer questions relating to who 'owned' the intervention, which agendas were being addressed and how the narratives were used to frame support for the interventions. This helps us to explain why particular research activities or technologies prevailed over others (Andersson and Sumberg, 2017).

In each of the cases researchers, politicians, technicians and farmers created spaces for joint CA projects. These actors shared an interest in CA projects, although for different reasons. Researchers need politicians to fund their research. This forces them to present technologies, such as CA, in ways that fit prevailing political agendas. Politicians need to be seen to be serving their constituencies. CA provided employment for technicians and, in some cases, this benefited farmers through technical advice, machinery or agricultural inputs.

Our study shows how agricultural technology development is not an independent technical process driven by 'advances' made by researchers or the impact of a technology on crop yields and farmers' incomes. In our case it was the different motivations and agendas of researchers, politicians, technicians and farmers that resulted in a shared interest in CA projects. The fact that CA projects were successful in addressing these diverse agendas may explain the repeated re-invention of project interventions. They are part of a process of 'musical chairs', driven by the players, each with their own interests, who came together to 'play the game' of sharing a project. Regardless of the project's performance, our players always found a place to fit in and to keep on playing.

To be able to say something about the actual performance of the projects and technologies, we would need more scientific and published evidence about how CA affected productivity and farmers' livelihoods. One of the criticisms of CA has been the dogmatic way in which it has been promoted, especially in Africa (Andersson and Giller, 2012). In our case, CA evolved to fit with the SI narrative that is even more flexible and conceptually wider, meaning that more farmers can be linked to the CA/SI narrative not because more farmers changed their practices but rather because what they practise already is being incorporated into wider contours of this concept.

We want to emphasise that this study and reflection on the politics of CA is not intended as a criticism of individual researchers, politicians, technicians or farmers. We ourselves are part of this world and this study has (once again) made us aware of the dynamics in which we are caught and which, at the same time, we maintain. We note, as shown by Camacho-Villa et al. (2016), that the current coordinators of MasAgro Programme also experienced the need for the time, energy and capacity to manoeuvre politically to mobilize resources and pursue continuity.

Chapter 4

Encounters between modernity and tradition: The hybridization of the culture of maize

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Farmers cultivating maize and doing 'tequio' in the Oaxaca mountains, Mexico in 2016 (Source: Martinez-Cruz, T.E.)

Abstract

Despite the modernising productivity paradigm promoted in agricultural research and development (AR&D), food systems relying on traditional technologies, such as native seeds, are still widespread. This research aims to understand how and why farmers from an indigenous community in Mexico continue to cultivate native maize, although they have adopted other aspects of 'modernization'. We find that the interactions of migration, climate shocks and Mexican agricultural and rural development policies have shaped farmers' culture of maize technology, resulting in a hybrid system that neither follows the narrative of the modernisation productivity paradigm nor that of traditional food systems. Native maize is therefore a technology that is embedded in broader practices, meanings and discourses. We show that native maize is a traditional element in the farmers' world that co-exists and is blended with others from the so-called modern world in order to maintain continuity in their livelihoods in a changing world and to maintain self-determination. For example, farmers have introduced irrigation into their rainfed *milpas*, adjusted their sacred belief that "maize should be fed by rainfall". When migration affected the social fabric and therefore several agricultural practices, such as seed and labour exchanges, the farmers adapted by starting a gene-bank, a farming school and other spaces to reinforce both their social fabric and agriculture. Farmers' livelihoods are grounded in the principle of *'comunalidad'*: with farmers linked to their *'territory'*: the space where they enact their right to self-determination (*'usos y costumbres'*) and reinvent their social fabric and community based work (*'tequio'*) to find continuity to life ("fiesta"). This reinvention includes aspirations, identity, culture and maize cultivation and is an adaptation to a changing world. As scholars, policy makers, and social activists in AR&D we usually adopt a pro-modernity or pro-tradition position and interpret and portray the livelihoods of farmers through these opposed and dichotomic worlds. However, farmers choose to take what suits them best from the pluriverse to creating a hybrid life and fit a changing world.

4.1. Introduction

We arrived at Yavesía after a three-hour drive, stopping at an isolated place in the mountains with no phone signal, internet or public transportation. We saw the mud-brick (adobe) houses with corrugated iron roofs. We parked our car by the entrance to the village and explored it by foot, careful to avoid breaking the quiet and calm atmosphere; we heard water flowing and the rustling of the leaves. As we were walking, we saw *milpa* fields on both sides of the river, with their maize stalks and their cobs hanging down. We saw a woman, Juana, weeding her *milpa* and doing *arrima* (adding soil to the roots of the maize to avoid lodging) and asked if we could help her, to which she agreed. Her *milpa* had white maize, pumpkins, beans, flowers and some peach trees. She was working alone in the *milpa* and we wondered if she had relatives to help her, as cropping activities in the *milpa* are generally done in a group. Afterwards she invited us back to her house to have something to drink. Red and mixed colour maize were hanging on the outside wall, to dry before being eaten. She said that in her childhood, when they lived in the upper-lands, they cropped more types of maize: blue, red, white, yellow and mixed colour maize called *pinto*. It was a sunny day that we sat in the shadow, we asked her if she lived alone. She said her husband had gone to another town to do some paperwork, as he was about to leave for the U.S. and that she has two daughters, one a single mother who was busy with her child and the other studying in Oaxaca City. She told us that the landscape we could see had changed a lot since the 1940s, when men from the village started migrating: many upland *milpas* had been abandoned since then.

At the end of the day we were discussing what we had learned that day and what we wanted to explore about the community. We had been told that almost half of the farmers spent half of their lives as migrants in the U.S. But we did not see any modern-style houses, or many trucks, as one finds in many other communities in the mountains of Oaxaca: typical signs of an imported migrant culture. We kept on thinking and chatting, and some questions came to our minds. Are the people who live here isolated? Has the outside world not reached them? Or have they been able to defend themselves against the threats and challenges of the modern world, the government of Mexico, improved maize varieties and the globalised word? How have they done that? Have other aspects of the community changed? And, are these changes related? Are they the result of the policies at national level? Have people migrated because of a lack of opportunities? We later found ourselves debating the introduction of improved fruit trees (such as the peach trees we saw in Juana's *milpa*) into the community. They can be seen as a sign of modernisation and development and perhaps that farmers in Yavesía are slowly catching up the rest of the world. On the other hand, one could argue that farmers have been denied the 'right to not migrate' (Bartra, 2008) and that the cultivation of native maize varieties is valued as being in line with farmers' traditional ways of living and livelihoods which are being threatened by globalisation.

These questions partly reflect the dichotomies that we have internalised as a result of working in the world of Agricultural Research and Development (AR&D). While the productivity paradigm has dominated the agenda of AR&D for many years (Benton, 2016; World Bank, 2008), there are several movements, both within and outside it, that propose alternative development trajectories, such as La Via Campesina (Soper, 2019), the 'living-well movements' (Gudynas, 2011). In Mexico these movements are focussed on food sovereignty, peasantries and traditional knowledge/livelihoods and linked to anti-GMO maize movements (Carro-Ripalda and Astier, 2014; Fitting, 2011). Part of the criticisms of the agricultural productivity paradigm lays in the promotion of the modern technologies and high yielding seed varieties as a means to lift farmers out from poverty (Benton, 2016; World Bank, 2008) which it is argued, displays a lack of understanding of local contexts and realities. In recent decades, the participation agenda has gained importance in AR&D, initially through the Farmers First Movement (Chambers et al., 1989) and, later, to inclusive approaches to innovation (Heeks et al., 2014), which is seen as a means to achieve inclusive development whilst embracing a market-oriented rationale. Nonetheless this late approach is still rooted in the productivity paradigm and, generally disregarding traditional technologies and other rationales that are at odds with it. For example, native seeds are often disregarded as they are thought to have less potential to contribute to food security than improved seeds. Advocates for alternative agricultural development trajectories argue the need to better understand the ways of perceiving and conceiving the world that underlie these strategies and, particularly, the existence of 'pluriverses' (Escobar, 2018). In the case of Mexican agriculture, social activists have been advocating the defence of native maize cultivation, linking it to what we called the 'bicultural diversity of indigenous peoples', often portrayed as 'traditional' (Martinez-Mendoza et al., 2016; Toledo and Barrera-Bassols, 2008). The most representative example in Mexico is the anti-GMO maize campaigns that bring together the discourses of many actors and promote 'native maize cultivation [that] do[es] not use any modern technology and remains pure as the only solution for food security'[12] which seems diametrically opposed to modern technologies. This is line with Soper's (2019) findings in Ecuador where many social movements portray farmers as the victims of the dominant paradigm. Thus, it seems that farmers are expected to fit into either the modern or the traditional world. We, researchers and practitioners of AR&D, generally reproduce the approaches of pro-modernity (as opposed to pro-tradition) in our work, but how do farmers do actually reconcile these approaches and live with them?

Challenging these apparently opposed perspectives, providing an example of what we call the hybridisation of cultures of technology, to show how farmers play with elements of modernity and traditionality in an attempt to fit their changing reality and yet keeping essential elements of what their identity and culture. We depart from the

[12] These expressions are commonly found among social activists.

concepts of 'technology' and 'cultures of technology' (Nowotny, 2006) to show the different meanings that maize has in farmers' livelihoods and the different norms and values tied to it. These norms and values are intertwined with farmers' lives, shaping the social fabric of the community in which elements of the modern and the traditional are combined. We elaborate our argument around maize, which has been a highly politicised crop in Mexico since the productivity-oriented programmes of the Green Revolution in the 1940's (Harwood, 2009). We define technology as a "the human capacity to make or unmake" (Richards, 2009:495), which renders technology as a highly social activity that has different meanings in time, space and for several actors (Sismondo, 2010:10-11). For example, while a breeder considers seed as a pool of genes resistant to a disease, for a Quechua indigenous farmer seeds are "his *enfants* and sisters", artefacts that are strongly embedded in their culture and identity (Nazarea, 2013). We also explore how this technology culture finds continuity or discontinuity (Long, 2001) over time. Our entry point is maize cultivation in Santa María Yavesía, a Zapotecan indigenous community in Oaxaca, Mexico and farmers' collaboration with the Sustainable Modernisation of the Traditional Agriculture (MasAgro) Programme. In this research we explore how farmers have hybridised their culture of technology, based around native maize cultivation, in an attempt to adapt to a changing world and yet, at the same time, exercise self-determination.

4.2. Methodology

Our case study is based Santa María Yavesía (Figure 4.1), a Zapotecan indigenous community located in the State of Oaxaca. We follow a case study approach (Gerring, 2006; Yin, 2003) in which we analyse the history of the practices around maize in Yavesía from 1940 until today. The data collection took place between March and September 2016 and involved semi-structured interviews with key actors, through which we construct a time-line of critical events that have affected local farming practices around maize.

We interviewed 25 farmers, using the life-histories method to identify key events in their lives, such as where they were born, if they have migrated or moved into a new location/place (and why), marriage, the birth of children and, events that have shaped the community's life (such as natural disasters). In most of the cases we focussed on three points in farmers' histories: their childhood, the time following their marriage and the present day. We performed a systemic mapping (Ridaura, 2014) of each of these points to identify what farming was like at these different stages: i.e. the location and number of fields, crops, topology and people engaged in the farming activities. All the farmers were interviewed at least twice.

We also interviewed three technicians working with the farmers in Yavesía, five technicians collaborating with or working on the MasAgro Programme, eight researchers linked to the MasAgro Programme and seven government officials with positions in agriculture and social development.

We also did participatory observation, joining in with some farming activities and attended six training and field days with technicians and researchers. We also attended a workshop with farmers of the community around the dynamics of their livelihoods and sacred places in order to better understand their relationship with the environment. The organiser of the workshop was a researcher in a local institution and a member of the community.

We also consulted the grey literature and analysed meteorological data, using ERIC II software (IMTA, 2009) (from Ixtlán de Juárez meteorological station, the closest to Yavesía) and other reports to confirm extreme events cited by farmers, read newspapers to verify specific information shared by farmers and read studies done in the community by students of a local university and the internal reports of MasAgro Programme.

4.2.1. The study area: Santa María Yavesía, Oaxaca.

Santa María Yavesía is a Zapotecan community of 448 people, 107 of whom are bilingual, speaking Zapotecan and Spanish with the rest only speaking Spanish. It is located 1900-2100 masl in the state of Oaxaca, in the southern part of Mexico (Figure 4.1). The agricultural land of the community stretches from 1900 to 2500 masl, and the forest is found at 2500-3400 masl. The temperatures range from 10 to 18°C and annual precipitation is 1000-1500 mm. The total area is 9,147 ha. Only three percent of the land is used for agriculture and one percent is urban. Two main permanent water currents run through the community, later forming the Yavesía river (Shoo Raa in Zapotecan) that divides the community into two neighbourhoods: Asunción and San Miguel. The farmers refer to the microclimate along the river as humid and to the area above 2400 m as cold. The social organisation is communal by *usos y costumbres* meaning that the lands are owned by the community and that they

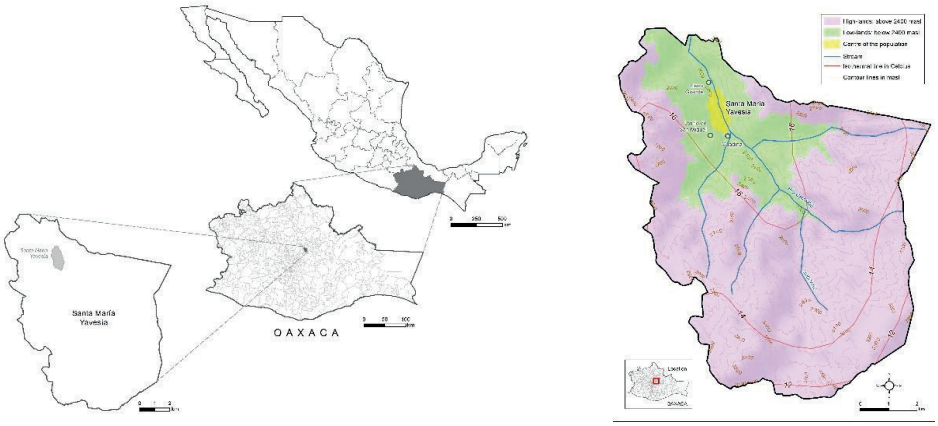

Figure 4.1. Location of Yavesía and the distribution of fields, lowlands and uplands (Based on INEGI, 2018 maps).

make decisions collectively. Despite the influence of other religions, the elements of nature still play a role in their cosmovision, with water and the forests being the main components.

4.3. Results

4.3.1. The making of the milpa in Yavesía: hybridization of practices

We talked to farmers, men and women, young and old, to learn how practices for growing maize and cultivating a *milpa* had changed over time. We wanted to understand why farmers continued to grow native maize varieties and had not replaced them with improved varieties. During these conversations it was brought to our attention that the villagers had changed many other practices in cultivating their *milpas*, ranging from planting fruit trees to introducing irrigation.

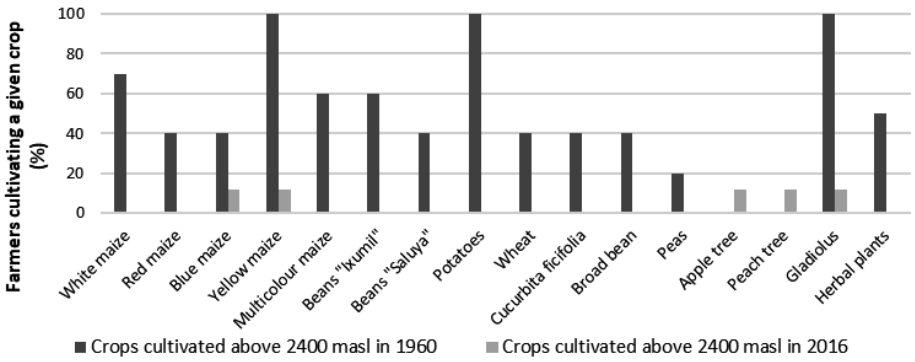

Figure 4.2. Crops in the milpa fields located above 2400 masl in 1960 and 2016.

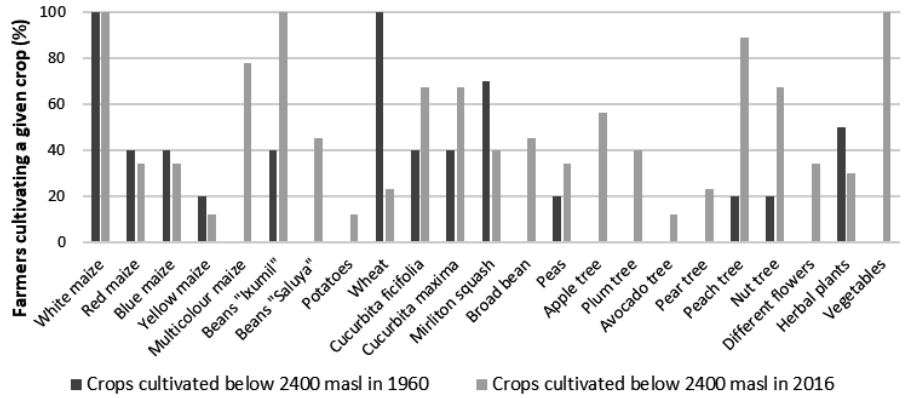

Figure 4.3. Crops in the milpa fields located below 2400 masl in 1960 and 2016.

4.3.1.1. Crop diversity and planting arrangements

According to farmers' recollections, 17 different types of crops could be found in the *milpas* in 1950. In 2016 there were at least 23 different crops. The *milpas* in the upper lands (> 2400 masl) have changed the most (Figure 4.2): many crops are not cultivated regularly anymore although a few farmers were still cultivating blue and yellow maize in 2016. The number of different crops in the *milpas* in the lower lands (<2400 masl) increased from 13 crops cultivated regularly in 1960, to 23 in 2016 (Figure 4.3).

Fruit trees have always been part of the milpa but more as part of the landscape. In 1991, some farmers started grafting local varieties of fruit trees with improved cultivars to generate extra income by selling the fruits. Yet, this was not widely taken up by farmers. Later, in the 2000s, technicians from government programmes promoted the use of MIAF systems (milpa systems intercropped with grafted fruit trees of peaches, avocados, apples and nuts). These MIAF systems used a better topological arrangement, using trees grafted with improved varieties. Village women learned to process those fruits and make marmalades for a more diversified diet and to sell locally or in other neighbouring communities. In the figure 4.4 on the left we see the fruit trees were more dispersed (before MIAF) whereas on the right (after MIAF), we see the fruit trees organised in a square topology arrangement.

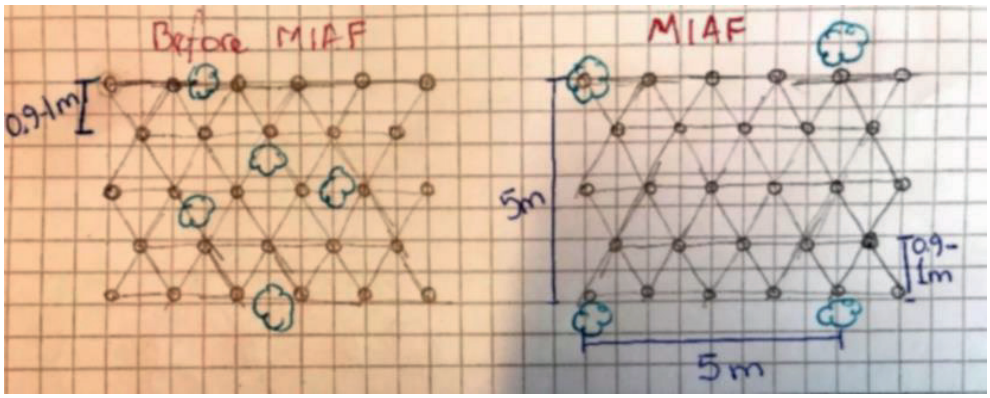

Figure 4.4. Topology arrangements before MIAF in the 1990s (left) and after MIAF in 2005 (right).

4.3.1.2. Maize seeds, topology arrangements and harvesting

Although not immediately visible to the casual observer, there has been a significant change in the planting distances between maize plants. In 2011, after a difficult year when farmers struggled with their maize crop (see section 4.3.3.2.), farmers and a researcher from Chapingo University started a Farming Field School where farmers tried out new techniques to improve their *milpas*, although the idea of 'improving' meant different things to the researcher and to the farmers. The researcher wanted to support farmers in getting higher maize yields and suggested using improved native seeds from other regions with similar

environmental characteristics to Yavesía. The researcher was an expert on participatory maize breeding, and he wanted his farming school to focus only on maize. Yavesía farmers made it clear to him that mono-cropping in the way that he proposed was not an option for them. The farmers argued:

> *Uncle Humberto (the Chapingo researcher) this is not the way it works, we need our beans, our pumpkins and other foods to see us through the year. Change the maize seeds? Are you kidding? No, I have been using those seeds for many years, my land has gotten used to them, no way can I do that. If you want to try your new seeds, let us go there over the hill and there you can show us if your seeds work. Planting two seeds every 20 cm? Are you kidding me? When am I going to finish sowing? Why not do as we do and plant every 60 cm because that is the length of my steps? This suits me better (Ines).*

Humberto then developed a more integral system that better fitted local farmers' contexts. Figure 4.5 indicates how the *milpa* fields look now with the new topology arrangement. Besides the planting distances, farmers also readjusted the plant density, now instead of using five seeds per hole, they plant two to three seeds, they realised that with three seeds they get more grain filling, bigger cobs and more maize. Now the farmers and the researcher laugh about this negotiation process, and they acknowledge that they both learned from each other.

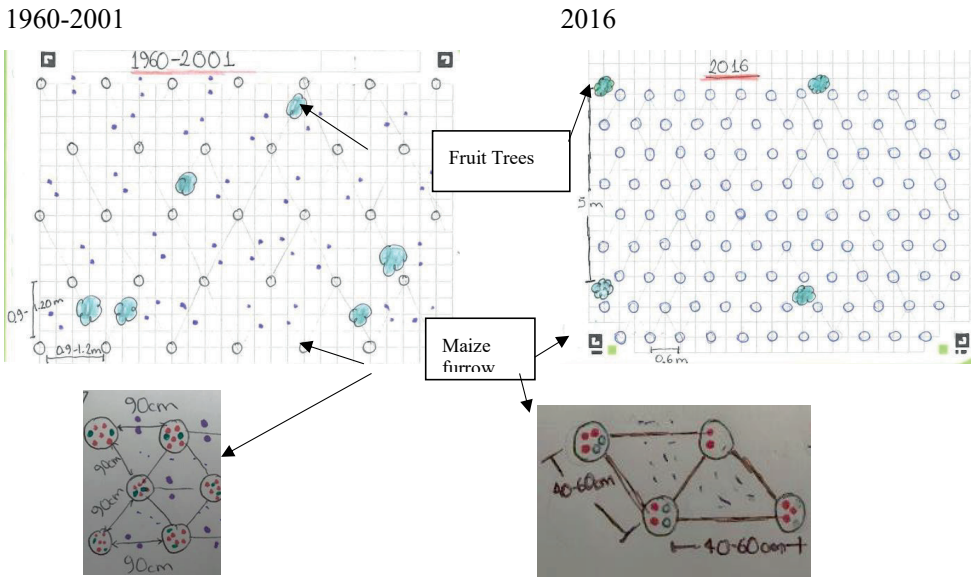

Figure 4.5. Changes in milpa configuration in 1960/2001 and post 2016.
Beans (green); Maize (red); Potato (purple); Squash ('Chilacayote') black

Because farmers are attached to their seeds, which they do not even call native or improved maize, simply maize, the researcher taught farmers how to improve their seed selection process. Farmers used to select the seeds when the grains and cobs were already drying at home. Humberto showed farmers that is more efficient to select the maize seeds while the maize plants are in the field so they can choose the desired characteristics, e.g. height of the plant, the diameter of the stalk, propensity to lodging or the quality of the ears or husk, amongst others.

> *"I put a red ribbon on the plants I like. I take off the tassel if I do not like that plant. Do you see my maize? It looks pretty isn't? Now I have fields with just blue, white, red or yellow maize, I do not mix them anymore"*
> (Everardo).

Everardo is considered one of the best farmers and he proudly shows his maize plants and explains in detail how he has improved his own maize. He explains that they have learned how to prevent undesired plants from pollinating others. When selecting the seeds for the next cropping season, farmers chose the maize husks from the plants they like the most. Once those husks and grains are dried, the farmer performs another selection based on the appearance of the kennels, taste and colour. When he shells out the maize grains, he keeps the grains from first three quarters of the cob (where the maize grains are smaller) which will be used before the planting date. Just before the planting date, the farmers shells off the small grains left in the cob, cooks them and eats them in a ritual to ask mother earth for a good cropping season and to give thanks for the seeds she provided him last year.

Farmers have also improved their harvest and grain storage techniques. In the past farmers would let the husks and maize dry on the plant before the harvest, but now the farmer bends the plant so if it rains, the trapped humidity does not allow the development of diseases or pest attacks. Some farmers have purchased metal silos to store their grains but those who have not, use three-litre plastic bottles to store their grains to prevent the development of pests. This allows farmers to take smaller amounts of maize for their weekly maize supply. Farmers somehow also play at being scientists, before storing their maize, they test the water content of the maize seeds by exposing the grains for an hour to the sunlight in a closed glass container. If there are drops of water after the testing time, the maize is not ready yet to be stored.

4.3.1.3. Water and soil fertility management practices

A very important change in cultivating the *milpas* relates to water. Water is a main element of the cosmovision of Yavesía, which regards the conservation of the river and forests as essential. Farmers have a sacred place where *"Shoo Raa"*, their main god linked to the water, lives. Farmers believe that water is sacred and that the rains are also sacred, so the time of maize cultivation was determined by the gods' will. However, relying on rainfall was

challenging because farmers needed to sow their fields before migrating for six months (see section 4.3.3.1) and over time the rains started coming later and later. Farmers realized that water was a limiting factor in maize cultivation and wanted to explore alternatives that made them less reliant on rainfall. Hence, the researcher and farmers developed a project to use water from the river. While the older farmers refused to use irrigation because of the sacredness of water, the younger farmers agreed, thinking that since the 1990s several farmers had used the water from the river to irrigate fruit trees, — *"why should not we do the same with maize if we can still protect and preserve our forests and our water?"— (Pablo).*

The farmers, in collaboration with the researcher, installed two main irrigation lines on the top part and along each hill, with the farmers' fields downhill of the main pipelines. The farmers did not have enough funds to install both lines in the same year, so they built one on one side of the community in 2012 and, two years later, they built the other on the other side. The farmers requested a subsidy from the government as part of the municipal development plans, added more money from their own pockets and used their own labour to reduce costs. Since installing these pipelines the farmers can now sow their fields before migrating and can rely on the irrigation if the rainy period has not yet started.

Last but not least, soil management practices have also changed because of migration. In the 1940s, farmers rotated their fields to allow the soil to recover, *"We used to let the soils rest, we sowed them for three years and then gave them a break, some years we planted wheat instead of the milpa, so the soil could recover, but we cannot do that anymore"* (Amanda). Farmers are aware of how plants use some soil nutrients and the importance of not exhausting these. They practised crop rotation, but when they relocated their fields in the lower lands, land pressure increased as less farming areas were available. While the arable lands were still available in the upper lands, social gender norms did not allow women to stay there alone to cultivate the land: how could a woman stay there by herself? In 1970, the first chemical fertilisers were introduced into the community through several government programmes, although no studies were performed to determine the actual needs of the soil. Farmers did not adopt the fertilisers immediately but in 1991 they adopted fertilisers thinking that they were 'like vitamins' for their plants. Farmers explained that they thought that the more fertilisers they added to the soil, the better the results would be. With Humberto, farmers learned that each soil and crop had different requirements and that the fertilisers are more effective if added at specific phenological stages. Since 2011, several farmers have performed soil analyses and have reduced their fertilisation dosages from 300 g to 60 g, applying them twice in the cropping cycle. They are also now slowly moving into organic fertilisation because they value the ability to be self-sufficient and the cleanliness (as they call it) of the food they produce and eat. The farmers have also slowly adopted the use of mycorrhizas that increase the rooting system, reduce lodging and therefore the need for the *arrima*, i.e. tilling the soil to add soil to the roots,

which can involve between 2 and 5 tilling operations in one cropping cycle. This makes easy that women left when men migrate, can take care of the milpa fields.

4.3.2. The role of maize in farmers' livelihoods

Maize seeds are passed from one generation to other to secure a harvest and food supply. In the past, land tenure was linked to the men, who mostly inherited land from their parents. As the land was inherited, the maize and other crops' seeds that were used in the *milpa* were also passed from the parents to the sons. This generational inheritance of seeds meant that these seeds were already adapted to the soil and environment conditions and increased the chances of a good harvest. Nowadays, women can also inherit land and seeds. Since men started to migrate, seed selection and crop management more often falls on women's shoulders. For example, when farmers stopped cropping for a cycle or two and had no seeds to re-start farming again, it was the women who looked for seeds to re-start cropping. Local farmers believe that preserving their seeds is crucial for their survival. They express shame when they refer to the episode when they stopped cropping as it made them vulnerable to a lack of security about food provision and could have threatened their entire existence (see section 4.3.3.2). Matilda explained to us:

> I had to go to another community to get maize seeds, I do not know why but I stopped farming two years in row. It was easier to buy maize than cultivate it. However, when we had the maize shortage in 2010, I knew we needed to do things differently. I got scared, that this could not be happening to me. I do not want to go and ask farmers outside the community to help me out again (Matilda).

Maize is also intercropped with other crops, as noted in section 4.3.1.1, as farmers need a range of crops to fulfil their dietary needs. We learned that there are different colours of maize and each one plays a role in farmers' diets. For example, farmers love the pork tamales made with blue maize, but also enjoy a potato soup with local beans with a hard and chewy skin and yellow tortillas, *atole* (a beverage) can only be made with white maize and is complemented with black beans. All these crops are part of their *milpa*. The farmers do not wait until the *milpa* crops are mature and dry, farmers can take the little non-mature maize cobs while the plants are growing and use them to make a soup or a special *elote tamal* (a typical food) or simply pick the green beans or any other leaves or plants to supply their immediate food demands. To have a *milpa* is to have a constant food source: a *milpa* is life.

Maize cultivation and seed exchange are strongly linked to the social fabric and the meaning of community. Local people refer to this social fabric and way of living as following the principle of *'comunalidad'*. It embraces their territory; their collective work or *'tequio'*; their right to self-determination locally called *'usos y costumbres'* and the festivals and celebrations of life which are strongly linked to maize. When migration began the practices

around *comunalidad* were reshaped and new spaces to cultivate it emerged. Back in the 1950s, maize cultivation was conducted in groups of families through the *tequio*. The farming had a division of labour within families, with the men responsible for tilling the soil and the women cooking for everyone to celebrate at the end of the day. For example, three farming families with farms A, B and C would work together. On day one, farmers worked on the fields of farmer A, on day two farmers worked on the field of B and on day three farmers worked on the fields of farmer C. The hosting family cooked a good meal for all the farmers helping but each farmer had to bring his own maize tortilla. All the tortillas, of different colours, textures and flavours were put in a big clay *comal* (pan). Farmers shared the tortillas, which also helped them to choose new seeds for the next cropping season with expressions like —*"I like this tortilla, can I have some of your seed"*— (Severino). Farmers enjoyed spending time in the fields because they celebrated and asked mother earth to provide them a good harvest that fulfilled their food needs. Every time that farmers performed an activity in the fields, they also praised mother earth pouring some *mezcal or pulque* in the older times (traditional alcoholic beverage) and women cooked the best meal they could to share with all the *tequio* participants.

> We loved coming to the field as children. We did not eat chicken every day but when we were working in the fields, the meals were the best. We had a big feast to celebrate with mother earth and request an abundant harvest to provide us food for the rest of the year. The fields were the best places to eat (Eloisa).

When farmers started to seasonally migrate this affected the social fabric and the *tequio*, as we will explain in the section 4.3.3.1. Previously labour exchange and seed exchange happened in the fields and the whole family was engaged. With migration, women could not stay alone, nor do the *tequios* on the upper lands on their own due to social norms. Thus, they relocated their fields in the lower lands and mostly cropped their lands individually. This affected the whole seed sharing system. In 2016, less than 20% of farming families used *tequio* to cultivate their lands and their seed exchange now depends less on it.

Farmers faced a maize shortage in 2010 (we will explain the causes in section 4.3.3.2.) and realised how their practices around maize cultivation had changed and how life threatening it was not to be self-sufficient in maize. Building on the living principle grounded on the *'comunalidad'*, farmers developed other spaces for exchanging seeds and knowledge, to make their community more resilient again. In 2011 farmers opened a gene bank, managed by the whole community and supported by the municipality and the researcher with whom they had worked previously. Here the farmers can store and exchange their maize and the seeds of other crops that they cultivate in their *milpas*. It is like an open library of seeds, anyone from Yavesía can access them but should also replace the seeds she takes and be willing to share her own seeds too. Another way of sharing seeds and knowledge that, although not new, has become more frequent since 2012, is observing

neighbours' fields and requesting seeds and directly asking for advice. Another communal space for seeds and knowledge exchange is the field farming school where farmers try out different seeds, which offers another opportunity to share seeds and knowledge. Although the farmers actively participating in the farming school can change from year to year (because of new priorities, such as. having a public responsibility with the municipality, or taking care of a sick relative), farmers still have access and benefit from the gene bank and other related activities, because they are part of the community and the principle of *'comunalidad'*.

Maize also plays an important role in the village's festivities and identity. We have mentioned in several places how maize cultivation is linked to the celebration of life. Another expression occurs when farmers return from their migration period at the end of November, to celebrate the Immaculate Conception of the Virgin Mary festivity in December, staying some months to celebrate Christmas and New Year's Eve with their families. By this time some of the fields are ready to harvest and the harvested crops are used to prepare meals for the celebrations. In 2014 the village also started a maize fair, alongside the main festivity, creating a competition that gives prizes to the farmers with the most diverse *milpa* (in terms of crops) and most attractive maize (medium sized and healthy grains, long and well filled grains). Farmers proudly say that they now harvest more than one ton of maize per hectare whereas in the past, they only harvested 300 kg.

4.3.3. The drivers of changes in the technology culture surrounding native maize

We have discussed how the material elements of the maize cultivation have changed over time and elaborated on how those elements are intertwined with farmers' livelihoods. In this section we will describe the drivers that shaped farmers' maize cultivation practices, which can be broadly categorised into three types: migration, climatic shocks and policies. Table 4.1 summarises these events and the effects they have had on the community.

Tabel 4.1. Summary of key events affecting farmers' livelihoods and farming activities (1944-present).

Date	Event	Effect in Yavesía (community and farming)
1943	• Drought	• No visual effects, farmers continued farming and being self-sufficient
1944	• Heavy rains and landslides, roads blocked	• The bridge connecting the two neighbourhoods of the community fell • Farmers still had enough food to feed their families as having different fields allowed them to have sufficient food
1946	• *Braceros*, policy to recruit labourers to work in the U.S. after WWII	• 1/3 of the male population migrates to the U.S.* • The social fabric of the *tequios* is affected and farming fields are relocated • Farmers are still self-sufficient
1960	• Migration to the U.S. and other regions continues • The last mine is shut down	• Population continued migrating to the U.S. and more fields were relocated in the lower lands • Farmers were still self-sufficient
1972	• CONASUPO**[13] stores are launched in Mexico	• One CONASUPO store is established in Yavesía and people started to buy maize and other basic foods from the store
1980	• Drought, pests and more migration	• 50% of the fields are now in the lowlands, few people live in or cultivate the upper lands • Farmers bought more maize from the CONASUPO
1994	• Migration to U.S. to work half of the year • PROCAMPO[14] as a response to NAFTA[15]	• 80% of the fields are now in the lowlands • Farmers are not self-sufficient but still crop, they complement their dietary needs with foods from the CONASUPO • 84 farmers got subsidies from PROCAMPO to support their maize farming activities
2000	• Temporarily migrants in the U.S.	• Few farmers are self-sufficient, 80% of the population relies on the CONASUPO and only cultivates for special meals/celebrations
2005	• Hurricane Stan causes landslides and blocks roads	• Many fields along the rivers were lost and some houses relocated, *tequio* practices are now less common
2007	• Boom of biofuels, tortilla crisis and increases in maize prices	• Farmers managed to adjust as they had an income that allowed them to buy maize/food
2010	• Hurricane Matthew, roads are blocked and food shortage in different regions of Oaxaca	• Farmers were isolated and out of communication. They had money but NO food, maize crisis in the Sierra Norte • Migrants from Yavesía living abroad sent food aid in trucks to support their village
2011	• Encounter with Chapingo researcher	• Farmers rescued their seeds, started a field farming school and a seed bank based on the principle of "our seeds, our sovereignty"
2012	• Introduction of irrigation	• Cropping calendars changed as farmers use irrigation to water their crops as opposed to the idea of sacred rainfall
2016	• Hybrid *milpa* and maize system	• Farmers adapted their *milpas* and maize practices, combining traditional and modern knowledge

* According to the INEGI, Yavesía had 1012 inhabitants in 1930 and by 1950, the population was 777 (Secretaria de Economia, 1950; Secretaria de la Economia Nacional, 1948).
**Now referred as SEGALMEX (Mexican Food Security Programme) stores. Source: https://adnpolitico.com/mexico/2018/08/16/que-es-segalmex-y-como-sustituira-a-diconsa-y-liconsa

[13] National Company of Popular Subsistence
[14] Programme of Direct Assistance for the Countryside
[15] North American Free Trade Agreement

4.3.3.1. Migration and the promise of a better life

The changes in the *milpa* practices were related to changes in the social fabric of Yavesía community and livelihoods. Migration was probably the most important factor driving these changes. Before the men started to migrate in the early '50s, they were responsible for tilling the soil as this demands strength. Women sometimes helped with sowing but were mostly occupied with the cooking to feed the people helping in the *tequio* (see section 4.3.2.). However, when the men started migrating to the U.S. there were fewer hands available and this led to a decrease in the cultivated land, with the upland plots and surrounding houses mostly being abandoned. There was a reduction in the frequency of tillaging which has been reduced from seven to, now, just two. The first tillage and sowing are done by the men before they embark on their migration and the last one by women who do it just to remove weeds.

The first migration waves date back to the 1940s when a few farmers embarked on an adventure to the U.S. sparked by a curiosity to explore other lands in what many people called 'the developed world', the United States of America. We met older farmers in the community who told us about their migration as being adventures. They were curious and left their wives and children behind and in charge of the maize fields to go on this adventure. According to Garcia (2008) in 1946 about a third of the men of the community registered in the 'Bracero Programme' (manual labourer programme) and moved to the U.S. at the end of WW2, where labourers were needed to work in agricultural fields, hoping to improve their incomes. In 1980, the last mine in the region, which employed quite a few Yavesía farmers shut down (Méndez García 2017) and more farmers migrated to Mexico City and the U.S. In 2008 at least one member of each family was living outside Yavesía for at least part of the year (Garcia 2008). The farmers normally migrate for about six months and, returning in November to celebrate the community annual fest (see section 4.3.2). With the promise of a better income and a life, migration to the U.S. has continued in subsequent years although the migrants generally do not have any formal contracts. By the mid-1990s more people migrated when a new offer to work temporarily in the U.S. arose. Farmers recall that while they still cropped the land, they did not consider being self-sufficient to be so important as the women were busy taking care of the household and could afford to buy food in the CONASUPO (See section 4.3.3.3.). Although some farmers got permanent residence in the U.S., the majority continued returning to Yavesía because of their linkage to their motherland: summarised in the following conversation:

> María: "I have to push him to visit our children in the U.S., we have our papers now, so we can go there anytime we want. I could be there with my children and that would be no problem because for me they are the most important, but we have our house here too and my husband does not like being away from home".

> Juvencio: "I do not like going to the U.S., I do not belong there, she is always pushing me to go. I get bored, I cannot do anything in there. When I get really bored, I go outside and collect trash, so I feel like I am doing something useful, but I always miss my home, my fields, my food, my forests, my people, my language… When I come here, I like playing the radio and listening to Zapotec, I miss speaking Zapotec, I feel like I want to visit to the radio station so I can speak Zapotec again. I like my land, I belong here, I have everything I need here. I only go to the U.S because my children live there."

Swinging between these two different worlds, the motherland and the U.S. or urban and rural areas, is normal for Yavesía farmers. Yet, what farmers will always call Yavesía their home. María and Juvencio are some of the few farmers who keep cultivating the upper lands, when we asked them if they have ever stopped farming in the upper lands, Juvencio whispered, as if he didn't want to admit it —*"yes, but only once"*—.

4.3.3.2. Climate shocks and threats to food security

The literature suggests that the climatic shocks (heavy rains and a severe drought) in the 1940s were linked to migration as some regions of Oaxaca had a food shortage and farmers were attracted by the promise of better incomes to buy food (Leon Santiago, 2015). Yet, in the case of Yavesía, this seems to have been less the case. Farmers in Yavesía learned to deal with climate shocks in different ways. A drought in 1943 and the heavy rains the following year (IMTA, 2009) affected the community and while farmers recall that those events were calamitous, as the rains led to the blockage of the few roads leading in and out of the village, it did not seriously affect their food security as they had enough maize. In 1980, their *milpas* were attacked by pests, but having various fields in different places helped farmers to cope with the effects and their food provision was not seriously affected.

The stories of survival and resilience changed in the 2000s. In 2005, hurricane Stan caused floods in the urban area of Yavesía and many of the houses and fields along the riverside were destroyed. The effects did not seem to be long lasting; farmers rebuilt the damaged houses and the agricultural fields on higher ground. The CONASUPO store and local farmers provided enough for these events not to threaten food provision. In 2008 and 2009, the community was successively hit by a drought and heavy rains, yet the CONASUPO store still managed to satisfy the community's maize needs. In 2010 there were further problems, the storms caused by hurricane Matthew blocked the routes that connected Yavesía with the rest of the world and there was a shortage of maize and other foodstuffs, a clear threaten to the village, *"We had money, but we could not buy maize nor other foods, there was no maize, how could we survive without maize?" (Irene)*

Farmers looked for maize in upper lands and from neighbouring communities and requested help from relatives living in the cities. This situation challenged farmers to think that they needed to be self-sufficient again, as with their maize and milpas they had

been more resilient against such climatic shocks in the past. This event hit not only Yavesía but also several neighbouring communities and surrounding regions. In 2010 the regional manager of the CONASUPO stores, also an inhabitant of the region struck by the situation, visited several communities, including Yavesía, to discuss why the crisis happened.

> "It was terrible, my store was empty, I have never before run out of maize, I always manage to supply all the smaller CONASUPO stores. People were coming every day, and I had to tell them, 'there is no maize'. I was shocked, how could we, who call ourselves peasants, have gotten into this?" (Flavio, CONASUPO stores regional manager).

Flavio, as a local person from the Sierra Juarez visited several communities whose shops he supplied with basic products and asked the local authorities to invite farmers to meetings where he challenged them as to why they still called themselves peasants, when they were no longer self-sufficient. He asked them what they needed to become self-sufficient in maize again. The only ones who reacted were the farmers from Yavesía who asked Flavio to find a technician or someone who could help them to improve their maize system as they did not want to fall into this situation again. This marked the beginning of the collaboration between Humberto, a researcher from Chapingo Autonomous University and the Yavesía farmers and the encounter and hybridisation of two cultures of technology around maize.

4.3.3.3. The role of policies and global factors

Yavesía is not an isolated place: despite its remote location in the mountains of Oaxaca, policy and globalisation have their effects. The Bracero Programme of the Mexican and U.S. governments encouraged men from Yavesía to migrate as early as the 1940s. Later, in the 1960s a CONASUPO food store opened (Garcia, 2008) in Yavesía, where farmers could buy basic foods, such as maize, beans, milk, eggs and sugar. The government thought that by supplying farmers with their basic needs, they would be more easily transformed into industrial wage labourers.

Another policy that has indirectly shaped the internal dynamics in Yavesía is the North American Free Trade Agreement (NAFTA), launched in 1994. In the wake of NAFTA, Mexico started importing more than 50% of the maize that it required, part of which was supplied to the CONASUPO stores. To compensate domestic maize producers through the assumed 15 year transition period in which it was thought that Mexico's peasants would become labourers or industrial workers, the Mexican government launched the Programme for Direct Assistance in Agriculture (PROCAMPO), which 80 farmers from Yavesía benefitted from. PROCAMPO's subsidies were linked to the size of land and number of cropping seasons, and this meant that big farmers benefited the most, due to the sizes of their holdings and their access to irrigation which allowed them to sustain two cropping seasons

(García-Salazar et al., 2011). Yet this programme also extended to more remote rural regions of Mexico, such as Yavesía. This programme continues today under the name of PROAGRO, but no more farmers nor land can be added to the list of beneficiaries.

In Mexico, AR&D is dominated by the productivity paradigm and this means that farmers in Yavesía receive limited support as the area is not seen as having a potential for increasing its productivity or becoming more market oriented. Regions like Yavesía are considered to have a limited potential to contribute to national food security and the only support they receive is via 'social development programmes', e.g. capacity building programmes and basic service projects related to water, electricity, health, etc. This binary approaches to agriculture and rural development in Mexico means that most agricultural policies are oriented towards commercial agriculture, i.e. the productivity paradigm (promoting improved varieties of maize and the use of modern technologies) (Brush et al., 1988; De Ita Rubio, 2003; Gates, 1988) with a residual set of social development programmes aimed at native maize farmers and 'marginal' areas. This set of policies has systematically excluded many farmers. the culture and technology around maize adopted by many farmers in Yavesía does not follow the productivity paradigm but is intertwined with farmers' lives in many intangible ways. Several authors (Aguilar et al., 2003; Brush et al., 1988; Gómez-Oliver, 1995) have documented how maize cultivation, particularly among indigenous communities, maize cultivation is part of their biocultural diversity and not exclusively about seeking to maximise yields. Yet most policies of the Mexican government have sought to excluded 'subsistence' native maize farmers, due to the fact that they are not fitting in with the agricultural productivity approach, including: the Mexican Agricultural Programme in the 1940s (Harwood, 2009), the Puebla Plan in 1967-1984 (Cano and Winkelmann, 1972; Felstehausen and Díaz-Cisneros, 1985; Redclift, 1983), the Maize Plan in 1969-1975 (Maximiliano-Martínez et al 2011) and most recently MasAgro Programme (2010-2020), although this did begin to include native maize and indigenous regions four years after its launch (Camacho-Villa et al., 2016).

MasAgro Programme and Yavesía farmers encountered each other in 2014 when Humberto, the researcher, had no more resources to continue working with the local farmers. The emergence of MasAgro Programme and the encounter of Humberto and Yavesía farmers were somehow shaped by similar factors. In 2007, Mexico faced 'the tortilla crisis' due to its dependence on maize imports from the U.S. and the boom in demand for maize based-biofuels in the U.S. Despite this critical event, Yavesía farmers in 2007 had enough money and enough maize to supply their own needs. In 2008 and 2009, the climatic shocks not only hit Yavesía, but much of Mexico, creating a shortage of maize. This stimulated the emergence of the MasAgro Programme, which adopted the narrative of food security and the need to modernise Mexican agriculture through the use of sustainable and modern technologies, e.g. conservation agriculture and improved maize seeds, among other things (Camacho-Villa et al., 2016). The maize shortage in 2010 also pushed farmers in Yavesía back into native maize farming. Yet, the initial thrust of the MasAgro Programme

meant that subsistence farmers, such as those in Yavesía, who cropped native maize were excluded. Despite this, the Chapingo researcher received annual grants to sustain his work in Yavesía in 2011, 2012 and 2013 from different Mexican government institutions. He explained that this was quite rare since most support given to farmers using native seeds was only on a short-term basis, mostly to explore the genetic potential of the seeds that were being used and to see if they were 'worth preserving'. But after the elections in 2012, the government launched the programme 'National Crusade Against Hunger' which prioritised the indigenous population and requested that the MasAgro Programme embrace native maize and include indigenous populations within their strategies. This benefitted the farmers of Yavesía.

The events we have highlighted in this section help explain how native maize farmers have coexisted with the rationales underlying the agricultural productivity paradigm, while also hybridising traditional farming with other elements in an attempt to adapt to a changing world.

4.4. The right to self-determination and the right to food

On repeated occasions farmers mentioned how important their maize is, in our words, their right to maize is a simplification of their right to food. This right to maize is linked to their *milpas*, natural resources and enclosed in a *'territory'*: the Yavesía community, which the farmers call home and feel deeply linked to. The expression "we had money but no maize" was repeated many times and was used to express how farmers' lives were threatened by the absence of maize. For maize cultivation and to cultivate their lives, farmers need land, water, soil and other elements within their territory. Farmers' narratives constantly refer to their territory as the space they own and need to defend in order to protect themselves. Andres had this to say:

> "Did you know that we are brave people? My father fought in the Mexican revolution, he defended our territory from the revolutionaries, our parents slept with guns in the lower parts of our mountains with the farmers from neighbouring communities. They were ready to die to defend our ancestral land because no one has the right to take it away from us. The revolutionaries understood that and left."

Although the Zapotecan language is not widely spoken anymore, farmers repeatedly call themselves Zapotecan. For many years, Yavesía and many other communities in Oaxaca, especially the indigenous ones, have defended their right to self-determination and enacting this right has been made easier by making the claim to the ancestral land, the sense of place and an identity as Zapotecan people. This gives farmers a sense of place where, within flexible boundaries, they can weave together elements of their cultural identity and modernity, hybridising different elements that fit their changing aspirations and the changing world around them, such as bringing in improved fruit varieties and irrigation

into the *milpa*. This is also the space where all the inhabitants play a role in defining and maintaining the rules and norms that everyone should respect: they decide and participate collectively over matters that affect everyone and they claim their right to self-govern by the *usos y costumbres* and also to work and participate in collective activities (*tequio*) that affect them as a community. For example, farmers refused to exploit their forests fearing that their water resources, maize and lives would be affected. This has led them into conflicts with neighbouring communities that wanted to exploit the forests. However, they collectively agreed on cleaning the forest to keep it healthy and only cutting down old and infested trees. Keeping a healthy forest ensures them access to the water they need for their maize plots and to continue their way of life.

Migration has been and continues to be an important driver of change in Yavesía. However, the farmers we talked to do not seem to have an internalised discourse of poverty as a result of this experience. While farmers from Yavesía are able to travel legally to the U.S. for temporary labour, some farmers choose not to leave. Those who do, usually return home every year and finally settle down in Yavesía when they approach the age of retirement. Ines, an 80-year old grandmother, told us about her son Juan, who never left the village. When we visited him in his home, we saw the adobe walls and the laminate roof, the sacks of maize at the entry, a washing machine and the ground floor. Our first thoughts associated the family with poverty. We talked to Juan and his wife as we climbed the mountain to feed and give water to *´Niño´* (*kiddo*), his beloved donkey. We asked him why he never left and he explained:

> "Well, this is my land, here I am my own boss, I have all what I need. I have my family, my house, my maize, my donkey. I go and work sometimes in neighbouring communities, but I do not really need to, with what I make here locally and what my wife does, we have sufficient to live. If it is too rainy and cold, I can afford not to work and stay home. I like my freedom; I like deciding what I want to do".

Poor? Who is poor? What does actually mean to be poor? Juan has his maize fields, a house, his family and his beloved donkey in a place where his way of living is 'normal'. For him there is no reason to leave.

4.5. Conclusions

We synthesize our findings on maize in Yavesía in three main points. First, the Yavesía maize culture embraces other intangible elements that are at odds with the productivity paradigm. Second, farmers' culture of maize is dynamic and has been hybridised over time in attempts to fit changing conditions and preserve autonomy and security linked to a territory. Third, the dichotomic approaches that are part of the discourse of AR&D do not reflect the reality of a farming community like Yavesía.

The concept of the culture of technology of maize accommodates the different ways that farmers relate to a technology, e.g. the use of native seeds and their link to the social fabric, a sense of belonging, sovereignty and resilience. As researchers in AR&D we learn and propagate the idea that agriculture is about food production, and increasing yields per unit of input (following the modernisation paradigm). However, the farmers of Yavesía demonstrate that there are other aspects of the maize that R4D practitioners ignore, and at times have undermined. These aspects cannot be captured in approaches that commodify culture, identity, territory, as such approaches fail to understand how farmers and the principles of *comunalidad* are intertwined and are an essential component of the livelihoods of farmers. Farmers do not make a distinction between modern or traditional seeds; they keep their seeds as their *enfants* (Nazarea 2013) which have intangible (to us) meanings beyond their productive potential. Farmers in Yavesía do not (only) consider the yield of their maize in the *milpa* but also how well it preserves, how good it tastes and if it can grow with sufficient beans, pumpkins and fruits. It is important that maize is able to survive hurricanes and that working the *milpa* fields can be combined with temporal migration of the husband to the U.S., allowing the farming households to live self-determined lives. The maize is essential to farming families and has other intangible meanings that affect farmers in ways we hardly can imagine or measure, e.g. social cohesion, which is linked to their territories (Loring and Gerlach, 2009).

Our second point is that the maize and farmers' livelihoods, as a culture of technology, is dynamic and changes over the time. The culture of maize and farmers' livelihoods is repeatedly adapted to changing conditions regardless of the nature of the driver, e.g. the abandonment of the *milpa* systems in the upper lands to the adoption of improved fruit trees or planting arrangements that allow the women to manage with a reduced tilling regime in response to the migration of their husbands. While the *tequio* has been abandoned for more individual labour arrangements, people have continued planting native maize varieties to assure the availability and access to food, independent from the outside. The incorporation of irrigation, of mycorrhiza and fertilizers and the organisation of a seed bank, are all ways in which the village has adapted its practices to meet new situations and try to remain resilient to climatic and political shocks. We can say that farmers have hybridised their culture, farming practices and livelihoods in order to defend their autonomy and their territories, which are closely linked to their sense of belonging and identity. They

draw on the modern and traditional worlds to create a hybrid one in their attempt to defend their livelihoods in the face of changing external realities and changing opportunities and aspirations. By reinventing themselves they seek to co-exist with a changing world, yet also maintain their own cosmovision and values. This supports the argument of Escobar (2018) that farming communities take elements and from a pluriverse and hybridise them in to accommodate to a changing world. This hybridisation or expression of their *comunalidad* (Martinez Luna, 2010) is easier in a *territory* that they call their homeland, i.e. where their rules, their community-based organisation (*tequio*) and right to self-determination (*usos y costumbres*) can be enacted and where they cultivate maize and celebrate life (*fiesta*). This is what Dukpa et al. (2018) referred to when they wrote about place-based identity. This defence of territory, self-determination and life comes to the fore every time that the farmers recall how their parents were revolutionaries and were willing to die to defend their territories.

Agricultural development and research has tended to approach food security from dichotomic rationales as Soper (2019). The world of AR&D has grown used to using opposing rationales, resulting in a world of dichotomies. There is one (dominant) element within AR&D that promotes the productivity paradigm (using modern technologies to increase yields) as the way to achieve food security and improve farmers' livelihoods, thus converting 'underdeveloped' traditional agriculture to modernity. There is also a counter-movement within AR&D that advocates the preservation of traditional farming systems, advocating their purity and often demonising the modernization paradigm. At the end of the day neither of these approaches seems to fit the world of the farmers in Yavesía, who seek to combine elements from the traditional and the modern, as they see fit, to give continuity to their lives in changing circumstances. Having understood the broader cultural meaning of maize technology and the dynamics of hybridization within it, we argue for a hybridization of these two seemingly competing, if not conflictual, paradigms within AR&D, which needs to move beyond this dichotomy if it wants to be an effective agent in contributing to the lives of people in places like Yavesía and their efforts to cope with changes. Sometimes this can involve exercising their "right to stay home" (Bartra, 2008) but it can also involve to migrating voluntarily, rather than by being forced to do so by external factors. Embracing new ways of perceiving the world is important because, while some might talk of 'food security', and others of 'food sovereignty', in the end the ultimate goal is improving peoples lives and respecting their own ways of perceiving "their will to improve" (Li, 2007), *'comunalidad'* (Martinez Luna, 2010) or something else.

Chapter 5

The continuous process of learning in an SMS mobile-based intervention: the case of MasAgro Mobile in Mexico

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Farmer using MasAgro Mobile service in Mexico in 2013. (Source: Martinez-Cruz, T.E. and CIMMYT, 2013).

Abstract

Assuming that information can empower farmers to lift themselves out of poverty, information and communication technologies (ICTs), especially mobile phones, are promoted in agricultural development. The effectiveness of mobile phone-based interventions are contested however, because, whereas some are reported as successful, others are reported as unsuccessful. We highlight two elements that might affect the success or failure of these interventions. First, there is limited literature on the role of learning in ICT4D interventions and the factors that affect whether projects adapt through learning and redesigning, or whether projects are discontinued, and new projects emerge. Second, mobile-phone initiatives are criticised for overlooking contextual complexity and tending to problematise situations in technical terms, ignoring broader socio-political factors. We examine these factors in the case of MasAgro Mobile (MMV), an SMS-based information system that originated in 2009 in Mexico. The MMV experience suggests that the development and implementation of ICT-based information services is a socio-political process in several respects (e.g., via political changes, the role of monopolies, the diversity of needs, the agendas of donors) and underscores the importance of anticipating that process to make interventions more effective. At the same time, MMV is an example of a technology-based intervention that achieves continuity using different narratives, discourses, target groups, identity, and donors over a 10-year period.

5.1. Introduction

Development organisations promote Information and Communication Technologies in rural development (ICT4D) assuming that reducing information asymmetries can contribute to economic transformation and benefit the poor (Jensen, 2007). Mobile phones are among the most popular ICT4D´s due to their penetration rate and low cost (Duncombe, 2016). The outcomes of mobile-based interventions are contested, however, with some reported successful and others as unsuccessful or in need of improvement. This is partly because the outcomes are mixed and context specific (Aker et al., 2016; Harris, 2016). Arguably, assessing whether or not mobile phone-based projects yield positive outcomes is not a neutral endeavour because it depends on whose goals, agendas, and interests are taken as the starting point (Heeks, 2010; Schech, 2002; Thompson, 2004).

A regular criticism in development projects that also applies to ICT4D interventions is how they overlook contextual complexity and tend to problematise situations in mostly technical terms (Ferguson, 1990; Li, 2007), and ignore broader social and political factors. These intervention are approached as a rational plan of action that will yield predictable outcomes, even though Long and Ploeg (1989) and Martinez-Cruz et al., (2019) have shown that outcomes of interventions are shaped and negotiated in a contextual, messy, and politically laden process of interaction that frequently results in unforeseen dynamics and unintended outcomes.

In response to the complexity of the dynamics of those interventions, there are long-standing calls to enhance the learning capacity of both development interventions (e.g. Guijt and Woodhill, 2002; Ringsing and Leeuwis, 2008) and ICT development trajectories (Arkesteijn et al., 2015) and pay more attention to emergent goals and expectations rather than to prespecified objectives to assess whether an initiative yields positive outcomes. However, Ramalingam (2013) argues that there is limited manoeuvrability to grasp lessons in interventions and that – in practice – even once learned, lessons are not easily incorporated. Others add that there should not be naive expectations about the role of learning and that the recognition and acceptance of lessons can be affected by vested interests, selective observation, and/or institutional constraints (Arkesteijn et al., 2015; Kilelu et al. , 2013; Leeuwis, 2000). In other words, learning must be regarded as a socio-political process influenced by social relations and contextual conditions (Ringsing and Leeuwis, 2008) that can lead to processes of continuity and/or discontinuity (Long, 2001) in actors, agendas, goals, narratives, donors as shown by Martinez-Cruz et al., (2019).

Currently there is limited literature on how learning takes place in ICT4D and there is a need to shed light on how political and contextual dynamics influence ICT4D development and use (Duncombe, 2016; Njihia and Merali, 2013). In this paper we aim to examine how learning takes place in ICT-based projects and how this is influenced by broader socio-political dynamics shaped by processes of continuity and/or discontinuity. To do so, we studied the case of MasAgro Mobile (Referred from now onwards as MMV because its name in Spanish

'MasAgro Movil'), a Short Message Service (SMS)-based information system and show how this project found continuity from 2009 to 2019 and whether lessons learned were incorporated or not and why. MMV project originated in 2009 and was incorporated into a bigger intervention called MasAgro Programme (Sustainable Modernisation of Traditional Agriculture) launched in 2010. MasAgro Programme is a joint effort of the International Maize and Wheat Improvement Centre (CIMMYT) and the Mexican Ministry of Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA) that seeks to contribute to food security and improve rural livelihoods (Camacho-Villa et al., 2016).

This article seeks to answer the following research questions:

1. What are the key challenges in developing SMS-based information services for smallholder farmers?
2. Understanding redesign as continuity and/or discontinuity of processes, what factors influence how lessons and experiences are incorporated in the redesign of SMS-based services?

5.2. Methodology

The MMV case study is reconstructed and presented diachronically to elucidate the evolution of the project and its drivers (Gerring, 2007). In line with the evolution, we analysed two sub-case studies, one pertaining to MMV in the state of Guanajuato and the other covering other regions that are known as hubs[16] in MasAgro Programme. The period of analysis comprises 2009 to 2018. Several approaches to data collection and data analysis were combined:

1. Document review: Reports obtained from CIMMYT on MMV were analysed to reconstruct the process. The figures presented in this research come from official reports from the MMV team, accessed via CIMMYT. These include:

- Think-tank report prior the launching of MMV in June 2012.
- Reports on monitoring via phone in 2014, 2015, and 2017.
- Report on exploratory fieldwork to identify farmers' needs in five different hubs (Highlands Maize, Highlands small grains, Bajío, Chiapas, and North Pacific) through semi-structured interviews (124 farmers were interviewed) and six focus groups from October to December 2012 (Figure 5.1).
- Report of a training and reflection meeting with two groups of 40 technicians (80 in total) on MMV in February 2013 that aimed to get feedback to improve the tool.

[16] A hub is 'a network of value chain actors from a particular agroecological region who work together on sustainable solutions for maize- and wheat-based farming systems' (Camacho-Villa et al., 2016, p. 457).

- Report on monitoring the MMV pilot in March 2013, covering the Bajío hub and four states: Querétaro, Guanajuato, Jalisco, and Michoacán. Thirty semi-structured interviews were conducted, and the information collected was processed using the socioeconomic survey designed by the socioeconomics programme within CIMMYT and MAXQDA software. Only data presented in official reports were incorporated in this research.

2. Participant observation: From October 2012 to October 2013, one of the authors of this paper was part of the MMV team and participated in the design and monitoring of MMV at this stage. From October 2014 to 2016, one of the authors was linked to MasAgro Programme and CIMMYT as a PhD student, allowing her to follow several MMV activities.
3. Semi-structured interviews: From July to September 2016, 15 key actors (government officers, consultants who had formerly been part of the MMV team, and ICTs experts in Mexico) were interviewed to create a historical reconstruction of the project. In August 2016, we conducted semi-structure interviews to 14 farmers, five technicians, the MasAgro Guanajuato manager and two government officials; and run a focus group with farmers. We covered topics such as the characterisation of the farms (size, cropping patterns, and location); usage and perception on the MMV service; and sources of information.

We used the information to construct several timelines of critical events, mapping critical events, drivers and key actors.

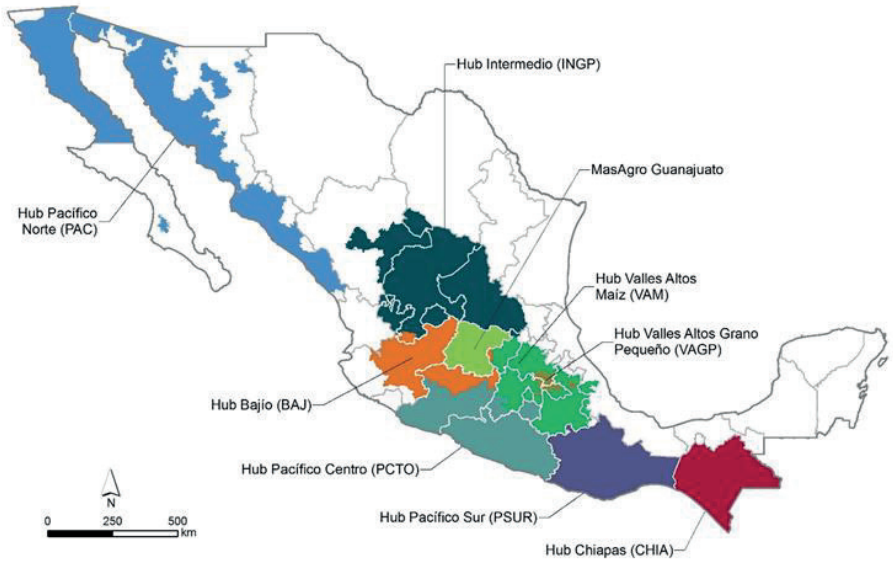

Figure 5.1. The MasAgro hubs and operation areas of MMV

5.3. Results

Our findings are presented in four sections. In section 5.3.1, we present the MMV project setup in 2017. In section 5.3.2, we present the general MMV history. In section 5.3.3, we elaborate on the evolution of specific services (weather forecasting, crop price, and agronomic information) within MMV and the challenges they faced. Finally, in section 5.3.4, we summarise figures on the number of users.

5.3.1. MMV setup in 2017 as part of the ICT4Ag MasAgro Programme unit

MMV is a SMS mobile-based service that aims to democratise information by giving everyone access to information so that they can benefit from it. MMV has three specific goals: Empowering farmers in their decision-making to increase crop yields in a sustainable way, improving communication and interaction among different actors in agricultural value chains, and scaling up MasAgro Programme in Mexico (CIMMYT, 2018b).

5.3.1.1. The role of MMV in the ICT4Ag unit

MMV is a dissemination component of MasAgro Programme ICT4 agriculture (ICT4Ag) package that consists of three elements: a database and information repository, data analysis, and dissemination channels.

Regarding the database and the repository, the MMV team collects information on key practices and factors that leads to specific outcomes in given contexts. These data can be extrapolated to other regions with similar characteristics and help others in making better decisions. This information is stored in a database to enable its re-use for future events. Some of the information sources are as follows:

1. A MasAgro Electronic Field Book (BEM), where all the data on *modulos*[17] are reported (e.g. location, cultural practices, yields, production costs, farmer characteristics);
2. GreenSat, which estimates crop nitrogen needs using satellite images;
3. Weather forecasting sources;
4. Local informants/institutions providing information related to agriculture.

The database development started in 2014 and is ongoing. Farmers feed the system by providing information about their farms throughout the cropping season (this process started from the moment they joined MasAgro Programme), and technicians constantly monitor the data collection to ensure data quality.

The database and repository are processed, analysed, and sorted to generate insights that may be helpful to various users. Some of the immediate uses of the information are as follows:

[17] Modulos are experimental fields on farmers' holdings used to validate MasAgro Programme technologies.

1. Identifying potential yields and factors limiting production as well as the best practices in each region that can serve as a reference for other farmers/users.
2. Analysing how MasAgro Programme is performing (number of hectares, farmers, and regions using MasAgro Programme technologies).

The insights generated are disseminated by MasAgro Programme for several purposes (e.g. research, reporting, accountability, and service provision) and audiences (e.g. farmers, donors, governments).

5.3.1.2. Services provided by MMV in 2017

The MMV SMS comprised two services in 2017: agronomic information and weather forecasting (see table 5.1).

MMV is organised in two ways based on coverage area: MasAgro Mobile Federal (MMV-F) and MasAgro Mobile Guanajuato (MMV-G). MMV-F provides information to eight hubs, whereas MMV-G operates only in the state of Guanajuato and is subdivided into five smaller regions. MMV-F provides information at the hub level and MMV-G does it at the sub-region level. Both can target specific groups or individuals in relation to a subregion, irrigation regime, crop, etcetera. Both MMV-F and MMV-G target farmers and technicians. MMV-F and MMV-G offer weather forecasting and agronomic information once a week and occasionally send more messages per week as requested by hub managers. Examples of the information distributed include training activities, field demonstrations, fertilisation dosages, pest control, and so forth. Neither MMV-G nor MMV-F charges for registration or information. Registration works in the same way for MMV-G and MMV-F as follows: users registered in MasAgro Programme, beneficiaries of the PROAGRO Programme (Programme of incentives for agriculture), attendees of MasAgro Programme events, and individuals requested by the hub managers are added to the platform. Assignation to hubs or regions is based on the hub manager's recommendation and on the farmer's phone code. MMV's current partner is Extensio, which provides the platform, runs the MMV system and manages a customer service line.

Tabel 5.1. Characteristics of the MMV services.

Feature	Description
1. Coverage area	1.1. ***MasAgro Federal*** operates in eight hubs: Pacifico Norte, Bajío, Pacifico Sur, Cereal grano pequeño y cultivos asociados intermedio, Valles Altos Maíz, Valles Altos grano pequeño, Chiapas, and Pacifico Centro 1.2. ***MasAgro Guanajuato:*** Operates in the state of Guanajuato and divides the state into five regions: Altos, Poniente, Centro, Sureste, and Sierra
2. User	Two users: farmer and technician
3. Type of information and content (fit into 160 characters)	3.1. ***Agronomic information*** - Names of chemicals (e.g. fertilisers, to combat pests/diseases) - Advertisement on field days or training events - News related to the hub - Yields that other farmers have achieved by using any MasAgro Programme technologies - Suggestions on agronomic practices Example: 'Identify whether there are pests in your field by taking samples once a week or every 10 days. Use the zigzag method.' 3.2. ***Weather forecasting information*** - Minimum and maximum temperatures, wind speed, and/or rainfall. Example: 'Light rain, Thursday 26th 60% rain, wind SE 9km/h' - Rain forecast for a month - Extreme events for a month, e.g. drought, hurricane - Information provided only through the cropping season for maize, wheat, barley, and sorghum
4. Frequency	- At least once per week and usually on Monday - Sometimes more messages are sent depending on the hub needs and usually on Mondays
5. Instructions to subscribe	- Via internet at http://movil.masagro.org/es/registro-en-linea/ - Through registration lists at training events and field days - Extensio, the MMV platform provider and administrator, adds users registered in the MasAgro field notebook (BEM) and the Mexican programme PROAGRO by sending farmers an SMS to confirm whether they want to be registered or not - By request of the hub managers, who send a list of users to be added
6. Target group	Farmers with access to a mobile phone and collaborating with MasAgro Programme and PROAGRO Programme in Mexico
7. Price	No cost for subscription or SMS

5.3.2. General history of the SMS service

In this section, we analyse the evolution of the MMV project until 2018 in terms of its leadership, narratives, objectives, funding, team structure, and services offered. In Figure 5.2, we summarise key events to elucidate the evolution of the MMV project. We have divided the project's history into five phases along developments in the underlying narrative and objective of the project.

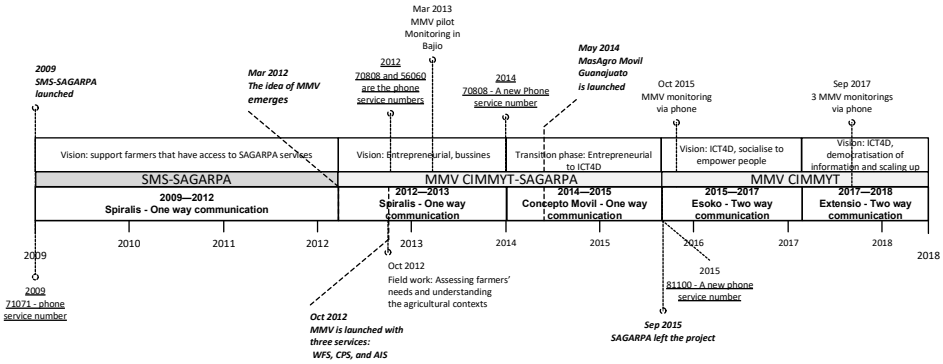

Figure 5.2. Critical events of the evolution of SMS-SAGARPA to MMV

5.3.2.1. Service to inform farmers about their subsidy application status

In 2009, an SMS mobile-based service was launched by SAGARPA (SMS-SAGARPA) to inform farmers about their subsidy application status with SAGARPA by requesting it through an SMS with an assigned code. Additionally, SAGARPA and the Unit of Support and Services for Commercialisation of Agriculture (ASERCA, *Apoyos y Servicios a la Comercialización Agropecuarias*) designed a weather forecasting service (WFS) and crop price service (CPS). The platform used was Spiralis, and the telephone registration number was 71071. Neither studies before the implementation of the project, nor monitoring or evaluation studies are reported. The project was shared in public events and advertised on the SAGARPA website.

5.3.2.2. Microbusiness vision

In 2012, CIMMYT considered developing an SMS system with a microbusiness orientation. The SAGARPA convinced CIMMYT to take over and build upon SMS-SAGARPA which CIMMYT called the MasAgro Mobile (MasAgro Mobile, MMV in Spanish) pilot version (MMV-pilot). CIMMYT added a new channel to the SMS-SAGARPA system run by Spiralis with a telephone number 56060, which provided agronomic information and aimed to reach various users fitting a microbusiness vision. The crop price service was restricted to maize and wheat because these crops fall within CIMMYT's research scope. The project was led by CIMMYT, with collaboration from SIAP (the Agricultural and Fisheries Information

Service) and SAGARPA. The agronomic information channel was the first attempt to reach beyond farmers to a broader range of actors. This implied a considerable widening of the target audience: while SMS-SAGARPA was aimed at farmers who were eligible for subsidies, MMV-pilot explicitly targeted all types of farmers. Five categories of users in six regions were identified, resulting in 30 user profiles.

The microbusiness vision was that the service would become sustainable by providing a platform for information exchange that people would be willing to pay for. For example, farmers would pay for technical advice and offer their crops to buyers, technicians would advertise their expertise, input dealers would advertise their products, buyers would advertise their collection points and their prices for crops, and researchers would support farming-related activities and benefit from this by selling their research expertise. In addition, MMV envisaged that banking institutions would come on board to provide microfinance services to farmers.

At this stage, CIMMYT hired an ICT4D expert with previous experience in Africa to join as a programme administrator on the MMV-pilot team. The latter left shortly after the project launch and was replaced by an agricultural engineer with some background in the Mexican agricultural landscape. At this point, the MMV project focussed on three goals: running MMV-pilot with the three services as a pilot to gather experience with the Mexican landscape; exploratory fieldwork in various regions of Mexico to learn farmers' needs and contexts and then fit them with a mobile tool; and exploring and meeting donors and potential collaborators. The MMV-pilot included training and promotion activities, and a range of monitoring activities to test the tool and gather experiences and feedback from farmers and technicians. All of this resulted in numerous meetings with collaborators to fix problems and engage them actively to build trust.

5.3.2.3. The transition stage from business model to ICT4Ag

At the end of 2013, the agricultural engineer left the team, and a microbusiness-oriented person joined the project. The new team member had a different vision that was less oriented towards fostering interaction with users in order to enhance the system, and more focussed on keeping it running amidst financial constraints. One of the major changes in 2014 was the migration of the service to a new platform called *'Concepto Movil'*, a more flexible platform that would allow the creation of a larger number of user profiles. This was deemed necessary if the project was to expand, and a new subscription number 70808 was introduced. A change in the local political leadership in the state of Guanajuato gave rise to the emergence of a more regionalised project, MasAgro Guanajuato (MasAgro-G) in 2014 with a similar logic as the national MasAgro Programme (see also section 5.3.2). In 2014, an ICT unit was created within MasAgro Programme and a leader was assigned to streamline various MasAgro Programme ICT-related projects, e.g. BEM, GreenSat. MMV then moved from being its own project under MasAgro Programme to a being a component of the ICT4Ag unit.

5.3.2.4. MMV as a mechanism to disseminate information in the ICT4Ag unit

From 2014, MMV has been a dissemination component of ICT4Ag directed towards the hubs. Early in this period, the new national level leader of SAGARPA announced a Crusade Against Hunger (Camacho-Villa et al., 2016) which demanded that MasAgro Programme prioritise subsistence and indigenous farmers. With this shift in vision and narrative, the microbusiness specialist left the project. At the end of 2014, the MMV team evaluated the performance of the system through a phone survey. In 2015, three changes occurred: a new leader with expertise in systems engineering joined the project, and a new platform called ESOKO (which was based in Africa) and a new telephone service number (81100) were adopted. These changes had important consequences for the project. First, the new leader was concerned with automatising the system to reduce costs. One of the solutions was that every time a message was pushed via MMV, users received it from a different number to reduce operation costs. Second, the ESOKO platform allowed for two-way communication, unlike *Concepto Movil*, facilitating interactions between the users and the MMV team. The ESOKO platform was also more flexible for future expansion and was fully managed by the MMV leader, meaning that problems could be fixed directly. At this stage, SAGARPA decided not to migrate the SMS-SAGARPA service (CPS and WFS), and therefore MMV-F only included the agronomic information service (AIS). In 2015, the MMV-team monitored the system via phone survey, and, in 2016, we (the authors) collected information alongside the MMV leader which he used to monitor the programme.

5.3.2.5. MMV to scale up MasAgro Programme technologies and processes

From March 2017 to date, MMV remains part of the ICT4D unit and using the platform Extensio, which is the Mexican version of Esoko. In 2017, the MMV-team ran three monitoring activities, using a sample of 7% of users (144 of 2,053 users): the first created a baseline of needs and users' profiles, the second evaluated the performance of the system and users' perceptions in mid-2017, and the third did the same as the second, but at the end of the year to have the overall figures for 2017.

5.3.3. Challenges and evolution of the SMS services

In this section, we focus on the three services offered by MMV throughout these years and elaborate on the challenges faced.

5.3.3.1. Experiences with the weather forecasting service

In this section, we present the main challenges faced by the WFS and some actions taken. Figure 5.3 summarises the critical events in the evolution of the service.

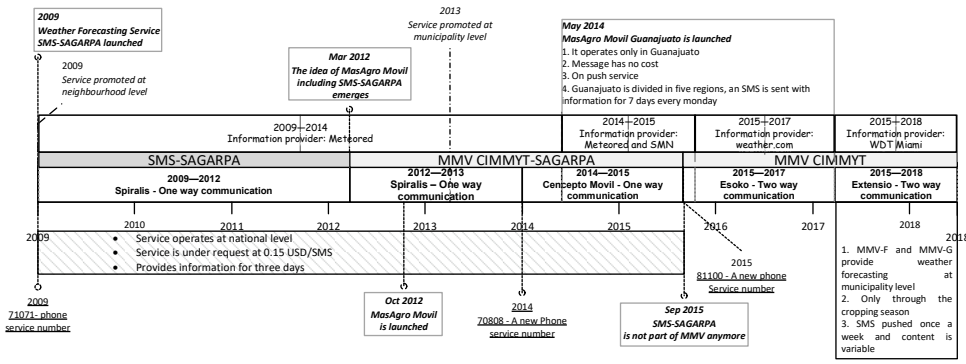

Figure 5.3. Critical events timeline of the MasAgro Mobile weather forecasting service

WFS was launched in 2009 by SAGARPA and provided weather information (maximum, minimum, and average temperatures, state of the sky, and a 3-day rain forecast) at a neighbourhood level drawn from Meteored, a Spanish free-of-charge database. The service worked on demand at a cost of 0.15 USD/request. It was a one-way communication system, meaning that MMV could send messages but users could not reply. In 2012, this service was incorporated into MMV without changes.

In January 2013, the MMV team tested the system to determine the reliability of the information. Requests for different locations over a two-week period and the data received from Meteored were compared against real-time meteorological information. The results suggested that the information provided was far from reliable, a complaint that had also been voiced by technicians during training events. Technicians also pointed out that not all neighbourhoods were available in the database. Subsequently, CIMMYT, SAGARPA, and SIAP concluded that Meteored could not provide more precise information for neighbourhoods, thus, they proposed the Mexican National Weather Service (SMN) as an alternative provider with a greater capacity to produce accurate information. The MasAgro Programme leader also considered that collaborating with the SMN, a Mexican institution, would help strengthen national partnerships. The negotiations started but the change never materialised, reportedly because in 2013 both SMN and SAGARPA acquired new leaders with different priorities after the federal elections in 2012. Eventually, none of the institutions involved wanted to pay for creating and processing more refined information.

Only in 2014 with the emergence of the locally-funded MMV-G and a new MMV leader with technical expertise in computer systems was it possible to process information from the SMN website and feed it to the WFS in Guanajuato, whereas the WFS in the SAGARPA sponsored MMV-F continued using information from Meteored. However, the MMV-G arrangement was short-lived because, from 2015 onwards, SMN data was no longer accessible due to a change on their website. Subsequently, MMV-G shifted to the Weather. com website as a source of information. When MasAgro Programme migrated their mobile

system to the ESOKO platform in 2015, the national weather forecasting programme returned to SAGARPA, and, from then until March 2017, the MMV project provided weather forecasting information only for Guanajuato. Field monitoring in 2016 in Guanajuato among farmers and technicians indicated that the weather forecasting was now more accurate although there were several reasons for not using the service (elaborated in sections 5.3.3.1.2–8).

In 2017, with the adoption of a new platform, Extensio, MasAgro Programme created their own weather forecasting system which was activated both for MMV-G and MMV-F and which provided information at the municipality level using databases from WDT Miami and the National Water Commission of Mexico. The new weather forecasting system works only during the cropping season of key crops, and the frequency and the specific weather details contained of the message is discussed and agreed upon with the hub managers, e.g. daily precipitation for a week, weekly or monthly average, maximum or minimum temperatures.

5.3.3.1.2. Actionability of the information

From 2009 to 2015, the weather forecast was given for three days and included four variables: maximum, average, and minimum temperature, and state of the sky. However, such information was not necessarily easily interpretable and actionable for farmers. The following testimony is typical of the issues encountered:

> At first, when I requested the weather forecast for my neighbourhood, the phone said it did not exist. I tried instead using my municipality, thinking that my neighbourhood was too small to appear on the map. When I got the message, I had no clue of what it meant. I forwarded the message to my technician. He said that there might be a frost that night because temperatures below zero were predicted. I am the 'canalera' (the person who distributes water in the fields). I am responsible for turning the pumps on and off and verifying who gets water based on our schedule. I remembered that, when a frost comes, we are advised to irrigate our fields. 'Entre que son peras o son manzanas' (I was not sure) I tried and irrigated two of my three fields. To my surprise, the next morning many people had lost their crops due to the frost and I managed to save the ones I irrigated (Interview-F-IH, 2013).

This testimony indicates that the information was relevant, but that translation and interpretative support by a technician was needed to make it actionable. In addition, we see that actionability may depend on other conditions, such as – in this case – immediate access to water. In the 2013 monitoring, 13% of the farmers interviewed in the Bajío hub used the MMV WFS at least once. At the same time, all these interviewed farmers opined that more training was needed because it was not clear how the WFS could support their

farming activities, and that also included a better description of units of measurement and their meanings. Later in 2013, the training was improved along these lines.

In 2014, with the emergence of MMV-G, the format of information changed. Farmers and technicians in Guanajuato received information for up to seven days every Monday (maximum, minimum, and average temperatures in Celsius, percentage of relative humidity, and state of the sky). MMV-F at national level kept running in the same way with messages up to three days. In 2016, an earlier recommendation to change the 'state of the sky' to 'mm of rain expected' was voiced again, but no actions were taken because changes in the MMV team caused the request not to be passed to the new leader, meaning that information was lost in the process of transition to different team members. In 2017, the monitoring showed that farmers are mostly interested in precipitation, and in 2018 the MMV team is prioritising precipitation and extreme event alerts as part of the SMS content.

5.3.3.1.3. Insensitivity of the system to human logic and error

From 2009 to 2015, the users could request a weather forecast message by typing the word 'clima' followed by their locality and state. The MMV system was programmed to read some typographical errors. However, 19% of the requests received from December 2012 to May 2013 had so many typographical errors that the system could not read them, and therefore no messages were sent back to the users. Moreover, 18% of the requests that the system processed correctly were answered with the message 'no information is available'. A first reason was that the programmed algorithm was unable to process additional words such as those underlined in this example: 'Please send me clima from San Pedro y San Pablo Ayutla Oaxaca'. Second, due to spelling issues, especially with longer locality names, the system often could not find the exact match. To fix these problems, training materials were adapted to help farmers anticipate the logic of the system. In the MMV-G version in 2014, and later with the new weather forecasting system for MMV-F in 2017, these issues were resolved by sending push messages linked to the area codes of users' phone numbers.

5.3.3.1.4. Mismatches due to ambiguity in location names

A related issue from 2009 to 2012 was that local names of neighbourhoods and municipalities did not always match those in official databases, even if MMV was designed to read some homonyms. For example, a user would receive an incorrect response if she requested information for 'Cieneguilla' (as it is known locally), whereas this community is officially named San Luis Cieneguilla in Oaxaca and labelled in the MMV database as 'Luis Cieneguilla, Oaxaca'. Instead, the user would receive information for a community named officially "Cieneguilla, Durango", which is registered in the MMV system as 'Cieneguilla', with 'Cieneguilla' as a homonym (Figure 5.4). Plans were made to address this homogenisation issue as part of the intended shift from Meteored to SNM but never materialised in view of the cancellation of this collaboration. A solution suggested by the Gates Foundation was to find the user location via the GPS function of their phones. However, this was not possible

due to Mexican privacy and security regulations. Eventually, MMV-F resorted to addressing the naming issues in the training of technicians, who were advised to use the official names and share these with their farmers. For MMV-G, and later MMV-F in 2017, this issue was resolved using area codes as described earlier. In the 2016 monitoring, 23% of the MMV-G farmers interviewed were using the system with such codes.

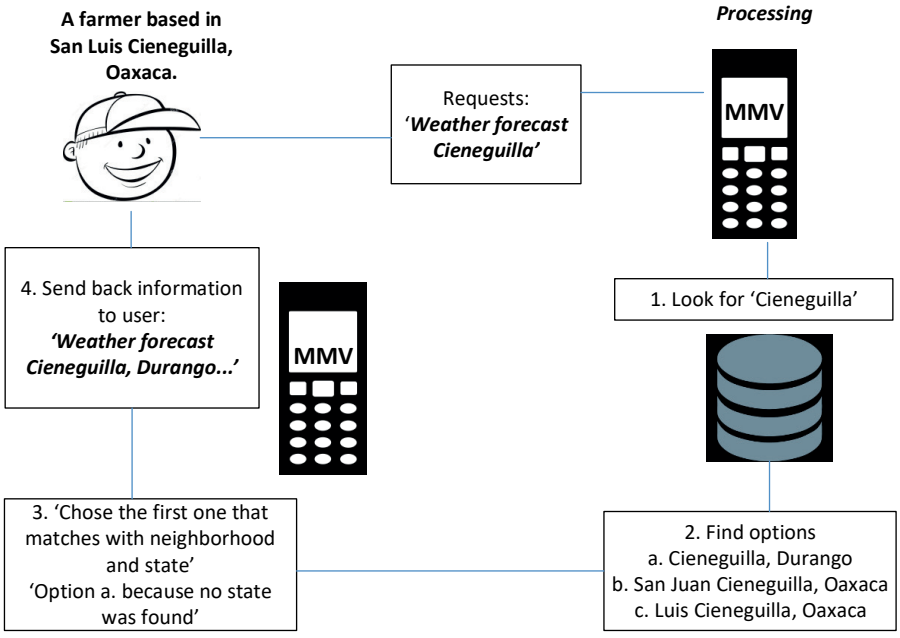

Figure 5.4. Description of the weather forecasting service algorithm to deal with homonyms

5.3.3.1.5. Different operation numbers

Throughout the history of the project, different operation numbers were used, causing confusion among users. From 2009 to 2013, the number 71071 was utilised and linked to the Spiralis platform. From 2014 to 2015, *Concepto Movil* used the number 70808. From 2015 to 2017, the WFS operated only in Guanajuato, with the ESOKO service number 81100. However, every time the MMV-G system sent a message back to the user, it did so from a different number. Many users indicated that they found the range of numbers used confusing, preventing them from accessing the service. In 2017, the 81100 number was preserved and is now the only number pushing the messages.

5.3.3.1.6. Cost of the service

From 2009 to 2015, the WFS cost 0.15 USD approximately per request. This cost was associated with the network provider rather than with the production and processing of information itself, which was already covered by SAGARPA. Many users claimed that, due to the problems described in the sections above, the service did not deliver value for money and should have been free. As mentioned, the local MMV-G donor allowed the service to become free from 2014 onwards. Also, MMV-F was free of charge from March 2017 onwards.

5.3.3.1.7. Challenges of an SMS for diverse users

The MMV team became aware over time that text-based messages in Spanish did not suit all the users. However, changing the format has been challenging. The monitoring activities revealed that a diversity of users in Mexico required different information formats. For example, in some areas, illiteracy and mobile illiteracy were high, leading to the conclusion that a voice-based system might have added value. Such a system was also considered given that there are 68 native languages in Mexico, most of which are used only orally and not in written format. The MMV team explored a collaboration with the Gates Foundation to develop a voice-based messaging system in native languages, but this did not materialise because the Gates Foundation and the MMV team had different geographic regions of interest, and MMV would have had to cover all the costs involved in developing such a system for their regions of interest.

In other regions, an SMS seemed obsolete because users had access to smartphones and were familiar with other internet-based applications that provided more information more cheaply. In the areas where an SMS system seemed feasible, the limitation of the messages to 160 characters led to messages in keyword style, which were difficult to interpret and contextualise (see 3.3.1.2.). A version of multimedia messages (WhatsApp) was piloted for Pac hub in 2017 to extend the message content and increase interaction among users. Groups of users were created based on farmers' cropping patters, farming characteristics, and locations. However, as everyone had access to the group chats, 'the chats were easily spammed' (Interview-P-DP, 2018), e.g. chain messages, pictures, jokes, and other information of non-common interest. This version remains as a pilot.

5.3.3.1.8. Network coverage

One of the main challenges for mobile-based tools in Mexico is regional variability in terms of network coverage, network quality, and diversity of network providers. In the southern parts of Mexico, not all the regions had mobile phone coverage and, in most rural areas, only one network provider was available. This contrasted sharply with urban areas in northern Mexico, where multiple providers were available and where some farmers had contracts with several network providers to resolve differences in network quality across locations. Suggestions for areas with poor coverage included the use of local radios that had better

penetration rates and collaborating with mobile network providers to increase penetration and coverage. None of those solutions was adopted, because using local radios required more investment and none of the network providers was attracted by the project because it was not deemed profitable to invest in infrastructure in those areas.

5.3.3.2. Experiences with crop price information

Key events in the evolution of the CPS are reflected in the timeline in Figure 5.5. Below, we present some specific developments, challenges, and lessons related to CPS. We leave to one side those challenges that were similar to those faced for the WFS, for example in relation to costs, operation numbers, and network coverage. We focus instead on the crops covered, the actionability of the information, the capacity to empower farmers, and the insensitivity of the system to language and wording.

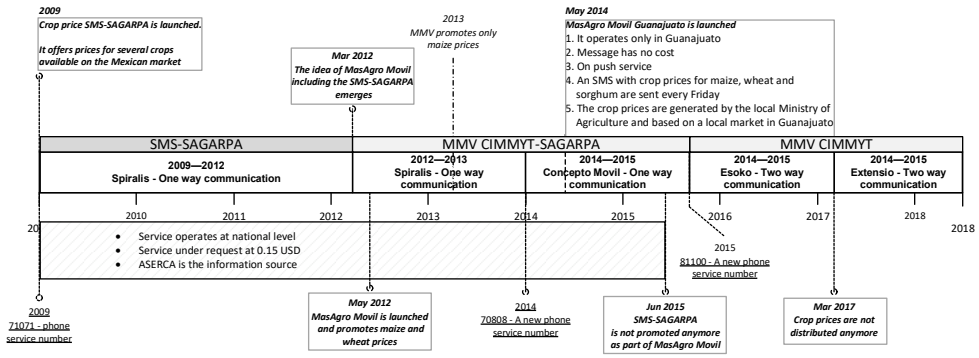

Figure 5.5. Critical events timeline for the MMV crop prices service

5.3.3.2.1. From all the crops to wheat and maize

The CPS was initially part of the SMS-SAGARPA service and provided information for a range of crops available on Mexico City's main market. SIAP collected and processed the information to feed the system.

In 2012, CIMMYT and SAGARPA incorporated this service into MMV and narrowed it to maize and wheat crops, i.e. crops dealt with by MasAgro Programme. In 2015, when MMV-G emerged, the system also provided price information on barley and sorghum because of the importance of these crops in Guanajuato.

In 2017, with migration to the Extensio platform, the CPS was suspended due to changes in the team and new action plans.

5.3.3.2.2. Actionability of the information and empowerment

This service aimed to empower farmers: giving them price information would give them greater leverage in determining selling strategies and during price negotiations. The prices

diffused through MMV were the prices on the main market located in Mexico City. In the 2013 monitoring and in several workshops organised as part of MMV-F, users claimed that crop price information from Mexico City's main market was not useful and – on the contrary – upset farmers because in practice they did not have much space for price negotiation as there was usually no choice in deciding to which intermediary to sell their crop. In further training sessions in 2013, the MMV team emphasised that the information should be used only as a reference point for understanding price developments and trends over time.

MMV-G learned from MMV-F and developed a more reliable CPS in 2014. MMV-G solicited price information from SAGARPA in Guanajuato, which in turn took the prices of the main Mexico City market, adjusted them using data from the main local market in Guanajuato, and made the information available on their website and through weekly MMV-pushed messages. According to users, this information was more realistic and useful and encouraged farmers to invest in crop insurance to ensure a guaranteed price. SAGARPA Guanajuato held monthly meetings with farmers to discuss issues related to agriculture and emphasised that the price information was valid only if the farmer had crop insurance, a type of forward sale contract. During the field monitoring of 2016, only 6% of the farmers interviewed were aware of the service, and none of them was using it.

There were limits to how farmers could act on the price information, but pressures from powerful private sector players suggest uneasiness about farmers having access to information that enhanced the transparency of the market. The idea of empowering farmers with information was challenged in 2013 by a few individuals controlling the wheat market, who requested SAGARPA to stop distributing the wheat prices through MMV because it was leading to anger towards the monopolies. Farmers were also unhappy when they realised that they were paid low prices and that they had no other options. SAGARPA and CIMMYT indeed yielded to these pressures and stopped providing information about wheat prices in February 2013. In Guanajuato, these tensions later diminished because it became clear that the price information was tied to the crop insurance.

5.3.3.2.3. Insensitivity of the system to language and wording

Another point of trial-and-error was the insensitivity of the system to the use of language and words. From 2009 to 2015, the user had to send the term 'precio crop' to get the crop price information from SMS-SAGARPA or MMV. Adding more words resulted in 'no information available' or no response at all. Figures in 2013 show that 57% of the requests for crop prices received the information requested, 30% did not get the actual price information, and 13% did not receive any response. Another language sensitivity was the local names for crops. In the case of maize, for example, two types of maize were registered in the system: yellow and white. If a farmer required the price of yellow maize but he typed 'maize' alone, the system would return information on white maize.

Aiming to overcome the insensitivity of the system, the training events emphasised that farmers should follow the logic of the system.

5.3.3.3. Agronomic information channel

MasAgro Programme launched an agronomic information service (AIS) in 2012 that aimed to distribute key information to several actors along the value chain for wheat and maize. In Figure 5.6, we present a summary of the key events that shaped this component. Below, we discuss key developments and challenges specific to this service, leaving to one side more general challenges already discussed in relation to the WFS and the CPS.

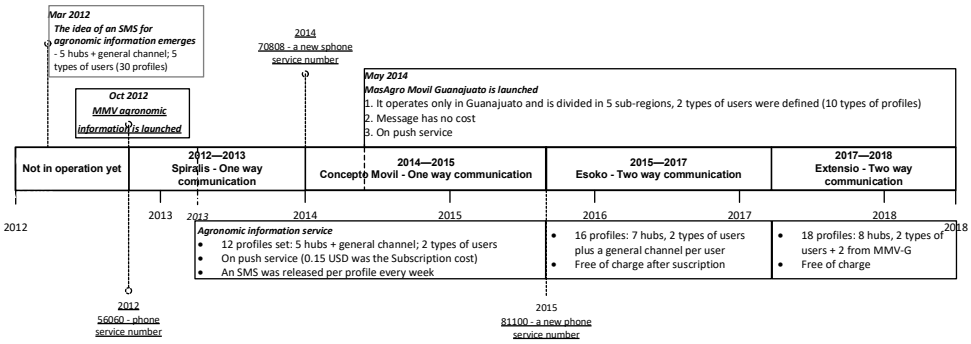

Figure 5.6. Critical events timeline of the agronomic information service within MMV

5.3.3.3.1. Fitting the needs of a wide a variety of users and agro-ecologies

Anticipating the needs of a wide variety of farmers operating in diverse agro-ecological conditions was a challenge from the start. To meet this challenge, weekly messages were tailored to five geographically defined hubs with supposedly similar agro-ecologies, in addition to a more general messaging channel. Also, five types of users were distinguished (farmers, technicians, researchers, buyers, and input suppliers), resulting in 30 unique profiles. As the project unfolded, users in the project often complained about the value of the information provided, and MMV realised that the hub was still a diverse area in agro-ecological and socio-cultural terms. For example, farmers working commercially for export markets had different information requirements than those farming for subsistence and/or the local market. Thus, further tailoring to specific needs was required. A matrix of topics needed per profile throughout the year was created, but one SMS of 160 characters per week did not provide enough space to accommodate the varied needs. However, because of financial limitations and lack of information to fit all these needs, MMV decided on a limit of two profiles per hub: farmer and technician. Monthly interaction between project staff, hub managers, and technicians was organised to foster a better understanding of user needs. These meetings resulted in a list of priority topics for the forthcoming month that would form the basis for the formulation of draft messages by the MMV team. These messages were then reviewed and validated by the hub manager and/or a technician, and subsequently pushed through MMV. This system still exists for MMV-F, which has extended its coverage to eight hubs and MMV-G for its respective regions. Thanks to funds provided by

a local donor from 2014 onwards, MMV-G managed to develop more refined and targeted messages by dividing Guanajuato state into five smaller regions. Interviews in 2016 with MMV-G users suggested that farmers and technicians greatly appreciated this development. With the migration of MMV-G and MMV-F to Extensio, the users can be tailored by different criteria (see section 5.3.1) because of the flexibility of the platform. Similar to the WFS, in PAC hub, a WhatsApp message system was designed but only ran in 2017.

5.3.3.3.2. Registration of users

Given the specific technical platforms utilised at the start, having 30 specific user profiles made the registration process a challenge. To register, users needed to type the right user category and hub, e.g. 'farmer pacífico norte'. An infographic was released to help users to register. However, on the basis of the subscription figures after six months, and observations during training events, the MMV team realised that users found the registration process complex and, similar to the WFS and the CPS, the typographical errors resulted in failed registrations. Thus, new infographics per user category and hub were released. For MMV-G, the registration difficulties were resolved in 2014, as the platform assigned regions based on the area codes of the user's phone number. In the 2017 version of MMV-F, the users are registered by Extensio and linked to the location assigned in the BEM, in PROAGRO Programme, or by the hub manager, solving this issue too.

5.3.3.3.3. Strengthening collaborators' engagement and ownership

Soon after AIS was launched, MasAgro Programme collaborators started to challenge the usefulness of the information provided. To deal with these critiques in a constructive way, MMV started monthly meetings with collaborators either via phone or face-to-face. These meetings served to identify ways in which MMV could help them to improve their work and strengthen joint ownership. For example, if a pest was attacking farmers' fields, MMV invited technicians to share messages on preventive or combative strategies. Similarly, technicians were encouraged to share the details of any events that they organised in order to enhance farmer attendance. According to respondents, such active strategies indeed improved the relationship with the collaborators. Specifically, in the Guanajuato case, the 2016 monitoring indicated that at least 50% of the technicians had shared messages through MMV-G. In the 2017 version of MMV-F and MMV-G, hub collaborators provide information and validate any information disseminated.

5.3.3.3.4. Conflicts of interest over naming

Several of the agronomic messages shared through this channel related to the use of inputs, e.g. for combating a pest, eradicating weeds, or improving soil fertility. Because the project was funded with public money, SAGARPA stipulated that only generic names of products should be used. However, farmers and technicians constantly emphasised the need to distribute commercial names, because these helped to find the appropriate products in the

stores, and references to active substances only were deemed unfriendly to the farmers. However, the MMV project insisted that sharing commercial names was not appropriate, as it might signal that the project leaders were favouring some private companies over others.

5.3.4. Users over time according to project documents

The numbers of MMV users changed over time, but precise and reliable information is unavailable. The figures are unclear for some periods of the project because monitoring was intermittent, and the type of monitoring changed from one period to another. Whereas in the beginning face-to-face interactions were encouraged, in later years most of the monitoring took place via telephone calls. In project documents is not clear whether numbers provided related to numbers of users or numbers of requests. When respondents were being selected for this research, it became clear that a substantial number of phone numbers registered as users belonged to people who did not know about MMV or had never actually used the service. For example, in the 2017 monitoring, 50% of the people interviewed by phone did not know what MMV was. In 2017 and similar to the experiences of the previous monitoring, few farmers (<20%) in the selected samples were willing to answer the monitoring phone calls. Additionally, the questions posed in the monitoring via phone tended to be close-ended, lacking the whys and other explanations.

It is also difficult to evaluate the performance of MMV based on the number and types of messages sent or the numbers of users. From 2009 to August 2012, no figures were reported. Shortly after the launch of MMV, figures were reported for September and October 2012. For MMV-F in 2014, the report summarises only the total users and requests, without specifying which services (i.e., WFS, CPS, AIS). In 2015-2016 for MMV-F, data are available

Tabel 5.2. Number of users and SMS pushed over the time by MMV project

Year/ service	MasAgro Mobile-Federal				MasAgro Mobile-Guanajuato	
	WFS (# of SMS)	CPS (# of SMS)	AIS (# of users registered)	# users	WFS + CPS + AIS (# of SMS)	# users
2009–2012	nd	nd	nd	nd	Not in operation yet	
2012	1 784a	3 999a	21a	2 038		
2013	2 192b	4 712b	595b	3 128		
2014	99 264			2 706	nd	nd
2015	It no longer exists		146 221	3 436	81 300	542
2016			149 968	1 540	122 004	1 359
2017	32 863	Does not exist	70 527	1 793	16 449	260[c]

Source: CIMMYT ICT4Ag unit
Note: The data were obtained from the MMV leader, the numbers with superscripts come from some MMV reports
a Internal CIMMYT reports
b Monitoring and Evaluation Report, August 2013
c MMV report in 2017
nd = no data available

only for AIS because the other services were cancelled. In 2017, data for AIS and the WFS are available for MMV-F. In the case of MMV-G, since 2015 all the messages of all the services and all of the users are counted together per year; this does not allow differentiation of the frequency of each service. Table 5.2 summarises the figures available from different reports.

For MMV-F, on the basis of the available data it is difficult to identify specific trends per service over the whole period. In 2012 and 2013, the number of users and SMSs was increasing. This can be attributed to the diffusion and training campaigns that were encouraged and mandatory in the first year of the project. In 2014, the number of users dropped. This can be attributed to the change from the Spiralis platform to *Concepto Movil*. In 2015, the users and SMSs increased, possibly thanks to the addition of more users through training events. However, in 2016 the number decreased again when the MMV team eliminated inactive users and kept only those appearing on 2016 registration lists and in the BEM.

In the case of MMV-G, no records are available for 2014. In 2015, the first figures were reported, and, in comparison to them, the number of rose in 2016 thanks to the training campaigns and the addition of farmers registered in the BEM. In 2017, the number of users decreased with the elimination of inactive users.

5.4. Analysis

In line with our research questions, we analyse our findings by focussing on the mechanism that affects learning in organisations and in the design and implementation of interventions. We reflect on the socio-political mechanisms that influenced how lessons and experiences were incorporated and how the MMV project found continuity over time but also led to discontinuity of some processes.

5.4.1. Responding to diversity in demands

One challenge that the MMV project faced was the difficulty to satisfy the diverse agro-ecological (e.g. climate and soil types) and social (e.g. literacy, language use, purpose of production, communications access) needs of farmers. The implications of this diversity were only recognized after a few years, as there was no serious interaction with users in the SMS-SAGARPA era.

Learning how to manage this diversity was not a smooth process. Although several ideas emerged among MMV staff about making adjustments, few of these materialized. To some degree, MMV-G succeeded in making its weather, price, and agronomic information better attuned with local realities, something that was made possible by acquiring additional funds from a local funder. This points to the fact that developing tailor-made services requires considerable investment and that funding limitations can be an important barrier. Thus, the political desire to roll out a service at national level despite limited funds led to

sub-optimal information provision and perhaps limited opportunities to experiment with alternatives.

Funding limitations were not the only factor preventing lessons regarding diverse needs being taken on board. First of all, these limitations were arguably related to socio-political issues and developments. For example, the unwillingness of commercial parties (e.g. banks and mobile phone providers) to engage in what was initially supposed to become a public–private partnership affected the funding situation. Similarly, the additional funding for MMV-G was a direct consequence of changes in the political landscape in Guanajuato. In addition to such issues of support and coalition formation, there also appeared to be legal constraints, in that telecommunication regulations did not allow GPS facilities in mobile phones to be used to identify the location of users and use this to tailor messages. Finally, the technology and ICT platforms used also entailed serious restrictions. The choice of SMS, for example, prevented the kind of interactivity that would be needed to tailor messages and constrained the number of characters that could be used in a message, reducing the messages' nuance. In 2017, the multimedia messages aimed to overcome the character limitation, but other limitations emerged, such as how to keep users actively engaged. Thus, even once issues of diversity were recognized, addressing them and turning learning into redesigning was limited by socio-political factors.

5.4.2. Meaningfulness and actionability of information

Related to the diversity in demands, issues arose regarding the meaningfulness and actionability of the information. Several of these challenges relate to mismatches between the language and terminology used by farmers and those used in the MMV database and messages (e.g. the location for WFS, variety names for WFS and CPS, and the use of generic rather than commercial product names for AIS). Arguably, the results of our research suggest that provision of general information through SMS is insufficient on its own, as further interaction with the target audience is often needed. Provision of meaningful information was also prevented at times because of quality issues, such as in the WFS case where the available databases were simply not refined enough to provide valid information for different localities. Finally, even if information was conveyed successfully, sometimes the farmers could not act upon the information because there was limited opportunity for them to do so. For example, provision of information about crop prices on national markets improved transparency but could not be easily capitalised upon in a local market dominated by only a few buyers with whom complex relations of dependence existed.

Again, lessons learned were not easily incorporated in the MMV design. Language and terminology issues were mostly addressed by offering better training so that farmers could adapt to the logic of the system. For MMV-F, efforts to improve weather forecasting and price information stalled due to lack of funds, and these services were abandoned altogether until 2017. As with diversity in demand, limitations in funding and financial support and the restrictions posed by the chosen SMS technology restricted the ability to

redesign MMV. Regulatory and political issues also played a role, in that SAGARPA insisted that commercial names could not be used despite farmers' preferences for these. Similarly, powerful interests lobbied successfully against enhancing the transparency of the wheat market, for fear of causing unrest among farmers. This suggests that donors and market parties had an important say in defining what types of information could be provided. Thus, the complex political sphere was again able to inhibit turning learning into change.

5.4.3. Finding continuity: shifting identity, meaning, and recognisability of the project

We have seen how the overarching idea of the SMS service evolved over the time in an attempt to find continuity. The SMS service evolved from being a tool for the efficient distribution of subsidies by SAGARPA to a self-sustaining mechanism for private service delivery to eventually a pro-poor information service intended to capitalise upon the results of publicly funded agricultural research and to a distribution information tool to support the scaling up of MasAgro Programme. This discontinuation of narratives and objectives, and the adoption of new ones, reflect a considerable degree of learning and had important implications for the leadership, partnership arrangement, ICT platform, type of services provided, and financial model applied. Arguably, we can speak of mutual influencing, whereby the change in narratives and objectives both reflected and induced changes and discontinuations in the project, and vice versa. For example, when it was realised that MMV could not be turned into a commercial endeavour, there were changes in staffing and partnership arrangements, which in turn reinforced relations with, and investment by, the public sector, leading, for example, to the emergence of MMV-G.

Although the rationale for the discontinuation in narratives and objectives is not fully transparent, there seem to be several broader influences and factors at play. First of all, the emergence of the microbusiness narrative and objective was in line with dominant neoliberal thinking in donor communities at the time (Matus-Ruiz and Ramirez-Autran, 2012; Thompson, 2008) and also coincided with greater CIMMYT involvement with SAGARPA that needed to revamp and reinvent the existing SMS-SAGARPA service. Quite possibly, the interest of CIMMYT (as an international research organisation) in this kind of downstream service delivery (MasAgro Programme itself) in the first place could have been stimulated by reductions in core funding within CGIAR, the simultaneous donor pressure on supporting and demonstrating the development impact of research performed (Leeuwis, et al., 2018), and the enthusiasm for mobile ICT as a new medium for scaling and dissemination (Heeks, 2010; World Bank, 2017). The later discontinuation of the microbusiness vision and narrative became necessary after the feedback that – despite many efforts – private parties such as banks and telephone companies were simply not willing to invest financially in MMV and the associated public–private partnership because the target farmers (lacking, for example, in financial education) did not represent a profitable and sustainable option for these potential investors.

As mentioned, the shifts in vision and adoption of new narratives were accompanied by changes in the partners involved and also in the technological platforms adopted for the SMS services (i.e. from Spiralis, via *Concepto Movil*, then to ESOKO, and finally to Extensio). The discontinuation of platforms and the adoption new ones was intended to address technical or organisational inflexibilities and limitations (e.g. the number of profiles that could be accommodated and the potential for interactivity), but these technical shifts also caused considerable confusion, especially relating to phone numbers and registration issues. Over the lifespan of the project, at least four different numbers have existed. These changes and discontinuities undermined the visibility of MMV as a recognisable service with a clear identity. Although there were campaigns and trainings to announce and explain changes in numbers and platforms, respondents found these insufficient. Project staff indicated that budget restrictions prevented this from being remedied.

5.5. Discussion and conclusion

5.5.1. Finding continuity by adopting new narratives and objectives

We found that the development of MMV was not a straightforward process, but was rather a circuitous process of identifying challenges, and generating insights and learning from those challenges. Our results suggest that MMV from the times of the SMS-SAGARPA had no clear theory of change and rather tried to find continuity in a messy political context by having numerous redirections and changes over time. However, we can still argue that a lot of learning took place, as those involved in the MMV intervention made changes based on reflection and feedback from previous actions. For example, the MMV project made changes of an operational nature, directed towards addressing substantive and technical challenges. In terms of classification of learning levels (Argyris and Schön, 1978), this could be termed 'single loop' learning; that is, learning towards achieving a given objective. At the same time, the changes in narratives and objectives that evolved over time may be classified as 'double loop' learning, as this reflects a questioning of the underlying assumptions and goals of the MMV endeavour. However, we also saw that several challenges could not be addressed, and that feedback and insights did not lead to the redesign of the system. Although the ambition to cater for the diverse needs of farmers across the hubs and the country continued, the project did not achieve much in terms of tailoring the information services to the contexts, languages, capacities, life-worlds, and needs of a wide variety of users operating across a range of agro-ecologies. Similarly, alternatives to the text-based SMS system with all its limitations were not addressed, even though alternatives (e.g. a voice-based system) were proposed and multimedia messages (WhatsApp) implemented with limited success. Neither were there serious attempts to explore how better tailoring could be achieved by forging linkages between SMS and other communication channels and sources. However, something positive is that in 2017 the target groups were narrowed down and the current platform is more flexible in reaching specific groups of users.

Interestingly, we see that instances both of learning and change and of non-responsiveness and stagnation were affected by socio-political dynamics and broader developments in the environment. Such dynamics included, for example, the influence of powerful stakeholders, competition and trade-offs between different values and interests, the willingness or unwillingness to join and invest in the partnership and shifts in political support and demands following elections.

5.5.2. The need to enhance the quality of the learning and adaptation process

Although learning and adaptation certainly took place, it is important to note that no research on users or feasibility had been carried out before SMS-SAGARPA started, and the quality and intensity of monitoring, once it started, varied considerably. In the 2009 to 2012 period, there are no reports of any monitoring performed by SAGARPA. Organised efforts to learn from users and technicians started only in 2013 when the MMV team conducted field monitoring in the Bajío hub and started to ask technicians how the system could be improved. In 2014, 2015, and 2017, MMV-G and MMV-F conducted forms of monitoring by a phone survey with closed questions that did not allow further elaboration by users on the 'how and why' of their answers. More space for this was allowed during a field monitoring exercise organised by MMV-G in 2016. Despite these monitoring activities, clear and reliable figures on users and usage over the project period are lacking. According to respondents, this was due in part to the discontinuities in leadership, staffing, and partnership arrangements – a condition that also complicated the incorporation of lessons over time. The overall picture, therefore, remains that feedback was not systematically sought and was largely a local affair in Guanajuato, with few linkages to MMV at federal level.

The literature on ICT4D suggests that the MMV experience is not unique in this regard. Mansell (2010) signals that such ICT projects are regularly conceived on the basis of development trends and technological enthusiasms, and not on the basis of studies that underpin their logic in the relevant social and historical context (Thompson, 2004, 2008). The experience with MMV suggests indeed that the project could have benefitted considerably from formative and evaluative research in both technical disciplines (e.g. agronomy, meteorology, software engineering) and social sciences (e.g. economics, sociology, communication science, and anthropology). Multidisciplinary research along these lines could have helped to identify and anticipate a range of challenges at an earlier stage and foster critical reflection in the project team on core assumptions regarding, e.g., the needs and capacities of users, the quality of available data, and/or the conditions under which stakeholders would invest in the project. Similarly, it might have been easier to learn lessons and translate them into practice if the scope of the project (in terms of geography and target groups) had initially been narrower. The project could have taken the form of a pilot or niche experiment that was given time and space to make mistakes and become mature before attempts were made to scale it up (Geels, 2002). In sum, although learning certainly took place, limited deliberate attention was paid to organising the learning process

and creating an optimal environment in which feedback could be generated, discussed, and acted upon. In Argyris and Schön's (1978) terms, more attention could have been paid to 'triple loop' learning, i.e. reflection on the methods and approaches through which learning would be organised.

5.5.3. Moving beyond technical issues in ICT4D development

The experience with MMV suggests that the development of ICT-based information services is a socio-political process in several respects.

First of all, the choices made do not emanate from a rational planning process but entail the promotion of different values and views on development and are influenced by power positions and pressures and demands in the broader institutional environment, e.g. donors, dominant research narratives, and paradigms (Heeks, 2010; Martinez-Cruz et al., 2019; Thompson, 2004).

Second, we have seen that offering information services is not just a matter of developing a technology, as its operation requires numerous changes in the social-organisational sphere. These include, for example, agreements with partners about the delivery of information, an organisational setup to make the system operate and develop useful content, efforts to alter constraining regulations, conducive task divisions with other media and sources of information, and – last but not least – financial arrangements that can guarantee sustained service delivery. Third, we see that information itself can be a politically sensitive product that may challenge existing orders and be subject to tension and competition. In sum, the development of ICT-based information services takes places in an arena of struggle (Long and Ploeg, 1989) in which outcomes are negotiated. However, as signalled by several authors (e.g. Ferguson, 1990; Li, 2007) such socio-political dynamics are often downplayed and ignored in development interventions, which have a tendency to frame and present development efforts as a largely technical affair and aim to fit the dominant discourses and narratives in agricultural R&D (Ferguson, 1990; Li, 2007; Martinez-Cruz et. al, 2019). Our study indicates that it is important to recognise and anticipate these socio-political dimensions in processes of developing ICT4D.

We recognise that learning took place as the MMV project unfolded, but the learning was not only for the practitioners involved in the implementation of the MMV project; the learning also reflected on us as the writers of this case study and researchers in agricultural development because we realised the importance of institutional memory and why in development processes it is also important to reflect on the lessons learned to improve our practice over the time. In the end, our study shows that learning in development is slow, we learn as our processes unfold, but often this learning process is not appreciated as an outcome in itself. Thus, we end up, as researchers and development practitioners, selling our ideas in terms of success stories (Sumberg et al., 2012) and fitting new narratives, discourses, and target groups to find continuity in our work (Martinez-Cruz et al., 2019) otherwise we might be unable to find investors for our projects.

Chapter 6

Discussion and conclusions

CIMMYT researchers doing field work in Chiapas to design a mobile tool (Source: Urs Schulthess, 2012)

My aim with this thesis was to investigate the mechanisms that affect the social life of technology-driven interventions and how these mechanisms explain processes of continuity and discontinuity, while also producing inclusion and exclusion for different groups of people. My case studies were all related to MasAgro Programme, a prominent example of a technology-driven intervention in Mexico. In the first part of this discussion I synthesise the findings of my case studies and address the main research question. In the second part of this discussion, I reflect on the implications of my findings.

6.1. Mechanisms of continuity and discontinuity in the making of interventions

6.1.1. Continuity in the productivity paradigm and associated practices

To analyse the mechanisms that resulted in continuity and discontinuity of processes and actors in the technology-driven interventions, I will use table 6.1 (see at the end of section 6.1) which summarises the findings of the four case studies.

In all four case studies I found that the project narratives were central to the interventions and the technologies they introduced: these narratives were all constructed around the objective of increasing crop yields and agricultural productivity. While this agricultural productivity paradigm was continuously present, it took different forms, such as in the form of a flexible, adaptive technology portfolio (Chapter 2) and changing narratives that included novel scientific trends (Chapters 2, 3 and 5) and policy objectives (Chapters 2,3 and 4). MasAgro Programme started out with Conservation Agriculture (CA) (Chapter 2 and linked to Chapter 3) and adapted its portfolio of technologies over time (Chapter 2). While including a more flexible combination of technologies over time, it was still mainly geared towards achieving a more productive agriculture, including a more nuanced scientific view of the effectiveness of a complex set of integrated crop and soil management practices, so that it would finally become integrated in the concept of Sustainable Intensification (SI).

In a similar way, in the Bajío case (Chapter 3), CA was the central technology and it was used in different research approaches, i.e. on-farm research for innovation platforms and to serve varying policy agendas. Also, in the case of MasAgro Mobile (Chapter 5), the objective was to empower farmers and enable them to make better decisions to achieve higher productivity of their crops. In this case the narrative also changed, while the overall objective of making farmers more productive remained. On the other hand, the native maize case in Chapter 4 shows a different rationale. Mexican agricultural policy has historically promoted an agricultural productivity-oriented paradigm that has excluded farmers like those in Yavesía and has intended to suppress their native maize cultivation (Appendini and Liverman, 1994; Fox and Haight, 2010; Gates, 1988). Yet, maize cultivation in Yavesía has co-existed and readapted because it is embedded in farmers' lives as part of their living principle of *comunalidad*, so that their culture of maize technology goes beyond a simplistic

approach that focusses on agricultural productivity to include a key component of their culture and identity.

The case study I present in Chapter 4 explains why despite that Mexican agricultural policy has promoted improved seeds and a modernisations paradigm since the times of the Green Revolution (Fox and Haight, 2010), native maize cultivation has continued in parallel. There are several arguments for this. For example, Turrent Fernández et al. (2012) indicate that cultivating native maize is an expression of farmers' resilience and risk management because their seeds are better adapted to their fields, as farmers in Yavesía say (Chapter 4). Sweeney et al. (2013) point out that native maize and farmers' livelihoods are intertwined and have co-evolved over time. In other words, the culture of maize as a technology (Nowotny, 2006) is deeply rooted in farmers' lives, and both of them have co-existed and hybridised over time, as I show in Chapter 4, adapting and providing continuity in a rapidly changing world. MasAgro Programme encountered the Yavesía farmers when the funder, SAGARPA, requested the inclusion of indigenous peoples and poor farmers (Chapter 2) as part of a new SAGARPA strategy. However, when the researcher Humberto Castro met farmers in Yavesía several years earlier, he also initially advocated an agricultural productivity-oriented approach based on improved seeds and mono-cropping. He and the farmers had co-learned to make a hybridised system.

In addition to aligning with the Mexican policy, the interventions in the case studies at local or national level also align with the trends and narratives in the international AR&D arena. In these trends and narratives, improving productivity remains the dominant objective in research and policy making (Thompson and Scoones, 2009), i.e. we need to be able to feed the world in 2050 and beyond by linking productivity and sustainability (FAO, 2018). This agricultural productivity paradigm is linked to the promotion of modern agricultural technologies, it is now embedded in the broader narrative of food security (Benton, 2016), and it has become increasingly integrated into the agendas of participation (Chambers, 1992; Sumberg et al., 2013), environment (Newell and Taylor, 2018), importance of biodiversity, migration and gender (FAO et al., 2018; Townsend, 2015). For example, according to the United Nations (2017), there are 821 million undernourished people in the world and agriculture provides income to 40% of those households worldwide. Thus, to end poverty (Sustainable Development Goal 1, SDG 1) and achieve Zero Hunger (SDG 2), the World Bank proposes the building of sustainable food systems (Townsend, 2015) by increasing agricultural productivity. The World Bank recognises that most of the food in the developing world is produced in small farms and that by 2030 this still will be the case. Thus, small farmers will have to contribute to these global goals by increasing their crop yields and agricultural productivity. The pursuit of improving agricultural productivity, as well as its associated narratives and agricultural technologies thus continue to play an important role, but there is increasing attention to the sustainability of food production (gearing to

discontinue high input agriculture) and other concerns such as climate change, not leaving anyone behind and the preservation of biodiversity.

6.1.2. Discontinuities in narratives and discourses

As indicated above, one key phenomenon in the continuity of the interventions and the central objective of crop productivity was the shifts in narratives and discourses. In this section, I will elaborate on the mechanisms that explain the discontinuities and how they shaped the 'making of interventions' that were instrumental to the continuities.

6.1.2.1. Researchers pursuing continuity and fitting new policy narratives

My case studies show that researchers were able to create a space for the continuation of their research projects by rebranding the same interventions or technologies or by creating new ones. These new or rebranded interventions were adapted to landscapes in which narratives, goals, agendas, discourses and settings were constantly being discontinued and changing. These changes of narratives took place in two spheres: at the higher AR&D level and the local and national political arena. Scientists revamped the offered solutions in new vocabulary and approaches in order to comply with the requirements of originality and progress – essential to the scientific process - and responding to demands from policy makers and donors to come up with solutions where earlier ones did not work. Thus, while still striving for increased crop productivity, new concepts emerging from scientific progress were integrated: participatory approaches and technology portfolios were able to adapt to the range of farmers and contexts in which technologies were promoted. At the local and national level, the political landscape in Mexico was highly fragmented and constantly changing. These changes in governments, usually being marked by elections, required researchers and others to adapt to new policy agendas, and resulted in constantly emerging new programs and projects that overtook and erased the former ones.

Researchers needed to align with the changes in both spheres in order to create a space for their practice. For example, in the case of CA (Chapter 3), researchers did so by first moving from rainfed maize producers in Jalisco to a second region with maize producers under irrigation in Guanajuato, to finally a third region with maize producers and other grains under both irrigation and rainfed conditions in Michoacán. The researchers showed that the technology was flexible and could be variably portrayed to fit diverse contexts and meet the agendas of the different funding governments. For instance, in the early CA interventions in Mexico (Chapter 3) researchers aimed to make farmers competitive in the context of the NAFTA (North American Free Trade Agreement). Later they aimed to make them more water-efficient and to include them in rainfed production areas to fit the agenda of the incoming government. Researchers rebranded the technology in each new space from conservation tillage to direct seeding to conservation agriculture to later integrate it as a key component of sustainable intensification allowing them to position their work as new. In the case of MasAgro Mobile (Chapter 5) the failure in attracting collaborators and a global change in narratives

resulted in the project also changing its narratives over the time: from sharing information to microbusiness orientation, to a tool from an ICT4D unit to socialise information and scale MasAgro Programme technologies. MasAgro Programme (Chapter 2) was initially launched in 2010 as a response to the food crisis in Mexico and it has since transformed into a multipurpose programme, addressing environmental agendas and national security, and offering a way to mitigate the migration crisis by promoting agriculture as an alternative activity for young and rural people. With CA being initially the core agricultural technology, it has now broadened its menu of technologies, including native maize, which is referred to as special maize, fitting the agricultural productivity and market-orientated narrative. The technology is now promoted as a box of tools that fits every political context and aligns with trends in international AR&D, and which is now embracing the Sustainable Intensification concept.

Building on prestige, selling success stories and showcasing quick wins were all key factors in attracting funders and collaborators, and in supporting continuity. For example, the reputation of CIMMYT due to Norman Borlaug's work and the Green Revolution was used several times to attract funders like the Mexican government in the early and later stages of MasAgro Programme. Most of the other interventions documented in this thesis did so as well. Using the words of MasAgro Programme implementers (Chapter 2), they also used the 'puppy strategy' to engage the farmers first and then move to the politicians: you first engage a child with a dog and then convince her parents to get it for her. The other strategy, the selling of success stories, was also quite effective to create alliances from which all collaborators benefitted (Chapters 2, 3 and 4). For example, in the CA case (Chapter 3), the farmers used their reputation of being innovative collaborators in Michoacán to engage with three different CA interventions through six government transitions which showed positive results and which in turn were used by MasAgro Programme leaders to show the positive outcomes of CA. In the case of native maize in Yavesía (Chapter 3), the farmers also offered their potential to work in a hybrid system cultivating native maize and thereby filling the category of indigenous and marginalised farmers that MasAgro Programme was expected to serve. MasAgro Programme implementers learned that if they wanted to show impact and align with new narratives and demands of the funders and donors, it was more effective when they included collaborators already working with the technologies or target groups of interest rather than starting from zero (Chapter 2). Finding collaborations was never difficult since there were always projects or organisations struggling to find money after political changes.

While presenting successful stories was a key element in the making of the interventions and finding continuity, regardless of whether they were actually successful based on research evidence (Martinez-Cruz et al., 2019), the funders needed such stories to legitimize their support. This has been also highlighted by De Roo et al. (2017) and reflects how we, as researchers, have gotten trapped into a cycle of playing the game of quick wins with limited impact.

6.1.2.2. The government driving the continuity and discontinuity of AR&D

The interventions addressed in this thesis were mainly funded by Mexican governments at two different levels: the national and the state level. The governments used the interventions to promote their policies to their constituency by indicating they wanted to support food security by improving agricultural productivity (Chapter 2, 3 and 5); or that they wanted rainfed maize producers to be more competitive at the opening of the NAFTA or more competitive at international level (CA in Chapter 3); or that they sought to counter the effects of climate change and the maize crisis in Mexico (MasAgro Programme in Chapter 2); or empower farmers with information to make better decisions (MasAgro Mobile in Chapter 5); or include the most marginalised farmers cultivating native maize (Chapter 4).

The common pattern in these projects is that most of them were discontinued or reformulated after a change of government, either at the state level or national level, depending on which was the funding level of government. Thus, the success and continuity of interventions depended on the will of changing political leaders. New leaders coming into power needed to frame their own projects with a new narrative tied to it, a discourse and label to differentiate themselves and their project from the previous government and their projects. This was very obvious in the case of the CA projects (Chapter 3): the interventions were mainly linked to the state governments and every time a new government invested in a CA project, it emerged with a new label and narrative, linked to a new implementation area or arrangement of actors. The encounter of MasAgro Programme with the CA in Bajío, native maize in Yavesía and MasAgro Mobile linked interventions were the result of opportunities that emerged with political changes at national level, e.g. changes in government after 6-years, the common governance period in Mexico. Nevertheless, MasAgro Programme was able to find continuity through three different 6-year periods despite the change of ruling political parties. CIMMYT and MasAgro Programme were able to adapt to different political narratives in Mexico in three main ways. First, by responding to a food crisis and offering a second green revolution in 2010. Second, by diversifying its collaborations to align itself to the 'national crusade against hunger' with the second government in 2014 and allowing the federal government provided subsidies to farmers through MasAgro Programme even when this contradicted the initial vision of the programme as established in 2010. Third, by shifting the narrative of CIMMYT and MasAgro Programme towards food sovereignty in an effort to align itself with the narratives of a new government that promoted sovereignty, autonomy and self-sufficiency.

6.1.2.3. Other actors

Apart from politicians and researchers, other actors who participated in the interventions used them to ensure the continuity of their personal agendas, as well as those of their allies. Amongst the key alliances of MasAgro Programme are those with NGOs and private companies. Private companies have to fulfil their social responsibility to improve their image

with the consumers as shown by Cochran (2007). Thus, many companies and NGOs have partnered with MasAgro Programme in this role, each one with its own agenda.

Technicians were also key actors and allies in the interventions I presented. In the Bajío case which was linked to CA (Chapter 3), the narratives and the role of the technicians changed over time. Those trends were linked not only to the changes in the national context but also at an international level where the increase in the participation agenda was modifying research approaches. For example, research approaches shifted from the transfer of technology (Muñoz-Rodríguez and Santoyo-Cortes, 2010) to the innovations systems platforms as a result of various economic crises and the emergence of the neoliberal agenda (McMahon and Valdés, 2011; Muñoz-Rodríguez and Santoyo-Cortes, 2010) which called for less intervention from the state. Since the 1990s there has not been a government extension service in Mexico and support to farmers has been organised through specific government calls or programmes that invite technicians to collaborate by providing specific services that farmers needed. Some programmes emerged with specific goals that the government set in a similar way to how some other programmes were framed in Chapter 3 or such as the ones I referred to in Michoacán with CA or PROMAF, PIMAF and PROAGRO that associated with MasAgro Programme in Chapter 2. However, these programmes were mostly discontinued over time, typically after a government change took place. Thus, technicians found themselves moving between the narratives and agendas of the ruling funders in order to find continuity for their own professional activities and the support they provide to farmers.

Ultimately, farmers were also key players in the interventions. Most of the interventions are framed as a way to improve the life of farmers and at the same time to fulfil national and global goals that benefit the Mexican population and the world in general, e.g. food security, migration reduction, and increased sustainability. Therefore, the interventions that I studied had a defined target group which was often farmers, who continuously found themselves as part of an intervention. Similar to technicians, some farmers have learned to play the rules of the game so they could benefit from all of the interventions and thereby achieve a continuity of their own interests. For example, farmers in Indaparapeo (Chapter 3) contributed to the making of three different interventions linked to CA and found continuity in technical support to their CA efforts through at least six government changes. Another example is Doña Juana in Oaxaca (Chapter 2) who plays with her intersectionality to advocate for herself, for MasAgro Programme, or for any other project that benefits her. Doña Juana was one of the examples needed to fulfil the requirements of the coming government in 2012, which prioritised indigenous areas and native maize farmers. She is a woman, an indigenous person, she farms under rainfed conditions in the mountains and she cultivates maize in a traditional way. Doña Juana started collaborating with a local organisation in Oaxaca that gave her technical assistance through different programs and that later merged with MasAgro Programme. She has worked with a specific group of technicians in Oaxaca and they advocated for each other so they could find opportunities to continue their collaboration. Doña Juana is now frequently present in the MasAgro Programme activities and meetings.

One case that contrasts with these interactions in the cases I observed was the one of the Yavesía farmers and their maize cultivation (Chapter 4). These farmers were less affected by the fragmentation of technical support that is associated with the political dynamics in the landscape because they have not been the denominated beneficiaries of interventions that were seeking increased agricultural productivity. As a result of having been excluded as beneficiaries of these programmes, farmers in Yavesía appeared to be less dependent of continuing/discontinuing interventions and have managed to define their life strategies by enacting their right to self-determination without the need to adapt to maintain access to interventions.

6.1.2.4. Mutual dependency

In the case studies I presented, the actors contributing to the making of the technology-driven interventions negotiated and arranged themselves around the technologies and the interventions. Those technologies and interventions became the 'bridges' or interfaces (Long, 2001a) for actors to find continuity of their own individual agendas and therefore are the ones included in the interventions. However, some actors did not fit the target group of the interventions (whether voluntarily or not) and they were therefore not included in the interventions.

As elections and changes in government brought discontinuation and emergence or rebranding of previous projects, actors were forced to play around with those technologies and interventions to find a space that would give continuity to their agendas, i.e. to be funded, to be included as collaborators. At the same time, these processes of continuation and discontinuation were windows of opportunity for new actors to become part of the projects, e.g. the native maize farmers in MasAgro Programme (Chapter 2). In other cases, it led to discontinuation like with the PROAGRO farmers beneficiaries (Chapter 2) and the farmers in CA-like interventions in Bajío (Chapter 3).

In this process of trying to find continuity or be included, many actors had to show quick wins and offer something to the new configuration, e.g. funders or donors willing to finance projects, researchers offering technologies that could solve a current issue, technicians with the ability to work with farmers and the technologies proposed and farmers willing to try or already trying some technologies and belonging to the target groups of interest. Thus, as we see, the making of interventions is a game that many of us play in agricultural research and development and that is how we reinforce some narratives, paradigms and technologies (Andersson and Sumberg, 2017). In the end, the main funders of the interventions I present (governments), the researchers and other players formed a strategic alliance in which there was mutual dependency. Authors like Ferguson (1990), Li (2007) and Mosse, (2011) have presented some cases of the same dynamics in development organisations but in the cases presented in this thesis, there is a clear alliance of the agricultural researchers (national and international) who have now stepped more into the role of development practitioners, and the Mexican government as the main funding institution.

Tabel 6.1. Summary of continuities, discontinuities and inclusion in the technology-driven interventions presented in this research

Case study	Continuity	Discontinuity	Inclusion (Actors)	Why?	How?
MasAgro (Ch 2) Period: 2010 up to date	- Productivity paradigm - Technology focus	- Narratives and discourses: framing of the objectives - Evolving portfolio - Project periods - Funding sources	- Changed over the time (narrative, objectives, agenda) - Key partnerships remained - MasAgro and SAGARPA remained	- Funder-driven - Researchers' prestige - Broadening of the objectives and target beneficiaries	- Successful stories - Collaboration with strategic actors - Larger technology portfolio - Adapting to changing narratives, discourses and agendas - New donors
Conservation Agriculture (Ch 3) Period: 1987-MasAgro	- Agricultural productivity paradigm - Technology	- Projects - Funding - Target areas	- Key actors remained (farmers, technicians and researchers)	- Funder-driven - Researchers' prestige	- Adapting to changing narratives, discourses and agendas in global AR&D - Successful stories - New areas and new actors - Using political changes - Public challenging
Native Maize (Ch 4) Period: 1944-MasAgro	- Maize as central element of culture - Comunalidad paradigm	- Some milpa crops	- Farmers remained - National researchers	- Part of the livelihood - Changing aspirations	- Adapting livelihood strategies - Co-learning and hybridising
			- CIMMYT researchers	- Opportunistic and strategic decisions - Donor-driven	- Absorbing already well established collaborations
MasAgro Mobile (Ch 5) Period: 2009-MasAgro	- Agricultural production paradigm - Technology - Lack of institutional memory	- Type of services (SMS) - Vision/ Narrative - Learning process	- Leaders and donors - Key collaborators at a given time	- Donor-driven	- Adapting to changing narratives, discourses and agendas

6.2. The intentionality of social exclusion

This section presents a more reflective part of my work. Therefore, I use the pronoun 'we' as I consider myself part of many of these different communities, e.g. researcher, practitioner, social activist, woman and indigenous person.

6.2.1. Quick wins lead to exclusion

In the previous section I explained how the different actors contribute to the making of the interventions that I present in this thesis. There is continuity in the groups and sometimes even at individual level in terms of who participated, and thus also who did not. Considering those who were involved and those who were not requires that we, as AR&D practitioners, reflect critically on the way we contribute to the making of interventions and therefore to social inclusion and exclusion. To make my argument, I use social exclusion to refer to groups or actors that are socially and politically disempowered and that cannot fully participate in a given process (Hinrichs and Kremer, 2008; Warschauer, 2003) or in the case of this research, excluded from interventions. In this sense, for example, at a national level, the Mexican Agricultural Programme in the 1940's (Harwood, 2009), the Plan Puebla in Puebla from 1967-1984 (Cano and Winkelmann, 1972; Felstehausen and Díaz-Cisneros, 1985; Redclift, 1983), Plan Maize in the State of Mexico from 1969-1975 (Maximiliano-Martínez et al., 2011), the Mexican Agri-food System in 1980-1983 (Gates, 1988; Spalding, 1985) and MasAgro Programme (2010) have all been criticised because they have socially included some actors, and failed to include others. In line with Roo et al. (2017), I argue that by striving for 'quick wins' – which is usually a condition from those who finance our work - we are producing specific beneficiaries with whom we continue to work over time (e.g. Indaparapeo farmers documented in Chapter 3). Thereby we exclude others, which reconfirms and sometimes even reinforces social inequality. Fox and Haight (2010) refer to this as subsidising inequality in Mexico. I will explain this with an example.

I had been working for a year in the region of Indaparapeo, Michoacán, doing my research (Chapter 3) and being impressed by the lobbying abilities of 'my' farmers, that is, the farmers I interacted with. Although I talked to as many people as possible, I got myself trapped in a circle of the 'successful' farmers, technicians, government officials and researchers linked to Indaparapeo doing CA. One morning I was visiting Don Rodrigo to tell him I would finish field work soon and wanted to thank him for his support. While I was at Don Rodrigo's house, Don Juvencio knocked the door selling fresh milk. I thought Don Juvencio was part of Don Rodrigo's farming group. But he was not, he was not even practicing CA. Don Rodrigo tried to convince me that Don Juvencio was an exception and in fact most of the farmers in Indaparapeo were already practicing CA in one form or another, all being medium scale farmers with access to irrigation and producing for regional markets. When I talked to Don Juvencio, I realised there were still many farmers who actually did not

have access to irrigation, and were not doing CA, and lived up in the mountains or on the more marginal lands in the valleys.

Indaparapeo is known as a valley and its few mountains and their inhabitants are much less known. Thanks to a priest and other local people I met through friends, I reached the farmers in La Huerta who did not practice CA. La Huerta is a tiny locality in the mountains that strongly contrasts with the villages in the valley. I asked farmers from La Huerta if they were in touch with technicians or people from the Ministry of Agriculture or if there was any other agricultural programme operating in the region. One farmer explained:

> "We get nothing. The only person who visits us is the priest every weekend and maybe every second year a person like you shows up. The 'others' (referring to the farmers in the Valley like Don Rodrigo and his organisation) always get everything. We don't even bother to show our faces in the agricultural offices or municipality. Going there is a waste of time and money. The only thing we have recently gotten from the government is some toilets but other than that, we do not receive anything".

Another farmer from La Huerta commented that they were talking to me because the priest asked them to do so: "We are talking to you so you might share how we live and maybe help us to change things. As we said, we do not get anything from anyone, the others always get everything".

Dealing with this social inclusion and exclusion is not an easy matter, especially if donors or funders request us to show impact, which increases the need for quick win opportunities. In the example I present here, Don Rodrigo and his farming organisation have learned to lobby over more than 10 years, and know how to present themselves as attractive partners to CA researchers and find continuity through their collaboration. Choosing to work with farmers like Don Rodrigo results from one constant assumption we have as practitioners: the farmer who is willing to innovate and experiment is our ideal collaborator because they produce good adoption results and they can serve as an example for others, supporting more impact down the road. Additionally, trying to work with 'other farmers' has high transaction costs: we need to build relationships with them, and usually travel further and invest more in convincing them to experiment with us. Also, because the context may not immediately fit the technologies we bring them, the adaptation will require serious and costly efforts.

My aim with this example of inclusion and exclusion of Indaparapeo farmers is to critically reflect on our practices and to make an argument for increasing our awareness of the unintended consequences of our practices in AR&D. I also want to note that the location of farmers in the upper-lands (La Huerta) and fertile lands in the valley of Indaparapeo is linked to other historical processes that can be traced back to time of the colonisation. For example, some farmers explained that their grandparents were relocated in upper lands

after the colonisers and landlords took the most fertile lands. Others indicated that after the Mexican Revolution and the agrarian reform, the landlords *'hacendados'* and the catholic church prevented farmers to take lands in the fertile areas because that was a 'sin and stealing´ in the eyes of 'god'. Some other farmers besides being religious, ignored the messages from the priests and got fertile lands while others remained in the mountains. Thus, even before the CA-like interventions, there were already other historical ways of exclusion or maybe auto-exclusion that might need a different analytical lens for us to draw conclusions. Hence, in line with Long (1989), we need to move beyond the simplistic assumption that interventions are a set of steps that fall within certain pre-defined time and space regimes. We need to acknowledge that interventions are part of a complex, uneven and messy chain of events located in a broader framework of the activities of the interveners, and the actions of different interest groups that operate in the areas of interventions. Moreover, we never intervene in an empty place and therefore it is important to realise that all our interventions build on a history that is usually full of earlier interventions.

6.2.2. Our choices in AR&D and their effect on social inclusion

Another aspect of our practice that I want to reflect on is the inconsistency between the numerous assumptions underpinning our interventions and how they actually fit the actors we target with these interventions. The experiences with the farmers of La Huerta (see above, linked to Chapter 3), the farmers in Yavesía (Chapter 4) and the effort to empower farmers through information with MasAgro Mobile (Chapter 5) made me understand that while we might aim to improve farmers' livelihoods through improved productivity, they may aspire to or prioritise something else. Not putting their aspirations first is a deliberate choice and results in the inclusion and exclusion of particular groups of farmers. My argument is that we need to listen more and better, like Humberto Castro, the researcher, did in Yavesía (Chapter 4) so that we can include the rationales and aspirations of local people. I learnt that Humberto, through listening, started to understand the local context and farmers' aspirations and together they were able to co-learn and come up with a hybrid maize technology system that fitted farmers' aspirations, rationales and embraced the intangible meanings of maize cultivation. Humberto Castro recognised how he was trained to 'only' look at the seed, the crop and the yields, and how his assumptions had to change to be able to work with the farmers rather than narrowing his intervention to the maize productivity. For farmers in Yavesía, maize cultivation was not a pure food production activity (Chapter 4) and it was not solely centred around the milpa. Instead, it was more about the cultivation of their social fabric, identity, a celebration of their life, their right to self-determination, sovereignty and resilience. To achieve continuity, farmers adopted elements from different worlds that fitted their context, their realities and aspirations. Humberto also learned to hybridise his knowledge and expertise with farmer´s knowledge and expertise.

Such flexibility to increase more inclusion also emerged in MasAgro Programme (Chapter 2), where the researchers started with a relatively narrowly defined technology,

e.g. CA as the main technology to improve crop productivity. However, in the later stage of MasAgro Programme, researchers and collaborators also showed openness to diversify and increase inclusion by moving beyond the productivity rationale and trying to understand the local context, needs and agendas by collaborating with other actors that had experience in those topics. While Humberto and the researchers in Bajío (Chapter 3) and MasAgro Programme implementers learned as their interventions unfolded, the AR&D practitioners in MasAgro Mobile (Chapter 5) were hindered in their good intentions by the limitations to learn and apply lessons. However, a choice to co-learn with the ones whom we target is limited as shown in Chapter 5 and often threatens the continuation of funding our efforts. Factors limiting our space of manoeuvre, which are completely beyond our control, include monopolies, regulations at governmental or federal level and limitations of funding, among others.

We have seen how the technology-driven interventions and the target groups have changed over time in the four cases presented. Even as the narratives and discourses adapted to their changing context, being updated by incorporating the latest scientific trends and addressing political priorities, the technology continued to focus on agricultural productivity. In chapter 2, the technology menu in MasAgro Programme changed from an initial push for CA in every context to a broader portfolio of technologies from which a combination of elements fitted for different contexts could be chosen. In the case of Bajío (Chapter 3), CA initially targeted maize farmers who lived in rainfed areas and who had little access and shifted to target farmers high access to technology and irrigation. In Chapter 5, information through mobile phones (MMV) aimed, in the early stage, to empower all small farmers to increase their agricultural productivity and turn them into microbusiness-oriented people. Later, MMV shifted to support farmers collaborating with the MasAgro Programme to disseminate practices that lead to increasing productivity.

In the end, after the research for this thesis, I conclude that all of us AR&D practitioners have the genuine intention to improve livelihoods of farmers and food security in the world. But I have now also experienced and become aware of our naïveté. As practitioners of AR&D, we continue to think and act within the confinements of the productivity paradigm through our technologies and interventions, even when we make efforts to be more inclusive – as slogans like 'leaving no-one behind' testify. Yet, in our current way of doing AR&D we have a responsibility to reflect on the validity of this approach and the technologies we tie to it. We need to verify how our assumptions match the aspirations of our collaborators, and explore alternatives if needed, like Humberto Castro does in Yavesía. For me this implies that in AR&D we need to move beyond our professional expertise and our overly-technical terms. We have to be willing to recognise that we need to be open to diversifying our approaches and learning in bidirectional ways.

6.3. Conclusions

The cases of the technology-driven interventions in this study show how the mechanisms that pursue an increased productivity of agriculture are enabled by constantly changing labels and narratives of the technologies and different interventions linked to them. The changes of labels and narratives are necessary to navigate the fragmentation in the Mexican landscape that results largely from its political dynamics. These fragmented dynamics also allow for the continuity in addressing agendas, not only for us researchers but also for our collaborators, i.e. technicians, NGOs, private sector partners and farmers. This continuity – discontinuity interaction also results in a continuity of groups of farmers and other collaborators who are included or excluded. These findings are relevant for Mexican farmers for two reasons. First, in the context of Mexico, where we continue to face a fragmented political landscape with projects being terminated and new ones emerging, I have examined how people strategise to find continuity in seeing their agendas and interests addressed. We need to think of a longer term 'planning' policy for projects to fit farmers' needs. Many of the farmers in the case studies I presented learned to find continuity for their projects if a technology could fit their contexts. In many instances these farmers adapted the technologies to their contexts but the results were not immediate and required a longer time of experimentation. Thus, the need to have long-term collaborations with researchers and technicians was crucial. Second, MasAgro Programme showed the potential of involving diverse collaborations to increase the relevance of technologies and thereby being more socially inclusive, like in the case of Humberto Castro and the Yavesía farmers and in the later stages of MasAgro Programme. Mexican agricultural policy, historically, has excluded native maize farmers (Chapter 4) and now that global trends place more emphasis on social inclusion, the agricultural narrative also embraces this type of farmers, opening up opportunities for a programme like MasAgro Programme to engage with them. If this signals a real change, then I believe there will be increasing opportunity for us in AR&D in Mexico to work on diversifying our approaches that help us make a meaningful contribution to global, national and local problems of food security, climate change and social inclusion. An important question is of course if this change is sufficient. This will, among other things, depend on our opportunities to learn and apply these lessons.

Through my continuous interaction with MasAgro Programme collaborators, I have realised that there is a lot of learning entailed in the implementation of technology-driven interventions. But learning is not easy, and it is often undermined or does not find a receptive institutional environment. Learning first requires awareness of the hidden mechanisms that affect our practice. Furthermore, often the only learning that is appreciated is the learning that comes from successes. Lessons from failures are usually ignored or swept under the rug. I have also learned that if we want to continue to find funds for research, we need to know the rules of the game and sell successful stories (Sumberg et al., 2011), come up with quick wins (Roo et al., 2017) and use the 'puppy strategy' (Chapter 2). And as we do so, we

are, like our collaborators and funders, all pursuing the continuity of our agendas (Martinez-Cruz et al., 2019): Farmers from Indaparapeo have done so through the years, Doña Juana also does it, and I do it as well, both as a researcher seeking quick successes, and also by using my intersectionality to find continuity for my research, my social activism, my life in the community or all of them depending on my desired agenda.

Finally, as an agronomy researcher and development practitioner, my expectation is that the strength of the agricultural production paradigm may weaken, as more voices saying different things are getting space in the making of technologies and interventions. Seeing how MasAgro Programme is embracing more local projects, shifting objectives and including a diversity of actors with varied agendas allows me to think that there is hope in our science and in our applied work as development practitioners in agriculture, and that we can become more inclusive. As a social activist and researcher who has been in other arenas like the FAO, the UN or the Mexican senate where topics such as food security, social inclusion, sustainable agriculture, sustainable development and climate change are addressed, I feel enthusiasm as I see more space for inclusive narratives. Yet I question how many voices from the minorities or marginalised groups are actually contributing to the research and policy making internationally and nationally. Few voices have a say on 'how those paths should look like', whether they are market oriented, comunalidad, living well based or something else. I wrestle with these concerns every time I engage with my indigenous sisters and see how they continue to fight to be recognised as individuals with rights, who want to have a say on how policies and projects affect them. In the end, all of these that we call minorities or marginalised people in AR&D should have a say in how projects are planned in their territories and how these projects will affect them. I do not have the answers on how we could create the pluriverse that Escobar (2018) suggests or if it is even possible, but I will certainly continue exploring these possibilities, which have been advanced by the projects and the technologies I portrayed in this dissertation.

Appendices

Chatino woman sowing maize in 2016 under the MasAgro project
(Source: TE Martinez-Cruz, 2016)

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Tania Eulalia Martínez Cruz

Wageningen School of Social Sciences (WASS)

Completed Training and Supervision Plan

Name of the learning activity	Department/Institute	Year	ECTS*
A. Project related competences			
STEPS Summer School on Pathways to sustainability.	Institute of Development Studies, University of Sussex, UK.	2014	3.0
PhD Proposal writing.	WASS, WUR, the Netherlands.	2014	6.0
Communities, Conservation and Development (FNP31306).	MNF, WUR, the Netherlands.	2014	6.0
Summer Writeshop-workshop in Critical Agrarian and Development Studies.	Journal of Peasant Studies and College of Humanities and Development Studies, China Agricultural University. China.	2019	3.0
"The politics of agricultural technology driven interventions: The case of CA in Bajio, Mexico".	Contested Agronomy Conference, Institute of Development Studies, University of Sussex, UK.	2015	1.0
"Green Revolutions Then and Now"	Institute of Development Studies, University of Sussex, UK.	2015	0.5
"Community milpa (native maize) system improvement in an indigenous community of Oaxaca, Mexico",	3rd International Conference on Global Food Security, Cape Town, South Africa.	2017	0.5
"The promotion of minimum tillage technologies in Bajio, Mexico: on continuities and discontinuities."	International Maize and Wheat Improvement Centre, Texcoco, Mexico.	2017	1.0
"The evolution of the MasAgro hubs: responsiveness and serendipity as drivers of agricultural innovation in a dynamic and heterogeneous context"	The Royal Tropical Institute, Amsterdam, the Netherlands.	2017	0.5
"How research agendas find continuity in a discontinuous environment?'	Smallholder Farming in The Tropics seminar, Department of Plant Sciences, Wageningen University, Wageningen, the Netherlands.	2018	1.0
"The long process of learning on SMS-based interventions: the case of MasAgro Mobile in Mexico"	International Maize and Wheat Improvement Centre, Texcoco, Mexico.	2019	1.0
Chair on the session "Maize, insects and smart chemistry: Challenges in crop management and ecosystems", Jornada Fulbright-Garcia Robles.	Fulbright Program, USA-Mexico, Mexico city, Mexico.	2019	0.5
B. General research related competences			
Information Literacy including EndNote Introduction (ILP).	WGS, the Netherlands.	2014	0.6
Qualitative Data Analysis with Atlas.ti: a hands-on practical.	WASS, the Netherlands.	2014	1.0
Workshop on multi-actor dialogues on biocultural diversity and sociological resilience, 2nd.	Conference of the programme on ecosystem change and society. PECS. Oaxaca, Mexico.	2017	1.0
Collaborative Filmmaking Approaches in Archaeology, Heritage, and Development Workshop.	Archaeology Department, Leiden University. The Netherlands.	2018	1.0
Speaker at the 1st. High Level Expert Seminar on Indigenous Food Systems, Session 5 –Natural resources use.	Food and Agriculture Organisation, Rome, Italy.	2018	1.0
"Grandaughter, how do you survive without native maize in the other world?" Landscapes Talk.	Global Landscape Forum "Rights on the landscape", Bonn, Germany.	2019	0.5
Speaker as a social activist and researcher, *"Vision 2030, Restore the Earth: Opportunities and partnerships"*	Global Landscapes Forum, United Nations, New York, U.S.	2019	1.0

C) Career related competences/personal development			
WASS Introduction for new PhD candidates.	Wageningen Grad School, Wageningen, the Netherlands.	2014	1.0
Documentation, design and facilitation of several workshops for CIMMYT, MasAgro Project in Mexico and Buena Milpa Project in Guatemala.	International Maize and Wheat Improvement Centre, Texcoco, State of Mexico, Mexico.	2014-2016	4.0
Workshop of diagnostic, challenges, and opportunities for the insertion of indigenous women ex-CONACyT scholarship holders through projects that contribute to community development.	Mexican National Council of Science and Technology, Mexico City, Mexico.	2017	1.0
French course A1	Wageningen into languages, WUR, the Netherlands.	2017	4.0
Thesis Path: Period 4, 5 and 6, 2017-2018 academic year and Period 4. 2018-2019. Teaching assistant.	Master's in development and Rural Innovation, Wageningen University, the Netherlands.	2018-2019	1.0
"Gender in development", guest lecture in the course Introduction to Technology, Agro-ecology and Development. Period 1.	Master's in development and Rural Innovation, Wageningen University, the Netherlands.	2018	0.25
El maíz nativo y la diversidad de los pueblos indígenas. Seminar.	Latin American Studies, Institute for Latin American Studies, Freie Universität Berlin. Berlin, Germany.	2019	0.25
Cultivating native maize and cultivating life: a case of the Zapotecan indigenous peoples from the mountains of Oaxaca, Mexico. Guest lecture for Ethnobotany (course F&ES 681 01).	Yale School of Forestry and Environmental Sciences, Yale University, New Heaven, Connecticut, U.S.	2019	0.25
Keynote speaker at the 8th Ibero-American Forum, Making policy together: Challenges of the Youth.	Forum organised by the Ibero-American League of Civil Society Organizations "La Liga", Spain.	2017	1.0
Speaker at the Peace Integration Summit, CUMIPAZ, Panel Women in Science.	Peace Summit CUMIPAZ, Guatemala, Guatemala.	2018	1.0
Speaker "Natural and social co-evolution of the native maize: Encounter of modernity and traditionality."	Conference at the Mexican Embassy in Germany, Berlin, Germany.	2019	0.25
Encounters of worlds in Rome. Screening of the movie Roma and facilitation of the discussion on women´s rights.	Seminar organised by the Mexican Embassy in the Netherlands and Cervantes Institute, Utrecht, the Netherlands.	2019	0.25
Speaker and moderator in the session "Agribusiness: the seed of the future, the role of youth in Agriculture".	IV Summit of Youth from the Pacific Alliance: Mexico, Peru, Colombia and Chile. Mexico City, Mexico.	2019	0.5
Conference "Cultivating native maize, cultivating life and cultivating sustainability in Oaxaca, Mexico".	Conferences series "America +30: leaderships for the future of our continent" organised by Casa America-Catalunya, Barcelona, Spain.	2019	0.5
"Education as a tool to transform your reality" (Conferences given to different groups of students and youth in collaboration with NGOs, especially those ones with vulnerable backgrounds, e.g. migrant children, women, girls, indigenous children, women facing violence issues).	- Guadalupe Musalem Fund for Indigenous Women's education. - Several elementary, secondary, high schools and universities in Mexico. - Leadership Program for Indigenous Youth, Department of State of the USA.	2014-2018	0.5
"The Mixe that took the maize to the Netherlands", Newspaper interview and article reflecting on the right to education.	El Universal, Mexico. https://www.eluniversal.com.mx/entrada-de-opinion/colaboracion/orgullomexicano/periodismo-de-investigacion/2017/05/13/la-mixe-que	2017	0.2
"The indigenous woman that sees the world to change hers", Newspaper interview and article on the right to education.	El País, Spain. https://twitter.com/fundesplai/status/861859429444194305/photo/1	2017	
"Aquí estoy, ingeniera agrónoma Mixe" the role of traditional knowledge to face global challenges. TV Programme	TV Deutsche Welle, Germany, https://p.dw.com/p/2z0Wi	2018	
Total			44.8

*One credit according to ECTS is on average equivalent to 28 hours of study load

About the author

Tania Eulalia Martinez-Cruz is an Ayuuk indigenous woman who was born in 1987 in Tamazulápam del Espiritu Santo, Mixe, Oaxaca, Mexico.

She received her B.Sc. in Irrigation Engineering from Chapingo Autonomous University in 2009. In 2008, she was awarded the "Susana Aspiroz Rivero" award for her outstanding academic trajectory in the Irrigation Engineering program. From 2006 to 2009 she worked in sanitary and environmental engineering. At the end of 2009, she got involved in several agricultural irrigation projects and she decided to pursue a career in agriculture.

In 2009, she became the first indigenous recipient of a Fulbright scholarship in Mexico, and pursued her graduate studies in the US. In 2012, she graduated with a Masters degree in Agricultural and Biosystems Engineering from the University of Arizona after working on issues of crop modelling, water stress in crop production, biofuels and water management. In 2012, she was also awarded with the best paper award in the Agricultural Engineering category in the 4th Khon Kaen University International Engineering Conference organized by Khon Kaen University in Thailand.

In 2012, she joined the International Maize and Wheat Improvement Centre (CIMMYT) as a consultant for the Sustainable Modernisation of the Traditional Agriculture (MasAgro) Programme for an ICT4D project and agricultural extension component in Mexico. In 2013, she was awarded a scholarship from the Mexican National Council of Science and Technology to pursue a PhD. In November 2013, she started a joint PhD connected to both Wageningen University and CIMMYT and funded by several grants. Since 2012, she has collaborated in several projects and international organisations on different projects in Latin America, such as CIMMYT, Value for Women and the Oversees Development Institute. Currently she works as a Community Specialist for the Global Landscapes Forum, Center for International Forestry Research, where she mobilizes local landscape initiatives around the world. Her research interests cover politics of knowledge and research, and processes of social inclusion and exclusion in technology-driven interventions in agriculture. She is also interested in working to create more inclusive initiatives linked to agriculture, climate justice and rural development.

Tania is also a social activist promoting the conservation of native maize as key to the biocultural diversity of indigenous peoples. In 2018, she presented on these issues at the 1st High-Level Expert Seminar on Indigenous Food Systems at the Food and Agriculture Organization (FAO) in Rome and in the "CUMIPAZ" Peace Summit in Guatemala. In 2019 she also presented on these issues in the Global Landscapes Forum in Bonn, Germany and in the United Nations headquarters in New York. She also collaborates with several pro-education NGOs that support indigenous girls, women, and children, and children and youth in vulnerable situations. In 2016, she was awarded the Mexican National Youth Prize for academic achievement but also for her commitment to supporting social causes. On January 1st, 2020 she also received her 'baston de mando' (a symbolic wooden cane used

to confer authority in some indigenous communities) to fulfil a year of community service as the Secretary of the Women's Office in her hometown of Tamazulapam del Espiritu Santo. During her one-year term, she will be supporting the leader of the Women's Office in issues related to the welfare of women in her community.

Author's publications

Martinez-Cruz, TE, Almekinders C. and Camacho-Villa TC. (2019). ***International Journal of Agricultural Sustainability.*** Collaborative research on Conservation Agriculture in Bajío, Mexico: Continuities and discontinuities of partnerships. doi.org /10.1080/14735903.2019.1625593

Camacho-Villa TC, Hellin J, Almekinders C, **Martinez-Cruz TE**, Rendon-Mendel R, Guevara-Hernandez F, Beuchelt T and Govaerts B. (2016). The evolution of the MasAgro hubs: responsiveness and serendipity as drivers of agricultural innovation in a dynamic and heterogeneous context. ***Journal of Agricultural Education and Extension.*** doi.org/10.1080/1389224X.2016.1227091

Martínez-Cruz TE, Slack DC, Ogden KL, Ottman M. (2014). The water use of sweet sorghum and development of crop coefficients. ***Irrig Drain.*** 2014. doi.org/10.1002/ird.1882

Slack, Donald C., **T.E. Martinez-Cruz**, Ogden K., Ottman M. and Husman S. (2012). Sweet sorghum a bioethanol crop. Paper presented Paper presented at the 4th. KKU ***International Engineering Conference***". May 10-12, 2012. Khon Kaen, Thailand. 6p.

Under Review

Martinez-Cruz, TE., Leeuwis C. Almekinders C., Camacho-Villa TC and Govaerts B. (*Submitted to the Electronic Journal of Information Systems in Developing Countries*). The continues process of learning in a SMS mobile based intervention: the case of MasAgro Mobile in Mexico.

Martinez-Cruz, TE., Almekinders C. and Camacho-Villa, T.C. (*Submitted to World Development Journal*). Hybridization of cultures of technology: Natural and social co-evolution of the native maize in Mexico, encounters of the traditionality and modernity.

Martinez-Cruz, TE. (*Submitted to the Journal of Peasant Studies*) Cultivating native maize, cultivating comunalidad and cultivating life in Oaxaca, Mexico.

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My journey to my PhD would not have been possible without the generous support of many organizations and institutions that funded my research and my studies, so I would like to acknowledge them. This research was funded by the Postgraduate Fellowships Programme for Indigenous People in Mexico led by the Centre for Research and Advanced Studies in Social Anthropology in collaboration with the Mexican National Council of Science and Technology. I appreciate and acknowledge the support from the Socio-economics and Sustainable Intensification and Integrated Development Programs within the CIMMYT. I also acknowledge the CIMMYT-KTI (Knowledge, Technology, and Innovation) Wageningen University project on Socio-Technical Orchestration for funding part of the research in Chapter 5 and part of the writing process. This research was also funded by the Mexican Ministry of Education through their complementary scholarship for postgraduate studies abroad Mexico. I also want to acknowledge the Junior Grant from the Wageningen School of Social Sciences that helped me to write the Chapter 2 of this dissertation. Although I declined the fellowship due to unforeseen events, I would like to acknowledge the Fulbright Program and the U.S.-Mexico Commission for Educational Exchange for the fellowship that I was offered to conduct a research stay in the US in 2017.