Double Exposure, Dispossession, and Farmer Resistance in the Cornfields of Chiapas, Mexico.

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DOUBLE EXPOSURE, DISPOSSESSION, AND FARMER RESISTANCE IN THE CORNFIELDS OF CHIAPAS, MEXICO

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As members of the Dissertation Committee, we certify that we have read the dissertation prepared by ***Laurel Bellante***, titled ***Double Exposure, Dispossession, and Farmer Resistance in the Cornfields of Chiapas, Mexico,*** and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy.

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Dedication

I dedicate this dissertation with love to my husband, Kiri. *Eres la luz de mi vida.*
Thank you for walking this path with me.

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Acronyms and Abbreviations

AGROSAEMEX	*Aseguradora Agricola Mexicana* Mexican Agricultural Insurance
ANEC	*Asociación Nacional de Empresas Comercializadoras de Productores del Campo* National Association of Rural Farmers and Merchants
APE	Agrarian Political Ecology
BANRURAL	*Banco Nacional de Crédito Rural* National Bank of Rural Credit
CEFADECI	The Center for Agroecology and Campesino Training
CGIAR	Consultative Group for International Agricultural Research
CIMMYT	*Centro Internacional de Mejoramiento de Maíz y Trigo* The International Maize and Wheat Improvement Center
CONAGUA	*Comisión Nacional del Agua* National Water Commission
DE	Double Exposure
DDR	*Distrito de Desarrollo Rural* Rural Development District
ENSO	El Niño/Southern Oscillation
EZLN	*Ejercito Zapatista de Liberación Nacional* Zapatista Army of National Liberation
FAO	Food and Agriculture Organization of the United Nations
FERTIMEX	Mexican Fertilizer Company
FND	*Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero* National Financier of Agricultural, Rural, Forestry, and Fishing Development
GEC	Global Environmental Change
GHG	Greenhouse Gases
GR	Green Revolution
HYVs	High-yielding Varieties
IMF	International Monetary Fund
INEGI	*Instituto Nacional de Estadística y Geografía* National Institute of Statistics and Geography
INIFAP	*Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias* National Institute of Forestry, Agricultural, and Fishing Research
IPCC	Intergovernmental Panel on Climate Change
LAN	*Ley de Aguas Nacionales* Law of National Waters in Mexico
MSM	*Monitor de Sequía en México*

	Mexican Drought Monitor
NAFTA	North America Free Trade Agreement
NOAA	National Oceanic and Atmospheric Administration
OCEZ-CNPA	*Organización Campesina Emiliano Zapata-Coordinadora Nacional Plan de Ayala* Emiliano Zapata Farmer Organization-National Coordinator of Plan de Ayala
OPVs	Open-pollinated varieties
PACCCH	*Programa de Acción Ante el Cambio Climático del Estado de Chiapas* Climate Change Action Plan for the State of Chiapas
PECC	*Programa Especial de Cambio Climatico* Special Program on Climate Change
PIMAF	*Programa de Incentivos para Productores de Maíz y Frijol* Incentive Program for Corn and Bean Farmers
PROCAMPO	*Programa de Apoyos Directos al Campo* Program of Direct Support to the Countryside
PROCEDE	*Programa de Certificación de Derechos Ejidales y Titulación de Solares* Certification Program of Ejidal Rights and Land Titling
PROGAN	*Programa de Apoyo para Ganadería* Program for Livestock Support
RAN	*Registro Agrario Nacional* National Agrarian Registry
SAGARPA	*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación* Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food
SEDESOL	*Secretaría de Desarrollo Social* Ministry of Social Development
SEMARNAT	*Secretaría de Medio Ambiente y Recursos Naturales* Ministry of Natural Resources and the Environment
SIAP	*Servicio de Información Agroalimentaria y Pesquera* Agrofood and Fishing Information Service
SPR	*Sociedad de Producción Rural* Rural Production Association
UNFCCC	United Nations Framework Convention for Climate Change
WB	World Bank

Abstract

This dissertation focuses on the livelihoods and environments of small-scale commercial corn farmers in Chiapas, Mexico. I document processes of double exposure, dispossession, and farmer resistance using theories from agrarian studies, political ecology, and vulnerability studies. I draw on the double exposure schematic to examine corn farmers' experiences of and responses to the dual challenges of neoliberalism and global environmental change. Grounded in an agrarian political ecology approach, this research provides nuanced evidence of how different factors of double exposure intersect and compound one another. Through in-depth, ethnographic work in corn-farming communities, I demonstrate how current challenges of double exposure are interconnected with historical and ongoing processes of dispossession and environmental degradation.

I draw attention to several understudied dimensions of double exposure in the case of Mexican corn farmers, including: 1) the legacy of environmental degradation associated with Green Revolution modes of production and its implications for current vulnerabilities to ongoing environmental change; 2) the impact of the privatization and corporatization of Mexico's seeds, inputs, and agricultural extension services; 3) the barriers to increasing the adaptive capacity and sustainability of farm systems within Mexico's context of neoliberal food governance; and 4) the ways in which the crisis of double exposure can open possibilities for a double movement to emerge characterized by farmer-led, agro-ecological transformations.

Ch. 1 Double Exposure, Dispossession, and Farmer Resistance in the Cornfields of Chiapas, Mexico

Introduction

"Si con el cambio climático ya nos pega la sequia y es poco la cosecha, imagínate seguimos encareciendo con la semilla, con los costos de los insumos. Híjole es bastante difícil que una persona establezca un cultivo de esa manera."

> "If with climate change we are already being hit by drought and small harvests, imagine how [farming] keeps getting more expensive with the seed, the costs of inputs. Jeez, it is really difficult for someone to keep farming this way."
>
> - Julio, corn farmer, Benito Juarez Ejido

Julio Pérez, a 35-year old corn farmer, spoke the above words on a hot summer night from his simple home in a small farming *ejido*[1] in Chiapas, Mexico. Julio is among a growing stream of migrants who have returned home to their rural communities after years away in far-off cities or across the border in the U.S. He comes from a long line of farmers and ranchers. With a growing family to support, he has come back to this dusty town determined to find a way to make a living off the land. This task, however, is far from easy. Unlike his father's generation, which farmed with the support of government subsidies and guaranteed purchasing policies, Julio now faces the increasing uncertainty of climate change in a political setting in which farmers have been left to fend for themselves.

In 2000, geographers Karen O'Brien and Robin Leichenko coined the term "double exposure" to describe the way in which certain groups of people are disproportionately vulnerable to the combined impacts of economic globalization and environmental change. While O'Brien and Leichenko suggest that Mexico's small-scale farm sector is a classic example of a doubly-exposed population, few researchers have investigated the concrete ways in which this double exposure manifests on the ground in rural communities, or how doubly-exposed communities respond to their vulnerability (notable exceptions include Eakin 2005; McCune et al. 2012). Based on 18 months of ethnographic field research in the semi-commercial corn regions of Chiapas, Mexico, this study examines how small-scale, semi-commercial corn farmers are experiencing and responding to double exposure. Using an agrarian political ecology approach, I not only delineate the ongoing manifestations of double exposure in farming communities but also draw attention to how current vulnerabilities are linked to historical processes of uneven

[1] The ejido system was established following the Mexican Revolution. An ejido refers to the areas of land held in common by its inhabitants. Historically, this land was farmed cooperatively or individually. In 1992, Reforms of Article 27 of the Mexican Constitution put an official end to land reform. A process known as PROCEDE followed, which allows ejidal lands to be privatized and distributed as individual property titles.

development, dispossession, and ongoing capital accumulation in the rural sector. I further explore how farmers are organizing in new ways to counteract the stressors they face.

In the context of accelerating climate change and population growth, the UN and others have identified the small farm sector as playing a key role in the transition to more "sustainable, productive and resilient food systems" (FAO 2016). However, the more than 475 million families who constitute the small farm sector globally are also among the poorest and most vulnerable to climate change (Liverman and Vilas 2006; Fox and Haight 2010; Mercer et al. 2012). This tension – between global goals for sustainability and food security, and the complex pressures confronting farmer livelihoods – is particularly apparent in Mexico. Mexico is a hotspot for climate change and over 70 percent of Mexican farms are small-scale, with more than 85% of Mexico's corn being produced on farms measuring 5 hectares or less (SAGARPA 2010). The ability of Mexico's farmers to adapt and improve their production practices is of vital importance to Mexico's long-term food security and rural stability. Based in Mexico's southernmost state of Chiapas, this research contributes to the urgent task of identifying the challenges small-scale farmers confront and the barriers forestalling transitions to more sustainable food systems.

Over the last 40 years, Mexico's participation in processes of economic globalization has taken on a particularly neoliberal quality. In this dissertation, I use the concepts of neoliberalism and neoliberal food governance as shorthand to refer to the multitude of policy changes in Mexico since the 1980s, which have dramatically reconfigured the role of the state vis-à-vis agricultural production and national food security. Of particular interest in this study is the reduction of state subsidies for and provisioning of seeds, farming inputs, credit, and extension services; the promotion of free enterprise and free trade through international trade agreements such as the North American Free Trade Agreement (NAFTA); and constitutional amendments that marked the official end of land redistribution and created a path to land titling and privatization of formerly collectively held land areas through the program known as PROCEDE.

I use the term neoliberal food governance to describe Mexico's ongoing efforts to modernize the food sector through a rollback of state services and subsidies that once bolstered the small farm sector *and* a rollout of other new structures and conditions that tend to privilege large-scale producers and corporations. Based on structural adjustments prescribed by the World Bank and the International Monetary Fund, the Mexican state has attempted to separate its economic and political spheres by reorienting its role towards creating and enforcing the conditions for free enterprise to flourish. It has done this by creating programs to define and enforce private property rights and reducing government-led research, input production, extension, and so-called "entitlement" programs, among others, thereby facilitating increased economic competition and movement of capital within

the agrofood sector. Numerous scholars have documented the ways in which this shift has disenfranchised the small farm sector and given preference to large-scale commercial producers and corporate actors (e.g. Appendini 2014; Fox and Haight 2010; Eakin 2005). Nonetheless, because the state must always strike a balance between the dual goals of capital accumulation and legitimation (Fox 1993), the transition to a fully neoliberal regime has always been incomplete in Mexico. For example, in order to placate the poor and maintain some clientelistic linkages, the state has replaced productivist incentives with largely assistentialist, welfare handouts through programs such as *Prospera* and the *Cruzada Nacional contra el Hambre*.

A key theme in this dissertation is how shifting state involvement in the agricultural sector has contributed to ongoing processes of environmental degradation and dispossession in the small farm sector. In the mid-20th century, productivist state policies were key in the initial transition to the improved seeds and agrochemical packets generated by the scientific advances of the Green Revolution (GR). Through public subsidies, financing, extension services, and guaranteed purchasing policies, small and large farmers alike abandoned traditional farming systems and adopted a Green Revolution model of production. This not only induced significant farmer dependence on the state but also generated huge environmental impacts as polyculture systems of production were replaced by chemical-intensive monocultures. This work documents the decline of soil fertility, biodiversity, natural resources, and traditional farming knowledge linked to the adoption of a GR approach to production.

Upon the transition to neoliberalism, many state programs and subsidies were eliminated. As a result, small farmers who had transitioned to GR methods of production suddenly found themselves dependent on an increasingly expensive suite of GR seeds and inputs but stripped of the supports that had insulated them from the risks of crop loss and free market competition. The neoliberal shift increased the onus on farmers to further exploit their land in an effort to remain competitive within a free market context. As documented in this study, this drive to be competitive has deepened the environmental degradation caused by farming and increased experiences of economic vulnerability, thereby contributing to rural instability and ongoing processes of dispossession as farmers lose control of their land and livelihoods into the 21st century.

The patterns of double exposure identified herein resonate with challenges across different nations and contexts. The negative impacts of neoliberal restructuring on nations with significant small-scale farm sectors have been widely documented (e.g. Liverman and Vilas 2006), particularly in the cases of India (Walker 2008; Cohen 2013) and Brazil (Wolford 2005). Similarly, concerns regarding the implications of climate change for the small farm sector are shared across tropical and sub-tropical regions (Morton 2007; Vermeulen et al. 2014). Already climate scientists have observed an increase in the number of hot days in

Mexico and Central America and anticipate that both warming and drying trends will continue to affect these regions (IPCC 2014). Climate change has been attributed with producing significant global losses in maize production in recent years (Lobell et al. 2008; IPCC 2014) and climate predictions anticipate yield losses will continue to be more extreme in the tropics, raising significant concern for the millions of rain-fed smallholder farmers in these regions (IPCC 2014; Vermeulen et al. 2014). As such, although focused in particular place and time, this study also presents important considerations for other contexts where small-scale farmers are confronted by double exposure.

In southern Mexico, farmers show increasing signs of being "doubly-exposed" to processes of neoliberal globalization and environmental change. For over three decades, small-scale farmers have struggled to survive neoliberal changes in Mexico's agricultural policies, which have transformed how farmers produce and commercialize their crops. Now, yield losses linked to environmental and climatic change are pushing farmers like Julio to new levels of vulnerability. Overall, the double exposure of Mexico's small farm sector is characterized by increasingly extreme and variable climatic conditions, combined with degraded farmlands, inadequate public policies, fluctuating markets, and dependence on private development offices (*despachos*) and subsidiaries of transnational corporations for farming inputs and extension services. As explored in the following chapters, many of these factors are inter-related and having compounding effects.

The onset of climate change in the tropical lowlands is spreading greater uncertainty in the agricultural sector and resulting in steep yield declines and even total crop loss for some farmers. Climate change experts suggest this situation will become increasingly dire for farmers in the tropics as El Niño events become more frequent, temperatures become hotter, and rainfall patterns become more variable in coming years. Between 2014 and 2016 (the years addressed in this study), Chiapas experienced severe drought conditions that were compounded by the El Niño meteorological phenomenon. This study documents the incidence of crop loss among semi-commercial corn farmers in Chiapas, draws attention to how these losses are under-reported in official records, and examines how current vulnerabilities to climate change are linked to the legacy of the Green Revolution mode of production and the drive to remain competitive in the neoliberal context.

Experiences of vulnerability in the agricultural sector vary greatly and attributing yield losses to specific climate events or management practices can be difficult to calculate. Nonetheless, for farmers like Julio it is easy to identify the confluence of factors increasing the risks they face. Nearly all farmers I spoke with for this study describe how the rains no longer arrive on time and, when they do come, they fall sporadically and unevenly. Temperature extremes abound, resulting in hotter summers and colder winters. Farmers lament the paucity of information about climate change and express desires for better seasonal forecasts and extension services to help them navigate ongoing environmental changes in their

farms and region. In addition, farmers have observed an overall loss of soil fertility and increasing pest and weed problems associated with intensive, Green Revolution methods of production. They struggle with the rising costs of seeds and agricultural inputs, the variability of commodity markets, and the frequent mistreatment at the hands of intermediary buyers known as *coyotes.* They begrudge their lack of credit access, technical assistance, and feasible alternatives to farming corn.

Farmers are responding to this double exposure in a variety of ways. Many have reduced the land area they dedicate to corn production and have replaced corn fields with cattle pasture. Those lacking the necessary capital to go into ranching often prefer to rent or sell their land rather than risk farming it. Although many farmers insist on teaching their children how to farm for the sake of 'maintaining tradition,' most hope their children will get educated and find other livelihoods. Nonetheless, with few employment opportunities in the cities and harsher crackdown on immigrants in the United States, many farmers also worry that their family has few options for an off-farm future.

The farmers who have decided to remain in the struggle and keep farming have had to undertake new strategies to survive. Little by little, new farmer associations are emerging to counteract the many crises farmers face. Julio is the founder of one such group known as "Cerro El Peloncillo del Camotal SPR" (hereafter the "Peloncillo Group"). With technical support and guidance from the National Association of Rural Farmers and Merchants (or ANEC for its Spanish acronym), the Peloncillo Group is exploring new approaches to farming and ranching that reduce costs, increase farm resilience to climate shocks, and help farmers recover some autonomy in their production practices by decreasing their dependence on the inputs and expertise of transnational corporations. The experiences of the Peloncillo Group documented in the last chapter of this dissertation explores how experiences of double exposure can open the possibility of a Polanyian double movement and rural transformation founded on agroecological principles and farmer-to-farmer solidarities.

I focus this research on small-scale, semi-commercial corn farmers for a variety of reasons. Corn continues to be the most important crop in Mexico. It is the foundation of the Mexican diet and linked to countless cultural practices and culinary traditions. The farmers in this study still rely on corn as a principle component of their livelihood. As such, they are among the most vulnerable to the impacts of double exposure in the corn sector as it jeopardizes their ability to continue farming into the future. Although researchers have been continually surprised by the persistence of small-scale corn farmers into the 21st century, this study indicates that processes of dispossession are nonetheless still underway. These dynamics are slowly but steadily wresting from farmers their seeds, farming knowledge, and ultimately their means of production as land and resources re-concentrate in the hands of local elites and absentee contract farmers. Second, most of the farmers interviewed in this study represent examples of the "ideal" Mexican

farmer: They reflect both the Mexican revolutionary ideal of the small-scale ejidal farmer and the vision of modernity promoted by the Green Revolution (GR) (Lomnitz 2001). These farmers have attempted to follow each stage of agricultural development as prescribed by the Mexican state and have aspired to become good, small-scale farmer entrepreneurs. As such, their struggles with double exposure serve as a clarion call regarding the perils of continuing to promote a GR transition among Mexico's small-scale farmers within the context of neoliberal food governance and accelerating global environmental change.[2]

1.1 Global Environmental Change and Vulnerability in the Small Farm Sector

Food production globally occupies a contradictory place as one of the economic sectors most implicated in causing climate change and most affected by its impacts as well as other processes of global environmental change. Most studies estimate between 20-35% of anthropogenic greenhouse gas (GHG) emissions are associated with food and agriculture; some studies indicate this percentage could be as high as 50% of all global greenhouse emissions (Vermeulen, Campbell and Ingram 2012; Clapp et al. 2017). As such, the food sector is a key area for mitigating climate change. The 2017 book *Drawdown*, for example, suggests that 8 of the top 20 solutions for mitigating global climate change are food-related changes, including diminishing food waste and decreasing the consumption of animal products (Hawken 2017).

In addition to climate change, food production is linked to several other worrisome processes of environmental change. We have already transgressed the planetary boundary for climate change, biodiversity loss, and nitrogen pollution, and are uncomfortably close to the thresholds established for freshwater use, land use change, ocean acidification, and phosphorous (Rockstrom et al 2009). Agriculture consumes some 70% of global fresh water, occupies 40% of global land area, and is huge driver of deforestation (Clapp et al. 2017: 1). Increased use of synthetic fertilizers and agrochemicals are linked to damages in air and water quality, pollinator populations, and climate change. Declining soil quality leads farmers to increase synthetic fertilizer use, with drastic impacts on water and air. Global use of nitrogen fertilizers increased about 8-fold between 1961 and 2002 (IFA 2204 cited by Liverman and Kapadia 2010: 10). Estimates suggest that crops take up only 50% of the nitrogen applied, with some 20% ending up in aquatic systems (ibid). Of every 100 kilos of nitrogen fertilizer applied, an estimated 1 kilogram ends up as nitrous oxide in the atmosphere (Lin et al. 2011). Nitrous oxide is implicated in ozone destruction and is estimated to be 300 times more potent than carbon dioxide in producing the global greenhouse effect (ibid). Pesticide use is also linked to severe declines in pollinator populations, particularly bees. Pollinator decline is a contradictory problem. Just as agriculture causes the problem, it is also threatened by it because 75% of crops globally depend on pollination in order to

[2] See for example, the Masagro Program, which aims to promote the "sustainable intensification of corn and wheat production in Mexico" www.masagro.mx

thrive (Giraldo 2018: 63).

Agriculture globally is increasingly threatened by climate change. Data from the National Oceanic and Atmospheric Administration (NOAA) reports a long-term warming trend globally, with the six warmest years on record all occurring since 2010[3]. Currently, 2016 and 2015 are listed as the two hottest years globally on record (ibid). "All things being constant, record hot years should occur once every 150 years. Yet 1998, 2005, 2010, 2014 and 2015 have all been record breakers" (The Guardian, 4/14/16). In addition, the Intergovernmental panel on Climate Change (IPCC) further projects increased frequency and severity of extreme climate events such as heat waves, drought, and floods, as well as sea level rise, reductions in water supplies, and shifts in pests and disease (IPCC 2007; IPCC 2014).

El Niño-Southern Oscillation (ENSO), a coupled atmospheric-oceanic phenomenon with global impacts that occurs approximately every two to ten years, also impacts global climate change. La Niña refers to cold episodes. During El Niño, warmer than normal water is carried to the surface, increasing coastal sea temperatures. Particularly strong events occurred in 1982-83, 1997-98, and, most recently between 2014-2016 (the time frame of this study). ENSO can cause huge shifts in rainfall, producing flooding in certain regions and drought in others. Cai et al (2014) predict a doubling in el Niño events in the future linked to overall sea temperature rise under climate change. The 2014-16 el Niño event in Mexico was known as "El Niño Godzilla," creating the worst such event in 18 years and possibly even surpassing the impacts of the 1997-98 El Niño event (The Guardian, 4/14/16).

Over 2.5 billion people make their living from the food and agricultural sector (Clapp et al. 2017: 1). Because every link in agricultural commodity chains is influenced by climate, agriculture is among the most climate-sensitive economic sectors and many scholars have suggested that small-scale farmers are among the most vulnerable populations to climate change. The historic Paris Climate Agreement signed on April 22 in 2016 by some 175 countries recognizes safeguarding food security, ending hunger, and addressing food production vulnerabilities in climate change as a fundamental priority (UNFCCC 2015). Already, crop zone maps are being redrawn to reflect warming trends and scientists warn that crop zones may shift by hundreds of kilometers, leading to dramatic disruptions in current farming practices (Liverman and Kapadia 2010).

Climate impacts in agriculture occur both *directly* (through temperatures, precipitation, humidity, etc) and *indirectly* (through pests, diseases, biodiversity, land availability, etc.). Although climate change presents significant threats to food production in general, research on climate change raises particular concerns regarding the ability of smallholders to withstand these changes. Global projections on climate change from the IPCC and others spell a dire future for small-scale corn

[3] Source: Noaa.gov, accessed 11/10/18

farmers, particularly those that rely on rainfed production systems.

Beyond the total crop loss that results from extreme weather events, warming and drying trends in climate stifle crop development and affect crop yields. Climate change has already been identified as producing significant global losses in corn production (Lobell et al. 2008) and scientists have expressed concern that corn yields will continue to be reduced barring significant investments in crop breeding and seed systems (Challinor et al. 2016). Researchers at Purdue University have found that severe drought stress directly prior to silk emergence and during the silking and pollen shed can reduce corn yields between 3 and 8 percent per day [4]. High temperatures can also desiccate pollen grains and exposed silks. Temperatures over 90F can damage pollen and temperatures 100F or hotter can kill pollen completely[5]. Global models predict that yield losses will continue to be more extreme in the Tropics, causing significant concern for the millions of rainfed, smallholder farmers in these regions (IPCC 2007; IPCC 2014; Vermeulen et al. 2014; Altieri and Nicholls 2009). Over time, these models anticipate a net reduction in the areas of the Tropics apt for rainfed corn production.

Warming trends not only affect plant development but also are likely to increase the incidence of pests, diseases and weed problems facing farmers. For example studies show that increased atmospheric carbon dioxide concentration can drive increased weed growth and reproduction (Weltzin et al. 2003; Ziska et al. 2005; Mueller et al. 2016). Attributing fluctuations in crop disease directly to climate change is uncertain and complex (Anderson et al. 2004; Garrett et al. 2011). Because crop yields depend on a variety of environmental factors (such as climate, soil, and pests) and management factors (such as gemplasm, fertilizer use, labor, pesticides, irrigation, groundwater availability, and machinery) (Liverman and Kapadia 2010), it can be difficult to determine the exact causes behind yield declines. That said, this study documents worrisome trends in declining corn yields over recent years in Southern Mexico and suggests that Green Revolution agricultural practices combined with global environmental change factors are implicated in trends of increased yield losses.

1.2 Purpose of the Study

The main argument of this dissertation is that Mexico's neoliberal approach to food governance has increased vulnerability in the small, semi-commercial farm sector. This system has also created substantial barriers to adapting farm systems to withstand ongoing environmental changes, particularly climate change. I draw attention to several understudied dimensions of double exposure in the case of Mexican corn farmers, including: 1) the legacy of environmental degradation associated with Green Revolution modes of production and its implications for current vulnerabilities; 2) the impact of the privatization and corporatization of

[4] Source: ww.agry.purdue.edu
[5] Source: ww.agry.purdue.edu

Mexico's seeds, inputs, financing and agricultural extension services; 3) the barriers to increasing the adaptive capacity and sustainability of farm systems within the context of neoliberal food governance; and 4) the ways in which the crisis of double exposure can open possibilities for farmer-led agro-ecological transformations.

1.3 Research Questions

This research is oriented around two principle lines of inquiry:

1) How is "double exposure" to environmental change and neoliberal globalization impacting small-scale, semi-commercial corn farmers in Chiapas, Mexico?

Relevant sub-questions include:

A) What environmental and climatic changes have farmers observed in their farms?

B) How do current vulnerabilities relate to longer histories of agricultural development?

C) How do different factors of double exposure manifest and compound one another in the local context?

2) How are farmers responding to experiences of double exposure?

Relevant sub-questions include:

A) What role does the larger political economy of food governance in Mexico play in hindering or enabling farmers' ability to adapt to and mitigate ongoing environmental changes?

B) How do experiences of double exposure influence processes of dispossession and changing power dynamics in rural communities?

C) What are the long-term implications and trade-offs of different responses to double exposure in the short-term?

D) How is double exposure influencing new processes of farmer organizing?

1.4 Literature Review

In this study, I bring three sets of literature into conversation: agrarian studies, political ecology, and vulnerability studies. Using the lens of agrarian studies, I am able to consider the role of history, uneven development, and processes of capital accumulation in current moments of agrarian change. Political ecology provides a

toolkit for examining human-environment relationships and challenges in all their complexity, with attention to the role of political economy and feedback effects through time. In the area of vulnerability studies, I join a growing cadre of scientists advocating for a holistic approach to understanding human vulnerability to climate change. I draw upon and expand the "double exposure" framework in vulnerability studies to explain the interconnections and compounding effects of different political economic and environmental factors of vulnerability. I contend that concepts of vulnerability must be widened to consider the imbrication of current experiences of vulnerability with historical and ongoing processes of uneven development and dispossession.

Agrarian Studies

Grounded in the works of Karl Marx and Vladimir Lenin, researchers in agrarian studies have a long tradition of applying a critical perspective to understanding rural politics, development, and change. In this study, I draw on three inter-related concerns of agrarian studies: 1) the agrarian question; 2) accumulation by dispossession; and 3) the contradictions of capitalism and Polanyi's double movement.

At the turn of the 20th century, philosophers posed the "agrarian question" (or what Engel's called the "peasant question") to describe ongoing debates regarding the fate of the peasantry under capitalism (McMichael 2009). This debate is characterized by two distinct visions of the countryside. The first vision suggests that large-scale, industrialized production will inevitably overtake small-scale agriculture, thereby "freeing" subsistence farmers to become wage laborers (Kautsky 1988 reprint; Byers 2008). The second vision — represented by the work of Alexandar Chayanov (1966) and numerous contemporary scholars (e.g. Rosset et al 2006; Ploeg 2007; Altieri and Toledo 2011) — views "the small producer as a central actor in the economic activity of the countryside, destined to maintain an integral position within the rural class structure" (Courville and Patel 2006: 5). While the former generally views the peasantry as a hindrance to economic development, the latter not only foresees the persistence of small-scale producers but also suggests they are integral to developing long-term, sustainable solutions to global food provisioning.

Since the 1960s, agrarian studies scholars have employed Marxian analyses, Chayanov's theory of peasant economy, and Kautsky's agrarian question to shed light on processes of capitalist accumulation in rural spaces (Bernstein 2009; Byres 1977; Akram-Lodhi and Kay 2008; Goodman and Watts 1997). Although Kautsky — one of the original theorists of the agrarian question — advocated for the elimination of the peasantry, he also observed many factors that would slow and even stymie this process. These factors include: 1) the ability of peasant producers to self-exploit and/or migrate to make ends meet; 2) the dynamism of market competitions that allow enterprises of different shapes and sizes to emerge; 3) small

farms as ideal sites for the reproduction of low-wage laborers; and 4) state policies that protect the small farm sector (Kautsky 1899; Goodman and Watts 1997). The Mann-Dickenson thesis expands these arguments, pointing to additional factors hindering capitalist accumulation in agriculture, including: 1) land is a fixed resource that limits concentration of land holdings in certain regions; 2) capitalist production is an option for family farms but not a requirement; 3) the biological processes of food production leave little ability to consolidate growth times, machinery use, or socially necessary labor time; and 4) the perishability of many products limits the spatial-temporal flexibility of commodity circuits (Mann 1990).

Nonetheless, scholars have also documented the mechanisms whereby capital is able to circumvent the aforementioned barriers to accumulation in agrarian spaces (Djurfeldt 1981; Henderson 1999; Kloppenburg 2004). Kloppenburg (2004), for example, describes how the commodification of seeds has allowed for capital accumulation in the area of seed and input production. This commodification of seeds is further intensified through genetic modifications that render seeds unviable for replanting, thereby requiring farmers to repurchase seeds each season (ibid). The commodification of seeds is but one example of many related to processes of dispossession and commodification in agricultural systems. Commodification processes have steadily transformed small-scale farmers into "propertied laborers" who are distanced from the means of production without actually being dispossessed of their land or becoming wage laborers (Chayanov 1966; Kloppenburg 2004). This allows capital to accumulate in peasant agriculture without necessarily establishing economies of scale or alliances between peasant bourgeoisie and industrial capitalists (Djurfeldt 1981).

This process whereby farmers become "propertied laborers" is closely intertwined with another important theme of this dissertation: ongoing processes of accumulation by dispossession. Whereas primitive accumulation describes the starting point for capitalist accumulation wherein producers are separated from their means of production (Marx 1867), David Harvey uses the term "accumulation by dispossession" to describe continuous and ongoing processes of appropriation (Harvey 2003). The tendency of capitalism towards crises of over-accumulation requires that new assets (whether land, labor, or resources) be continually released and put toward profitable use (ibid). Processes of accumulation by dispossession—at times subtle, at times violent — facilitate this process by allowing capital to move into previously non-capitalized spaces.

Examples of accumulation by dispossession of labor, resources, and knowledge continue to abound in the agrarian sector. They often occur through the privatization of resources, forced displacement, monetization, or through systems of credit and debt that encourage either expanded reproduction or dispossession (Harvey 2003; Wolford 2007). A gradual process of "social enclosure" that privatizes previously collective spaces and emphasizes individual over collective processes often accompanies biophysical enclosure and dispossession (Federici

2005). Scholars have described how the seeds, natural resources, knowledge systems, and labor of small-scale farmers have long been a focus of accumulation efforts by both state and corporate actors (e.g. Kloppenburg 2010; Mullaney 2014). Kloppenburg (2010) demonstrates that dispossessing farmers of their seed systems is a fundamental component to encouraging farmer integration into and dependence on market economies. Indeed, battles over seeds and their relation to farmer autonomy are at the heart of the farmer struggles examined in this dissertation.

Lastly, I draw on ideas from agrarian studies related to the contradictions of capitalism and Polanyi's double movement. Polanyi (1944) understood that subsuming social and ecological values to market logics not only leads to widespread destruction but can also inspire counter movements that pushback against this process. Many scholars have drawn on a Marxian-Polanyian framework to examine the impacts of the commodification of nature in society and the environment (see for example, Castree 2003; Prudham 2005; Osborne 2015). Polanyi (1944) uses the term "fictitious commodities" to describe the things in society that were not produced for sale. These include nature, labor, and money. The commodification process produces a false dichotomy wherein nature and society are treated as discrete entities rather than an articulate whole. Combining this understanding with a Marxian analysis, we see that the processes of capitalist accumulation tend toward an over-exploitation of both natural resources and human labor, leading inevitably to crisis (Prudham 2013). O'Connor (2001) describes this self-destructive tendency of capitalism to destroy the very means of production on which it depends the "second contradiction of capital."

Just as the commodification process and attempts to dis-embed markets from their social-environmental foundation can lead to destructive outcomes, Polanyi also noted that this process can be contested by both social resistance and natural obstacles to commodification. This can manifest in the ways that nature proves uncooperative to the commodification process (e.g. Bumpus 2011) or in direct social resistance and market failure (e.g. McAfee and Shapiro 2010; Osborne 2015). Polanyi calls society's movements to resist the downward pressures of commodification and free markets a "double movement" (Polanyi 1944). Historically, this double movement has manifested differently among distinct sectors of the population. Whereas the working class has historically demanded protections from the market's tendency to over-exploit the labor force, the peasantry has often protested the enclosure of land and the means of agricultural production.

After a period of declining attention, this study contributes to a resurgence of the agrarian question as it relates to global circuits of capital accumulation and growing concerns over achieving agricultural sustainability and food security in the context of significant human-environmental change (Akram-Lodhi and Kay 2008). In this dissertation, I evaluate the many sides of the agrarian question in southern Mexico today. I explore the factors that support the continued existence of small-

scale corn farmers just as I also document the factors that are producing their slow dispossession. I describe how the corporatization of Mexico's seeds and inputs has allowed capital to circulate in agrarian spaces to the benefit of transnational actors without forcing these actors to take responsibility for the well-being and continued reproduction of the laborers themselves. In essence, this configuration allows corporations to "farm without farmers." In addition, I demonstrate that small-scale commodity production is linked to historical processes of capital accumulation that have not only dispossessed farmers of their seeds and farming inputs but also their traditional farming knowledge and farmer-based agricultural expertise. This loss of knowledge and autonomy in farming is a crucial component of farmers' experiences of vulnerability to climate change today and part of what can lead to total dispossession of small farmers.

In this study, I describe a multi-step process of accumulation by dispossession in Mexico's rural sector that I label "dispossession by double exposure." Using an agrarian political ecology approach (see **Section 1.5**), I document several layers of enclosure and dispossession of agrarian knowledge, seeds, inputs, and land that are related to historical processes of agricultural development as well as the ongoing impacts of neoliberalism and global environmental change. Reflecting O'Connor's second contradiction of capitalism (2001), the semi-commercial corn farmers featured in this study have exploited their land and water resources to the maximum. While this exploitation is part of an attempt to remain competitive within a free market context, the result is that farmers are now more vulnerable to climate change and experiences of crop loss.

Together, the cumulative effect of these dynamics contribute to a gradual displacement of small-scale farming in Mexico, allowing these resources to be captured by local elites, absentee investors, and transnational corporations. This dispossession process is not only through direct *economic* means that foreclose farmers' abilities to effectively compete and profit within liberalized grain markets but also through *extra-economic* forces including environmental degradation and climate change, which undermine the productivity of the farm systems themselves (Glassman 2006). The outcome of this dispossession by double exposure is that the middle peasantry of Mexico is gradually dissolving, sharpening the extremes between micro-scale subsistence farmers and larger-scale elite producers, a process previously identified by scholars such as De Janvry et al (1995) and Otero (1998).

Despite the many pressures facing corn farmers, however, I also find that a double movement is emerging to counteract these challenges. I document how the cumulative social and environmental impacts of double exposure have pushed farmers to such an extent of desperation that they are now actively pushing against commodification and dispossession processes through the pursuit of new productive activities and attempts to de-commodify their seeds and farming inputs. Although this countermovement has not yet resulted in any government-level

response to provide greater protections for struggling farmers[6], it has opened a path for farmers to reclaim some autonomy in production and resist the downward pressure of double exposure.

Political Ecology

In the 1980s, political ecology emerged as a field of social science committed to producing nuanced understandings of human-environment relations and change with explicit attention to the role of power and resource control. The interdisciplinary field of political ecology builds on various research traditions, including agrarian studies, early approaches to human-environment research (such as the critical hazards research of Gilbert White and the cultural ecology research of Carl Sauer), systems ecology, and political economic approaches to studying the environment (Robbins 2004; Peet and Watts 1996). It is a "field of critical research predicated on the assumption that any tug on the strands of the global web of human-environment linkages reverberates throughout the system as a whole" (Robbins 2004; 5). Political ecology provides a relational understanding between political economy, material nature and human agency at multiple scales and with attention to power, history and discourse. It allows a specific, local phenomenon — in this case, ongoing processes of double exposure, dispossession, and resistance in rural Mexico — to be evaluated in all its complexity, considering the historical, economic, cultural, political, and ecological aspects that have had a bearing on how it has developed and with what consequences.

This study builds on the long lineage of agrarian and livelihood studies in political ecology (e.g. Blaikie and Brookfield 1987; Bebbington 2001; Watts and Goodman 1997; Batterbury 2001; Wilder and Whiteford 2006; Klooster 2006; Osborne 2013). Political ecology studies often utilize multi-scalar analyses that link grounded ethnography and observation to larger-scale political economic processes, environmental policy, and narratives. Political ecology studies focused on food are varied and represent a dynamic arena of research. These studies overlap with agrarian political economy but generally pay closer attention to the ways in which the environment is impacted by human-environment interactions and power relations and, conversely, how environmental factors also inform human-environment relations and struggles.

Political ecologists have a rich history of contributing to understandings of environmental and social change in Mexico (e.g. Mutersbaugh 2004; Eakin 2005; Fitting 2006; Klooster 2006; Wilder and Romero Lankao 2006; Osborne 2011,

[6] The recent historic election of Morena presidential candidate, Lopez Obrador, suggests that changes may soon be underway to benefit Mexico's small farm sector. However, at the time of writing, it was still too soon to anticipate when and how these changes might play out.

2015). While the field has long analyzed the roots of agrarian change and the corresponding impacts on rural livelihoods, Robbins (2004) calls for political ecologists to widen the focus on farmers to include a larger network of actors influencing agrarian change (p. 211). To this end, my research extends beyond the farm level to include detailed analysis of the public policies, corporate practices, and social processes contributing to the current agrarian moment. While some researchers have pointed to the increasingly privatized and corporate nature of agricultural production in Mexico (e.g. Jennings 1988; Appendini 2014), few have documented the mechanisms through which transnational corporations such as Monsanto (now Bayer) have secured a now prominent role in determining the form and function of local agricultural systems (Craviotti 2016). In attending to this gap, the present study, therefore, endeavors to analyze not only the historical factors that have led to the double exposure of Chiapan corn farmers but also the ongoing struggles that have ensued as seed corporations expand their markets and exert influence as agricultural extension agents in the study region.

Although political ecologists have long-produced multi-scalar and embedded analyses, recent research in global political ecology has produced new lines of inquiry in the field. In the 2011 edited volume, *Global Political Ecology,* researchers demonstrate the many ways in which a political ecology perspective can be used to shed light on global processes and their dialectical imbrication with multi-scalar human-environment relations and practices. Emerging lines of inquiry in global political ecology include green governance, sovereignty and resource control, environmental subjects, the political nature of expert knowledge, and the material implications of different accumulation processes and 'solutions' at different scales (Peet et al. 2011). The embedded and networked perspective of global political ecology can enrich research on climate adaptation, for example, by pushing scholarship beyond narrow studies of local adaptive capacity to engage with larger political economic dimensions implicated in these processes, contemplate how local realities constrain global 'solutions,' and examine the trade-offs between adaptation measures at different spatial scales and temporal frames.

A global political ecology approach is particularly relevant to my work on semi-commercial corn farmers in Chiapas as it serves to emphasize the complex inter-connections between historical processes of development and dispossession, current discursive framings regarding the role of small farmers in national and global food security, and the multi-scalar challenges of adapting neoliberal food systems to accelerating processes of socioeconomic and environmental change.

Vulnerability Studies

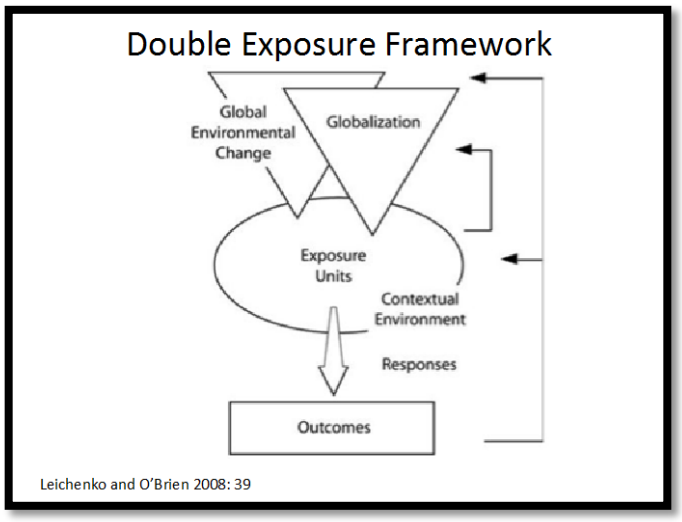
The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as the "propensity or predisposition to be adversely affected" by climate depending on exposure, sensitivity, and adaptive capacity (IPCC 2014: 1175). Geographers have been at the forefront of advocating for more holistic approaches to vulnerability that

move beyond a simple notion of how climate events impact different populations to include larger considerations of international political economy and processes of uneven economic development. Human-environment geographers have drawn attention to how adaptation, resilience, and vulnerability are not only due to biophysical exposure to environmental hazards and impacts but also socioeconomic factors (e.g. Liverman 1990; Appendini and Liverman 1994). Political ecologists have taken this awareness further, insisting that environmental problems and vulnerabilities can only be resolved if we attend to their underlying social inequities and injustices (Adger 2006; Eakin 2006; Ziervogel et al. 2006; Leichenko and O'Brien 2008). Political ecologists have not only complicated our understandings of vulnerability, but have also influenced how terms related to vulnerability are defined and considered in climate change reports and agreements (Liverman 2014). Overall, there is a growing interest among scholars to produce embedded analyses of vulnerability that consider multi-scalar dynamics as well as the trade-offs of different responses (Turner et al. 2003; Misselhorn et al. 2012; Vermeulen et al. 2012; Ribot 2014; Vermeulen et al. 2014).

Critical social scientists are increasingly studying climatic vulnerability and neoliberal processes in tandem (Fieldman 2011; Peet et al. 2011; McMichael 2011; Ribot 2014; Isakson 2014; Marsden et al. 2018). The concept of vulnerability has been expanded to describe "the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of the capacity to adapt" (Adger 2006). Adaptation is defined as the "adjustment of social-ecological systems in response to actual, perceived, or expected environmental changes and their impacts" (Janssen and Ostrom 2006: 237). Rural geographers have documented not only how climate-driven impacts have undermined the livelihoods of smallholder farmers (Warner 2016) but also how adaptive capacities to these impacts are often constrained by various socioeconomic, demographic, and policy-related processes (Morton, 2007). Many studies now reveal that the limited ability of rural populations to adapt to climate change is not due solely to environmental factors but rather is closely related to economic factors such as volatile market prices, risks, and uncertainties.

Processes of global environmental change (GEC) and economic globalization are often at the heart of experiences of vulnerability. O'Brien and Leichenko (2000) use the concept of "double exposure" to describe how certain populations are particularly vulnerable to the combined impact of GEC and economic globalization (See **Figure 1**). Although these processes are increasingly interconnected, few studies have examined the linkages and feedbacks between double exposure processes. Indeed, as Leichenko and O'Brien (2008) articulate, scholars have tended to address each issue in a compartmentalized way. In response, Leichenko and O'Brien offer the double exposure (DE) framework as a tool for analyzing the interactions between GEC and globalization. The DE concept is very similar to the expanded vulnerability framework proposed by Turner (2003).

Figure 1 Double Exposure Framework (Source: Leichenko and O'brien 2008: 39)



In their conception of GEC, Leichenko and O'Brien (2008) include not only large-scale changes influencing the global environment such as sea level rise and climate change but also cumulative local environmental changes such as soil degradation and water pollution. Globalization, in contrast, refers to the uneven patterns of global economic, political, and cultural integration across nations. A neoliberal ideology oriented around free markets, productivity, efficiency, and individualism is the driving force behind many globalization processes today (Leichenko and O'Brien 2008). In the food sector, neoliberal globalization encompasses factors such as international trade agreements, reduced agricultural subsidies and supports, and ongoing technology changes. The adaptive capacity of any particular actor or region depends on the contextual environment and the specific attributes of the "exposure units" (i.e. the actor or sector experiencing a stress or shock) (Leichenko and O'Brien 2008) (see **Figure 1)**.

Similar to a political ecology approach, the DE framework widens the research frame to consider multiple processes simultaneously and sequentially, including the role of local responses to these processes (Leichenko and O'Brien 2008: 33). As Leichenko and O'Brien (2008) explain, "By emphasizing the dynamic interactions between processes, responses, and outcomes, the framework aims to elicit new insights and research questions beyond those associated with separate framings and discourses" (p. 33). The DE framework allows us to: evaluate outcomes of DE and their implications for equity and sustainability; consider the feedbacks produced by different outcomes and responses (particularly if they point to a likely acceleration GEC and related vulnerabilities); and examine adaptive capacity from different perspectives and scales.

Several scholars have used the DE framework in different contexts. Bolin et al (2013) use it to describe the vulnerability of certain urban populations to both

climate-related risks and the crisis of finance capital and the devaluation of homes in Phoenix, AZ. McKune and Silva (2013) examine the impact of economic and environmental change on political instability, food crisis, and food insecurity of pastoral populations in Niger using the DE framework. Silva et al (2010) applied the DE framework to understand smallholder farmers' vulnerability in Mozambique to combined economic and environmental stressors. Similar to the findings of this study, both Silva et al (2010) and McKune and Silva (2013) found that economic stressors and shocks linked to neoliberal globalization and structural adjustment policies have decreased farmers' abilities to adapt to ecological and climate variability.

In Mexico, Turner (2003) has applied the similar expanded vulnerability framework to study the environmental and social impacts of neoliberal policy on changing farming activities in the Yucatan and the impacts of Green Revolution farming in the Yaqui Valley of Sonora. Hallie Eakin has been the most prominent scholar of DE in the Mexican context and is an important model for the work presented in this dissertation. Eakin (2005) provides a multiscalar, multistressor assessment of rural vulnerability to double exposure to political economic changes and climatic risk in three communities in Puebla and Tlaxcala in Central Mexico. Eakin (2005) shows how neoliberal globalization, market liberalization, and climatic risk together influence rural livelihood strategies of smallholders in Mexico. Importantly, Eakin (2005) demonstrates the ways in which farmers' abilities to manage climatic risk are hindered by agricultural policy. She documents crucial tensions between farmers' needs to adapt to economic uncertainty and the actions that best mitigate climatic risk. Eakin (2005) observes that the economic challenges facing small farmers in Mexico including the lack of credit access, insurance, fair markets, and technical support make it so the most viable adaptation strategy for small farmers facing environmental changes may very well be outside of the agricultural sector altogether.

Although there are many factors and feedback loops to consider, the DE schematic provides a useful anchor for exploring corn farmers' experiences and responses to both socioeconomic and environmental sources of vulnerability. In this study, the "exposure frame" is small-scale corn farming sector in Chiapas, Mexico and the "exposure units" are the individual farmers and households impacted by double exposure. As Leichenko and O'Brien (2008) point out, the outcomes of double exposure processes look differently depending on the scale of analysis.

1.5 Theoretical Orientation: Agrarian Political Ecology

While there are many scholarly approaches to understanding vulnerability, this study uses an agrarian political ecology (APE) approach focused on discerning the many factors behind *why* people are vulnerable (Greene 2018; Ribot 2014). The APE approach combines the concerns of agrarian studies with political ecology (see **Section 1.4**). It provides a useful lens for analyzing ongoing struggles over

agriculture and food governance as part of a longer history of rural development and change. APE highlights the shifting dimensions of the "agrarian question" within new phases of capitalism and rural transformation (Osborne 2011). In this study, APE helps me to deepen understandings of how double exposure (DE) operates on the ground for corn farmers and how these experiences are connected to larger political economic and environmental processes. While some geographers have used a "nested" approach to understanding the multiple drivers of food system vulnerability (e.g. Marsden et al. 2018), here I use the double exposure framework as an organizing schematic for understanding the multiple, inter-related stressors impacting farmer livelihoods and land use decisions (Leichenko and O'Brien 2008).

Most empirical studies of vulnerability and adaptation in rural Mexico are quite recent (since 2000). Most use a vulnerability and adaptation framework and equate adaptation with "farming" adaptations, thereby overlooking non-agrarian actors (Lutz Ley 2016). In addition, most studies cite poverty, risky markets, and lack of access to assets as key barriers to successful adaptation to climate vulnerability (ibid). My study expands this body of work by examining the political economic roots of these barriers (Fieldman 2011). Using a political ecology approach, I raise issues of climate governance and adaptation in the context of corporate-dependent farm systems. I emphasize how the privatization and corporatization of Mexico's seed, inputs, and extension services are essential factors not only in farmers' experiences of vulnerability but also their inability to successfully adapt.

Through my in-depth case study, I am able to deepen understandings of how double exposure processes unfold on the ground and the nuanced ways in which different factors interact and compound one another. By integrating considerations of the long-term feedbacks of different responses to vulnerability, I further expand the scope of most vulnerability studies. Lastly, by including a randomized household survey in my research design (see **Section 1.7)**, I integrate considerations of non-agrarian actors and observe the extent to which farmers have left agriculture in recent years in response to ongoing double exposure.

Rather than assuming a causal linkage between double exposure and negative repercussions on the small-scale farm sector (see for example, Torres et al. 2015), the approach used here shows the concrete processes by which small-scale farm systems are transformed by DE. Although the case study approach has its obvious limits, I find that it also reveals dynamics at play that are often unseen at other scales. For example, my case study draws attention to the way in which yield declines and total crop loss are under-reported in Mexico's official reporting. Furthermore, my study reveals how these poor farming outcomes are related to the process of dispossession by double exposure that is underway. The APE in-depth case study approach used in this work draws attention to worrisome changes already underway in the agrarian sector and raises important questions related to Mexico's ability to successfully meet goals for agricultural sustainability and food

security into the future.

Robbins (2004) describes a political ecology approach as providing both a "hatchet" of critique and a "seed" of generating research about how to generate "equity and sustainability" (p. 13). I employ an intensive, place-based approach similar to Batterbury (2001) to not only act as a "hatchet" of critique for ongoing processes of dispossession in the agrarian sector but also as a "seed" to highlight the ways in which farmers are effectively organizing efforts to counteract double exposure and create a Polanyian double movement. I take seriously farmers' agency in counteracting dispossession by double exposure but also identify limiting factors, contradictions, and enduring challenges in new farmer movements.

1.6 Contributions of the Study

Leichenko and O'Brien (2008) describe how the co-occurrence of negative outcomes can be additive and synergistic, pushing those that are exposed to double exposure processes beyond their ability to cope and adapt. These outcomes raise questions of equity. Much of the research presented in this dissertation describes the co-occurrence of negative outcomes for Mexico's small-scale corn farmers. I use the term "dispossession by double exposure" to describe how the accumulation of these negative outcomes eventually push farmers beyond their ability to cope, thereby driving them out of agriculture. This process often ends with farmers becoming permanently separated from their means of production as they turn to selling or renting their land and resources to adapt.

Drawing on an agrarian political ecology (APE) framework, I expand the Double Exposure schematic to include consideration of the role of historical processes of uneven development and ongoing dispossession linked to agricultural policy and corporate influence in food systems. All of these are dimensions of farmers' current experiences of DE in Chiapas. Furthermore, by grounding this research in an in-depth case study of semi-commercial corn farmers in Chiapas, I document the many factors at play in DE, the nuanced feedback loops between factors, and how these feedbacks complicate farmers' abilities to successfully adapt to ongoing environmental change, particularly climate change.

Following political ecology's emphasis on the role of local power dynamics, I explore the ways in which DE is transforming resource use and contributing to the re-concentration of resource and land control within the hands of local elites. The experiences of farmers in Chiapas and their different responses to DE raise important questions about how Mexico can achieve long-term food security and sustainability of its farming systems.

I describe how farmer responses to DE are not predetermined towards total dispossession but can also be used to motivate a kind of Polanyian double movement. This counter-movement led by farmer organizations pushes back against DE and historical processes of capital accumulation in Mexico's agrarian spaces.

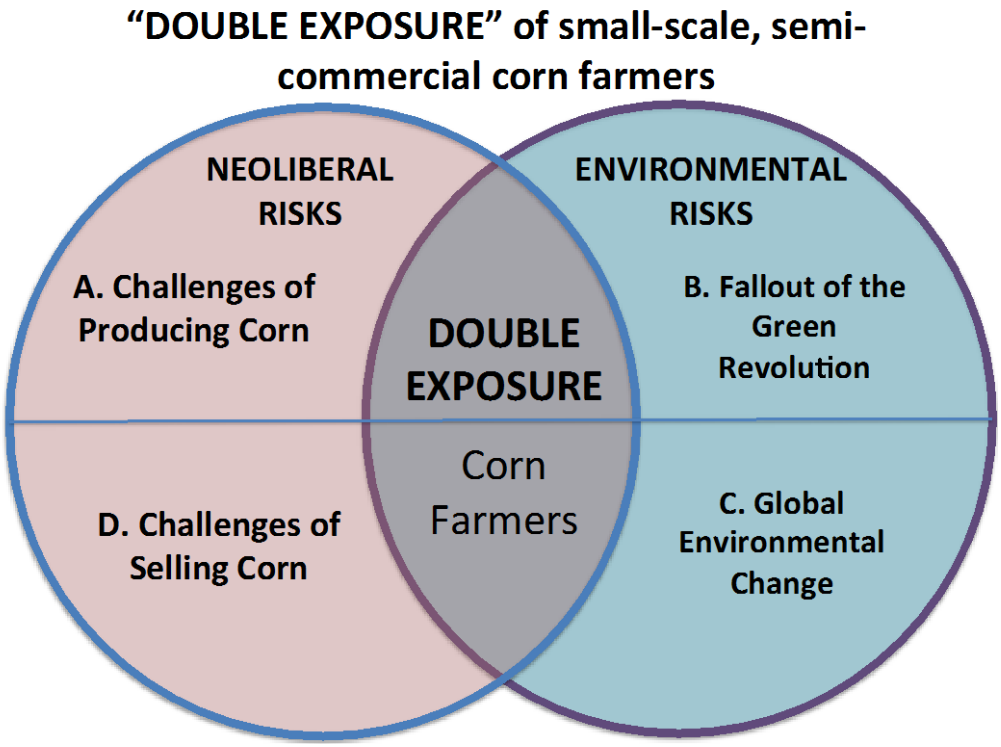
These findings (presented in Ch. 7) raise new considerations for the classic agrarian question regarding the ways in which farmer movements oriented around agro-ecology and farmer-to-farmer solidarities can undo some processes of dispossession that have occurred and may contribute to the endurance of small-scale family farms into the future. Hence, this work is not just an examination of DE and its feedbacks but also an exploration of the potential pathways to overcome these challenges.

This research also contributes to the literature on the political economy of seeds (Keleman et al. 2009; Kloppenburg 2005, 2010; Mercer et al. 2012) and climate adaptation governance (Fieldman 2011; Liverman 2015) by documenting how dependence on transnational corporations and private firms for seeds, inputs, and extension services not only increases small farmers' economic vulnerability but also severely limits the climate adaptation options available to them. Local experiences of vulnerability and dispossession such as those explored in this study relate to larger questions about how we can achieve sustainability and food security in a global food system wrought by climate change and characterized by increasing corporate control and decreased farmer autonomy. Overall, the farmers featured in this study find themselves in a precarious position wherein the drive to remain competitive sits at odds with the need to adapt to and mitigate environmental and climatic changes. Barring significant changes in agricultural policy, the experiences of farmers documented here indicate that small-scale corn farmers will continue to experience a slow dispossession through double exposure.

1.6.1 Expanding the Double Exposure Framework

The DE framework originally conceptualized vulnerability as being rooted in two kinds of exposure, one environmental and the other economic (O'Brien and Leichenko 2000). However, as I advanced in my research, I realized that "double exposure" for small-scale, commercial corn farmers in Chiapas is best understood in four components: two political economic and two environmental. The graphic in **Figure 2** below provides a visualization of these concepts. Neoliberal risks are divided into 1) the challenges of *producing* corn and 2) the challenges of *selling* corn in the neoliberal context. Environmental risks are divided into 1) the "fallout of the Green Revolution" and 2) global environmental change (GEC). Although all factors of double exposure are interconnected and do not necessarily occur in a linear fashion, for simplicity I have labeled each component of Figure X from A-D to reflect the the temporal order in which these factors typically affect farmers throughout each season of crop production. Corn farmers are located in the middle of these concentric circles where these quadrants of risk overlap and compound one another.

Figure 2 Double Exposure in Four Components (Figure by author)

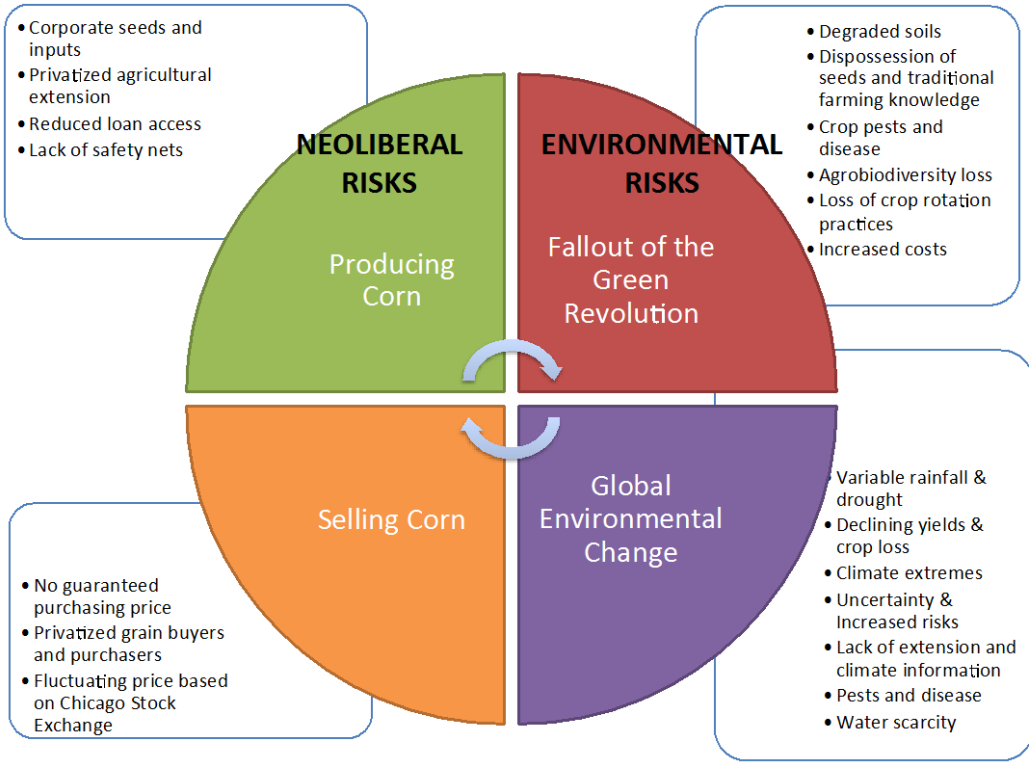


In this double exposure schematic, on the side of "neoliberal risks," the "challenges of producing corn" located in Quadrant A refer to the many challenges corn farmers face today related to corporate-dominated input provisioning of seeds and agrochemicals and privatized systems of agricultural financing and extension services. The "challenges of selling corn" found in Quadrant D refer to the economic pressures and uncertainty farmers encounter when attempting to sell corn within Mexico's liberalized markets. These pressures include a loss of price floors and purchasing guarantees following the privatization of Mexico's system for grain purchasing and processing, as well as competition from U.S. corn producers. In short, the political economic side of double exposure consists of the "neoliberal risks" that farmers face as they are squeezed between a privatized system of inputs and production processes and deregulated markets.

On the side of "environmental risks," the "fallout of the Green Revolution" located in Quadrant B refer to the decline of soil fertility, biodiversity, natural resources, and traditional farming knowledge that has occurred since farmers adopted Green Revolution strategies of production in the second half of the 20th century. The "global environmental changes" listed in Quadrant C refers to the increased challenges of farming in the context of climate change and other processes of global environmental change such as increased pests and water scarcity. In short, the environmental side of double exposure combines the Green Revolution's legacy of social and environmental impacts with the increased risks of farming caused by

ongoing changes in the climate and environment. **Figure 3** summarizes some of the key dimensions of each of the stressors involved in this approach to double exposure.

Figure 3 The Principle Elements of Double Exposure for Small-scale Corn Farmers



1.7 Research Approach and Methods

I used a primarily inductive, ethnographic approach to answer the aforementioned research questions taking the farming household as my unit of analysis. This qualitative approach is suited to the aim of this research of understanding farmers' lived experiences of and responses to double exposure. I present one in-depth case study focused on the Benito Juarez ejido in La Frailesca region of Chiapas. In it, I combine in-depth interviews, participant observation, and a randomized household survey. I complement this in-depth work with anecdotes and observations from other corn-farming communities and interviews with a range of other actors. Although I had several hypotheses prior to beginning fieldwork, I allowed farmer testimonies to guide me toward the key factors affecting their farming decisions and livelihoods. While this work privileges the voices and lived experiences of farmers themselves, I also triangulate farmer testimony with observations from other actors including government officials, extension agents, seed company representatives, farmer organizers, and researchers and with official climate reports and agricultural data.

This research was conducted according to the University of Arizona's Institutional Review Board's (IRB) Human Subjects Protection and Research guidelines (project No. 13-0451). All participants provided oral consent to participate according to IRB protocol. I took hand-written notes during the interviews and, if given consent, would also record the interviews for later transcription. The full names of people interviewed only appear if they provided written consent to do so. In most cases, people's identities are not revealed and are instead referred to by general descriptors (gender, age, role, etc.).

1.7.1 Interviews and Participant Observation

An ethnographic approach that combines interviews and participant observation allows researchers to compare and contrast what is said and what is done (Emerson et al. 2011). It reveals how actors conceptualize their realities and practices and how lived experiences differ from official narratives and reports. I conducted interviews with a wide variety of actors and participant observation in variety of settings (including farmer fields, government offices, farmer-to-farmer events, and farmer meetings).

Rather than attempting to describe a community in its totality, I use ethnography to capture the nuanced experiences of semi-commercial corn farmers in the Lowland region of Chiapas. While most of my observations were made as a passive participant (Laurier 2003), I endeavored nonetheless to practice reciprocity with research participants where I could, offering my services as researcher, note taker, photographer, and facilitator to support the organizing efforts of different farmer associations. I kept detailed notes of my observations and used them to track themes and develop further lines of inquiry. In addition, I used these notes to trace apparent contradictions between what people say and what they do, as well as key differences among perspectives expressed by different research participants.

Interviews for this research ranged from unstructured, informal conversations to formal, semi-structured interviews (Bernard 1994; Creswell 2003). I used interviews to explore patterns and activities I noted in my observations and to pursue clarification on research themes. With the help of local gatekeepers in each community I visited and a snowball sampling approach, I endeavored to interview a diverse cross-section of farmers ranging from subsistence, rainfed producers to wealthy, irrigated growers. In addition, I interviewed a diverse set of actors, including: community members with extensive knowledge of local histories; members of the *consejo ejidal,* the governing body of rural ejidos; government officials from federal institutions such as SAGARPA, CONAGUA, and government extension programs as well as state officials from the Agricultural Secretariat (*Secretaria del Campo*); seed and input distributors; extension agents working in non-profit and for-profit rural development offices (*despachos*); leaders of farmer organizations at the local, regional, and national level; and researchers at CIMMYT, ECOSUR, and the University of Chapingo.

While the thematic focus of interviews varied depending on what subset of actors was being interviewed, lines of questioning generally focused on: 1) farmer experiences of and observations of environmental change; 2) farmer production practices; 3) the political economic context of farming and ranching; 4) agricultural extension and support services available to farmers; 5) farmer experiences of vulnerability and crop loss; and 6) farmer organizing processes and activities (See **Appendix C** for samples of questions used in interviews). By using a semi-structured approach to interviewing, there was flexibility for participants to discuss matters they considered relevant in their own terms (Glaser 1992). This inductive approach drew my attention to additional challenges facing farmers such as the role illness plays in driving processes of debt and dispossession in farming communities. Informal conversations with a wide variety of actors added further nuance to my research (Bernard 1994). This strategy allowed me to collect additional anecdotes during mundane activities such as waiting for the bus, riding in a taxi, or walking through a field. Without the pressure of a microphone or a formal interview questionnaire, people let down their guard, reveal biases, and share personal stories that often linked back to my overarching research questions.

Interviews were conducted in Spanish, the native language of the interviewees and a language in which I am fluent. Semi-structured interviews generally lasted between one and two hours and were conducted at the interviewee's home, office, or farm. Most often these interviews would be with just one person at a time, though on occasion I interviewed two or more people simultaneously (usually when speaking with ejidal council, farmer organization leaders, or multiple government officials). Because most farmers and ranchers, as well as ejidal council members, extension agents, government officials, and farmer organizers are male, the large majority of interviews were conducted with men. A key exception was the interviews with the OCEZ-CNPA leadership and core members, most of who are women.

Social scientists have long been aware that the question structure and order in interviews can influence study participants' responses (Houtkoop-Steenstra 2000). To the extent possible, I endeavored to follow an open line of questioning that did not preemptively trigger a specific kind of answer. For example, questions about climate change were asked in more general ways. Rather than ask specifically about farmers belief in climate change, questions would invite farmers to describe any environmental or climate-related changes they have observed over their lifetimes. Similarly, interviews included open questions, requesting participants list what they see as the greatest challenges to success as a farmer or rancher (whether environmental, economic, or political). This line of questioning was complemented by concrete questions about crop yields, losses and sales in recent years.

Despite my efforts to structure interviews in ways that did not preempt certain answers, the other methods used in this research (particularly participant observation) were fundamental to my ability to confirm the validity of interview

responses. For example, while attending a local birthday party, conversation naturally turned towards shifting weather patterns and the disruption of the flowering of fruit trees, causing the entire mango and avocado crop in 2015 to be lost. By observing these casual conversations, I was able to confirm that climate change is something people are observing and concerned about.

A key, although perhaps unconventional, dimension of my research approach was that my husband, Kiri, accompanied me on nearly all community visits and interviews. Kiri is originally from Mexico City and while he may still be considered as an outsider in rural contexts given his urban background, in his language, cultural background, and race he is much more of a native than I. Kiri's presence greatly facilitated my research in numerous ways. Because most interviewees were male, having a male companion of Mexican heritage at my side helped to ease gender tensions, provided easy cultural and linguistic connection, and relaxed the discomfort of men sharing their experiences with a white, female outsider. In addition, our presence as a married couple in rural places where people highly value family connections allowed for easier integration into the daily life and celebrations of the community such as family reunions, birthday parties, and graduation ceremonies.

1.7.2 Household Survey

Based on the preliminary findings from participant observations and interviews, I designed a randomized household survey that was applied to 61 residents in the Benito Juarez ejido where the majority of this research was focused. By leaving the survey to the end of my time in the field, I was able to craft the questions to reflect the themes that had emerged in previous interviews. In other words, I took a progressive, multi-step approach to narrowing my research questions as the research progressed, culminating in the survey instrument.

A community member, Favian Ramirez, with a background in project evaluations administered the survey. I worked with Favian to edit the wording of survey questions to reflect local vernacular and logic (see surveys used in Appendices A and B). There are a total of 792 households in Benito Juarez. To establish an unbiased, representative sample, I used a systematic sampling technique to select 61 households (nearly an 8% sample of the population) at random for participation in the survey based on a map of all households in the community, which I procured from the local health center. While I used snowball sampling to select interviewees for this study based on their involvement in food production, the survey allowed me to sample a wider variety of community members, including those who have been dispossessed of their lands and/or have chosen to exit farming altogether.

Of the 61 survey respondents, 28 (46%) are non-farming households compared to 33 (54%) that are active farming households. Of the 33 active farming households, 32 (97%) plant corn and 17 (52%) raise livestock. 7 active farmers do

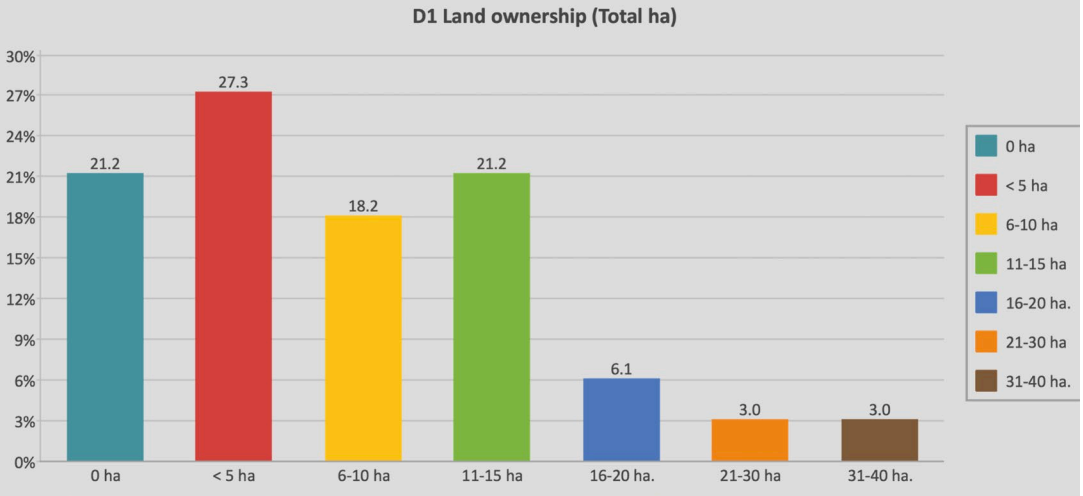
not own any land and must rent land in order to plant corn. Of 33 farmers surveyed, 85% usually plant corn in the rainfed, summer season and 61% usually plant corn in the irrigated, winter crop. **Table 1** shows the land area owned by each of the 61 participants in the randomized household survey. Although the majority of "non-farmers" no longer own any land, land ownership among "active farmers" varied from 0 to 40 hectares. On average, the 33 active farmers surveyed own 8.09 hectares; the median is 6.0 hectares. As seen in **Figure 4**, 21.2 percent (7 farmers) of active farmers surveyed (n=33) do not own any land and must rent land to farm each season. 27.3% (9 farmers) own 5 hectares or less. 18.2% (6 farmers) own 6-10 hectares; 21.2% (7 farmers) own 11-15 hectares; one farmer owns 26 hectares and one other farmer owns 40 hectares.

Table 1 Land area owned by survey participants (Benito Juarez, La Concordia, Chiapas) (2016)

Land Area owned (ha)	0 ha	.5-2.5 ha	2.6-5 ha	5.1-7.5 ha	7.6 – 10 ha	10.1 - 15 ha	16-20 ha	21-30 ha	31-40 ha
Non-Farmers (N=28)	24	1	1	0	2	0	0	0	0
Active Farmers (N=33)	7	3	6	4	2	7	2	1	1
Total	31	4	7	4	4	7	2	1	1

Note: Table based on randomized household survey applied to 61 households in Benito Juarez ejido. Each data point reflects the number of farmers who own land area as specified in each column.

Figure 4 Land ownership among active farmers surveyed (Benito Juarez, La Concordia) (2016)

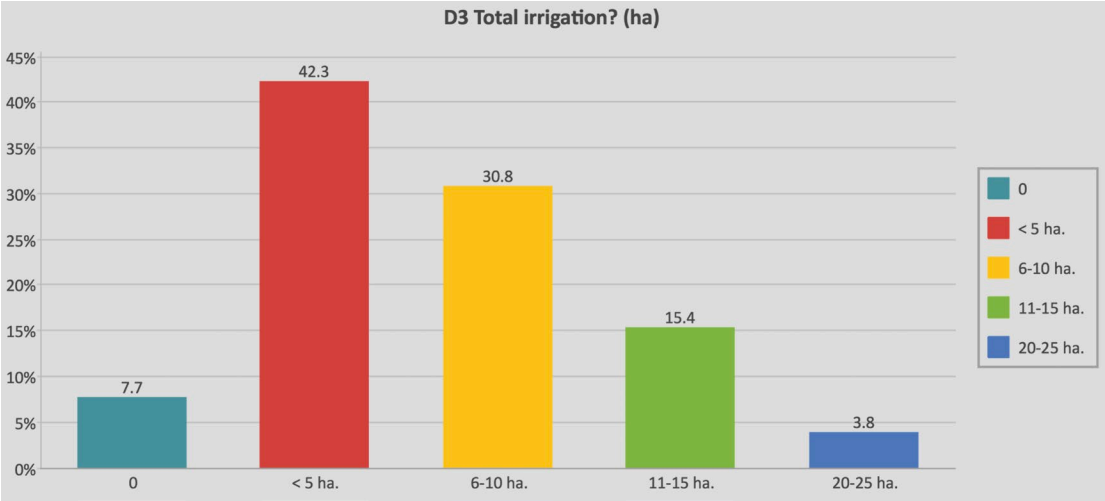


Note: N=33 active farmers surveyed in Benito Juarez. The X-axis indicates the number of hectares owned. The Y-axis refers to the percentage of farmers.

26 of 33 active farming households surveyed own land. Of these, 24 households have irrigation. **Figure 5** reflects the land area with irrigation access

owned by each of the 24 households with irrigation. Access to irrigation is highly uneven in Benito Juarez. While most active farmers have 5 hectares or less of irrigated land, some farmers have acquired as much as 25 hectares of irrigated land.

Figure 5 Land area with irrigation among farmers surveyed (Benito Juarez, La Concordia) (2016)



Note: N=26 active farmers surveyed in Benito Juarez with irrigation. The X-axis indicates the number of hectares with irrigation. The Y-axis refers to the percentage of farmers.

The aim of the survey was not only to collect the current observations and practices of active farmers and ranchers in the ejido but also to gauge the extent to which local families have abandoned farming as a livelihood endeavor and/or have been dispossessed of their property. As such, two different survey instruments were used. If the person surveyed was an active farmer or rancher, an extended survey about farming practices and observations was employed. If the respondent was not active in farming or ranching, a shorter survey was applied that included questions about past experiences with farming, land tenure, and current employment. (See the complete survey instruments in **Appendices A and B**).

1.7.3 Agrarian Archival Data

At the outset of this research, one of my aims was to determine how experiences of double exposure are related to ongoing processes of dispossession and land grabs in the fertile agricultural regions of Chiapas. In interviews it became clear that there are dispossession processes underway in which land and resources are becoming re-concentrated in the hands of local elites. In addition, there is evidence that private companies are increasing the practice of long-term rentals of land and water rights to undertake intensive production of cash crops for export (for example of papayas). I visited state and national agrarian archives with the hope of documenting how these trends have affected land tenure in the ejidos studied. Unfortunately, ejidal files in these archives only document the history of the community's founding and occasional community votes regarding general questions

such as the ejidal vote to participate in the PROCEDE land titling process in 2004. Specific information related to land sales is kept separately and are only accessible with a specific number that references the precise land title transfer. Given these obstacles at state and national archives, I attempted to gather land sale information by consulting local ejidal archives. This effort also led to disappointment, as the files consulted were incomplete and disorganized. It was quite surprising to realize that nobody is providing detailed oversight of the changes occurring in land tenure in ejidal communities. As a result, information on these processes is limited to my own observations and anecdotal examples gathered through interviews.

1.7.4 Data Analysis and Validity

All field notes and recorded interviews were transcribed and imported into the data management software MAXQDA. I coded this data based on location, organization and category of informants, and themes identified throughout the field research process. I then analyzed the content pertaining to each code, paying attention to similarities and differences in each category and across different actors and places. Survey data was also entered into MAXQDA software and used to create the descriptive statistics used herein. Cross-tabulations of both survey and interview data allowed me to understand how farmer positionality (class, irrigated/rainfed, education, involvement in farmer associations, etc) correlates with similarities or differences in experiences (for example of crop loss) and perceptions (for example of vulnerability) across categories of analysis. Lastly, I compared my analysis to data available in secondary materials such as official statistics related to agricultural production and crop loss.

I ensured validity in my analysis and conclusions in three ways: verification, triangulation, and awareness regarding the limited generalizability of research findings. By presenting my preliminary conclusions to study participants in Mexico, I was able to receive their input regarding the accuracy of my interpretations. Next, I sought coherence between the multiple data sources used in the study, triangulating between my observations, interviews, survey data, and information gathered from secondary sources. Any inconsistencies between different data sources were duly noted. Lastly, while this study offers insights regarding the challenges and vulnerabilities that other small, semi-commercial farmers may be experiencing in other parts of Mexico and beyond, I have limited my generalizations and noted the contextual factors that influence the particular findings of this study.

1.4 Research Sites

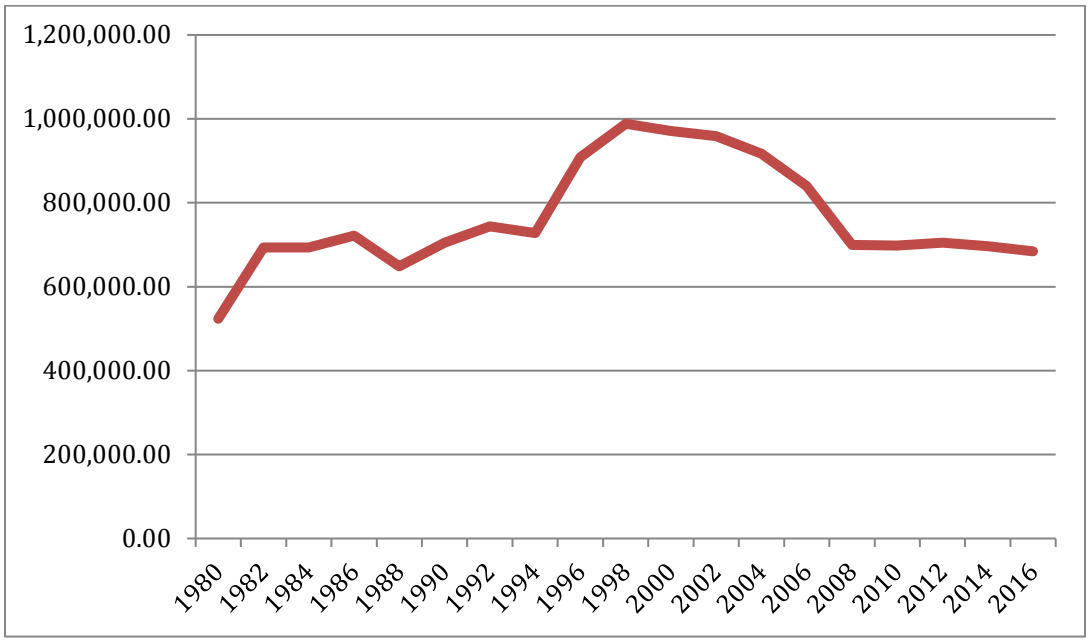
I conducted this study in Chiapas, the southernmost state of Mexico. I selected Chiapas as the area for this research due to its importance throughout history as a corn producing state—Chiapas has historically ranked between 3rd and 4th nationally for corn production—and its large population of small-scale farmers. 92.2 percent of the state's roughly 300,000 corn farmers are considered small-scale and farm 5 hectares or less of land (SAGARPA 2011). Chiapas is also a region that I know

and love. I have lived, worked, and researched there for nearly 10 years since my first visit to the region in 2003.

Despite the state's enormous wealth of natural resources and agricultural surpluses, Chiapas has long-reported the highest levels of poverty and food insecurity in the nation. In 2011, The Department of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) reported that 55 percent of the population lives in "high" or "very high" levels of marginalization (SAGARPA 2011). Since the 1990s, Chiapas has ranked as the state with the largest percentage of the population unable to purchase one CNA (Standard Food Basket) and among the five states with the highest number of food insecure citizens (Sandez 2002: 24). Overall, the heterogeneity of the ecosystems, climate, socio-cultural, and economic conditions in Chiapas has posed a continual challenge to crafting coherent and effective rural policy for the region (Eakin et al. 2014).

Although dominated by smallholder producers, the corn sector of Chiapas is highly productive, continually ranking among the top 10 corn-producing states in the nation and producing over 1.2 million tons of corn each year (SIAP 2018). Between 1996 and 2006, Chiapas was the state with the largest land area dedicated to corn production (SIAP 2012: 33). Nonetheless, the acreage dedicated to corn peaked in 1998 (at 988,367 hectares) and has been falling ever since; in 2016, acreage dedicated to grain corn production reached 684,462 hectares, an almost 31 percent drop in acreage since 1998 (SIAP 2018) (see **Figure 6**).

Figure 6 Acreage (in hectares) of Chiapas farmland in grain corn production, 1980-2016

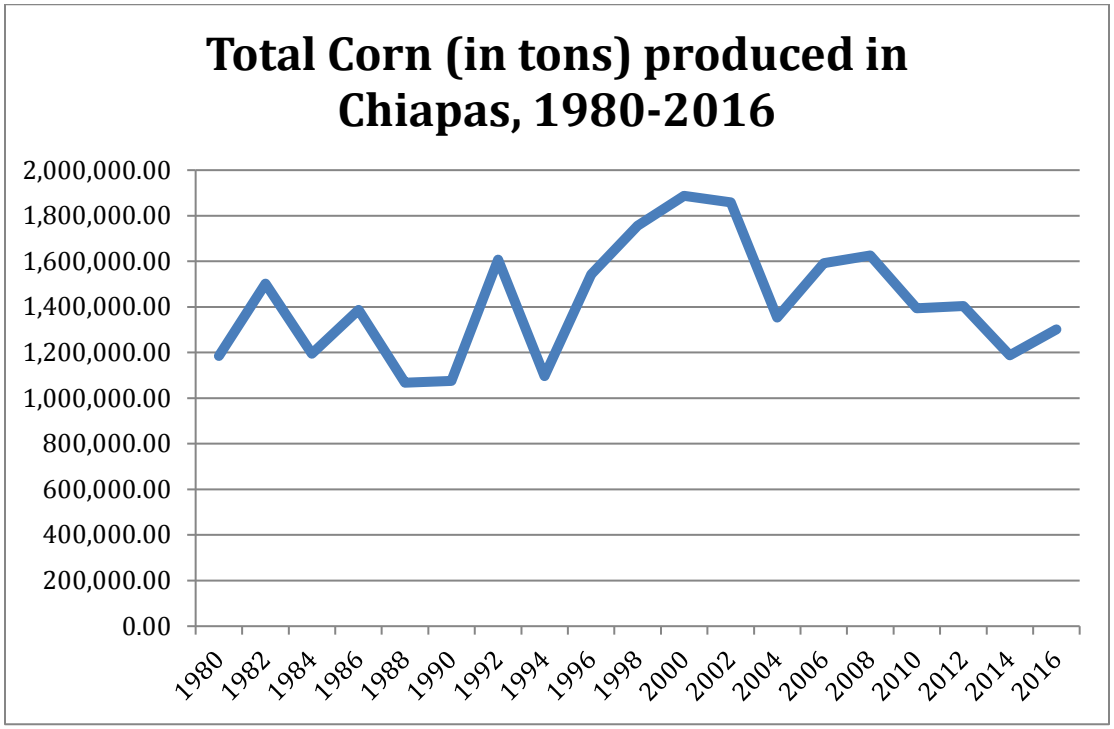


Note: Y-axis represents acreage in hectares dedicated to grain corn production in Chiapas. The X-axis represents the year. Beginning in 1994, corn production area expanded dramatically, reaching its

highest point in 1998 with 988,367 hectares dedicated to corn production. The acreage dedicated to corn has been falling ever since. (Compiled by author using data from SIAP 2018)[7]

Chiapas has not kept up with the yield gains achieved in the corn sector of other states. The tons of corn produced per hectare in Chiapas have actually declined over the last 30 years, dropping from 2.5 tons/ha in 1982 to 1.9 tons/ha in 2016 (SIAP 2018). **Figure 7** charts the changes in the amount of corn produced (in tons) in Chiapas between 1980 and 2016. After peaking in the year 2000, the amount of grain corn produced in the state has tended to decline, dropping as low as 1980 levels of production in 2014, a 37% drop in volume produced since the peak in 2000 (SIAP 2018). The combination of both decreased acreage and stagnant yields has caused the state to gradually fall in recent years from among the top four corn producing states in the nation terms of volume to 7th place in 2017 (SIAP AgroFood Atlas 2018).

Figure 7 Total corn (in tons) produced in Chiapas, 1980-2016



Note: Y-axis represents total corn production (in tons) in Chiapas. The X-axis represents the year. (Compiled by author based on SIAP 2018 data)[8]

I chose to focus my research in the semi-commercial corn farming ejidos of the Chiapas Lowlands. Although I originally hypothesized that highland farmers would be experiencing higher levels of vulnerability to double exposure, extensive scoping

[7] Source: https://nube.siap.gob.mx/cierreagricola/ consulted Nov. 3, 2018
[8] Source: SIAP 2018 https://nube.siap.gob.mx/cierreagricola/ consulted by author on Nov. 3, 2018.

research revealed this was not the case. Highland farmers in Chiapas generally have access to smaller and more marginal plots of land. As a result, although poverty levels remain high in highland communities, most people depend on off-farm sources of income and therefore rely on agriculture primarily for subsistence purposes rather than as a main source of income. In addition, most Green Revolution technology is not well suited to highland farming environments. As a result, most highland farmers continue to practice low-cost, low-input farming based on native seeds that can be saved and reused and few, if any, agrochemical inputs. Regarding changing climatic conditions, scoping interviews revealed that while highland farmers have experienced some declines in their corn harvests in years of little rain (such as 2014 and 2015), native landraces are generally better able to withstand climate extremes and the yield declines did not appear to dramatically affect the livelihoods of highland farmers with whom I spoke.

In contrast, many farmers in lowland ejidos rely on corn farming as a key source of income, practice more expensive "modern" GR modes of production, and have experienced more damaging yield losses and debt in recent years. Because Green Revolution approaches to agriculture continue to be the main model proposed as the path to modernizing the Mexican countryside (through programs such as MasAgro), I wanted to interview farmers who had already "modernized" and adopted the hybrid seeds and technological packets promoted by the Green Revolution. I sought to examine how farmers in these regions were experiencing and responding to ongoing environmental and political economic changes. By studying these populations, I was able to gain insights into the dangers facing farmers who follow development prescriptions to modernize production through GR approaches despite the increasing risks posed by double exposure.

My time in the field was divided between extended stays in three farming communities (Benito Juarez in La Concordia County; and Nuevo San Francisco Playa Grande and San Caralampio in Frontera Comalapa County) and with two different farmer organizations: the Peloncillo Group (based in the Benito Juarez ejido) and CEFADECI (the Center for Agro-ecology and Campesino Training of the OCEZ-CNPA based in Santa Martha ejido, La Trinitaria County that borders Frontera Comalapa County). All interviews were located in the Frailesca and Fronteriza regions of Chiapas (See **Figure 8**).

Figure 8 Map showing the Frailesca and Fronteriza Regions of Chiapas

The majority of research was conducted in the Benito Juarez ejido in La Concordia County in the rural development district (DDR) known as La Frailesca in the Chiapas Lowlands (See **Figure 9)**. This region in the Central Depression has long been considered the grain basket of the state and is dominated by commercial and semi-commercial farming activities. The Benito Juarez ejido was officially established by presidential decree in 1950 in a region ceded from a large-scale cattle hacienda known as *Nuestra Señora.* Today, the ejido covers a total area of 5,018 hectares (see **Figure 10)**. The national agrarian archive (RAN) describes the initial population as a mix of 157 *ejidatarios basicos*; 188 *avecindados*, and 116 *posesionarios* (Source: https://phina.ran.gob.mx/consultaPhina.php). Today, the ejido has a total population of 3,325 people (Health Center census, Benito Juarez, 2015). In 2004, a majority of the ejidal assembly voted to enter the PROCEDE land-titling program. Although this process has generated formal land titles for most of the community, about 31 percent of the ejido's land still does not have formal delineation or titles (data gathered by author at the Registro Agrario Nacional (RAN)).

Figure 9 Map of La Concordia County, La Frailesca Region, Chiapas

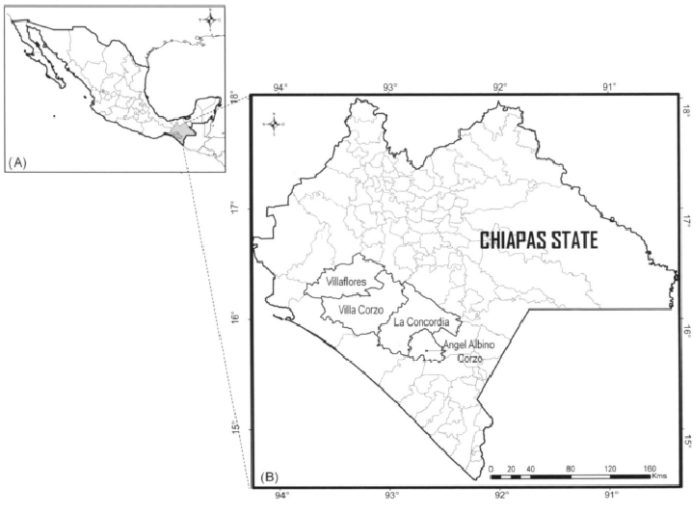


Figure 1 La Frailesca (DDR Villaflores) in Chiapas and Mexico
Source: V.M. Hernández, CIMMYT

Benito Juarez is located at 560 meters above sea level in the Central Depression of the state (See **Figure 10**). Its climate is characterized as warm and humid subtropical. The majority of precipitation falls in the summer months. Summer rains average 60 mm whereas winter rains average less than 5 mm. The average annual temperature is 72 degrees Fahrenheit. A dry period known as the *canicula* usually occurs for 10 to 14 days between July and August each year.

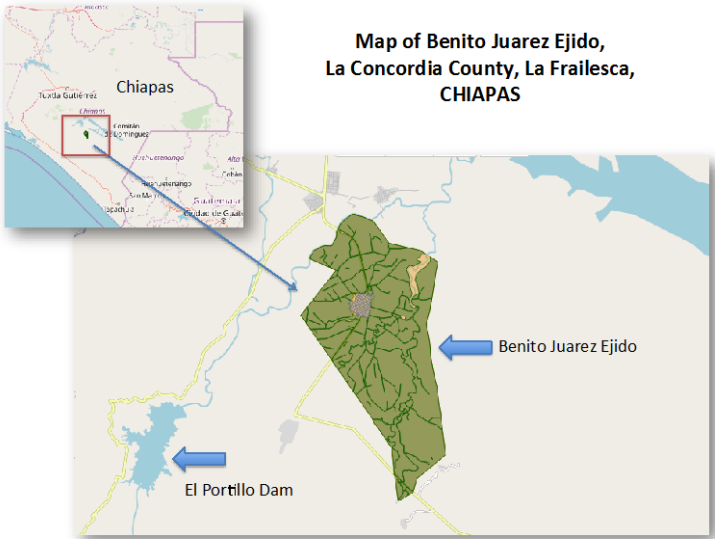
Benito Juarez is one of eight ejidos in the Cutepeques Irrigation District 101 that receives water from the Portillo Dam. The Portillo Dam was created in 1979 is one of only two dams in the state dedicated to agricultural use. Today, the Cutepeques Irrigation District 101 provides irrigation water to 8,278 hectares of land in 8 ejidos and some private users.

Both irrigated and non-irrigated farmers populate the region around the Portillo Dam in Chiapas. Many farmers own a mix of irrigated and rainfed farm areas. The irrigated farmers served by the Portillo Dam now own individual rights to irrigation water. Local users must pay a fee for the water they use and are responsible for the maintenance of the dam and irrigation canals. During the winter season (which runs from October 15th until May 15th), water users pay 250 pesos per hectare of land for irrigation. Irrigation is delivered by gravity through a series of canals and sluice gates adjacent to each farm plot. Interviews revealed that the reliability of water deliveries varies according to each farm's location, with the farms furthest away from the dam suffering most from unreliable deliveries. As discussed in Chapter 6, as rainfall becomes less reliable, access to reliable irrigation is becoming increasingly valuable to farmers throughout the region.

A local CONAGUA official estimates that the Portillo Dam has an estimated 15

years of productive life left (interview, CONAGUA official, 4/23/16). Due to the decentralized approach to water governance in Mexico, there is growing concern that the local water users do not have the financial resources needed to extend the life of the dam or to build a new one. The CONAGUA official admitted that water is becoming scarcer in the region, causing people to drill more wells and raising concern over future shortages (interview, CONAGUA official, 4/23/16). Despite several government programs incentivizing the installation of more efficient irrigation technology (such as drip irrigation), there is evidence that it is primarily wealthier, cash crop producers who are willing to invest in such technology (interview, CONAGUA official, 4/23/16). Interviews with residents of Benito Juarez reveal that representation on the watershed council that oversees how the Portillo Dam is managed is becoming increasingly political with *caciques* manipulating the elections of representatives through pay-offs to voting members and other strategies.

Figure 10 Map of Benito Juarez Ejido, La Concordia, Chiapas



Benito Juarez is located within the Frailesca rural development district that has been known since the 1930s as the grain basket of Chiapas. Historically, the region has been dominated by the production of corn, sorghum and rice. Beginning in the 1960s and 70s, the region began adopting a Green Revolution approach to intensive corn production, replacing much of the area previously planted in rice. **Figure 11** shows aerial photographs of the kinds of farmscapes that characterize the region. By the 1990s, most traditional corn varieties were lost in the region due to the adoption of open-pollinated varieties (OPVs) or hybrid seed varieties (McCune et al. 2012). Many small-scale producers in La Frailesca are commercially oriented (or semi-commercial) and farm for both subsistence and sale (Hellin et al. 2012). As discussed in Ch. 6, today there is a growing presence of livestock in the

region.

Figure 11 Aerial Images of La Frailesca farming region, Chiapas (photos by author)

I conducted additional interviews and observations in two ejidos in Frontera Comalapa County, which borders Guatemala. The ejido of San Caralampio was established in 1954 and covers an area of 3,809 hectares (Source: https://phina.ran.gob.mx/consultaPhina.php). The ejido of Nuevo San Francisco Playa Grande was established more recently in 1989 after farm laborers from a large cattle hacienda were finally able to successfully lobby the government for a concession of 231 hectares of land divided among 43 *ejidatarios* (of which 123 hectares are irrigated). The San Francisco Playa Grande ejido never entered the Procede land-titling program. Both ejidos are part of the San Gregorio Irrigation District 107 that receives water from the Rio Grande El Grijalva that flows westward from Guatemala into Chiapas. Deforestation and declines in rainfall in the upper parts of the Grijalva watershed are raising concern over the long-term availability of irrigation water in this region.

1.5 Research Scope and Access

I conducted 18 months of field research from June of 2015 through December 2016. During these visits, I interviewed a diverse cross-section of farmers, including farms of different sizes (ranging from 1 to 45 hectares), different uses (commercial, semi-commercial, and subsistence), with and without irrigation, and farms dedicated to corn, animal production, cash crops (e.g. mango plantations) or some combination. In addition, I interviewed local ejidal officials, state and federal government officials, leaders of farmer organizations, extension agents, seed distributors, community elders, and agricultural development researchers and experts. Formal interviews for this research were supplemented by countless informal visits, observations, and conversations with farmers and citizens

throughout rural communities in Chiapas.

A total of 148 people were interviewed for this study and 61 people were surveyed. Due to issues of access, most in-depth farmer interviews and all surveys were conducted in the Benito Juarez ejido in La Concordia County. As such, most analysis included in this dissertation focuses on the experiences of farmers from Benito Juarez. Nonetheless, I also draw on anecdotes and observations from interviews in other regions to identify similarities and differences across contexts. I interviewed numerous people on multiple occasions in order to conduct follow-up questions and to visit farmers at different times in the farming seasons. **Table 2** describes the number and kinds of people interviewed in each location and organization. **Table 3** summarizes the different events and activities in which I conducted participant observation.

Table 2 Summary of Interviews by location, organization, informant, and interview type[9]

LOCATION/ORGANIZATION	INFORMANT TYPE	INTERVIEW TYPE	N =
Benito Juarez Ejido, La Concordia County	Farmers/Ranchers	Semi-structured	30
	Elders/Community Members	Unstructured	16
	Local/Ejidal Government	Semi-structured	5
San Caralampio Ejido, Frontera Comalapa County	Farmers/Ranchers	Semi-structured Focus Group	15
	Elders/Community Members	Unstructured	3
	Ejidal Government		2
San Francisco Playa Grande Ejido, Frontera Comalapa County	Farmers/Ranchers	Semi-structured	4
	Elders/Community Members	Unstructured	2
Santa Martha Ejido, La Trinitaria County	Farmers/Ranchers	Semi-structured	3
FARMER ORGANIZATIONS[10]			
ANEC Organization	Director of ANEC	Semi-structured	1
The Chiapas Network	Extension Agent (1) Members (3)	Semi-structured	4
The Peloncillo Group[11] (Benito Juarez Ejido, La Concordia)	Group Leaders and Members	Semi-structured	2
OCEZ-CNPA Organization	Group Leaders and Members (CEFADECI branch of OCEZ)	Semi-structured	6

[9] **Note:** Table only refers to total number of research participants. Many interviewees were visited on multiple occasions for follow-up conversations, additional information, and to reconnect with farmers during different farming seasons.

[10] **ANEC Organization =** Asociación Nacional de Empresas Comercializadoras de Productores del Campo; **The Chiapas Network =** Red de Organizaciones Productivas y Desarrollo Rural Sustentable de Chiapas; **The Peloncillo Group =** Grupo Cerro El Peloncillo de Camotal SPR, Benito Juarez Ejido, La Concordia County; **OCEZ-CNPA Organization =** Organización Campesina Emiliano Zapata, member of Coordinadora Nacional Plan de Ayala;

[11] **Note:** The 10 most active members of the Peloncillo Group were interviewed. This number is included in the total farmers interviewed in Benito Juarez.

Sociedad de Ganaderos (Benito Juarez Ejido, La Concordia)	Ranchers	Semi-structured	7
OTHER ACTORS in Chiapas			
	Seed Company Representatives	Semi-structured	6
	Extension Agents (public and private offices)	Semi-structured	5
	Rural Development NGOs	Unstructured	5
	Farmers/Ranchers (Rural communities)	Unstructured	8
	Government officials (Federal and State)	Unstructured	8
	University Researchers	Unstructured	16
		Total N =	148

Table 3 Summary of participant observation activities

LOCATION	ACTIVITY
Benito Juarez, La Concordia	Ejidal Assembly (1)
	Farm Visits (15)
San Caralampio, Frontera Comalapa	Farm Visits (3)
San Francisco Playa Grande, Frontera Comalapa	Farm Visits (2)
Santa Martha, La Trinitaria	Farm Visits (3)
The Chiapas Network	Farmer-to-Farmer Demonstration Events (2)
The Peloncillo Group	Group Meetings (5)
OCEZ-CNPA Organization/CEFADECI	Campesino and Rural Development Forum – Tuxtla (1)
	2-day Encuentro Escuelas Campesinas (Chiflon) (1)
	2-day Workshop (CEFADECI) (1)
	2-day Systematization of Agroecology Training (1)
Government Events (Chiapas)	Political Events (2)
National Agrarian Archive	National Agrarian Archive (RAN) (Tuxtla, Chiapas) National Agrarian Archive (RAN) (Mexico City)
CIMMYT	Consultation and Presentation w/ CIMMYT Researchers

1.6 Structure of the Dissertation

The remainder of the dissertation is structured in the following way. Because current vulnerabilities in the farm sector relate to histories of uneven agricultural development and processes of dispossession and capital accumulation in the rural sector, Chapter 2 provides an agrarian political ecology of Mexico's agricultural development. I introduce the concept of Mexico's "Long Green Revolution" (Patel 2013) and describe Mexico's neoliberal approach to food governance since the 1980s. This chapter lays the groundwork for understanding how state-led transitions to a Green Revolution (GR) mode of production are related to increased socioeconomic and environmental vulnerabilities in the neoliberal context.

Chapters 3 and 4 treat each of the four components of the double exposure schematic as presented in Section 1.6.2. Chapter 3 describes the neoliberal

exposures affecting corn farmers in Chiapas. First, I examine the particular agricultural history of the study region, followed by an exploration of the challenges of *producing* and *selling* corn in the neoliberal context. In Chapter 4, I document the environmental exposures at play in the corn-farming sector. I describe the "fallout of the Green Revolution" and its impact on increasing current environmental vulnerabilities through a combination of degraded farmlands, a loss of seed sovereignty, and marginalization of farmers' traditional agricultural knowledge. Next, I document farmers' observations of ongoing environmental and climatic changes and relate these experiences to climate change trends and projections in Mexico.

In Chapter 5, I apply concepts from political ecology regarding the iterative relationship between society and the environment to examine how the multiple factors of double exposure interact to create connected and compounded vulnerabilities for semi-commercial corn farmers in Chiapas. I provide examples of how socioeconomic challenges complicate farmers' abilities to effectively cope with environmental challenges. Similarly, I demonstrate how degraded farmlands and ongoing environmental changes are increasing the financial costs and risks of corn farming. I emphasize the ways in which privatized and corporate-dependent systems of input provisioning and extension services further disadvantage small-scale farmers and thwart farmers' abilities to effectively adapt to ongoing changes. Together, these factors have created a "perfect storm" for small-scale corn farmers resulting in yield declines, crop loss, and lost income.

Chapter 6 explores the different strategies farmers are using to respond to experiences of double exposure over the mid- and long-term. I document a slow "dispossession by double exposure" that is occurring among some corn farmers as they are forced to reduce their corn production and exit agriculture altogether in response to DE. I also examine how different efforts to cope with vulnerabilities in the short-term can result in greater vulnerability over the long-term and at different scales of analysis (Turner et al. 2003). Finally, Chapter 7 documents how experiences of double exposure can lead to a Polanyian double movement as farmers organize in new ways to counteract the downward pressure of double exposure. I document the experiences of one particular group, the Peloncillo Group, and examine how agro-ecological principles and farmer-to-farmer solidarities are helping the group reclaim some autonomy in their farm systems.

Ch 2: An Agrarian Political Ecology of Mexico's Agricultural Development

Introduction: Mexico's "Long Green Revolution"

In their description of double exposure, O'Brien and Leichenko (2000) argue that Mexico's small farmers' livelihoods have been made more precarious by Mexico's liberalized economy. While my field research in Chiapas affirms this to be true, neoliberalism is but the most recent stage within a longer history of uneven development and capitalist accumulation in Mexico's agricultural sector that have had important impacts on farmers and their ability to navigate environmental and economic changes. In this chapter, I use an agrarian political ecology approach to provide a more nuanced understanding of the different stages of agricultural development in Mexico and their cumulative impacts on farmer experiences of vulnerability today.

The roots of many of farmers' current environmental and socioeconomic vulnerabilities extend back prior to the neoliberal era. Of particular importance is the key role the Mexican government played in shepherding the transition to an industrial, Green Revolution (hereafter GR) approach to agriculture. The GR model dispossessed farmers of their seeds and traditional farming knowledge and induced farmer dependence on commercial seeds and agrochemicals. This long arc of development created the conditions for increased economic vulnerability for farmers as Mexico's public system of seeds, inputs, and extension services was transferred to private and corporate actors under neoliberalism.

The environmental impacts resulting from the GR model of agriculture in Mexico also predate neoliberalism and set the stage for many of the increased risks farmers face today related to environmental degradation and climate change. As explored in greater depth below, the combination of a GR model of production within a neoliberal model of food governance has not only created an increasingly untenable economic situation for smallholder farmers in Mexico but also raises critical questions regarding farmers' ability to withstand and adapt to ongoing climate change.

There are four main eras of Mexico's agricultural development history that continue to inform farmers' experiences of double exposure today. These are: 1) the Mexican Revolution and the 1917 Constitution, which created land and water rights for the peasantry; 2) the uneven distribution of land and water resources in the post-Revolutionary period of land reform; 3) the Green Revolution and the internationalization of agriculture; and 4) the liberalization of agricultural trade and the reconfiguration of state involvement in the food sector (otherwise known as neoliberalization). In this chapter, I review each of these historical moments and, following Patel (2013), describe a "Long Green Revolution" in Mexico that continues

to unfold today. I focus in particular on the privatization of Mexico's seeds, inputs, and extension services in the neoliberal era. Following the overview, I next provide specific evidence of how the GR approach to agriculture continues to be promoted in the Mexican countryside today and the impacts of this approach on small-scale, commercial corn farmers in the Frailesca Region of Chiapas.

2.1 The Mexican Revolution and the Uneven Distribution of Resources in the Post-Revolutionary period

In the first half of the 20th century, the Mexican Revolution produced one of the most extensive land reforms in the history of the world. The 1917 constitution laid the foundation for massive landholdings and resources to be wrested from elite control and redistributed to millions of small-scale *ejidal* and community farmers. By 1940, about half of Mexico's cultivated land was placed under ejidal control and the number of landless laborers dropped from 68% to 36% of the population. Once approved by presidential decree, most ejidos divided their territory into communally managed areas and individual land plots farmed by ejido members.

Despite Mexico's legacy of small-scale agriculturalists, scholars have demonstrated that the redistribution of land and resources during the post-Revolutionary period was a highly contentious and uneven process, particularly in Mexico's southern states. Even as the government employed populist rhetoric about the 'fair' redistribution of resources following the Revolution, often times agricultural and infrastructure development initiatives further entrenched capital and resource control among middle and upper classes (Hewitt de Alcantara 1976). In Chiapas, the landed elite used diverse tactics to manipulate land reform proceedings in their favor and were able to maintain control of extensive landholdings in the most productive regions of the state, often located near market transportation routes (Reyes Ramos 1992; Howard 1998).

In a study of the land reform process in Chiapas, Reyes Ramos (1992) found that land reform did little to reconfigure colonial inequities in land ownership, allowing the best agricultural lands to remain concentrated in the hands of large landowners. Elite actors rapidly expanded their ranching and farming activities to qualify landholdings as "ineligible" for redistribution and allowed only certain lands to be redistributed. The landholdings ceded were often strategically located around the periphery of large estate plantations to establish an opportune reserve of cheap labor for plantation owners (Reyes Ramos 1992). This history created an unequal landscape and bimodal agricultural system divided between a rural bourgeoisie in fertile farming regions and a rural proletariat located on more marginal landholdings suitable primarily for small-scale subsistence agriculture (Fernandez 1977). Although Mexico's land reform was a spatially variegated process spanning many decades, this legacy of uneven resource access and control continues to play

an important role in the inequities observed in the farming sector today.

Despite a tendency to privilege larger landholders in development processes, the Mexican state has also offered important concessions and supports to the smallholder sector at strategic moments. Often times these interventions are used to achieve state legitimacy, overcome accumulation crises, and pacify rural populations. In the post-Revolutionary period, the modernization of Mexico's agricultural sector (including the nation's millions of smallholders) became a high priority, particularly during and after the tenure of President Cardenas (1934-40). Land reform and agricultural development became fundamental to creating a sense of Mexican identity (*Mexicanidad*) and legitimizing an interventionist and paternalistic State (Lomnitz 2001; Boyer 2003; Banister 2007). Cardenas established the Ejidal Credit Bank (*Banco de Credito Ejidal*) to provide credit to ejidal and community farmers and established new irrigation districts to further encourage commercial-scale agricultural production. While Cardenas did a lot to promote *campesino* and worker rights, his actions also brought these communities under political influence, coopting farmer organizations and bringing them under national party control. This strategy allowed Cardenas to establish the clientelistic relationship between rural communities and the state ruling party that has characterized state-countryside relations ever since, particularly during the PRI's 72-year long one-party rule. As explored in the following section, the role of the state in the countryside further expanded in the second half of the 20th century to facilitate the wide-scale adoption of Green Revolution modes of production in Mexico.

2.2 The Green Revolution in Mexico

"The Green Revolution was itself a moment in struggles around the creation of value, altering the balance of class forces, reconfiguring relations to the means of production, and setting the processes of production and reproduction on a new trajectory."
-Patel 2013 (p. 3)

Mexico continued to pursue the modernization of its agricultural sector throughout the 20th century. Modernization efforts played out upon the uneven control of resources established in the post-Revolutionary period and further entrenched inequalities between different rural populations (Hewitt de Alcantara 1976; Sanderson 1986; Jennings 1988; Appendini 1998; Fox and Haight 2010). Beginning in the 1940s, Mexico formed the epicenter of a paradigm shift in agricultural technology and epistemology that would later become known as the Green Revolution.

The Green Revolution was posited as a key strategy to stifle the spread of a communist "Red Revolution" throughout the developing world (Schmalzer 2016). It was based on science developed at international crop research centers and disseminated through government extension services and subsidies. In Mexico, an

agreement between the Mexican government and the Rockefellar Foundation led to the establishment of CIMMYT, the International Maize and Wheat Improvement Center, which became the primary research center promoting Green Revolution technologies in corn and wheat throughout the nation and the world. CIMMYT's mandate was to use crop breeding and extension services to expand grain yields and make agriculture the engine for Mexico's economic development (Jennings 1988). A dramatic reorganization of productive resources, practices and agricultural labor followed, the effects of which are still being felt today. This transformation relied on significant investments by the Mexican government in rural infrastructure such as roads and irrigation during the 1940s and 50s, particularly in northern states.

While GR technology has often been applauded for contributing to greater global food security, there is also extensive evidence that the benefits of these developments have accrued unevenly across regions and farmers. In Mexico, improved corn varieties have failed in many ways to be attractive or useful to farmers in southern states where dramatic geographies and inclined slopes, varied indigenous and mestizo cultures, little access to inputs, and small-scale landholdings predominate (Hewitt de Alcantara 1976; Barkin and Suarez 1983). While yield gains in corn have been achieved in northern states through the application of chemical inputs, hybrid seeds, machinery and irrigation, yield gains in southeastern Mexico have historically been produced through expanding the areas in corn production (Sweeney et al 2013).

The GR has been widely applauded for providing the improved seeds and agricultural technology necessary to vastly expand and intensify global food production. In countries such as Mexico and India, grain production was transformed. Between 1945 and 1970, for example, Mexico's wheat production increased seven-fold and its corn production increased four-fold (Tuckman 1976). These yield increases in grain production were integral to providing cheap, abundant food to feed growing urban populations and fuel industrialized development globally (Patel 2013).

Despite the positive gains in grain production, the transition to the GR also generated significant social and environmental impacts (Shiva 1991; Pingali 2002; Barkin 2002). Rather than focusing on the improvement of landrace seed varieties as some scientists (including geographer Carl Sauer) and politicians (such as President Cardenas) advised (Patel 2013), the Rockefeller Foundation pursued a purely productivist agenda oriented around the creation of high-yielding hybrid seeds (Jennings 1988). Eddens (2017) documents the ways in which the GR of corn was founded upon imperialist and racist logics that reproduced colonial hierarchies of race, class, and gender, exploiting the rich genetics of traditional corn varieties to create new hybrids while at the same time marginalizing and downgrading the legacy of indigenous knowledge and expertise in Mexico's agricultural history. As a result, the GR not only shifted the onus of agricultural expertise from farmers to laboratory experts and extension agents but also facilitated the transfer of

germplasm control from the global South to the global North (Kloppenburg 2004). In essence, "Western knowledge about seeds as genetic resource [has expanded] at the expense of other ways of knowing seeds" (Eddens 2017: 14).

The development of hybrid corn varieties in Mexico is a classic example of the real, material impacts that result from seemingly apolitical scientific endeavors. Although new technical interventions and scientific developments appear neutral, their impacts reverberate throughout social, political, and economic systems, forever altering human-environment relations (Shiva 1991; Scott 1998; Mitchell 2002; Peet et al. 2011). The GR focus on hybrid seeds produced significant changes in the inputs, costs, and expertise required to farm. After the first year of production, hybrid seeds do not perform the same and new seed must be purchased each year rather than being saved and replanted. Hybrid corn performs best in rich soils supplemented by fertilizer and irrigation. As a result, hybrid seeds tend to achieve the best results on the well-equipped and uniform fields of large-scale, commercial farms.

The shifts in knowledge and inputs as well as the transition towards a reliance on purchased hybrid seeds under the GR all correspond to a displacement and dispossession of farmers' traditional resources and ways of knowing. As such, the GR paradoxically produced abundance in yields while generating new kinds of scarcity, increasing the costs and impacts of crop production and reducing farmer autonomy (Lakshman 1993). This shift has been integral to creating new opportunities for capital to accumulate in agrarian spaces and initiating a transition towards an increasingly corporate-dominated agro-input industry. In addition, as discussed in Chapters 5 and 6, the dispossession that resulted from the GR continues to reverberate throughout Mexico's small farm sector today, affecting small farmers' ability to cope with and adapt to the onset of climate change.

In the US, the gains achieved by hybrid seeds were so significant that local corn varieties were virtually eliminated by 1950 (Brush 2004). In Mexico, however, these benefits accrued unevenly across the farm sector, concentrating among farmers in control of the land, water, and capital necessary to achieve abundant harvests (Hewitt de Alcantara 1976). These developments drastically reconfigured rural space, widened class disparities among farmers, and sent masses of unemployed people to cities unprepared to receive them (Hewitt de Alcantara 1976; Sanderson 1986; Jennings 1988; Otero et al. 1997). While the GR approach to development makes sense from a purely productivist perspective, a more nuanced understanding of the variegated landscapes, patchwork ownership, and disparate resource endowments of Mexico's rural populations would have prescribed a much different approach.

The GR is based on an extractive model of production that has caused widespread environmental and social harm. The GR's reliance on both extensive monocultures and chemical herbicides has reduced agro-biodiversity and

eliminated other useful plants that used to grow alongside grains in traditional poly-crop systems (Otero et al. 1997; Patel 2013; Shiva 1991). The adoption of hybrid grain varieties has diminished the genetic diversity of crops, causing particular concern in crop regions of origin as in the case of corn in Mexico (Brush et al. 1988). This loss of agro-biodiversity has simultaneously eroded traditional agricultural and culinary knowledge. Under the GR model, traditional ways of knowing have been marginalized to make room for capitalist growth logic founded upon monocultures, modified seeds, and intensive agrochemical use (Giraldo 2018). Just as the GR has been integral to the production of more food calories, it has also displaced nutritionally-rich food crops, contributing to malnutrition and the "diseases of affluence" currently afflicting much of the world's population (Patel 2013).

Giraldo (2018) refers to the Green Revolution model of production as "agro-extractionism" due to its reliance on continual extraction of nonrenewable resources. The intensive use of monocultures and agrochemicals strips soil of its fertility and micronutrients and induces reliance on mined elements such as calcium, magnesium, sulfur, and nitrogen (Shiva 1991). As the long Green Revolution has evolved, levels of extraction have expanded, mining the earth not only for minerals, but also for water, oil, and genetic material. Green Revolution technologies replaces natural nutrient cycling with linear flows that erode soil fertility, contaminate the water and atmosphere, causes deforestation, and devastates biodiversity (Shiva 1991; Giraldo 2018). After years of applying GR techniques, farmers tend to experience diminishing yields, resulting in increased use of artificial fertilizers and declines in profit margins (Howard 1998; Shiva 1991). In addition, these impacts contribute to multiple global crises, including passing the "safe" planetary boundaries for nitrogen use, biodiversity loss, and climate change (Rockstrom et al. 2009). In other words, the Green Revolution has become its antithesis, prioritizing capital accumulation over long-term sustainability of the ecological conditions necessary for human survival (Giraldo 2018).

Importantly, researchers have observed that the GR's technological and political economic transition has been accompanied by an epistemological shift that has transformed the meanings and values informing people's actions within agricultural systems (Shiva 1991; Giraldo 2018). Although this epistemological change may occur slowly at first and even take several generations to cement, often times this epistemological shift has greater staying power than the material changes themselves, thereby creating significant barriers to compelling farmers to change their agricultural practices (Giraldo 2018).

2.3 The Role of the State in Mexico's "Long Green Revolution"

"The Green Revolution strategy integrated Third World farmers into the global markets of fertilizers, pesticides and seeds and disintegrated their organic links with their soils and communities" (Shiva 1991: 191).

Patel (2013) critiques the typical periodization of the Green Revolution as lasting solely from the early 1940s until 1970. Instead, Patel (2013) suggests that the Green Revolution is a "decades-long complex of discourse, technology, state power, class politics, national and international relations, private investment, cultural intervention, education and ecological change" that has continued to expand and impact farming communities and food systems today (Patel 2013: 3). Rather than dividing agricultural development into several different Green Revolutions, Patel (2013) describes "one Long Green Revolution" in which the initial adoption of GR techniques was prompted by government programs and then progressively passed off to private actors. Scholars already anticipated this privatization of GR technologies and management in the 1980s (see Barkin and Suarez 1983). The effects of this process are a key component of farmers' experiences of vulnerability presented in this study.

Patel's (2013) conceptualization of one "Long Green Revolution" is consistent with my own observations in Mexico. Certainly the pretexts justifying the continued promotion of GR technology and market integration have changed over the years, ranging from the initial imperative to stop the advance of communism (Schmalzer 2016) to more recent concerns over how to ensure global food security for a growing population (Patel 2013). However, as demonstrated by Patel (2013), in all its phases, the GR has been integral to processes of capitalist accumulation in rural spaces.

The role of the state has also evolved throughout the Long Green Revolution. Initially, state subsidies and investments facilitated the adoption of GR technologies. This set the stage for the subsequent financialization of the agricultural sector and the neoliberal reconfiguration of public institutions (including property ownership, financing, insurance, and risk management) to allow for greater capital accumulation in rural spaces (ibid.). Understanding how this long Green Revolution has unfolded is key to comprehending the environmental and economic vulnerabilities currently facing Mexico's corn farmers. Here, I describe the government's role in inducing technological transformations in Mexico's agricultural sector and how this role has been gradually transformed under neoliberalism.

State-provisioned agricultural subsidies, financing, and extension services have been central to the transition to a GR model of agriculture throughout the Global South. Under this model, farmers become dependent on the state (and associated input providers and extension agents) for their livelihoods (Shiva 1991). Mexico is no exception. Given the nation's complex sociocultural and environmental realities, the Green Revolution was not immediately attractive to Mexico's peasant farmers living in more diverse and marginal landscapes (Sanderson 1986; Cornelius and Myhre 1998; Appendini 1998; Fox and Haight 2010). Due to this mismatch between GR technology and Mexican realities, the adoption of GR technologies in

Mexico has occurred in starts and stops and has only been achieved through significant government involvement (Patel 2013).

During the latter half of the 20th century, the Mexican government provided a series of economic and material supports to farmers to encourage the adoption of GR farming technologies and techniques. Simultaneously, the government adjusted policies and invested in large-scale transportation and irrigation infrastructure projects to support a reorientation of Mexico's agricultural sector in northern states towards international trade and agribusiness (Sanderson 1986). The role of the Mexican state in the GR transition has continually walked the line between the dual goals of accumulation and legitimation (Fox 1993). On the one hand, through the adoption of a GR mode of production the state set the stage for greater capital accumulation in its agricultural sector. On the other hand, the state also worked to legitimize its role as a paternalistic "pro-peasant" provider through heavy subsidies and state intervention, particularly for the small-scale farmers in southern states.

State supports to modernize Mexico's corn sector in the second half of the 20th century included: credit through the nationalized banking system, Banrural; crop insurance through the National Crop and Livestock Insurance Company, ANAGSA; subsidies for fertilizers; seed research, development, and distribution; extension services; and guaranteed purchasing prices for corn. During this period of government-led direct financing of agriculture, whole *ejidos* received credit based on a community contract with Banrural without the need for a collateral guarantee. ANAGSA provided insurance coverage to accompany Banrural's loans. In addition to financing, the state provided seeds, agrochemicals, and extension services to encourage GR methods of production. In 1961, PRONASE, the national seed agency, was created with the mandate of producing and distributing improved seeds to farmers. For several decades prior to the neoliberal transition and the opening of Mexico's seed markets, PRONASE existed as a quasi-monopoly of the nation's seed industry (Pereira and Garcia 1997).

To bolster the commercialization of basic grains, Mexico maintained protectionist policies against grain imports and, in 1965, established CONASUPO (the National Company for Popular Subsistence). CONASUPO provided price supports to grain producers, subsidized inputs, facilitated access to credit and insurance, and oversaw the storage and processing of grains, oils, and powdered milk (Hellin et al. 2012). In addition to this larger institutional involvement, the federal government occasionally created other shorter-lived support programs such as the *Sistema Alimentario Mexicano* (the Mexican Food System or SAM) (1976-82), which also served to promote GR technologies among smallholders. Lastly, regional and state governments also periodically created short-lived programs of seeds, inputs, and machinery supports in exchange for rural voting blocks. These clientelistic practices have continued into the neoliberal context of the 21st century.

Although Mexico's interventionist agricultural programs have not been

monolithic or uniform across time and space, the overall effect of these programs in the 20th century transformed the agricultural sector. Researchers have found that these government supports were vital to inducing the adoption of GR seeds and agrochemicals among both larger, commercial farmers and poorer, semi-commercial ones (Brush et al. 1988). CONASUPO's network of grain warehouses was able to collect grain from both small and large producers over wide areas. Its price floors and purchasing guarantees insulated corn farmers from the vagaries of grain markets. While commercial farmers quickly transitioned to the production of hybrid corn, smaller semi-commercial farmers usually first adopted the use of improved, open-pollinated varieties (OPVs) whose seed could be saved and reused for several years at a time and only later transitions to hybrid varieties (Brush et al. 1988).

Globally, larger producers and urban consumers quickly benefited from the GR through higher yields and increased food access. Nonetheless, peasant and semi-commercial producers have generally experienced fewer benefits (Shiva 1991; Barkin 2002; Pingali 2012; Patel 2013). In Mexico, the rollout of the GR co-evolved with accelerated processes of urbanization and the internationalization of Mexico's agricultural sector (Hewitt de Alcantara 1976; Sanderson 1986). Per capita income increased faster in the more productive regions of northern Mexico (Hellin et al. 2012) and the greatest technology investments typically went to larger, more profitable farmers (Appendini 2001).

Already in the 1980s, there was evidence that the combination of GR technology and the internationalization of Mexico's agricultural sector was leading to agrobiodiversity loss, increasing rural poverty and marginalization, and threatening Mexico's national food security (Barkin and Suarez 1983; Sanderson 1986). Despite a 1960 Law that created a national system of seed research, production, certification, and sales, Mexico's state-led seed industry continually failed to meet national needs due to a chronic lack of funding, excessive bureaucracy, and a lack of quality control. The failures of Mexico's public seed sector have been particularly devastating for the peasant sector, which has been unable to keep up with capitalist modernization processes. As demonstrated by Barkin and Suarez (1983), no private seed industry was ever going to attend to the specific needs and ecological niches of the *campesino* sector. Hence, the GR and the internationalization of agriculture allowed benefits to accrue primarily among wealthier farmers while further marginalizing the peasant sector. Barkin and Suarez (1983) anticipated that the failure of the public seed sector would pave the way for the privatization and corporatization of the seed industry, causing the Mexican state and *campesinos* to become beholden to transnational companies. Barkin and Suarez's (1983) predictions proved to be remarkably prescient, accurately anticipating the corporate takeover of Mexico's seed and input system described throughout this dissertation.

Throughout the second half of the 20th century, agricultural infrastructure,

land, labor, and subsidies became increasingly disarticulated from local needs and instead reoriented around the demands of urban consumers, international demands, and transnational food companies (Sanderson 1986). GR technology was enrolled to accelerate the transition to a livestock-feed complex and cash crop production that displaced Mexico's domestic crop production with animal feed and export crops (Otero et al. 1997). As a result, in the 1970s Mexico became a net importer of the same basic foodstuffs it once used to export. In the early 1980s, world oil prices plummeted and Mexico entered a complex crisis characterized by extreme debt, import dependency, rural unemployment, and widespread poverty and malnutrition (Sanderson 1986). Facing pressure from international development agencies such as the World Bank (WB) and the International Monetary Fund (IMF), Mexico began the long process of shrinking and restructuring government programs and policies, opening to global markets, all the while continuing the long GR but now under a new neoliberal doctrine.

2.4 The Neoliberal Transition: From Productivist to Neoliberal Food Governance

Although there are many definitions of neoliberalism (Ferguson 2010), here I follow Guthman's (2007, 2008) understanding of neoliberalism as the process by which state services are ''hollowed out'' and the regulation of human and environmental relations is transferred to market mechanisms, free trade agreements, and the ''third sector'' (volunteers, private foundations, and private–public partnerships). Numerous scholars urge us not to view neoliberalism in monolithic terms but rather to remain open and evaluate its effects in context (Collier 2012 ; Ferguson 2010 ; McCarthy 2005 ; Perreault and Martin 2005). While I acknowledge that neoliberalism is an increasingly fraught term, I employ it here as shorthand for the series of policy changes reviewed below.

In Mexico's agricultural sector, neoliberalism has been characterized by a reduction in public provisioning of agricultural inputs and services, the advancement of free enterprise and international free trade, the end of agrarian reform, and the promotion of private property. I use the term neoliberal food governance to describe Mexico's ongoing efforts to modernize the food sector through a rollback of state services and subsidies that once bolstered the small farm sector *and* a rollout of other new structures and conditions that tend to privilege large-scale producers and corporations.

Mexico's shift to neoliberalism began in the 1980s and was intended to increase government efficiency and reduce the state's role as benefactor. Rather than a complete withdrawal of state involvement in agriculture, however, this transition is best understood as a reconfiguration of the role of the state in agricultural development (Appendini 2014). Amidst an extreme debt crisis, the Mexican government was forced to restructure its policies according to global

economic integration and development models espoused by the World Bank (WB) and the International Monetary Fund (IMF). These neoliberal changes can broadly be characterized by a reduction in the protections offered to low-income producers and consumers and an increase in the opportunities for (and profits of) private firms and transnational corporations (Appendini 2014). The changes that have most impacted Mexico's farmers fall in two categories: 1) in production, through the removal of subsidies and public support for farm inputs, technical assistance, and financing; and 2) in commercialization, through the elimination of purchasing guarantees, price floors, and trade protections.

Neoliberalism is a loaded and variegated term that means different things in different contexts (e.g. Castree 2008, Ferguson 2010). In the case of Mexico, there are several policy changes that occurred during the last two decades of the 20th century that are integral to Mexico's version of a neoliberal doctrine. In 1986, Mexico joined the General Agreement on Tariffs and Trade (GATT), and, throughout the 1990s, Mexico ratified the North American Free Trade Agreement (NAFTA) as well as eight other free trade agreements under the premise that free trade would increase the efficiency and comparative advantage of Mexico's farm sector. In 1991, CONASUPO programs began to be eliminated and its system of grain storage and distribution was privatized. In 2002, the national program of seed production (PRONASE) began to be liquidated and state investments in the research and development of improved seed varieties through INIFAP were sharply reduced, leaving room for multinational corporations to greatly expand their presence in Mexico's seed market. By 2008, all remaining trade restrictions on basic grains were lifted (Keleman et al 2009: 54) (See **Section 2.5.1** for a more in-depth discussion of the privatization of Mexico's seed industry).

The official end of land reform in Mexico has represented a strong departure from the revolutionary ideals of the early 20th century and has opened the doors for land to become re-concentrated among landowning elite. In 1992, reforms to Article 27 of the constitution ended the redistribution of land. In addition, a land titling process known as PROCEDE was initiated to allow ejidal lands to be legally rented, sold, or used as collateral for the first time since their creation. Although this land titling process has not resulted in the rush of land sales originally anticipated by critiques, many scholars have documented the ways in which it has facilitated exploitative rental practices by absentee investors (e.g. Yetman 2000; Wilder and Whiteford 2006) and increased internal conflicts as community members have struggled to secure their individual land rights (Osborne 2013). Because many government programs and development initiatives are contingent on landholders' having official PROCEDE title to their land, internal land markets have increased in many communities and landholders without titles face disadvantages in program access. In addition, landless community members now face reduced access to natural resources previously managed as collective territory (Osborne 2013).

My findings in this research echo observations made by other scholars

regarding how the PROCEDE land titling process has impacted ejido communities. Mexican law no longer permits individual landholdings to be divided into smaller parcels (interview, RAN Tuxtla office). Hence, any official sale of ejidal lands requires landholdings be sold in their entirety. Because many ejidal members are reluctant to relinquish all of their landholdings, it appears that internal land sales between community members continue to be more common than sales to outsiders. However, land rentals to external investors for intensive short- or medium-term production are increasing in southern states, particularly in ejidos with irrigation access.

Water governance has also undergone dramatic changes. In the 1980s, as part of the nation's neoliberal restructuring, Mexico initiated a transition to a decentralized model of water governance (Whiteford and Melville, 2002; 17). Since then, Mexico's water policy reforms have been informed by concepts of integrated water resources management (IWRM), particularly the neoliberal understanding of IWRM that prescribes decentralization, tradable water rights and full-cost water pricing.

In the rural sector, the 1992 Water Law required management responsibility to be transferred from Mexico's 82 irrigation districts to water users themselves organized in water user associations (WUAs) and watershed councils (Wilder and Romero Lankao 2005). User organizations are responsible for charging and collecting user fees and applying those fees to maintenance works (Whiteford and Melville 2002; 18). "The law required full-cost recovery pricing of water for operation, maintenance, and system improvements, representing a dramatic departure from previous decades of water subsidies" (Wilder and Romero Lankao 2005). Watershed councils are responsible for considering the plurality of interests in each watershed and have representatives from the federal, state and municipal levels, as well as from water user associations, civil society and non-governmental organizations (NGOs) (CNA 2007).

Whiteford and Melville (2002) find that the water user associations (WUAs) can have divergent effects – increasing local participation in certain areas while resulting in more concentrated power of local *caciques* (powerful elites) in others (p. 19). The requirement to cover water system maintenance caused basic water fees to increase substantially in some areas, such as the Rio Yaqui district in Sonora where fees increased by 257 percent between 1992 and 2000 (Wilder 2002). Wilder (2008) finds that river basin councils have failed to establish thorough representation of the most marginalized members of both urban and rural areas.

The pattern of winners and losers that has emerged under neoliberalism has unfolded upon preexisting structural inequalities in Mexico's agricultural sector. While macro-level indicators may indicate positive economic growth for Mexico under these changes, a finer-scaled analysis reveals the dramatic impacts these changes have had on low-income consumers and smallholder livelihoods. Real

prices paid to farmers have dropped some 30 to 40 percent since the inauguration of NAFTA and the number of people making a living in agriculture has continuously declined (dropping from 26 million in 1980 to 15.8 million in 2000) (Barbassa 2011; Yunez-Naude and Barceinas 2006). Overall, farm employment dropped by 20 percent between 1991 and 2007 in Mexico (Fox and Haight 2010) and peasant labor has been sharply devalued (Brush 2004). Simultaneously, consumers have seen the price of corn-based foods increase as much as 300 percent (Barbassa 2011) and experienced increased levels of food insecurity, malnutrition, and obesity (Sandez 2002).

2.4.1 Food Production under Neoliberalism

One of the promises of NAFTA was that Mexico's food sector would continue to modernize via foreign direct investment (FDI). Although FDI in Mexico has increased since the 1990s, Henriques and Patel (2004) show that the majority of food sector investments have gone to secondary and tertiary food products. This has increased the prevalence of processed foods and created "significant concentration of transnational ownership in the food processing sector," thereby benefiting transnational corporations (TNCs) such as Cargill and Arthur Daniels Midland (Henriques and Patel 2004: 2). The FDI that has gone to the agricultural sector has concentrated in northern Mexico and served demands for export products, such as tomatoes and asparagus. These crops not only do little to support local food security, but also directly conflict with water conservation efforts and the need to restore already depleted aquifers in the most arid areas of Mexico (Wilder and Whiteford 2006).

The shift to a greater production of crops for export has been accompanied by an increased reliance on imported grains. Corn imports from the United States have increased four-fold since the inauguration of NAFTA in 1994 (Brooks 2012). Mexico now imports 46 percent of its food (Perez 2013) and about 34 percent of its corn (Wise 2012: 2). The majority of corn imports are yellow corn that are used as animal feed (57%) and processed food inputs (38%) (Nadal 2002: 8). This dependence on food imports has exposed Mexico to the increased volatility of international grain markets, particularly as demand grows for corn-based biofuels in the US (Wise 2012).

The programs intended to buffer smallholder farmers from the impacts of neoliberal policies and trade agreements have been negligible given the magnitude of changes (Appendini 1998; Myhre 1998). In 1993, just prior to the inauguration of NAFTA, PROCAMPO (the Direct Rural Support Program) was created to pay farmers a fixed amount per hectare of area farmed in basic crops, particularly corn. Although PROCAMPO was scheduled to end in 2008, the program's timeline has been continuously extended even as the cash amounts paid have been gradually reduced. Today, the program continues under the name PROAGRO. In a thorough review of agricultural programs, Fox and Haight (2010) concluded that even PROCAMPO,

"Mexico's most inclusionary, pro-poor farm program for corn growers excludes much of its target population and benefits better-off growers disproportionately" (p. 8).

In 2001, Banrural went bankrupt. Since then, government funding for agriculture has been managed by the FND (*Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero* (previously *Financiera Rural*) and FIRA (*Fideicomisos Instituidos con Relacion a la Agricultura*). The FND was established in 2002 following the closure of Banrural and is a branch of Mexico's *Secretaria de Hacienda y Credito Publico* (SHCP). Today, FND provides financing to farmers without the need for a collateral guarantee. However, access to lower-interest loans through FND require a personalized recommendation from a private extension office known as *despachos* and the loan amounts available do not meet the extent of need among farmers (Jesus, extension agent, interview 9/28/16).

FIRA is another lending branch of Mexico's SHCP. It is a 'second-floor' bank that guarantees private loans made to farmers by intermediaries. FIRA provides funding to intermediary banks and *despachos* at a 5% interest rate. From there, the intermediaries finance farmers, farming organizations and businesses for an additional 10-20 percent annual interest rate. In total, farmers receiving credit will pay between 15 and 25 percent interest on loans secured through FIRA and associated intermediaries (Jesus, extension agent, interview 9/28/16).

Although the government still provides some low-interest financing to farmers through the FND and FIRA, it has outsourced the oversight of these loans to private development offices known as *despachos* that generally charge high interest rates and are highly selective of their clientele (see **Section 2.5.2**). Because farmers (and small-scale farmers in particular) are considered high-risk clients, funneling public financing through private offices has decreased the amount of credit made available to individual, small-scale farmers considered too high of a credit risk. In the 1990s, many small farmers fell into "*cartera vencida*" (past-due) when they failed to pay back previous loans and today are no longer eligible for private sources of credit (farmer interviews, Benito Juarez, 2016). Most *despachos* will only work with small farmers who provide some form of collateral and are organized into groups that commit to mutually guarantee the whole group's loan payments. The rise of the *despacho* model of rural financing and extension services is explored in greater depth in **Section 2.5.2.**

2.4.2 Selling Corn in the Neoliberal Context

New challenges for selling corn have also emerged in the neoliberal context. Small-scale farmers face increasing difficulty in commercializing their crop at a price that covers costs and allows for farming livelihoods to be reproduced. Today, corn, arguably the most important food crop in Mexico, is sold on an open and unprotected market. In the early 1990s, CONASUPO, Mexico's national system of supports for both farmers and consumers, began to be phased out. Guaranteed

prices and purchases of staples were eliminated and the network of CONASUPO corn storage and distribution centers was privatized. Simultaneously, the North American Free Trade Agreement (NAFTA) was inaugurated in 1994, leading to the liberalization of agricultural trade, including corn. The loss of price supports and purchasing guarantees combined with the influx of cheap imported grains under free trade pushed many small-scale farmers in Mexico into crisis. The farmers who continue to produce corn for commercial sale in Mexico today do so within very trying circumstances. Whereas the previous sections of this chapter have detailed the difficulties farmers face in producing corn, this section explores the challenges farmers face in selling their corn upon harvest in the neoliberal context.

Although the late 20th century is characterized by a removal of market protections for both corn and coffee in Mexico, the trajectory of these crops since have differed dramatically. While there has been an incredible movement among coffee producers in Mexico and international partners to transition to fair trade and organic production for export, there has not been a similar movement for corn farmers. The economies of scale in grain production that countries such as the US manage create continuous downward pressure on corn prices in Mexico. Only a small sector of corn farmers has identified niche opportunities to sell native corn varieties and handmade corn tortillas in local and regional markets. Instead, most grain is sold to *coyotes* (middlemen) or corporations.

Four corporations dominate Mexico's corn flour market. Grupo Industrial Maseca dominates 71% of the market and Minsa, Agroinsa and HARIMASA cover the rest (Hernandez Ramos 2014: 22, citing campomexicano.gob.mx). Each season, grain buyers for these corporations calculate their purchasing price based on the Chicago Stock Exchange. Due to far-reaching free trade arrangements, grain-processing corporations have many options for sourcing the corn used in their products. As a result, if the price is right, they will often choose to import corn rather than purchase it from Mexican farmers. As an example, in 2012, Maseca imported 50,000 tons of corn from South Africa rather than purchase corn domestically from farmers in Chiapas (Extension agent, Masagro Chiapas Hub, interview 8/31/15).

The ASERCA program (the Agricultural Marketing and Support Program) was created to replace CONASUPO, but with fewer pro-poor results. Rather than overseeing the buying and selling of basic grains, ASERCA compensates farmers when market prices (based on the Chicago Stock Exchange) fall below local production costs. To receive the guaranteed price, farmers must sell their corn through private grain processors such as Maseca and meet precise quality standards. Those enrolled in ASERCA also receive some insurance coverage in case the crop fails. Interviews for this study reveal that farmers in Chiapas are disinclined towards the ASERCA program. They think the system is complicated and works to their disadvantage; they dislike the delayed payments and in general struggle to meet quality standards (SAGARPA official, interview 12/8/16). Overall, research on

ASERCA suggests the program acts more as a benefit to private grain processors than as a support to struggling farmers. One analysis found that 9 companies amassed 91% of ASERCA supports for corn commercialization in 2015, with Maseca and Minsa corporations attaining the majority (Ramirez 2015). Farmers interviewed for this study experience numerous problems with this system as detailed in Chapter 3.

Table 4 Summary of policy changes under neoliberalism that affect small-scale grain farmers

	Pre-Neoliberalism	Changes under Neoliberalism	Description of Change
International Markets	Trade Restrictions	Tariff-Rate Quota (TRQ) Transition to free trade; Procampo (Now ProAgro Productivo)	Special measures to protect corn farmers during transition to free trade; Procampo provides yearly cash transfers since 1993; In 2014, becomes ProAgro Productivo
Domestic Markets	CONASUPO	Private Intermediaries; ASERCA	Price no longer regulated by government but now informed by free market; ASERCA compensates farmers for difference between market price and production costs
Ag credit, extension, and technology transfer	Banrural	Fideicomisos Instituidos con Relacion a la Agricultura (FIRA) and the Financiera Nacional de Desarrollo (FND)	Shift from subsidized credit to FND and FIRA as 'second-floor' bank to guarantee loans made to farmers; credit often tied to full tech package suggested by *despachos*
	PRONASE	*Despachos* (private or non-profits); Private and/or transnational seed companies	Shift from government-sponsored seed production and sale to private firms and companies that sell seed, inputs, and technical assistance
		Kilo x Kilo	Rather than government-sponsored fertilizer, the new federal program allowed farmers to trade 1 kg of landrace seed for 1 kg of hybrid seed. This later changed to subsidy for improved seed purchases. Continued as state program until 2006 in Chiapas
Nutrition and	PRONASOL	Oportunidades	Shift to targeted cash

education policy		(now Prospera)	transfers for meeting education, nutrition and health targets
Land tenure	Ongoing redistribution of land control	Changes to Article 27; PROCEDE	End of land reform and beginning of the individual land titling and privatization of previously collective landholdings
Water governance	Centralized, bureaucratic control; subsidized	Decentralization, tradable water rights and full-cost water pricing	

Note: Table 4 is adapted from Keleman et al. 2009: 55 (updated by author)

Table 4 provides a summary of the policy changes affecting Mexico's small-scale grain producers under neoliberalism. Overall, these programs reflect a transition away from trade restrictions and government-subsidized production and towards privatized mechanisms of financing, input provisions, and technical supports combined with a more welfare-like system of supports for the poor. In 1989, the program originally known as *PRONASOL* (later renamed *Progresa,* then *Oportunidades* and now *Prospera*) was created as a conditional cash transfer program to female heads of poorer households who attend health clinics, nutrition classes, and ensure their children's regular attendance at school. Prospera has become the most important welfare program for rural populations in the neoliberal context. Although there have been evidence of its positive impacts among the rural poor, there is also widespread critiques that the program encourages dependence on government hand-outs rather than creating productive options for rural families (Villafuerte-Solis 2015).

The impacts of neoliberalism on the small farm sector in Mexico have been extensively documented (e.g. Tardanico & Rosenburg 2000; Conroy and West 2000; Henriques and Patel 2004; Wilder 2008; Keleman et al. 2009). Although many government officials and researchers anticipated Mexico's neoliberal shift would quickly eliminate the small-scale farm sector, smallholders have devised numerous strategies to survive. Small farmers have responded by diversifying their livelihood strategies (De Janvry 1997; Mercer et al. 2012), experimenting with new niche markets such as organic, fair trade, and alternative food networks (Tovar et al. 2005; Bellante 2015), migrating and securing off-farm income in urban regions or abroad (Fitting 2006; Henriques and Patel 2004; Eakin et al. 2014), and instigating international social movements and solidarity actions such as those led by the Zapatista Movement in Chiapas (Morton 2007) or the regional and national efforts of organizations such as ANEC explored in Chapter 7 of this dissertation.

2.4.3 Neoliberalism in Chiapas

Overall, scholars have characterized the supports available to smaller farmers and poorer rural households under neoliberalism as "assistentialist" and "clientelistic" rather than productive (Fox 1994; Yoworsky 2005; Fox and Haight

2010; Villafuerte-Solis 2015). Villafuerte-Solis (2015) suggests that the state of Chiapas offers the most blatant examples of the failures of Mexico's neoliberal policies. Rather than promoting smallholder production, the majority of public expenditure in Chiapas now goes to anti-poverty programs such as *Oportunitidades* (now *Prospera*) and the *Cruzada contra el Hambre* (Villafuerte-Solis 2015). With some exceptions (such as PESA, the Strategic Project for Food Security), the agricultural supports that do exist tend to promote "reconversion" from staples to cash crops for export, particularly biofuels (ibid). As a result, Chiapas has experienced substantial reductions in corn and bean production in recent decades (**See Section 1.4)**.

Although public expenditure on assistentialist, anti-poverty programs has increased, this spending has not reduced poverty in Chiapas. Instead, Mexico's ongoing rural crisis is seen in the loss of food sovereignty and rising indicators of poverty, hunger, migration and ecological devastation (Villafuerte-Solis 2015: 15). Nearly 75 percent of the population lives in poverty in Chiapas and the state ranks highest in extreme poverty (32.2 percent of the population) (Villafuerte-Solis 2015). While nationally 22.2% of families are enrolled in *Oportunidades*, in Chiapas 62.4% of families receive it (ibid). Overall, programs have greatly reduced incentives for substantive economic development and instead have promoted dependence on government hand-outs and social welfare supports (Fox and Haight 2010; McCune et al. 2012).

2.5 Neoliberalism as Capital Accumulation and In-Situ Dispossession in Mexico's Rural Sector

Mexico's transition to neoliberalism has facilitated increased capital accumulation in rural spaces and resources. As evidenced in this case study, the state-sponsored dispossession of farmers from the seeds, inputs, and knowledge that underpinned their traditional agricultural systems in Chiapas has been followed by a withdrawal of public services and an increased role of private actors and corporations in agriculture. In other words, the emerging and expanding role of the private sector in Mexico's long GR feeds upon the resources and dependences accumulated in the previous phases of subsidized agricultural development.

Although people are widely informed of how the removal of market protections for corn under NAFTA has affected small grain farmers, fewer are aware of how the removal of seed subsidies and public extension services has also played an important role in increasing farmer vulnerability. Following Patel (2013), many of the policy changes made under neoliberalism have further entrenched the Green Revolution approach to agriculture. In the neoliberal context, the pressure to become a capital-intensive, high-yielding competitive farmer is unrelenting. However, in the absence of public services and supports, farmers are also increasingly dependent upon the inputs, services, and ultimately the terms dictated by private actors and corporations (see **Section 3.4.3**). Those determined to

continue producing grain find themselves on the proverbial "technological treadmill" wherein their dependence on purchased inputs and the need to achieve ever-greater yields leaves them no choice but to continue investing in an evermore expensive suite of inputs and GR production strategies (Kloppenburg 2004).

Mexico's state-driven transition to a Green Revolution approach to agriculture followed by its extensive privatization of inputs, extension services, and grain commercialization can be understood as a long process of what Giraldo (2018) refers to as "in situ dispossession." The term refers to a dispossession process that does not necessarily require farmers be removed from their land. Instead, agro-extractionism accumulates capital in rural spaces through indirect means that place farmer production in service of territorial rent dynamics (Giraldo 2018: 15). Formerly independent *campesinos* become dependent operators in the agroindustrial chain (Giraldo 2018: 91). They get squeezed between the upfront costs of seeds and agrochemical inputs on the one hand and the free market farm gate prices of grain on the other. Although farmers assume all the risks of production, most profits accumulate among input manufacturers, food processors, and retail chains (McCune et al 2012: 486). This exacerbates farmers' condition as "propertied laborers" (Chayanov 1966; Kloppenburg 2004). Corporate seed and input providers and food processors benefit most from farmers' labor and reliance on purchased technology. However, they are not held responsible to provide for the social reproduction and safety of the farm laborers themselves. Farmers become dispossessed of profits, autonomy in production, and traditional farming knowledge and inputs while simultaneously facing constant pressures to adopt expensive inputs and technologies and increased production risks and debt. In sum, the neoliberalization of the Long Green Revolution has allowed agribusinesses to expand into rural spaces, exploiting labor and extracting surplus value without the need to directly appropriate land, compensate labor, or take on the risks of production (Giraldo 2018).

2.5.1 Seeds and Inputs

"As both foodstuff and means of production, seed sits at a critical nexus where contemporary battles over the technical, social and environmental conditions of production and consumption converge and are made manifest. Who controls the seed gains a substantial measure of control over the shape of the entire food system" (Kloppenburg 2010: 369).

Globally, the reduction of public systems of seed development and distribution has opened the door to the privatization and transnationalization of the seed industry (Shiva 1991: 213). Kloppenburg (2010) describes the corporate appropriation of genetic resources and seeds as an ongoing process of "accumulation by dispossession" (Harvey 2003). This process relocates power and value from the global South to the global North and from farmers to corporations

(Kloppenburg 2010; Shiva 1991). Over time, farmers become increasingly separated from the ownership and control over their seeds and production systems (Kloppenburg 2010; Giraldo 2018). Among Mexico's commercial and semi-commercial farmers, public programs that facilitated the Green Revolution initiated this process of dispossession from their seed systems. However, since the neoliberal turn, the control of Mexico's seed and agrochemical inputs are increasingly under the control of private firms and transnational seed corporations.

Historically there was a widespread view in Mexico that public control of the seed industry was necessary to ensure national food security and protect farmers from excessive seed prices. However, by the end of the 20th century this conviction had all but disappeared from Mexico's rural agenda. Although PRONASE, Mexico's national seed company was the largest seed company in Mexico in 1981, by 1992 it was not even within the top four (Pereira and Garcia 1997: 22). The role of private and transnational seed providers in Mexico increased sharply following the economic crisis of the early 1980s. As part of government restructuring and in preparation for NAFTA, the government made changes to significantly reduce restrictions on private sector participation in agricultural research, seed production and marketing (ibid: 23). The research institution, INIFAP, was also allowed to begin distributing improved varieties through private vendors rather than just PRONASE.

Adherents of neoliberal philosophy optimistically expected that the privatization of seed provisioning in Mexico would make the seed sector more efficient and competitively priced (e.g. Pereira and Garcia 1997). However, this has not been the case. In the wake of PRONASE's elimination, transnational corporations assumed control of the majority of seed sales in Mexico (Pereira and Garcia 1997). By 1993, the private sector controlled 91% of corn seed sales in Mexico (up from 13% in 1971 and 54% in 1991) (Pereira and Garcia 1997: 25) (See **Table 5**). Because private seed providers are driven by profit motive, private breeding programs do not invest in the development of open-pollinated varieties (OPVs) that can be saved and replanted each year but instead focus primarily on hybrid seed production (Pereira and Garcia 1997).

Table 5 Private sector control of Mexico's corn seeds

Year	Percent of Private Sector Control of Mexico's Corn Seed Sales
1971	**13%**
1991	**54%**
1993	**91%**

Source: Pereira and Garcia 1997: 25

It is important to note that much of the neoliberal shift in agricultural governance in Mexico has not resulted as much in an elimination of public supports in agriculture, but rather a reorientation of expenditures away from direct, productive supports to farmers and towards programming that has increasingly benefitted private actors and corporations (Appendini 2014). Private and corporate input providers have increasingly filled the vacuum left in the wake of the elimination of state seed and input provisioning. As a result, the government programs that offer purchasing supports to farmers have shifted to underwriting input purchases from private seed vendors and transnational corporations.

The majority of commercial farming inputs in Mexico are now sold through national subsidiaries of transnational corporations, particularly Monsanto (now Bayer), Dow-Dupont-Pioneer (now Corteva Agriscience), and Syngenta-ChemChina. Despite my efforts, I could not locate any complete report of the extent of corporate control of Mexico's seed and input markets. An email exchange with a CIMMYT researcher explained that "the availability of this data is irregular" (Email, CIMMYT, 11/1/16). She went on to suggest the closest approximation to such an understanding is through examining Mexico's national statistics on the extent of hybrid seed use in Mexico. She explained: "Since most of the improved seeds are Pioneer and Monsanto**,** you can have an idea of the seed sales." (Email, CIMMYT, 11/1/16). An interview with a Monsanto distributor in Chiapas explains that Dupont-Pioneer is Monsanto's largest competitor for input sales, followed by Syngenta and Dow.[12] Mexican seed providers, he explains, do not present a real threat (interview, Monsanto distributor, Villaflores, 9/28/16). In contrast, a recent study by OXFAM (2015), suggests that on a national scale, Syngenta occupies the lion's share of seed sales in Mexico followed by Dupont and Monsanto.

Multinational corporations now dominate the production and sale of technological packets of seeds and inputs in Mexico (OXFAM 2015). Oftentimes the very government programs intended to support the farm sector, such as Proagro, end up promoting these products. With this shift to a private system of seed provisioning, farmer access to OPVs in Mexico has sharply declined and farming costs have continually increased. Because OPVs can be saved and reused by farmers, they are often a key technology for containing production costs for semi-commercial farmers. Nonetheless, the privatization of Mexico's seed sector has reoriented the seed industry around profit motives rather than public needs, particularly those of small-scale grain farmers.

Even in the 2000s, government subsidies continued to play a vital role in encouraging the further expansion of GR seed and input use in Chiapas, only now those inputs have been increasingly sourced from subsidiaries of transnational

[12] Seeds and agrochemical corporations have undergone significant mergers and acquisitions in recent years. Dupont-Pioneer merged with Dow Agrosciences in 2017 and Bayer acquired the Monsanto Corporation in 2018

corporations. Programs to encourage the adoption of hybrid corn seeds have included those provided by the federal agricultural secretariat, SAGARPA, such as the program "Kilo por Kilo" or PIMAF (Programa de Apoyos para Productores de Maíz y Frijol, which provides technological packets to small-scale corn (up to 1,500 pesos/ha for up to 3 ha.) and bean farmers). Programs have also been offered through the agricultural secretariat (Secretaria del Campo) and the rural development secretariat (Secretaria de Desarrollo Rural) of Chiapas such as the *Programa Especial de Semilla* or the *Maiz Solidario* program, which both subsidized hybrid seed purchases in the early 2000s. Hand-outs of seeds and fertilizers also continue to be a common tactic used to "fertilize" the vote. Political candidates frequently offer these inputs as part of their election campaigns and distribute them to ejidos and farmer groups in exchange for their votes. As one farmer observes ironically: "A bag of corn. They buy your vote with a bag of [seed] corn. (Incredulous laughter)" (Victorio, farmer interview, Benito Juarez, 5/12/16).

Under neoliberalism, many state supports in agriculture have been reallocated from public purchasing and provisioning systems to private ones. For example, the PIMAF program today provides inputs to corn and bean farmers in the form of technological packets of seed, fertilizer, herbicides, and insecticides. Seed and input companies make agreements with the government to provide these packets. Only certain input providers are approved by the government to be input distributors in PIMAF (SAGARPA official, interview 12/8/16). SAGARPA officials admit that a handful of companies dominate government PIMAF contracts, primarily Pioneer, Monsanto, and American Seeds (SAGARPA official, Interview 2/12/16).

2.5.2 Extension Services

Public extension services in Mexico have also been sharply reduced under neoliberalism. Whereas public employees at SAGARPA used to provide year-round extension services to accompany farmers in their transition to GR modes of production, SAGARPA's role has been greatly diminished since the 1990s. Today, extension services have been consigned to rural development offices known as "*despachos*" or to private seed companies themselves who offer contract-based extension services with farmer groups (Extension agent, Masagro Chiapas Hub, interview 7/29/16)[13]. Within this new model, extension agents are no longer employees of the government, but independent contractors without any requirement to work with particular kinds of farmers. As a result, *despachos* tend to work with larger and wealthier groups of farmers and promote corporate inputs, thereby further marginalizing small-scale and low-income farmers who cannot access private financing and extension services. .

[13] Other sources of extension services in Mexico include those offered by ADRs (Rural Development Agencies that are part of the FAO-supported PESA program), the state-led extension program *Grupos de Extension e Inovacion Territorial (GEIT)*, and federal programs such as Masagro. However, no farmer interviewed in this study had access to any of these services.

Table 6. Total acreage planted with technical assistance by region (Source: SIAP 2017)

Region	Total hectares planted	Hectares with technical assistance	Percentage of total
Chiapas	1,396,698	371,338	26.59%
Sinaloa	1,149,320	1,115,893	97.09
NATIONAL TOTAL	21,590,575	8,906,545	41.25

Source: SIAP 2017 (https://www.gob.mx/siap/acciones-y-programas/produccion-agricola-33119)

Table 6 demonstrates the unevenness of how technical assistance is provided to farmers in different regions of Mexico. Northern states such as Sinaloa tend to have higher acreage covered. According to this reporting, Sinaloa in particular has access to assistance on nearly all of its acreage (over 97%). In contrast, Chiapas has assistance for only 27% of its total acreage in production.

In Chiapas, the decline in public extension services is sharply felt by farmers. One SAGARPA official in La Concordia County in Chiapas admits that SAGARPA has nearly eliminated their extension services in agriculture. "The [SAGARPA] personnel that was hired as extension agents have been reassigned to serve more as 'inspectors' if I can put it that way…Previously there were a lot more [SAGARPA] personnel as well, but that has largely ended" (SAGARPA official, interview 12/8/16). In interviews, SAGARPA officials in La Concordia County confirm that whereas in the past they would have been making rounds to assist farmers, today most of their duties consist of pushing paper, overseeing farmer requests for federal subsidies such as ProAgro or ProGan, verifying compliance, and filing reports.

Whereas ejido leaders used to facilitate the delivery of government-funded seeds and inputs to their constituents, today this role has been greatly reduced and individual farmers are left to fend for themselves. Farmers must now choose between allying with seed companies or *despachos* or foregoing access to production supports altogether. Although federal and state governments continue to offer certain supports for productive projects and financing, most individual ejidal farmers are unable to navigate the bureaucracy alone and many supports require group affiliations. Indeed, the process to draw down government supports has become so complex that farmers need lawyer-like assistance to navigate impenetrable government websites and program requirements. As a result, farmers interested in accessing government supports have had to organize into small groups and hire private or non-profit *despachos* for assistance. *Despachos* provide financial, technical and administrative assistance, helping farmers to solicit government subsidies, credit, and even technological packages of seeds and agrochemicals. These offices have become the new interface between rural populations and the government, overseeing applications for productive programs and ensuring project compliance. They can be for-profit or non-profit entities. They finance their operations by taking percentage cuts of every project approved and may complement these funds with additional supports from other government or philanthropic sources.

There are numerous concerns regarding a privatized approach to extension services. While sustainable resource management is an urgent priority for future food security, researchers have found that sustainability is not a priority of private extensionists (Landini 2016). In rural Guerrero, Yoworsky (2005) worries that NGOs that process applications for government supports do not challenge the status quo but instead further entrench farmer dependence on external inputs and supports, thereby deepening the incorporation of rural communities in the global industrial economy. In Chiapas, Hellin et al (2014) observe that private sector involvement in agricultural research and extension has failed to adequately replace state services, particularly for the most marginalized areas. Evidence suggests that few *despachos* are providing services to small farmers due to the high incidence of crop failure and loan default in this sector. Similarly, my own research demonstrates how privatized extension exacerbates environmental problems and fails to equip farmers with the tools and techniques necessary to navigate increasing climate variability and risks of production. These concerns are discussed in greater depth in **Section 3.4.3**.

It appears that privatized extension services (particularly those offered by private seed companies) have concentrated on expanding their presence in the most profitable farming areas. In Chiapas, corporate seed providers have focused in the farming regions of Chiapas with the requisite ecological and climatic conditions, as well as irrigation access, to cultivate new consumers of agricultural inputs. Both *despachos* and private seed companies prefer to work with groups of farmers to reduce transaction costs and lower the risk of individuals defaulting on their loans. This political economic context pressures farmers to behave increasingly as small-scale entrepreneurs with risk shared collectively by small farmer groups (Jesus, Extension agent, interview 9/28/16). Smaller-scale farmers who lack the resources and connections to self-organize in groups have difficulty accessing the inputs, credit, and the technical assistance necessary to continue farming. As a result, there is a widening gap occurring in many ejidos between the local farmers who are able to organize and access resources and those who find themselves increasingly pushed out of commercial farming altogether.

Conclusion

In this chapter, I have sketched the history of Mexico's approach to agricultural development since the early 20th century. In order to fully understand the mechanisms influencing farmers' experiences of double exposure today, we must first understand the layers of history informing the current conjuncture. Although much of the following chapters explore the present challenges of neoliberalism and environmental change, the roots of these vulnerabilities are linked to historical processes uneven development and capital accumulation in agrarian spaces. Importantly, farmers' current challenges in accessing affordable agricultural inputs and extension services trace back to the nation's state-led effort to initiate a Long Green Revolution in Mexico. A neoliberal approach to food governance has now been superimposed on a GR mode of production in Mexico's countryside that has further

stripped farmers of their autonomy over their seed sources and induced a dependence on external actors for inputs and expertise. The neoliberal transition has facilitated a continual process of both "accumulation by dispossession" and "in-situ dispossession" among Mexico's small-scale farmers. The following chapters present a case study of how these different forms of dispossession manifest in the Chiapas context among semi-commercial farmers and how they play a role in farmers' experiences of double exposure.

Ch. 3 Neoliberal Exposures in the Corn Farming Sector — Case Study: Benito Juarez, La Concordia County, Chiapas

Introduction

This chapter details the "neoliberal exposures" facing semi-commercial grain farmers in Chiapas today, focusing specifically on the case study from the Benito Juarez ejido in La Concordia County, Frailesca Region of the state. In Part 1, I address the challenges of producing corn in the neoliberal context. I begin with a brief history of agricultural development in the Frailesca Region of Chiapas. Building on the evidence presented in Chapter 2, I draw attention to the government's role in promoting a transition to a Green Revolution mode of production. Next, I explore farmer enrollment in government programs, tracing the decline in productive supports and the increase of assistentialist policies in the region. This is followed by a discussion of the rise of corporate-dependent production systems in Benito Juarez, focusing specifically on the reduction of landrace seed varieties and the rise in farmer reliance on corporate seed varieties and inputs. I next detail how production costs have increased in the neoliberal era just as financing options for semi-commercial and subsistence farmers have declined. I conclude Part 1 of this chapter with a discussion of privatized extension services and the mismatch between farmer needs and services offered. Part 2 of this chapter explores the risks and challenges of *selling* corn in the neoliberal context.

Neoliberal Exposures Part 1: Producing Corn in the Neoliberal Context

3.1 The History of Agricultural Development in La Frailesca Region, Chiapas

Due to its diverse environments and dramatic topography, the adoption of the Green Revolution (GR) mode of production in Chiapas has been uneven, concentrating primarily among grain farmers in lower and flatter regions of the state such as La Frailesca region. La Frailesca refers to the region located between the Sierra Madre and the Central Depression known historically as the Grain Basket (el Granero) of the state (see **Figure 12**). This region encompasses seven counties, including La Concordia, the county seat of my case study area. Improved corn varieties were first introduced in Chiapas in 1946 and some of the earliest adopters of improved OPVs provided by PRONASE were located in the Frailesca region throughout the 1960s, 70s, and 80s (Hellin et al. 2012; McCune et al. 2012). Bolstered by state subsidies, the fertile, lowland areas of La Frailesca and the Pacific coastal plain in particular became a vital area of grain production based on GR farming inputs, large-scale monocultures, and mechanization.

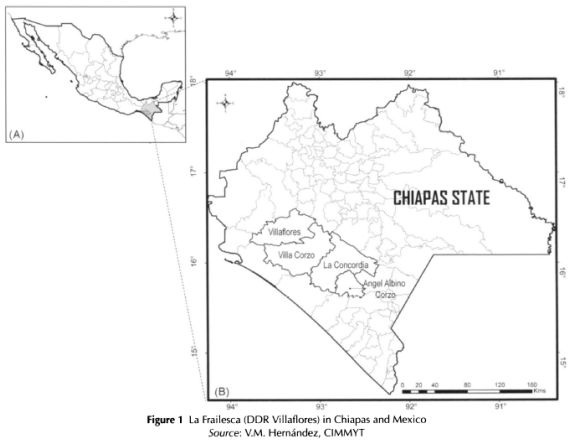


Figure 1 La Frailesca (DDR Villaflores) in Chiapas and Mexico
Source: V.M. Hernández, CIMMYT

Figure 12 Map of La Frailesca Region. (Source: CIMMYT)

By the 1980s, Chiapas had become one of five top corn-producing states in Mexico and the Frailesca region became known as an important corn basket for the nation (Brush et al. 1988; McCune et al. 2012). One study found that most farmers (both ejidal and private landowners) in the 1980s in the Frailesca region were able to rely on grain production for their livelihood without the need to seek off-farm employment (Brush et al. 1988). For many years, farmers in La Frailesca adopted GR technology and improved open-pollinated seed varieties (OPVs) such as the popular Tuxpeño variety but also maintained at least part of their corn production in landrace varieties (Brush et al. 1988; Bellon and Hellin 2011).

For most small-scale commercial corn farmers in La Frailesca, the transition from improved OPVs that can be saved and replanted to commercial hybrids that must be purchased each year did not occur until the late 1990s or early 2000s. This shift came in response to changes in seed provisioning policies and purchasing incentives and has been fostered by both state-led and private initiatives (See **Section 2.5)**. Research has found that seed subsidies have played an important role in encouraging the adoption of hybrid seeds among farmers in the Frailesca region in the 2000s (Bellon and Hellin 2011; Hellin et al. 2012). Bellon and Hellin (2011) surveyed farmers in 4 communities in La Frailesca and found that 60% of those surveyed had used seed subsidies between 2001 and 2006. These authors suggest, "Without government intervention, farmers would plant a larger area of landraces" (ibid: p. 1440).

Similarly, state-based programs such as *Maiz Solidario* in the 2000s equipped small-scale corn farmers with thousands of packets of urea fertilizer, herbicides, and hybrid seeds (Gomez 2008). Although government input supports have been varied and often short-lived in recent decades, it is clear that even within the neoliberal context, government programs have been influential in the adoption of hybrid seed and Green Revolution techniques. Indeed, interviews with seed distributors in Villaflores for this research (a hub for farming supplies in La Frailesca region)

confirmed these subsidies helped to bolster corporate seed sales (interview, Monsanto distributor, Villaflores, 9/28/16). So important were these subsidies, that distributors long for them to return and regret that today seed subsidies are only offered in select Chiapas counties (Frontera Hidalgo and Villaflores) (interview, Monsanto distributor, Villaflores, 9/28/16).

In 2014, Chiapas produced corn on 696,878 hectares, but the methods used to farm this corn varied widely. About 1/3 of the state's corn was grown using improved seed varieties in 2014 and about 2/3 was planted with landrace varieties (SAGARPA 2014). Certain counties have much higher adoption of improved seeds than others. Improved seed varieties are in much higher use in semi-commercial and commercial farming regions of the state such as La Frailesca.

Table 7: Total acreage planted in improved vs. landrace seed (Chiapas, Sinaloa, and National Totals)[14]

Region	Total area planted	Improved Seed	Percentage	Landrace seed	Percentage
CHIAPAS	858,955	279,263	32.51	579,692	67.49
SINALOA	1,075,582	1,068,087	99.30	7,495	0.70
NATIONAL TOTAL	14,815,936	10,139,762	68.44	4,676,174	31.56

Source: SIAP 2018[15]

Table 7 indicates the total farmed acreage by region and by seed variety (differentiated between "improved" and "landrace" seed varieties) in 2017. The state of Chiapas continues to rely predominantly on landrace seed varieties. SIAP data suggests that over 67% of area farmed in Chiapas uses landrace seed varieties compared to the national average of nearly 32%. In contrast, the state of Sinaloa reports only .7% landrace usage, reflecting the tendency in northern states to rely solely on improved, commercial seed varieties.

In the 2000s, the area dedicated to corn production in Chiapas declined but the use of hybrid corn seed and average yields in La Frailesca region increased

[14] **Note:** The data presented in this table is for total area planted (i.e. not limited to corn).

Note: SIAP defines "semilla mejorada" (Improved seed) as an area using seeds that were selected for genotype and phenotype within a crop improvement system that aims to increase yields, principally based on hybrid and other varieties that have been analyzed and certified for commercialization. SIAP defines "semilla criolla" (Landrace seed) as an area cultivated using seeds from local seed populations selected by farmers. (SOURCE: https://www.gob.mx/cms/uploads/attachment/file/339729/Normatividad_estad_stica_2018.pdf)

[15] Source: https://www.gob.mx/siap/acciones-y-programas/produccion-agricola-33119

(Villafuerte-Solis 2014; Bellon and Hellin 2011). As seen in **Table 8** below, the area in corn production in La Concordia County in Chiapas has tended to decline in recent decades. Similar to Chiapas state-level data, La Concordia County shows a 27 percent drop in the acreage dedicated to corn production between 2003 and 2017 (falling from 29,835 to 21,765 ha planted in corn) (SIAP 2018). This suggests that certain farmers continue to abandon corn production while those that are able to keep farming are increasingly reliant upon hybrid seed technology. Farmers in Concordia County in La Frailesca, for example, planted over 99 percent of their 21,288 hectares of corn using improved seeds in 2014 (SAGARPA 2014). The use of hybrid seed may increase yields in good years but it is also associated with increases in production costs. Between 2001 and 2008, the cost per hectare of corn production more than doubled from 3,474 pesos to 7,690 pesos (Mendoza Perez et al. no date: 3). As described in **Section 3.4.1,** today these prices have more than doubled again for corn farmers.

Table 8 Corn acreage planted in La Concordia County, Chiapas, 2003-2017 (Source: SIAP 2018) [16]

Year	Corn Area Planted (ha)
2003	29,835.00
2004	26,466.00
2008	18,125.50
2010	18,847.50
2012	20,625.00
2013	20,202.00
2014	21,288.00
2015	23,981.00
2016	22,027.00
2017	21,765.50

Even when modest government supports underwrite the production of hybrid corn among small-scale commercial farmer in Chiapas, researchers have found that the use of improved seeds and chemical fertilizers has not resolved issues of extreme poverty. In a study of corn farmers in La Frailesca, Keleman et al (2009) found that 99.4 percent of farmers surveyed have adopted "modern" techniques, but 63 percent of them continued to suffer "extreme poverty" (p. 56). Similarly, Bellon and Hellin (2011) found that higher corn yields and agrochemical

[16] SIAP agricultural data by county in Chiapas is only available beginning in 2003.
Source: SIAP 2018 (https://www.gob.mx/siap/acciones-y-programas/produccion-agricola-33119)

use since the 1980s has not guaranteed better economic outcomes for farmers. In a study of farmer responses to neoliberalism in La Frailesca, Hellin et al. (2012) found that the drive to remain competitive has encouraged some farmers to intensify their approach to grain production by adopting improved hybrid seeds, reducing periods of fallow, and intensifying agrochemical applications. However, there are also factors that work against intensification, including a lack of affordable credit access, PROCAMPO payments (which encourage maintaining more area in production but not necessarily higher yields per hectare), and higher costs of production (Hellin et al. 2012; Bellon and Hellin 2011). Overall, Hellin et al. (2012) observed that smallholders in la Frailesca were responding to the loss of government supports and trade protections under neoliberalism primarily by intensifying corn production, seeking more off-farm employment, or leaving agriculture altogether.

3.2 Rural Enrollment in Government Programs (Benito Juarez Ejido, La Concordia County, Chiapas)

Results from 61 random household surveys in the Benito Juarez ejido in La Concordia County of Chiapas mimic many state-trends in citizen enrollment in state programs, both productive and assistentialist (Villafuerte-Solis 2015). In general, there is an under-enrollment in programs that subsidize production such as Proagro (formerly Procampo)[17] and Progan (a direct cash support for cattle of reproductive age) and an increased tendency to rely on assistentialist programs, specifically Prospera (formerly Oportunidades).

Of 61 households surveyed, 33 are active in farming and 28 are not. **Table 9** reflects the absolute number of households enrolled in different government support programs. Today, ProAgro and ProGan are the two most common "productive" supports small-scale, individual ejidal farmers and ranchers can access. That said, the survey results suggest farmers are under-enrolled in these programs despite meeting program qualifications. Although all 33 corn farmers surveyed should qualify for Proagro subsidies for corn production, only 8 households (24.2%) receive this support. Similarly, although 15 farmers qualify for support through Progan for their cattle production, only 6 (18.2%) of those surveyed report receiving Progan.

Table 9 Enrollments in Government Support Programs, Benito Juarez, La Concordia County, Chiapas

	Proagro	Progan	Prospera	Pension for the	Student Stipend	No Government

[17] Proagro is a subsidy program intended to help offset the costs of basic grain production for small-scale farmers. When Proagro was established in the 1990s (under the name Procampo), the government established a fixed roster of recipients. Today, this master list of participants receive direct cash deposits each season in the following amounts: 1,300 pesos/ha for 1-3 ha; 1000 pesos/ha for 3-5 ha; and 800/ha for 5-20 ha, and 700 pesos/ha for 20-80 ha of corn production. Farmers are expected to use the resource to purchase the necessary inputs for a successful crop.

				Elderly		Supports
Active Farming Households (N=33)	8	6	16	2	1	8
Non-Farmer Households (N=28)	2	0	18	1	1	8
Total Households (N=61)	10 (16.4%)	6 (9.8%)	**34 (55.7%)**	3 (4.9%)	2 (3.3%)	16 (26.2%)

Table 3: Based on a random survey of 61 households in Benito Juarez ejido, this table reflects the absolute number of households enrolled in different government support programs.

In the 1990s, the Mexican government established a fixed roster of Proagro participants. Although this action was meant to prevent farmers from expanding the acreage they have in grain production with the sole purpose of extracting more government subsidies, it has also meant that corn farmers who were not registered in the original roster are unable to access these supports. At the same time, there is widespread corruption in the program. Many people who appear on the roster no longer farm but continue to collect payments nonetheless. Throughout my fieldwork, I heard many anecdotes of this kind of corruption occurring throughout Chiapas. Farmers complain that qualified corn producers do not receive supports while people who no longer farm corn continue to collect payments for corn they never grow. This tendency is also observed in the survey results: two non-farming households surveyed report collecting Proagro payments each year even though they no longer actively farm. Even the SAGARPA officials who oversee the Proagro program acknowledge that it has been rife with corruption historically. SAGARPA officials no longer do site visits to verify grain production of Proagro recipients and the chains of mutual favors and clientelism between landowners, regional political candidates, and government offices continue to influence how payments are distributed (SAGARPA official, interview 2/12/16).

Numerous farmers and ranchers interviewed in Benito Juarez express disillusionment with the lack of government supports for small, semi-commercial farmers. There is a widespread sense among producers that the few supports that do exist go to wealthy landholders with resources and political connections. One farmer who produces both corn and cattle observes that the government puts up a lot of "*trabas*" (barriers) to prevent poor people from accessing supports: "[We do not have] Procampo or Progan…It is only for rich people that have connections with those up there. Those of us who are poor can no longer access [government programs]. The government asks for many requisites and we cannot fulfill them" (Cein, farmer interview, Benito Juarez, 5/12/16).

As access to agricultural subsidies and supports has declined among farming populations, enrollment in non-agricultural, assistentialist programs for consumers

has increased. The most far-reaching of these programs is Prospera, formerly known as Oportunidades. As shown in **Table 9**, 55.7 percent of all households surveyed (both farming and non-farming) receive cash transfers from Prospera. **Table 9** illustrates that in both farming and non-farming households alike, enrollment in other non-agricultural support programs (such as the pension for the elderly or student stipends) is fairly minimal. 26.2 percent of all households surveyed do not receive any government supports of any kind.

Many people in Benito Juarez, particularly women, value Prospera payments as an important complement to otherwise precarious rural incomes. However, many community members regret that these assistentialist policies have become the norm. As one farmer notes, "The countryside is unattended" (Manuel, farmer interview, Benito Juarez, 5/12/16). This interviewee describes government policy today as more akin to Roman times of providing citizens with "bread and circus" rather than an effective vision for rural development. Farmers, he says, lack technical assistance, soil analysis, financing for development, and commercialization supports. The little that is done is carried out for political gains (Manuel, farmer interview, Benito Juarez, 5/12/16).

3.3 The Transition to Green Revolution Modes of Production and Corporate-Dependent Farm Systems in Benito Juarez Ejido, La Concordia County

Despite the state's rich history of landrace corn diversity and farmer activism (of which the Zapatista Movement is the best-known), the commercial and semi-commercial farming regions of the Chiapas Lowlands are increasingly characterized by grain monocultures, government abandonment, private loan and extension offices, and farmer dependence on transnational seed companies and their subsidiaries. Transnational seed companies and their subsidiaries have increasingly filled the institutional vacuum left in the wake of government withdrawal from agricultural services and input provisioning. Billboards advertising corporate seed varieties and agrochemicals decorate the freeways that snake throughout the Chiapas Lowlands. Monsanto signs describe their products as an "*angel en tu tierra"* (an angel in your land). Dupont-Pioneer signs announce the latest varieties of high-yielding and drought-tolerant seeds (See **Figure 13**). These billboards reflect the increasingly corporate-dependent nature of agriculture in commercial farm counties of Chiapas such as La Concordia and Frontera Comalapa Counties.

Figure 13 Dupont-Pioneer and Monsanto (Dekalb) Presence in Chiapas (photos by author)

In the Benito Juarez ejido, it was difficult to establish a concrete timeline of farmers' transition from traditional agricultural practices to improved OPVs and ultimately to corporate hybrid seeds and inputs. Interviews with farmers revealed that this transition was not linear but rather occurred at different times for different kinds of farmers. Nonetheless, interviews revealed that, similar to my findings in **Chapter 2,** government supports in the form of seed subsidies, safety nets, and extension services were integral to the initial transition in Benito Juarez ejido from traditional agricultural systems to Green Revolution modes of production.

Although the story varies for each farmer, all farmers interviewed indicate that the Mexican government (often in coordination with seed and input companies) was integral to the shift to industrial corn farming in the region. Some farmers, particularly those with large landholdings and access to tractors and technology, were early adopters of the Green Revolution model of agriculture since the 1980s. Others were reluctant to change their seed use with the improved varieties promoted by government and corporations and started first by simply integrating agrochemicals and fertilizers. For some, this reluctance was rooted in concern for the increased risks, costs, and long-term implications of the technology shift; for others, it was out of concern to protect their local seed varieties and culinary traditions.

The government induced reluctant farmers to the GR model through offers of "improved" seeds and their associated tech packets at little or no cost. Bancrisa provided credits to the ejido according to each farmer's needs. The credits would arrive in May and money would be available on time to keep up with fertilizing

schedules (Nicolas, farmer interview, Benito Juarez 2/6/16). In the event of a bad farm season, the government provided insurance to farmers to cover their losses. Upon harvest, CONASUPO would purchase the corn and aggregate it in the large state-owned grain silos. Since the elimination of CONASUPO, the silos have been sold to private businesses like Maseca that no longer offer a guaranteed price floor.

3.3.1 Seeds: The Shift from Landrace Varieties, to OPVs, to Corporate Hybrids

In the second half of the 20th century, many government programs promoted the seeds and inputs produced by PRONASE, the national seed program. Tech packets would include artificial fertilizers and improved open-pollinated varieties (OPVs) that farmers could save and reuse. However, in the 1990s as PRONASE lessened its reach, private seed companies began to take over input provisioning in the region and government supports became a conduit for further expanding farmer reliance on corporate varieties of hybrid seeds and inputs. Interviews in Benito Juarez indicate that seed handouts in the early 2000s were instrumental in convincing farmers to adopt the use of hybrid seed varieties, particularly those developed by Monsanto and Pioneer. Over time, the combination of free and/or low-cost inputs and extension services compelled farmers to abandon their seed-saving practices and embrace the new mode of production. Today, farmers and seed providers observe that government subsidies for seed purchases in the region are scarce, emerging only in isolated counties or during election cycles.

Farmers in Benito Juarez today have all but loss their landrace seed varieties and by extension much of their autonomy in production. For many farmers in La Frailesca, this transition to a reliance on corporate hybrids has accelerated since the 2000s as seed corporations have lobbied for farmers to adopt their products through demonstration plots, workshops, and free or discounted inputs. One farmer describes the process:

"What I have observed is that the companies are very strategic here in Mexico. For years they started giving away seeds and seeds and seeds. They gave it away for like 3 or 4 years and people saw the change was a bit better because they were gifted the seeds and also the liquids and well they linked that matter in such a way that a lot of people got used to it and they became dependent. All of a sudden they stopped giving out seed and the people said, 'Well now what am I going to do because I lost the seed that I had. I destroyed it because I could not conserve it during the 3 or 4 years that that process was happening.' Now there's no option, they have to buy from them and that is what has happened." (Julio, farmer interview, Benito Juarez, 2/12/16).

The same farmer further explains how the shift to corporate hybrids was as much mental as it was physical:

"Prior to the year 2000, [my parents] planted pure criollo (landrace corn). Around 2004 that started to change. They started giving out seed. My father always conserved a small plot. He did not lose his seed so easily but he lost it as they changed

his ideas. They offered many courses, many workshops that induces you mentally that you are going to do things this way and you are going to depend on it and in the end, you believe in that idea. They put [the idea] in your head and today hardly anyone conserves [their seed]…That makes it so people become dependent. That is how they changed the whole ideology of people and now everyone depends on the seed companies. Now, if you don't have money, you don't have a crop. That is the situation" (Julio, farmer interview, Benito Juarez, 2/12/16).

Questions about seed use in Benito Juarez revealed that there is a lot of confusion today regarding what constitutes a landrace corn seed, an open-pollinated variety (OPV), and a hybrid variety. The landrace varieties farmers recall planting prior to transitioning to hybrid seeds include varieties known as *olotillo, crema, rojo, tuxpeño, elotillo, blanco, crema, jarocha, Pioneer 222,* and *American Seeds* (2nd year). In a good year and with proper care including pest control and fertilizer, farmers recall native corn varieties yielding as much as 5 tons per hectare. Both Pioneer 222 and American Seeds are hybrid varieties that have been saved and reused and are now considered locally to be "*criollo*" or landrace varieties despite the lower yields they produce after several cycles of replanting. Over time, farmers' management of OPVs and native landrace varieties has declined and hybrid varieties have become the norm. "Today everyone depends on seed companies. It is now a common belief that if it is not hybrid, it does not work and everyone around here plants pure hybrid." (Julio, farmer interview, Benito Juarez, 12/11/16).

28 of 33 farmers surveyed in Benito Juarez report that they no longer plant any native varieties of corn seed. Only 5 farmers continue to plant 1 hectare of "landrace" corn varieties (See table **10**). When questioned further about their "landrace" corn varieties it became clear that of these 5, only 2 retain a true landrace variety of corn seed, known locally as "olotillo" (see **table 11**). It appears that the other 3 "landrace" varieties that farmers continue to plant actually refer to hybrid corn seed varieties from INIFAP and Pioneer seed companies that farmers have saved and subsequently managed as "landraces." In addition, although 5 farmers surveyed claim to still plant native corn varieties, when these same farmers were questioned about their seed choices between 2014-2016 only one farmer reported planting a native variety during that time period. This suggests that farmers may still retain some seed that they consider a "native" variety, but do not plant them regularly.

Table 10 Use of landrace varieties of corn (Benito Juarez, La Concordia County, Chiapas)

Do you plant landrace varieties of corn?	Number of Farmers	Percentage of Farmers
Yes	5	15.2
No	28	84.8
TOTAL	33	100.0

Table 7: N=33 active farming households surveyed in Benito Juarez

Table 11 Varieties of landrace corn planted (Benito Juarez, La Concordia County, Chiapas)

What landrace varieties do you plant?	Number of Farmers	Percentage of Farmers
“Olotillo”	2	6.1
H507	1	3.0
Pioneer 222 ("criollo") blanco	2	6.1
Not Applicable (No landrace corn)	28	84.8
TOTAL	33	100.0

Table 8: N=33 active farming households surveyed in Benito Juarez

When asked about when they stopped planting landrace varieties of corn, answers varied among farmers in Benito Juarez. 18 of 33 farmers (54.5%) surveyed in Benito Juarez report never having planted native corn landraces. Newer generations of farmers in particular (age 35 years or younger) generally have no experience with planting and saving native, landrace corn varieties. Rather, these younger farmers have grown up completely dependent on purchased farm inputs. 3 farmers stopped using landrace corn varieties in the 1990s; 2 in the 2000s; and 9 in the 2010s (see **table 12**). While farmers may have begun using improved, open-pollinated varieties (OPVs) many years prior, these survey results suggest that about a third of farmers did not completely abandon their native landraces until the 2000s or 2010s. For a time, farmers planted their commercial crop but also planted between 1 and 3 hectares of native corn varieties for home consumption. This study indicates that this practice has gradually been reduced.

Table 12 When farmers last planted landrace corn varieties (Benito Juarez, La Concordia County, Chiapas)

When was the last year you planted landrace corn?	Number of Farmers	Percentage of Farmers
1990s	3	9.1
2000s	2	6.1
2010s	9	27.3
Never planted “landrace” corn	18	54.5
No Data	1	3.0
TOTAL	33	100.0

Table 9: N=33 active farming households surveyed in Benito Juarez

Farmers surveyed in Benito Juarez list a similarly wide range of years to describe when they began planting commercial hybrid varieties of corn (see **Table 13**). Of those that responded to the survey question, most describe beginning to use commercial hybrid varieties in the 2010s.

Table 13 Year farmers began planting commercial hybrids (Benito Juarez, La Concordia County, Chiapas)

When did you begin planting commercial hybrid corn varieties?	Number of Farmers	Percentage of Farmers
1990s	5	15.2
2000s	6	18.2

2010s	12	36.4
Not Applicable	2	6.1
No Answer	8	24.2
TOTAL	33	100.0

Table 10: N=33 active farming households surveyed in Benito Juarez

In contrast to the above survey results that describe the near-disappearance of native, landrace corn varieties, in-depth interviews with farmers in Benito Juarez revealed that at least some farmers still maintain landraces for home consumption. 5 farmers interviewed explained that the maintenance of these varieties is linked to taste preferences, an interest in preserving native seeds, and economic need. Farmers comment that the landrace varieties have a better taste and texture and are preferable to hybrid varieties when used in local cuisine (tamales, tortillas, elotes). If a farmer has an extra plot of land going unused, they may still plant a small amount of seed (6-9 kg) just to have the pleasure of eating fresh *elotes* or *tamales* made with their favored corn varieties. Others tell that they continue to plant some native corn because they do not want to lose the seed that has been farmed in their families for generations. Still others explain that their economic situation is so dire that saved corn seeds are the only ones they can afford to plant. As explored in **Chapter 7**, recovering the use of landrace corn has also become a key strategy for farmers attempting to overcome the challenges of double exposure.

Today, most farmers in Benito Juarez are completely dependent upon seeds and inputs sold by transnational companies, particularly Pioneer and Monsanto. Because the pricing of these products are pegged to the US dollar, as the Mexican peso has lost value in recent years, farming inputs have become evermore expensive. 97% of farmers surveyed (N=33) say the costs of production have increased over the last 10 years just as the supports for purchasing inputs have disappeared and the price paid for corn has decreased.

As reflected in **Table 14**, corn farmers in Benito Juarez primarily plant white corn in both the summer and winter season. White corn is most often used for human consumption while yellow corn is usually grown as animal feed for chickens, pigs, or cattle. Although only a handful of farmers surveyed report planting yellow corn, in interviews farmers express interest in increasing the amount of yellow corn they plant, particularly as farmers become more involved in livestock production and learn how to process the yellow corn into silage for cattle feed (see **Ch. 6**). Interviews with extension agents confirmed that there is a growing tendency among (semi)-commercial farmers to plant more yellow corn.

Table 14 Number of farmers planting white vs. yellow corn (Benito Juarez, La Concordia County, Chiapas)

Year/Season	White Corn	Yellow Corn	Yellow/White Mix	Did Not Plant Corn
2014 Summer	21	4	3	5
2014/15 Winter	13	4	2	14

2015 Summer	20	3	3	7
2015/16 Winter	8	4	3	18
2016 Summer	18	4	3	8

Table 11: N=33. This table shows how many of the 33 farmers surveyed in Benito Juarez planted white and yellow corn between 2014-2016. It also reflects how fewer farmers planted corn each passing year covered by the survey, reflecting the tendency to reduce corn production during and following periods of drought. Each data point represents the number of farmers planting a particular corn color each season.

Both the household survey and in-depth interviews with farmers demonstrate that Monsanto's Dekalb seed is the most widely-used variety of corn seed in Benito Juarez today. As shown in **Table 15**, Monsanto's seed is the most popular among farmers surveyed for both crop cycles (summer and winter). Dupont Pioneer seed is the next popular, followed by American Seeds. A small number of farmers report using a mix of different hybrid varieties each season (planting different sections in Monsanto, Dupont, and/or American varieties). One farmer uses a hybrid developed by Mexico's INIFAP (Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias) known as H-507. Lastly, a few farmers plant a "pirate" hybrid variety known locally as "Zorro." The seed is sold by an independent vendor who claims the seed is a hybrid from American Seeds. Locals explain this seed is "*pirata,*" that is pirated seed of unknown origin that some farmers purchase at a lower cost than what they can buy in farm shops. Of 33 farmers surveyed, only one farmer reports planting a "native" variety of corn between 2014-16.

Table 15 Corn seed variety planted (2014-16) (Benito Juarez, La Concordia County, Chiapas)

Year/Cycle	Monsanto	Pioneer	American Seeds	INIFAP H507	Mix of Hybrids	"Zorro" Pirate seed	Landrace variety	Didn't plant
2014 Summer	13	6	3	1	2	2	1	5
2014/15 Winter	13	1	1	0	3	1	0	14
2015 Summer	12	6	4	1	0	2	1	7
2015/16 Winter	9	2	2	0	1	1	0	18
2016 Summer	12	5	4	1	1	1	1	8

Table 12: N=33 farmers surveyed. Each data point represents the number of farmers planting a particular variety of corn seed for each farming season between 2014-16.

In interviews, farmers and government officials express nostalgia for the native corn varieties that have been lost in La Frailesca region. One SAGARPA official observes that people have lost the custom of maintaining their native seeds, even if only for home consumption (SAGARPA official, Interview 2/12/16). He misses the *moro* variety used to make *pozol agrio* and the *olotillo* variety that is hardy and drought resistant. Numerous officials express concern that the increased use of

hybrid seeds is causing other native varieties such as the *Comiteco* (out of Comitan), *Napalo*, and *olotillo* to disappear, thereby eroding the region's genetic corn diversity.

When asked how they learned about their particular seed choice, most farmers (about 77%) responded that a friend or family member recommended the seed to them. However, about 19% of farmers also report adopting a particular variety of hybrid corn after visits from seed company representatives promoting their seeds and inputs, particularly Monsanto and American Seeds. Another 4% became interested in their chosen seed varieties after seeing commercials on television. While friends and family are clearly important points of contact for farmers to determine their seed choices, demonstration events by seed companies often reinforce farmers' seed choices. Of the survey respondents who report planting corn in the summer, rainfed season, between 21-28% report having attended a demonstration event promoting their chosen seed variety.

Farmers in Benito Juarez express mixed feelings about the loss of landrace corn varieties and their dependence on hybrid varieties today. On the one hand, farmers speak with deep nostalgia for the native land races they used to plant, noting their rich texture, unique taste qualities, and their durability against pests and drought. However, they also remember that many native corn varieties tend to grow very tall and are vulnerable to lodging when weather conditions become dry and windy.

Most farmers originally transitioned to the use of hybrids because of the promise of higher yields and the generous promotions government programs and seed companies offered as incentives. However, many farmers interviewed in this study lament that hybrid seeds cannot be saved from year to year. Seed promotions are no longer common and every year farmers are forced to find ways to finance the seed and input purchases upon which their farm systems now depend. They regret the loss of autonomy in farming this shift has represented and how they are now completely dependent on seed companies for their livelihood. Those that have attempted to maintain their native corn varieties alongside hybrids have been frustrated in their efforts. Cross-pollination from neighboring fields of hybrid corn compromise the purity of native land race varieties, thereby further reinforcing farmers' abandonment of native corn varieties.

3.4 Corn Farming Challenges in the Neoliberal Context

3.4.1 The Costs of Production

The costs of farming corn in Mexico are higher today than ever before. 97% of farmers surveyed in Benito Juarez (N=33) report that the costs of production have continually increased over the last 10 years. In interviews, farmers frequently expressed concern about their ability to finance their production each season combined with the uncertainty of whether the market price for corn upon harvest will be sufficient to cover their investment, let alone provide a margin of income.

The increased costs of farming corn are due to several factors. Firstly, the transnational seed varieties and inputs farmers now rely upon are priced in US dollars. As a Monsanto distributor in Chiapas explains, all Monsanto products from seeds to fertilizers to pesticides are pegged to the US dollar (interview, Monsanto distributor, Villaflores, 9/28/16). In recent years, the value of the Mexican peso to the US dollar has imploded, surpassing 20 pesos to one US dollar. Although corporate farming inputs were already expensive, the devaluation of the peso has led to sharp price increases. Whereas a bag of Monsanto Dekalb seed sold for 940 pesos in 2005, in 2015 the same seed was selling for 2,000-2,200 pesos per bag (field observation, 2015).

Secondly, the cost and quantity of inputs used in corn farming have also increased in recent years. As discussed in **Section 5.1**, farmers are applying more inputs than ever before in an attempt to overcome problems of soil infertility, pest infestations, and weeds. Mexico's privatized approach to extension services also means that when farmers manage to receive advice for handling crop problems, they are most often directed to purchasing additional agrochemical inputs, which further drives up production costs (see **section 5.5**).

In 2015, corn farmers in Benito Juarez estimated they invested between 10,000-16,000 pesos in producing one hectare of corn during the summer, rainfed season (farmer interviews, Benito Juarez). This estimate includes the cost of seed, fertilizer, pesticides, herbicides, labor, and machinery costs. The winter, irrigated crop costs more due to additional investments in irrigation water and labor. Farmers estimated they invest between 16,000-20,000 per hectare of corn production during the winter, irrigated crop. When farmers harvest their corn as silage, the costs per hectare can increase as high as 24,000 pesos per hectare due to machinery rental and additional input costs (Jaime, farmer interview, Benito Juarez, 7/13/16).

The costs of production vary depending on farmers' abilities to invest in inputs, labor, and machinery. With access to credit, farmers tend to invest more, paying more for machinery rental and labor, and adhering to intensive fertilizer and agrochemical schedules. Conversely, farmers without credit or personal savings to invest will farm as cheaply as possible. They will plant seed that has been gifted, recycled, or pirated to them. These lower-income farmers will avoid using machinery, be sparing with inputs (reducing fertilizer and agrochemical applications), and will rely on manual labor for the whole process from planting to harvest, drawing on a moral economy of labor exchange with local acquaintances rather than paying for day laborers. Cutting as many corners as possible, these farmers may drop their per hectare costs as low as 7,000 or 8,000 pesos but will likely harvest less than other farmers who invest more.

My research suggests that small-scale farmers are suffering under the increased costs of seeds and inputs in the neoliberal context. Like Hellin et al.

(2014) and Mercer et al. (2012), evidence from farmers in the lowlands suggests the need for breeding efforts to focus more on improving farmers' landraces and generating low-cost inputs for commercial farmers. In Benito Juarez, hybrid seed costs and associated agrochemical inputs represent significant investments that can drive farmers into debt or push them to exit agricultural production altogether if sufficient credits and insurance are unavailable. Depending on the success of their crop and the market price for corn upon harvest, most farmers interviewed for this research are surviving on extremely thin margins of income. Should a crop fail or a family member become sick, income is even more threatened, resulting in insurmountable debt and dispossession by double exposure (see **Section 5.1.5)**.

Higher production costs make it increasingly difficult for low-income farmers to make the upfront investments necessary to ensure a successful farm season. One farmer explains the challenge: "The costs [of farming] have increased because the price of products is going up. Sometimes you cannot apply all the [inputs] to your crop as you should because the inputs are all expensive…You see everything must be ready at the right time - the fertilizer, the planting — it must be done right. Sometimes we have trouble getting the money to buy the seed, the fertilizers, the liquids. That is the challenge, the problem we have — there are no economic resources" (Vidaul, farmer interview, Benito Juarez, 7/17/16). Frequently in interviews, farmers explain that the lack of liquid capital keeps them from managing their corn crop as they need to. The failure to stay on top of crop problems as they arise can lead to lower yields or even total crop loss, which then further complicates farmers' abilities to continue farming thereafter.

Even when farmers manage to invest in inputs, they can end up strapped with debt when crops fail as they did for many in the drought-filled summer crops of 2014 and 2015. One farmer notes that the cost of inputs is pushing his family to the "breaking point" (Transito, farmer interview, Benito Juarez). Several farmers interviewed lament that more research is not focused on developing high-yielding open-pollinated varieties (OPVs) that can be saved and replanted each year. As discussed in Chapter 7, recovering high-yielding OPVs and landrace seed varieties, as well as developing, lower cost, organic inputs, is among the highest priorities of the farmer organizations working to transform farming in Chiapas.

3.4.2 Challenges of Financing Production in the Neoliberal Context

Since neoliberal restructuring in Mexico, rural development offices or *despachos* (whether for- or non-profit) have become the primary conduit for farm financing, productive projects, and extension services. These *despachos* now oversee many of the supports and credit options offered through the government. Here I discuss the ways in which the *despacho* model of farm governance further contributes to the marginalization of small-scale farmers and extends neoliberal governance in Mexico's rural sector. This model extends many neoliberal qualities: It requires individual property titles and collateral guarantees, prioritizes individual

farmer entrepreneurs and farmer associations, and further entrenches profit-driven approaches to crop financing, production, extension services, and management. Farmers that do not meet these characteristics find themselves excluded from financing, project supports, and extension services.

There are many ways the *despacho* model of delivering government projects and extension services marginalizes small-scale famers in Chiapas. One researcher observes that although some *despachos* (particularly those managed by non-profit organizations) run effective programs for diverse kinds of farmers, the tendency is towards privately-run institutions that prioritize profit over social and environmental concerns. This places financing and extension services out of reach for those in greatest need while simultaneously allowing the government to wash its hands of responsibility (researcher, University of Chapingo, interview 8/25/15). Another researcher finds that rather than creating a cohesive approach to food security and rural development, the *despacho* model that has emerged since the 1990s has created a culture of "*projectitis.*" The technical nature of government program requirements has caused *despachos* to proliferate. *Despachos* and farmer associations alike have become dependent on *gestionar proyectos* (applying for projects) to survive. Insignificant endeavors and "phantom" projects abound, pulling down government resources to cover project administration costs rather than providing the intermediate technology, technical assistance, and financial supports rural producers truly need (researcher, ECOSUR, interview 9/22/15).

Overall, the changes made in Mexico's approach to financing and providing agricultural services over recent decades have shifted the playing field in favor of wealthier producers and well-organized farmer associations, leaving small-scale, individual producers to fend for themselves. As one rancher commented: "The government is implementing [requirements] that farmers form small groups so they [can access government programs]. They must be well-organized" (Panchito, rancher interview, Benito Juarez 6/28/16). Because government programs now require farmers to be organized in associations, some observe that groups often form with the sole intention of accessing government funds. People in desperate need of cash, will go with the groups where they are promised access to government hand-outs, even if just a agrochemical packets worth 1,000 pesos. "Even though the [government] supports are miserable, groups will still form just to get those" (Extension agent, Red Chiapas, interview 9/20/16).

Concerns about corruption in the *despacho* system are widespread. One extension agent explains that the process to become a government-approved provider of extension services or a *prestador de servicios publicos (PSP)* is corrupt and based on insider deals, political favoritism, and quid pro quos rather than merit (Jani, extension agent, interview, 7/30/16). Several extensionists interviewed for this research suggest that government-*despacho* relations serve as a "*negocio redondo*" (or a foolproof business) that allows politicians to award government contracts to *despachos* owned by their friends and family (Extension agent, Red

Chiapas, interview 9/20/16). These *despachos* pull down government resources, buy inputs through insider connections, inflate prices charged to farmers, and once all is said and done deliver only a fraction of the government aid to farmers themselves (Extension agent, Masagro, interview 9/29/16).

Indirectly, the funds that underwrite government agricultural programs largely end up with transnational corporations. Government institutions negotiate contracts for seed and input packets with registered national input providers who carry transnational products such as the seed lines of Monsanto. Just the Agricultural Secretary of Chiapas alone will put in orders for 150,000 or 200,000 packets (Extension agent, Red Chiapas, interview 9/20/16). In this way, the government is complicit in the corporate takeover of agriculture: "I think that the government is complicit with the companies…the privatization that is happening now is benefitting corporations. Here everything [the government does] is through large companies owned by transnational corporations and they are the ones that get the money. The government takes its cut and is in agreement. [Government representatives] are also involved as partners in some companies. That is what governments do, partner with corporations. I think it is wrong that the government [does that] instead of helping. They end up affecting all of us" (Vidaul, farmer interview, Benito Juarez, 7/17/16). "The [input] providers are the ones that get all the benefit of the [agricultural] packets….they increase the price of inputs, hand out input packets, and keep the rest of the money for themselves. It is the providers that are registered on the national level that take all the business of the programs" (Extension agent, Red Chiapas, interview 9/20/16).

With the rise of the *despacho* model, financing options for small farmers have been sharply reduced. Corn farmers in Benito Juarez have struggled to meet the requirements for accessing financing and productive project supports through *despachos.* Many farmers do not have the formal property titles required by *despachos.* Although the ejido voted to enter the PROCEDE land-titling program in 2004, several hundred farmers in Benito Juarez refused to participate and therefore still lack formal property titles.

Because most ejidal farmers in Benito Juarez (and the surrounding region) are small-scale landowners, they must be enrolled in farm or ranching associations in order to access *despacho* services. However, such associations in Benito Juarez are sparse. As seen in **Table** 16, only 3 of 33 active farming households surveyed are affiliated with a farming or ranching association. 2 of these respondents are members of the farm association, El Peloncillo (discussed in detail in Ch. 7). The other belongs to a ranching association called El Vaquero, which was formed to solicit financing support for cattle purchases. In-depth interviews revealed there are at least two other ranching organizations as well as an association of mango producers in the ejido. Despite these isolated examples, the vast majority of corn farmers in Benito Juarez have suffered the loss of government supports and financing in the neoliberal era and have simultaneously been unable to achieve the

group affiliations and property titles required to access supports through the new *despacho* system.

Table 16 Farmer participation in farming organizations (Benito Juarez, La Concordia, Chiapas)

Do you belong to a farming or ranching organization?	Number of farmers	Percentage of farmers
Yes	3	9.1
No	30	90.9
TOTAL	33	100.0

Note: N = 33 active farmers surveyed in Benito Juarez ejido.

Even if farmers are organized into associations, the small-scale nature of corn production in many ejidos like Benito Juarez often do not meet the land extensions required to qualify for loans through private *despachos.* Most *despachos* are for-profit entities that take a percentage cut of all projects they manage. After numerous incidences of bankruptcy in the 1990s and early 2000s due to farmers defaulting on loan payments, most *despachos* now require farmers manage a minimum property size and loan amount in order to access their services. Many also require regular weekly loan repayments, which can be difficult for farmers lacking liquid capital in the months prior to harvest. One *despacho* agent explained that because financing to farmers is tied up for so many months between planting and harvest, they must be sure that farmers they work with are trustworthy and business-minded. The guidelines of their *despacho* is to not finance any corn farming operations smaller than 5 hectares because of the small and uncertain profit margins in corn (loan meeting, Peloncillo group, Benito Juarez).

Interviews with other *despacho* agronomists confirm that many guidelines for client selection are shared across different offices. For example, the private *despacho* Agrosur (a member of the ASEA central financing network with 34 branches in Mexico) will only process financing for projects worth a minimum of 100,000 pesos (Jesus, Extension agent, private *despacho,* interview 9/28/16). Of course, larger projects (worth as much as 5.5 million pesos) are preferred. The *despacho* will work with any association or individual the meets the 100,000 peso minimum and is established as a legal entity. Interest rates are generally 15 percent per year. If clients provide an upfront guarantee for repayment, the agency can work to reduce their interest rate. Hence, we see that wealthier farmers are not only better-able to access *despacho* services but they also receive preferential treatments, which ultimately translates into even more wealth.

Agrosur's staff estimates that only about 5-8 percent of their clientele in La Frailesca region are ejido-based farmers, an average that is shared across most private loan offices (Jesus, Extension agent, private *despacho,* interview 9/28/16). The fact that 53 percent of agricultural land in La Frailesca is held by ejidos but represent only 5-8% of *despachos*' project and lending portfolios suggests that

private landowners are capturing a disproportionate amount of productive resources processed by *despachos*. Indeed, the agent I interviewed at Agrosur explained that most of Agrosur's clients are individual property owners who are "business-minded, more prepared, and constantly seeking to improve their production or business" (Jesus, Extension agent, private *despacho,* interview 9/28/16). For example, they request financing to improve their cattle breeds, establish African palm plantations, or to process their corn crop into silage for animal feed (Jesus, Extension agent, private *despacho,* interview 9/28/16).

Corn farming has become more expensive than ever before just as small-scale farmers have more limited options for financing their production. Well-timed credit is vital to farmers' ability to invest in inputs, land preparation, machinery, and labor for each production cycle. If farmers lack access to credit, farmers usually choose one of following options (or a combination thereof): 1) Finance their production out-of-pocket using their own savings or assets, often farming smaller plots as a result or foregoing the application of inputs necessary for a successful crop (e.g. fertilizers); 2) Request loans from local acquaintances (usually at a 10-15% monthly interest rate); 3) Accept financing through predatory lending agencies where exorbitant interest rates commonly run as high as 24-30%. (e.g. One group of corn farmers interviewed could only access financing at 24% interest rates); 4) Sign contracts with seed companies or *coyotes* who front tech packets of inputs and seeds or purchase future crops "*adelantado*" at lower than market prices; or 5) Forego a season or two of production altogether, choosing to instead rent out their land, work as day laborers or migrants, and/or sell assets such as animals or property as needed.

One corn farmer in Benito Juarez explains that he finances his 2 hectares of corn production each season through loans from local acquaintances at a 10 percent monthly interest rate. He prefers this approach because it is based on the farmer's word and does not require putting forth any collateral (Nicolas, farmer interview, Benito Juarez). Another corn farmer says if he cannot acquire a loan, he plants his corn "*a partir*." That is, an acquaintance will provide all the inputs for the crop season and he will provide the labor. At the end of the season, they simply divide the harvest in half.

Many farmers in Benito Juarez fell into "*cartera vencida*" (past-due) on previous loans and are ineligible for future loans. In interviews, several people in Benito Juarez described local *caciques* as practicing predatory lending practices to farmers in need and accumulating local land titles as farmers default on their loan repayment. As a result, many farmers have reduced the area they plant in corn and attempt to finance their production out-of-pocket. As shown in **Table 17**, of the 25 farmers surveyed who planted corn in the 2016 summer, rainfed season, 22 report financing their corn production out of pocket and 3 report borrowing money from a local acquaintance. None accessed credit through formal financing channels. Today, it is generally larger, more mechanized farmers and/or well-organized farmer

associations who are able to access lines of credit through *despachos.* Overall, access to credit has become deeply uneven and affects who is able to continue farming corn commercially.

Table 17 Strategies for financing corn production (Benito Juarez, La Concordia County, Chiapas)

How did you finance your corn production for 2016 summer, rainfed season?	Number of farmers	Percentage of farmers
Out of pocket	22	88
Borrow from local Acquaintance	3	12
TOTAL	25	100.0

Note: N=25 farmers surveyed. Of the 25 farmers surveyed who planted corn in the 2016 summer season, 22 report financing their corn production out of pocket and 3 report borrowing money from a local acquaintance. None accessed credit through formal financing channels.

Table 18 Financing strategy divided according to the acreage of corn planted

Area planted in corn (hectares)	Number of farmers financing out-of-pocket	Number of farmers financing through loans from acquaintances	Total Number of Farmers
1 – 1.5 ha.	11	2	13
2 – 4 ha.	9	1	10
4.5 – 6 ha	1	1	2

Note: This table shows how the 25 farmers surveyed that planted corn in summer of 2016 financed their production. Benito Juarez ejido, La Concordia County, Chiapas

As one farmer explains, most farmers in Benito Juarez are considered too risky to receive credit today. Feeling increasingly unable to keep up with the costs and risks of farming, these farmers wish the government would again provide low-interest financing to help make farming more viable: "I'm not asking they give it to us [for free] but at least finance [our activities] at a low cost. Banks are private businesses that only see their own profits; they do not care if it goes well for you or not. They just collect their percentage and that's it" (Abraham, farmer interview, Benito Juarez 5/2016). Indeed, even the seed vendors in the region suggest that the lack of financing is among the largest problems facing farmers today (interview, Monsanto distributor, Villaflores, 9/28/16).

3.4.3 Privatized Extension Services

In addition to financing, farmers are also desperate for extension services to improve their farm systems. This need for technical assistance and guidance in the context of both environmental change and neoliberalism was palpable throughout the farming towns I visited in Chiapas. In interviews, farmers and ejidal officials in Benito Juarez frequently expressed dismay over the lack of extension services given the increased economic and environmental challenges they face. The president of the ejido lamented: "Farmers want to improve but they are falling behind. We need to improve in order to be able to compete" (Jaime, ejidal official, Benito Juarez, interview 2/6/16).

Official records and farmer experiences differ dramatically regarding government provisioning of extension services. Although it is easy to find government reports and media pieces providing glowing descriptions of extension services provided to farmers in Chiapas, it is difficult to find farmers who have actually benefitted from these efforts. In all of my interviews with farmers throughout La Frailesca and Frontera Comalapa Counties, I did not encounter one farmer who had received government-funded technical assistance in recent years. As one extension agent observed: "The [government agents] just have a farmer here and there that does whatever they say and that's it. They create lists of farmers that are all fake. They present that list and they always take advantage when there is a farmer meeting so they can go and take their picture with them so they can fill out their reports. That's what they do…It is a waste" (Extension agent, Red Chiapas, interview 9/20/16).

Another farmer and ejidal authority in Benito Juarez describes the situation: "The government talks so much, whether state, federal or municipal. [They say] they are going to provide technical assistance to farmers but it is a LIE because it never comes. They only come to collect signatures so they can collect their money but they never provide the technical assistance. I have never seen an agronomist here. Not even [in my role] as an ejidal authority. No one has come to me to say, 'Let's go to your field. Let's go see your animals.' That does not exist. The government supposedly sends technical assistance to each ejido and municipality but I repeat they only come to get signatures and collect their money" (Ejidal official and farmer, Benito Juarez, interview 7/17/16).

The role of ejidos in agriculture has decreased as resources have been increasingly funneled through *despachos* and farm associations. Whereas ejidal officials used to facilitate government assistance to farmers, today ejidos have few opportunities to secure benefits and opportunities for ejidal farmers. At most, the ejido may arrange for government donations of fertilizers and agrochemicals (particularly during election season). Otherwise, ejidal officials in Benito Juarez generally play a lesser role in agriculture today. Often times, ejidos simply coordinate requests from different seed companies to use their assembly halls and hold meetings with farmers to promote their latest products (Jaime, ejidal official, Benito Juarez, interview 2/6/16). One farmer observes: "We are really forgotten by technical assistance [in Chiapas]" (Julio, farmer interview, Benito Juarez, 12/11/16).

The ejidal officials of Benito Juarez regret the lack of effective technical assistance. Farmers, they say, are in need of guidance in how to lower costs but increase production, reduce agrochemical use, and acquire more organic methods. They would like farmers to have access to soil analysis, information about proper fertilizer schedules, and assistance specific to each crop, farm, and season. They would like to see ranchers equipped with guidance on herd genetics and proper nutrition to improve the quality of milk and meat produced. In short, they say,

farmers are in desperate need of the government's attention (Focus group, ejidal officials, Benito Juarez, 2/6/16).

When asked how farmers are managing within the new system of privatized extension, liberalized markets, and uncertain climate, one farmer observes that farmers only survive if they form groups and solicit supports through *despachos*. Even then, it is much harder to access resources if you do not have a *palanca* (insider connection) to a *despacho.* He explains: "[Farmers going] it alone are disappearing. It is fairly difficult due to the lack of information, the lack of someone with the connections or the ability to access financing. Many people have migrated because they cannot create a source of work in their community…This issue [of farmer organizing] is very difficult but the people who are unorganized have struggled more and that is also why migration has resulted due to the lack of resources to work because not just anyone can access the opportunity to ground a [project] resource. Even if there is financing, not all of us can access it for many reasons: sometimes because we don't know the institutions or we don't have the relationships, la *palanca* (insider access). Sadly that's how it is. If you don't have the good insider connection, you simply will not be able to access anything. That is the reality in which my community is living." (Julio, farmer, Benito Juarez, interview 2/12/16)

3.4.4 Extension Services Through *Despachos*

Interviews with both farmers and extension agents throughout Chiapas suggest that the existing *despacho*-based extension services are vastly insufficient given farmer needs and augmenting problems with soil fertility, pests, and climate variability. Although private *despachos* often include the cost for providing technical assistance to farmers in project budgets, this assistance is often delivered late, if at all. If extension services are not covered by government funding, farmers must pay for the assistance out of pocket, yet another expense that most farmers in Chiapas are unable to pay when profit margins are already too thin. One corn farmer describes his experience working with a private *despacho*: "You have pay for technical assistance to receive credit but they do not provide the assistance as they should. And you have to pay for crop insurance and the insurance doesn't actually cover you. Then you have to pay for other requisites and there are expenses you pay to obtain credit and they don't give things to you as they should. And then they charge you interests on top of the credit. That is why what I have done is buy my own things with my own savings to avoid all that" (Vidaul, farmer interview, Benito Juarez, 7/17/16).

Staff in private *despachos* admit that the shift from dedicated public extension services to the *despacho* model, which combines financing, project proposals and reports, and extension services, has caused many trained agronomists to become more office-based business administrators than hands-on extension agents (Jesus, extension agent, private *despacho,* interview 9/28/16). A

government official observes that *despacho* staff are frequently assigned too many duties and placed in charge of too large a geographical region to be helpful to small farmers (SAGARPA official, Interview 2/12/16). In addition, many *despacho* staff are under-trained and lack the personal commitment to farmers necessary to establish successful, long-term working relationships (SAGARPA official, Interview 2/12/16).

Even when project budgets include funds for extension services, private *despachos* are rumored to provide little oversight to ensure true project success and instead pocket funds for their own personal gain (SAGARPA official, Interview 2/12/16). Another extension agent describes how *despacho* services are often entangled with politics: "Many extension agents never follow-through with their work projects due to political questions. They end up accomplishing nothing. It is a huge problem…[As a result], there is no real lasting impact" (Extension agent, Masagro Chiapas Hub, interview 7/29/16).

Whether due to delayed delivery of government funds, the incompetence of *despacho* staff, exorbitant fees, or an overall lack of planning, interviewees frequently commented that extension services provided by private *despachos* are ineffective at best if not altogether inaccessible to small farmers. One loan officer observes that government programs lack a coherent vision for change in the countryside. Rather than designing projects based on observed needs and specific production objectives, agricultural packets solicited through *despachos* tend to provide random combinations of urea, potassium, and a mix of liquid pesticides or herbicides (Extension agent, Red Chiapas, interview 9/20/16). Because these agricultural tech packets are distributed without formal instruction, they fail to generate positive changes in the countryside and instead further entrench indiscriminate agrochemical use among farmers. Even when government-funded extension services reach farmers, there is a broad sense of disappointment in the kinds of services offered. As one agent observes: "The SECAM [Secretariat of Agriculture] programs don't have a clear objective…I have seen what they suggest as technological advances and I don't see any impact with that" (Extension agent, Red Chiapas, interview 9/20/16).

3.4.5 Extension Services through Seed Companies

"Monsanto es el monstruo ahora que va agarrando todo"

"Monsanto is the monster that is taking over everything"

(Julio, farmer interview, Benito Juarez, 5/8/16)

Some seed companies and their distributors also provide lending and extension services. They extend credit in the form of seeds and inputs at the beginning of the farming season and frequently promote their products at convened

farmer gatherings and field days. Interviews with seed distributors in Villaflores (a hub for farming inputs in La Frailesca region of Chiapas) confirm that, like *despachos*, input vendors tend to give preferential treatment and services to wealthier farmer entrepreneurs or farmer associations with productive profiles.

One distributor of Monsanto products explains they prioritize working with farmers who have access to good soil and water and who are willing to purchase whatever products are necessary to control pests and "get the most out of the product" (interview, Monsanto distributor, Villaflores, 9/28/16). The distributor ranks farmers into 3 categories: "elite", "medium", and "low". The "elite" farmers are those with the land area and capital necessary to consistently produce high yields of 9-10 tons per hectare. "Low" farmers, in contrast, are those who lack the ability to invest in their crop and only achieve yields of 3 tons per hectare at most (interview, Monsanto distributor, Villaflores, 9/28/16). The distributor interviewed admits that "elite" farmers are larger landowners with at least 10 hectares of land in corn production and as much as 150 hectares of corn or more (interview, Monsanto distributor, Villaflores, 9/28/16).

Seed companies and distributors offer many services to their preferred or "elite" clients. If farmers agree to use a specific suite of seeds and inputs, seed companies will provide farmers with contracts, deliver packages of seeds and agrochemicals, and even provide some extension services (Julio, farmer interview, Benito Juarez). Monsanto will offer a 10-15% discount on seed if farmers commit to buying it early in the season and will front inputs to its "elite" farmers (interview, Monsanto distributor, Villaflores, 9/28/16). Monsanto will also provide more personalized services such as soil analysis or in-field crop evaluations of individual farms of their "elite" groups (interview, Monsanto distributor, Villaflores, 9/28/16). Some companies, such as the Mexican company American Seeds, will support the entire production chain, fronting the inputs and purchasing the harvest, discounting the costs of their seeds and inputs from the final price paid to farmers (interview, seed official, American Seeds, 9/30/16).

Despite the tendency of *despachos* and seed companies to work with larger, better-endowed farmers and farmer associations, even working with these "elite" farmers has become a risky endeavor. Seed distributors complain that the drop in government subsidies and the increasing variability in the local climate have decreased their seed sales in recent years. Even "elite" farmers can experience bad seasons and fall behind on loan payments. For example, one distributor of Monsanto seed was still waiting a year later on payment for 1,200 bags of corn seed from the 2015 summer crop when hundreds of farmers lost their crop to drought (interview, Monsanto distributor, Villaflores, 9/28/16). After several bad seasons between 2014-15, many farmers in Chiapas were unable or unwilling to purchase seed for the following year. Whereas the Monsanto distributor in Villaflores sold 13,000 bags of corn seed in 2015 summer crop, they sold only 8,000 bags in 2016, a drop of almost 40% (interview, Monsanto distributor, Villaflores, 9/28/16). The Monsanto

distributor admits that farmers are losing faith in planting corn. The rising costs of inputs means they have a limited ability to invest what is required and the increasing incidence of drought makes farmers worry whether they will be able to recover their costs of production should they get a poor harvest (interview, Monsanto distributor, Villaflores, 9/28/16).

The extension services offered by private seed companies present several environmental and social concerns. Liberalized agricultural markets pressures farmers to produce and sell as much as possible in the short-term, often without regard for the long-term environmental and social impacts. Individual farmers are under pressure to achieve the greatest yields in the shortest amount of time and at the lowest cost. Similarly, input distributors associated with transnational corporations such as Monsanto and Pioneer prioritize short-term sales over long-term sustainability. As a result, the extension services offered through these companies are not focused on increasing the long-term resilience or adaptive capacity of farms. Instead, company representatives use their role as the purveyor of extension services to encourage the adoption of new seed varieties, technologies, and intensified agrochemical use, all of which raise production costs, accelerate agro-biodiversity loss, and increase risks while decreasing resilience in local farm systems.

In general, most small-scale ejidal farmers interviewed for this research do not have access to extension services to overcome crop problems as they arise. For many, the most accessible extension services come from seed and input companies themselves, particularly when they visit the ejidos to conduct field days to promote their suite of products. During my fieldwork it became clear that these company visits and services are oriented toward promoting commercial products, not attending to the underlying causes behind farm problems. The focus is always on a commercial exchange, a movement of products. As one distributor explained, despite the great need among farmers for effective extension services, company employees are paid to sell agrochemicals, not to provide extension (interview, seed and agrochemical distributor, Villaflores, 2/14/16).

Seed and input distributors always prescribe the same medicine to address crop problems. It is always: 'Buy and apply our products.' As one farmer notes: "At the end of the day, the company wants to cover the entire cycle. They sell you the seed, they sell you the extension support but they also sell you the products and, at the end, they buy your crop. In other words, they control the whole process and [farmers] —out of ignorance and because [the companies] have the power and are more capitalized—end up saying, 'Ok, that is fine.'" (Julio, farmer interview, Benito Juarez, 12/11/16). This approach to agricultural extension is designed to induce dependence on purchased products, not to encourage long-term resilience of agricultural systems: "The corporations give you assistance but all of it is based on chemical inputs, one hundred percent…Today it is hard to farm without agrochemicals and chemical fertilizers because that is the farming model they have

imposed on us. They have made us believe that that model is the only one that exists" (Julio, farmer interview, Benito Juarez, 12/11/16).

Many seed distributors in Chiapas are subsidiaries of transnational corporations and are paid on a commission basis based on the number of seeds and products they sell. One Monsanto distributor explains that each year Monsanto expects them to sell a certain amount of seed and product. While they can return unsold seed and product at the end of the season, there is an implicit understanding that if the distributor fails to meet its sales quotas, they will be eliminated from Monsanto's list of approved distributors (interview, Monsanto distributor, Villaflores, 9/28/16).

As a result, the extension services offered by private seed companies are oriented towards promoting products, not on reducing farming costs or addressing in-field issues facing struggling farmers such as soil health. Farmers explain that while some seed corporations do offer extension support when you purchase their products, this extension "is based 100 percent on agrochemicals" (Julio, farmer interview, Benito Juarez, 12/11/16). Another farmer adds: "Yes, it is true that seed companies' interest is to move their products. They want to sell their products. The [company] agronomists go [out to the communities]…And what do they recommend? Well, their products. If there is another product that could be more effective but is not their product, well they won't be promoting it. They will always go with selling what they are producing" (Extension agent, Red Chiapas, interview 9/20/16).

One of the common practices companies use to compel more farmers to use their seeds and inputs is to establish demonstration plots such as the one seen in **Figure 14.** Seed companies make deals with local farmers to establish demonstration plots on farms with high quality soils located along main thoroughfares where passersby can observe the crop and take note of the seed advertisements posted in the plot. As I traveled throughout farming regions of the Chiapas Lowlands, this scene was repeated again and again: Companies would establish demonstration plots, provide all of the inputs necessary for a robust crop, and then organize field days through local ejidal councils once the plots were bursting with corn. Company representatives would make the rounds in their company trucks to extend personal invitations to the field day and announcements would be made over the town's loudspeakers, inviting everyone to observe the power of the company's products directly in the field. After describing the qualities of the different seed varieties and inputs, farmers (and any accompanying children and family members) would be fed a free *taquiza* and soft drinks. At the end, farmers are invited to place discounted pre-orders for the inputs for the next farming season.

Figure 14 Demonstration Plot by Dupont-Pioneer (Frontera Comalapa County, Chiapas)

The promotional purpose of these workshops is not lost on farmers. As one farmer explains: "Right now Monsanto is offering assistance to make [corn] silage but at the same time, they are inducing [people]. They tell you 'I will give you the corn seed now and I will support you with the fertilizer and will help you to manage your crop with an agronomist.' But why? 'So you will see that my seed is good and you will become dependent on my products.'" (Julio, farmer interview, Benito Juarez, 2/12/16). However, as discussed in **Chapter 7**, farmers have good reason to be wary of company claims that all good results can be attributed to their products. As farmers learn to test and compare different conventional and alternative methods and inputs, they have found that good farming results are less about a particular company's seeds and more about the soil and the growing conditions of each farm (Julio, farmer interview, Benito Juarez, 2/19/16 - see more in **Ch. 7**).

Semi-commercial farmers throughout Chiapas express contradictory feelings about the increasingly corporate-led model of agriculture that has been established. On the one hand, farmers are frustrated that it encourages farmer dependence on corporate providers and their suite of products rather than equipping farmers with the tools to manage their crops with a range of products and techniques. Repeatedly in interviews, farmers agonized over the ever-increasing costs of production. They observe a grave injustice in farming today: Although farmers take on all the work and risk of production, the majority of profits accrue to the corporations that sell the inputs or process the outputs. On the other hand, because company-led field days

are often the closest thing farmers have to extension services there is also a feeling that at least this something is better than nothing at all. As a local school teacher in Benito Juarez observed, the seed companies are the ones bringing opportunities to farmers in forgotten rural areas. Otherwise, he says, because no consistent government-based extension services exist today, the region would be completely abandoned (Beto, school teacher interview, Benito Juarez, 2/22/16).

As reflected in the opening quote, there is a sense in the commercial corn farming regions of Chiapas that corporations (particularly Monsanto) are the "monster" that is taking over everything. One farmer estimates that Monsanto is behind some 80 percent of the input sales in La Concordia County today (Julio, farmer interview, Benito Juarez, 2/19/16). One agronomist explained that because Monsanto is the owner of glyphosate and various proprietary genetic materials, the corporation is also behind many products sold under other company names such as Dow and Syngenta. In short, he says, "Monsanto is truly a monster" (interview, seed and agrochemical distributor, Villaflores, 2/14/16).

Although commercial corn farming is primarily a male occupation in the Chiapas Lowlands, the entire farming household experience the economic pressures created by the current model of production. Sitting with two housewives in Benito Juarez one day these challenges came up. The women expressed their frustration that it is always the seed and input suppliers that get all the profits while their families suffer with all the unknowns, uncertain how their crop will turn out and what price they might fetch each season. However, at the same time**,** these women acknowledge that corn is still the closest thing to a safe bet they have to survive (for more on this see **Section 6.3**. In this sense, they feel their families have no other option but to play by the rules of the seed companies and hope for the best.

Overall, private seed vendors do not provide farmers with new tools and modes of production, let alone guide farmers in how to respond to the onset of climate change and other environmental changes. Indeed, as discussed in greater depth in **Section 5.5**, the lack of technical assistance attuned to each farm region's specific environmental and social needs is a key factor behind the ongoing degradation of farmland, increasing experiences of crop loss, and overall confusion regarding how to successfully manage planting, fertilization, and input schedules within an increasingly variable climatic context. When farmers lament that corn farming is no longer profitable, it is not only due to liberalized grain markets and depressed prices explored in the next section. Rather it is also connected to the Green Revolution mode of production and a privatized system of extension services and inputs that has increased farming costs and caused environmental impacts that have been compounded over time.

Neoliberal Exposures Part 2: Selling Corn in the Neoliberal Context

3.5 Corn for Subsistence, Animal Feed, and Commercialization

"[Today the corn buyers] offer you the price they want to give you. You can no longer make a purchasing agreement with the government" (Abraham, farmer interview, Benito Juarez 5/2016).

The majority of farmers interviewed in the Benito Juarez ejido recall the elimination of CONASUPO and the acceleration of free trade under President Salinas in the early 1990s as a key turning point in their ability to survive as corn farmers. In this section, I review the aspects of *selling* corn in the neoliberal context that are most challenging to the livelihoods of semi-commercial grain farmers in Chiapas today.

Within the neoliberal context, farmers find they are now in competition with each other to sell their grain. "We compete against each other because we are all farming corn and we are small producers. Out of necessity, we must sell to the *coyote* and we know they take the majority of the profits" (Panchito, farmer interview, Benito Juarez). Overall, farmers observe that since the 1990s the price of corn has continually decreased while the price of everything else has gone up (farmer interviews, Benito Juarez, 2016).

Farmers speak with nostalgia for the days when the government guaranteed a fair price and aggregated the ejido's grain production in the CONASUPO warehouses (farmer interviews, Benito Juarez, 2016). Since the elimination of CONASUPO, corn farmers in Chiapas do not receive a guaranteed price for corn and, instead, are at the mercy of international grain prices. Grain prices are constantly fluctuating and farmers have difficulty anticipating what corn prices will be each season. Only farmers enrolled in the ASERCA program (or with access to protected, niche markets) are insulated from these price fluctuations. Most farmers interviewed for this study are not enrolled in ASERCA and instead sell their grain to *coyotes* (middlemen) that come to the ejidos and purchase grain for later resale.

Upon the closure of CONASUPO, the Maseca Corporation originally took the government's place as the main purchaser of corn in the Benito Juarez region in the mid-1990s. In the beginning, the company paid farmers well but over time the prices and treatment of farmers declined (Nicolas, farmer interview, Benito Juarez, 2/6/16). Today, farmers dislike working with Maseca because the company pays low prices, discounts for quality issues, and pays by check weeks after taking the harvest. In communities like Benito Juarez where there is no bank, being paid by check requires paying for a trip to the nearest city to cash it. One farmer explains: "Maseca takes our corn and then they discount [the price]: discounts for impurities, discounts for damaged grains, for humidity, for pests. If we hand over 3 tons, they will discount some 400 kilos" (Nicolas, farmer interview, Benito Juarez, 2/6/16).

Another further describes: "[Maseca] treats us badly. They buy from us at the price they choose; they pay us when they want; and they decide if they buy from us or not. Meanwhile, we get stuck sometimes with debt because they have their standards of quality and if you don't meet those standards well they simply don't buy your product. It is always the farmer that suffers. We almost always end up losing" (Julio, farmer interview, Benito Juarez).

Farmers express frustration that Maseca takes the majority of the profits but then sells an inferior, undifferentiated product for a much higher price. In 2016, farmers were selling a kilo of grain to Maseca at between 2-3 pesos. At the same time, Maseca corn flour was selling for between 10-14 pesos the kilo. As a result, farmers end up suffering twice: first as corn farmers receiving a low price for their grain and second as consumers who must pay three times the price for a corn product, which many consider to be inferior. There is a widespread notion among corn farmers in Chiapas that Maseca corn products are stripped of the most beneficial nutrients. As one farmer exclaimed incredulously: "How much is a kilo of Maseca? Some 11 or 12 pesos if not more per kilo of Maseca flour. And how much is our grain worth? And in that kilo of [Maseca] they remove things. We don't know exactly but they have told us that they remove the oil and the pericarp (bran) of the corn. They remove various parts and they return it to us in flour that costs three times more than what we sold it. That is why the industry is growing so much and we are getting squeezed out" (Julio, farmer interview, Benito Juarez).

Despite this poor treatment by Maseca, many corn farmers in La Concordia County continued to sell corn to Maseca well into the 2000s because it was their only option. However, since 2006 corn buyers have been entering La Concordia County to purchase corn for export to Central America (Manuel de Jesus, farmer interview, Benito Juarez, 7/15/16). While these buyers have long been active in the border region along the Chiapas-Guatemala border, they have expanded further and further into the state (particularly since 2013) to take advantage of the state's white corn production and farmers' disillusionment with Mexican markets (SAGARPA official, Interview 2/12/16). These Central American *coyotes* usually pay a higher price, do not discount for quality issues, and pay in cash upon delivery (Nicolas, farmer interview, Benito Juarez, 2/6/16). The majority of farmers interviewed and surveyed in Benito Juarez now prefer to sell their corn to these intermediaries over Maseca and other Mexican buyers.

33 corn-farming households were surveyed in Benito Juarez about their corn farming and commercialization practices for the five corn seasons between 2014 summer season and 2016 summer season. Corn farmers generally divide their corn harvest between home subsistence, animal feed, and sales to grain buyers. **Table 19** shows how many farmers allotted corn to each of these activities in the 2014 summer crop. 21 of the 28 farmers who planted corn in 2014 summer (75%) kept at least some of the corn for subsistence purposes (generally between .5 and 2 tons); 8

of the 28 farmers (29%) allocated part of their crop to animal feed; and 22 of the 28 (79%) sold at least part of their harvest to commercial buyers.

Table 19 Allocations of corn to subsistence, animal feed, and market (Benito Juarez, La Concordia County, Chiapas) (Summer 2014 corn crop)

	0 tons	<1 tons	1-2 tons	2.1-5 tons	5.1-7.5 tons	7.6-10 tons	>10 tons	No Data	Total # Farmers
Subsistence	6	8	13	0	0	0	0	1	28
Animal Feed	18	1	2	4	0	0	1	2	28
Sold	5	0	2	6	5	5	4	1	28

Note: N = 28 farming households surveyed that planted corn in 2014 summer.

3.6 Corn prices, yields, and average incomes per hectare

Even in years of successful harvests, the costs and benefits of farming corn using modern seeds and technologies offer only modest margins of income for small-scale farmers. For example, in a good summer crop, farmers may harvest 5 tons per hectare; a very successful farmer may harvest much as 7 tons per hectare. At an average price of 3,500 pesos per ton of summer corn, farmers would earn between 17,500 and 24,500 pesos per hectare before subtracting costs.

Average incomes for corn during the winter, irrigated season are only slightly better. Based on an average price paid per ton of 3,725 pesos per ton, resulting incomes would range between 18,625 pesos (with a yield of 5 tons) and 26,075 pesos of income per hectare (with a yield of 7 tons per hectare) before subtracting costs. With farmers investing between 16,000-20,000 pesos per hectare in the winter crop, this amount may just barely cover the costs of production. Even an excellent harvest of 7 tons per hectare, would produce.

This already dim outlook for small-scale corn farmers attempting to make a living in grain farming becomes even grimmer during years of drought and crop loss. **Table 20** shows the range and average prices and yields per hectare for corn farmers surveyed for each of the 5 corn crops harvested between summer 2014 and summer 2016 in Benito Juarez. During the 2014 and 2015 summers of extreme drought, farmers averaged less than 4 tons per hectare. Due to these low yields, the average income per hectare for all years covered in the survey never pass the upper limit of farmers' estimated investments per hectare of corn production.

The lowest price for corn was 2,200 pesos per ton in 2014 summer and the highest price paid was 5,000 pesos per ton in 2014/15 winter crop. In general, most farmers received between 3,000-3,500 pesos/ton in the rainfed summer seasons and between 3,200-4,000 pesos/ton in the irrigated winter seasons. The average price ranged between 3,100 and 3,850 pesos paid per ton of corn. The last row in **Table 20** presents the average income per hectare before costs for each year surveyed.

Considering farmers generally invest between 10,000-16,000 pesos per hectare in the rainfed season (as well as many hours of their own labor time), this data further confirms that income based on corn sales are razor thin, particularly in years of depressed yields and crop loss as occurred in Chiapas in 2014 and 2015. In such years, income from corn does not even cover the costs of production. Admittedly, the years included in this study (2014-16) reflect particularly difficult farming years due to drought and the additional weather-related impacts caused by El Niño. Nonetheless, climate projections suggest that such climate-related challenges will only increase into the future. Hence, these results reflect the kinds of outcomes that can be expected into the future as climate change impacts accelerate and El Niño phenomena become more frequent.

Table 20 Corn prices, yields, and average income per hectare (Survey data, Benito Juarez, La Concordia County, Chiapas) (2014-16)

	2014 Summer	2014/15 Winter	2015 Summer	2015/16 Winter	2016 Summer
Price range per ton of corn (MX pesos)	2200-3700	2700-5000	3000-4500	3500-4300	3300-4000
Average price paid per ton (MX pesos)	3100	3600	3500	3850	3650
Yield range (tons/ha)	0-7	1.5-7.5	0-8	3-7	0-7
Average yield (tons/ha)	3.86	4.68	3.55	4.88	4.13
Average income per ha[18] (MX pesos/ha)	11,966	16,848	12,425	18,788	15,075

Note: N varies for each column as the number of farmers surveyed who plant corn varied each season. 2014 Summer N=28; 2014/15 Winter N=17; Summer 2015 N=26; 2015/16 Winter N=13; 2016 Summer N=16 (9 had not yet harvested at time of interview)

As reviewed in **Section 3.2**, most corn farmers in Benito Juarez do not receive any subsidies to support their corn production. Although ASERCA was intended to replace the CONASUPO system of price supports to grain farmers and provide farmers with a federal subsidy per ton of grain sold to approved grain purchasers, few farmers in Chiapas participate in ASERCA. Of 33 corn farmers surveyed in Benito Juarez, only 1 household received ASERCA price supports for their corn sales (See **Table 21**). Considering both the low market price for corn and the lack of subsidies, it is unsurprising that desperate farmers continue to be eager to offer their votes in exchange for clientelistic handouts from politicians in the form of seeds and fertilizers.

Table 21 Farmer enrollment in ASERCA (Survey data, Benito Juarez, La Concordia County, Chiapas) (2016)

Do you receive price supports through ASERCA?	Number of farmers	Percentage of farmers
Yes	1	3.0

[18] Average income per hectare calculated here assumes that farmers sold all of their harvest and is calculated by multiplying the average price paid by the average harvest per hectare.

No	32	97.0
TOTAL	33	100.0

Note: Of 33 active corn farmers surveyed in Benito Juarez, only 1 household receives ASERCA price supports for corn sales.

3.7 Corn Markets: Maseca, Coyotes, and Central American Buyers

Table 22 describes the number of farmers surveyed in Benito Juarez who sold their corn to different buyers for the five corn harvests between 2014 and 2016. The vast majority of corn farmers surveyed sold their corn to *coyotes* (or middlemen). A surprisingly low number of farmers sold their corn directly to Maseca[19]. As seen in **Table 22**, only 2 or 3 farmers sold their corn to Maseca each summer season and no farmers sold to Maseca during the winter season. Instead, most corn farmers surveyed sold their corn to *coyotes*. Interviews suggest that the majority of corn purchased by *coyotes* is sent to the Guatemalan border and beyond, ultimately destined for consumers in Central America. Farmers explain that buyers from Central America pay in cash, often offer higher prices than Maseca, and do not deduct farmers' pay for issues of quality control.

Table 22 Number of farmers selling to different corn buyers (2014-16) (Survey data, Benito Juarez, La Concordia, Chiapas)

To whom did you sell your corn crop?	2014 Summer	2014/15 Winter	2015 Summer	2015/16 Winter	2016 Summer
Coyote (middleman)	19	14	14	8	8
Maseca	3	0	2	0	0
Did not sell any corn	5	2	5	0	5
Other	0	0	1	0	1
No Data or Not Applicable	1	1	5	4	9
Total # of corn farmers	28	17	26	15	25

Note: Data points represent the number of farmers. Total number of farmers varies by season. 2014 Summer N=28; 2014/15 Winter N=17; Summer 2015 N=26; 2015/16 Winter N=15; 2016 Summer N=25 (In 2016, 9 corn farmers had not yet harvested or sold their corn at the time of the survey).

Many corn farmers are responding to market pressures by using their corn production for animal feed (particularly for cattle) rather than grain sales. In other words, corn farmers are finding it is of greater financial benefit to turn their corn into meat rather than to sell it as grain. This strategy is being promoted by several corn seed companies and has received some government supports, as well. As one seed vendor explains, with a good yield of 5 tons of corn per hectare and an average grain price of 3,500 pesos per ton, you earn only 17,500 pesos per hectare of corn if you sell it as grain. In comparison, you can use that hectare of corn as feed to fatten 5 calves over a period of 9 months. If each calve increases in weight by 180 kg and you sell the calve for 40 pesos/kg, then you can get 36,000 pesos of income from that 1 hectare of corn, over twice the amount of selling it as grain (Interview,

[19] Although it is possible that some of this corn purchased by coyotes ultimately ends up being purchased by Maseca

Proseso Seed distributor, 9/22/16). This increasing trend towards producing corn for cattle feed is explored in greater depth in **Chapter 6**.

After overcoming the risks and challenges of producing a corn crop, small, commercial farmers still face the problem of accessing fair-priced markets for their corn. The entrance of corn buyers from Central America has generated a key market and alternative to Maseca for corn farmers throughout La Concordia County. Nonetheless, even the prices offered by Central American buyers fluctuate and are still too low to make corn a lucrative endeavor for semi-commercial farmers. In addition, a follow-up visit to Chiapas for this research in December of 2017 indicated that changes may be underway in how corn sales are regulated at the Mexico-Guatemala border, potentially negatively affecting farmers' ability to sell their corn to Central American buyers into the future. Numerous farmers interviewed in Benito Juarez suggest that without the Central American market for their corn, they would have to abandon corn farming altogether as a source of income.

Ch. 4 Environmental Exposures in Corn Farming - Case Study: Benito Juarez, La Concordia County, Chiapas

Introduction

In this chapter, I explore the environmental dimensions of double exposure. This chapter is divided in two parts. Part One examines the environmental "fallout of the Green Revolution" and Part Two focuses on impacts of global environmental change in the study region, particularly as related to climate change. This research expands the notion of environmental risks as conceived in the original conceptualization of double exposure to include an evaluation of contextual environmental factors that augment the risks and impacts of ongoing environmental change. This contextual work is important because, as explored in this chapter, many of farmers' current experiences of vulnerability and crop loss are related to the underlying conditions of the farmland itself prior to any particular climate event or pest infestation. Because many of these issues have their roots in the industrial farming model that has been adopted, I refer to these increased vulnerabilities and impacts as evidence of the ongoing "fallout of the Green Revolution." In other words, the cumulative biophysical impacts of the Green Revolution mode of production are integral to farmer experiences of vulnerability in the context of climate change and neoliberalism.

In Part One, I examine the environmental "fallout of the Green Revolution" of double exposure (See Sector B of **Figure 2)**. This term describes the environmental degradation that has occurred in the region due to poor land use practices and intensive Green Revolution (GR) modes of production. The environmental impacts of the industrial, GR model of agriculture started through government extension programs of the 1970s and 80s. Today this model is extended through a system of privatized extension services and commercial input providers. I begin this section by tracing the shift from "*milpa* to monocultures" in the Benito Juarez ejido. I highlight the ways in which traditional knowledge has been marginalized in the semi-commercial farm systems that now dominate the Chiapas Lowlands. I next describe how the decline in traditional farming knowledge has coincided with an ideological and epistemological shift in agriculture oriented around Green Revolution techniques and ways of knowing. In the final sections of Part One, I explore the "fallout of the Green Revolution" in the Benito Juarez ejido and describe farmers' complex and even contradictory positions towards GR technology and its impacts on their health, both personally and in their fields.

Environmental Exposures Part 1:The Fallout of the Green Revolution in Chiapas

4.1 From *Milpa* to Monocultures in Benito Juarez, La Concordia County, Chiapas

Historically, proponents of the industrial, GR mode of agriculture continually dismissed traditional farming methods as "backwards" and "inefficient" (Jennings

1988; Eddens 2017). In Mesoamerica, the traditional approach to farming, known as *milpa,* has long been spurned by development experts. As discussed below, the transition to GR modes of production has not only dispossessed farmers of their traditional milpa and seed systems but has also stripped farmers of their traditional knowledge associated with these systems. However, new studies have demonstrated *milpa* systems often safeguard agricultural biodiversity, conserve soil health, and include many techniques that can increase adaptive capacity of farm systems (Altieri and Nicholls 2009; Altieri and Toledo 2011).

The *milpa* is a polycrop approach to agriculture based on companion planting of the "three sister" crops of corn, beans, and squash. Although varied in their specific seed varieties and management styles, Mexican *milpas* have historically included a broad range of crops such as *quelites*, herbs, vegetables, and fruit trees. Traditional companion planting, crop rotation, and fallowing practices balance soil nutrients, provide natural pest control, and maintain soil fertility over many years of use. For example, corn provides a natural stalk upon which bean vines can grow. While the corn plant strips nitrogen from the soil, beans serves to fix nitrogen back in the soil. Squash provide ground cover to maintain soil moisture and deter weed growth; their leaves serve as natural mulch; and their fuzzy stems serve as a deterrent to pests. Together, this trio of plants provides complex carbohydrates, essential fatty acids and amino acids that create the foundation for a nutritious, plant-centered diet.

The transition to GR systems of production has gradually dispossessed farmers in the Benito Juarez ejido of their traditional farming systems and knowledge. Farmers 35 years or older in Benito Juarez still remember how their parents' and grandparents' generations managed polycropped agricultural systems in addition to commercial rice production. Although younger farmers have lost most of this practical knowledge, they still remember helping the elders to select and save the corn seed for planting the following year. They recall the time before the widespread use of artificial fertilizers and agrochemicals when they cleaned the fields by hand using simple tools and prepared the fields with the help of oxen. The fields were smaller and required constant manual labor and vigilance. These practices have gradually disappeared as GR technologies and techniques have taken over.

Monocultures of corn were first established in the Frailesca region in the 1970s following the decline of large-scale rice production. The transition was supported by state policies that provided financing, extension services, technological packets of seeds and agrochemicals, and purchasing guarantees (see Chapter 2). In the beginning farmers did not have irrigation access and could only plant one corn crop per year during the summer rainy season, often followed by a short-cycle bean crop. Although large-scale monocultures were beginning to be established at this time, the fact that farmers could only farm one corn crop per year helped to limit the environmental impact of this production model. Following

summer corn with a bean crop in the fall would return some nitrogen to the soil after the corn harvest. The fallow period before the next cycle of corn would allow the fields to rest nearly half of the year prior to being replanted.

Following the opening of the Portillo Dam in 1979 and the foundation of the Cuxtepeques Irrigation District in the 1980s, corn production greatly intensified in the Chiapas Lowlands. Suddenly, farmers with irrigation access were able to plant two corn crops each year, one in the summer and one in the winter. Eager to expand their incomes, many irrigated farmers began planting two corn crops each year, doing away with crop rotation and fallowing practices. At this time, farmers also began to expand their use of technological packets of improved seeds, agrochemicals, and machinery in production. By 1994, the state of Chiapas had become the third most important corn producer in the country and about 70 percent of production was shipped to other states in Mexico (Nieuwkoop, et al. 1994).

By promoting a GR agricultural model based in monocultures and agrochemical use, the Mexican state encouraged farmers to abandon *milpa* production and, along with it, the crop diversity and cultivation practices that underpinned soil and human health. Today, corn monocultures have become the norm for most farmers in Benito Juarez. The practice of planting continuous corn crop after corn crop has reduced crop diversity and stripped the soil of nutrients, particularly nitrogen. In addition, agrochemical use has eliminated many of the companion cropping practices once common to *milpa* production such as the inclusion of squash and *quelites* or leafy greens. Increasing pest and disease problems in bean crops have motivated many farmers to stop planting beans as well. Today, in Lowland ejidos such as Benito Juarez, these additional crops (if any exist) make only sporadic appearances in places beyond the reach of agrochemicals, such as the hedgerows framing farm plots or in people's home *traspatio* or backyard spaces where small plots may still be planted in squash, fruit trees, herbs, or chilies.

4.2 Green Revolution Ideology and Epistemology

The transition to an intensive, GR approach to agriculture not only transformed how agriculture is practiced but also generated an ideological and epistemological shift in agriculture oriented around Green Revolution techniques and ways of knowing. It shifted the fulcrum of agricultural expertise from the farmers in the field to the laboratories and offices of specialized agronomists and crop scientists. Whereas *milpa* farmers used to rely on their own methods for observing the landscape and anticipating the weather, today this farmer-based knowledge is quickly disappearing or no longer holds true within the context of accelerating climate change (see **section 4.6**). Interviews with farmers and extension agents throughout Chiapas reveal that the decline in traditional agricultural knowledge has not been replaced with new knowledge forms. Although farmers continue to be insightful observers of their crops, many farmers lack in-

depth understandings of GR products and the impacts these have on farmer health and the environment. As a result, there is often confusion among farmers regarding GR inputs and their proper use.

In my study, newer generations of farmers (between 20-45 years of age) have little, if any, memory of traditional farming methods. At the same time, due to the decline in extension services, these farmers have lacked guidance from extension agents. Most farmers have no formal training in how to properly manage the suite of seeds and agrochemicals now required for farming. As a result, there is vacuum of knowledge wherein farmers are ill-equipped to respond to the accumulating challenges they face due to climate change and other environmental changes affecting their crops. Without undervaluing the valiant efforts farmers make daily to make do with the tools and resources they have on hand, the truth is that farmers today have adopted an industrial agricultural model without the knowledge and expertise necessary to manage it successfully —let alone sustainably—, particularly in the context of accelerating climate change.

The economic and political shifts in farming in the neoliberal context have encouraged a largely individualistic and productivist approach to farming. As income from farming has decreased, the number of family members involved in agriculture has decreased (Alcanzar Sanchez 2015). Overall, collective ownership and management of farmlands have been reduced. Now land areas are parceled out in privatized units. As one farmer notes: "Now everyone is on their own. Now everything is parceled out of what is mine and what is yours" (Cein, farmer interview, Benito Juarez, 5/12/16). While there are still vestiges of solidarity and a moral economy of labor among some farmers (see **Section 6.3**), the shift to a largely individualistic approach to farming means that most farmers are navigating the risks of production alone.

Neoliberal ideologies and market pressures have instilled productivist mentalities among (semi)-commercial farmers in Chiapas. The combination of free trade policies, the removal of input subsidies and guaranteed purchasing prices, and the increasing costs of production push farmers to produce as much as possible in the short-term with little regard for the long-term health and environmental consequences. As a result, farmers invest little time in conservation practices or more sustainable farming techniques. This emphasis on profit over sustainability reflects O'Connor's (2001) second contradiction of capital. As explored in the following section, farmers, particularly as the climate changes, are now feeling the repercussions of this disregard for long-term farm sustainability.

4.3 The Fallout of the Green Revolution in Benito Juarez

Consumers throughout Mexico, particularly in burgeoning urban regions, benefitted greatly from the abundant and cheap (i.e. subsidized) supply of corn that resulted from government efforts to intensify corn production nationally. However, already in the 1990s, the environmental impacts of this GR, industrial model of

production began to show. While substantial yield gains have been achieved in corn production in Northern Mexico, even surpassing the U.S.-levels, there are signs that yields are reaching their upper limits, resulting in a sense of urgency to achieve production gains in other regions (Sweeney et al. 2013). While programs such as Masagro reflect an ongoing concern to expand national grain production, there are also growing concerns regarding the long-term environmental impacts of the GR agriculture in Mexico. Impacts include increased salinization, depleted aquifers, compacted soils from machine use, eutrophication of waterways, biodiversity loss, vulnerability to climate change, and increased competition between urban and rural resource users (Wilder and Whiteford 2006; Appendini and Liverman 1994).

Already in the 1990s, the impacts of GR corn production were being observed in Chiapas. In the Frailesca region, scientists from INIFAP and SAGARPA observed that intensive corn farming was reducing soil fertility, increasing the use of artificial fertilizers, contaminating water and producing sedimentation (Nieuwkoop, et al. 1994: 1). Corn monocultures have continued to degrade agricultural lands in La Frailesca, stripping soils of nutrients and increasing chemical loading, acidification (particularly due to ammonia-based nitrogen fertilizers), and salinization of agricultural soils (Mendoza Perez et al. no date: 2). This environmental degradation is now jeopardizing the ability of farmers to adapt to and cope with the impacts of ongoing environmental change, particularly climate change. Interviews with farmers and extension agents in the Frailesca region reveal that farmers' current experiences of vulnerability and crop loss (whether due to extreme climate events, pest infestations, or weeds) are often related to the underlying health (or lack thereof) of the farmland itself prior to the event.

Until now, little focus has been given to the extent to which industrial, GR modes of agriculture can contribute to farmer experiences of vulnerability to both climate change and neoliberalism. However, both the cumulative environmental impacts and the market dependence of these practices are integral to a comprehensive understanding of double exposure processes. On the one hand, industrial practices have accelerated the environmental impacts of farming. On the other, the increasing enrollment of farmers in commercial crop production has exposed famers to cycles of market booms and busts. Farmer reliance on monocultures means that success hinges upon a bountiful harvest and favorable markets of just one crop. While farmers are accustomed to there being good and bad years in farming, they are less accustomed to navigating bad years without any public safety nets. When the Mexican government was heavily involved in agriculture—providing insurance coverage in the case of crop loss and guaranteeing minimum price floors—farmers were buffered from the hardest losses that can occur in a bust year. Now, farmers experience these booms and busts without much (if any) buffer.

The fallout of the Green Revolution model of agriculture in La Frailesca region is most noticeable in farmers' increasing experiences of declining corn yields

and crop loss, depleted soil fertility, and the need to use ever-greater amounts of agrochemicals and fertilizers to secure a good crop. Extension agents note that the intensive corn production based on the Green Revolution model of agriculture has impacted the environment and depleted agricultural soils in the Frailesca region (Extension agent, Masagro Chiapas Hub, interview 8/31/15).

Farmers with access to irrigation regularly plant two consecutive corn crops each year without periods of fallow in between to allow the soil to recover. While some farmers still occasionally plant beans, there is wide consensus among farmers that beans are now more susceptible to pests and disease. As such, beans have become a risk that many farmers are no longer willing to take. As a result, most corn fields no longer receive the kickbacks of nitrogen once provided by the fall bean crop. As discussed in greater depth in **Chapter 6**, corn and cattle continue to be the "safest bet" for farmers and, as such, have become the activities farmers practice over and over again despite the environmental impacts that accrue on their land over time.

Practices that may help farmers in the short-term can end up causing unintended consequences and prove maladaptive to ongoing climate change over the long-term. In this case, the continued monocropping of corn is producing long-term soil degradation and farm vulnerability. Irrigation access, in particular, is an ironic example of a tool that provides short-term benefits and long-term trade-offs. Just as irrigation access is a key factor in reducing the risk of crop loss in periods of extreme drought, it is also an unmistakable factor in increasing farm vulnerability over a longer temporal scale. This finding resonates with prior observations such as those made by Liverman (1994). Although access to supplemental irrigation water can be vital to helping crops survive during periods of drought, that same irrigation access has encouraged an intensive model of corn production that has increasingly depleted farm soils and affected productivity.

While planting corn crop after corn crop may be the most accessible livelihood strategy for struggling farmers, this approach jeopardizes long-term farm health. Continuous corn planting increases pest problems by eliminating crop diversity necessary to keep pest populations in check (Extension agent, Masagro Chiapas Hub, interview 7/29/16). At the same time, corn monocultures strip nitrogen from the soil and create a destructive cycle wherein farmers must apply more and more agrochemicals to compensate for nutrient imbalances in the soil.

The dearth of environmentally- and socially-minded extension services for farmers (as discussed in **section 5.5**) also has significant environmental ramifications. The few services that do exist in the region are generally not focused on addressing the underlying causes of crop problems and soil health but rather on promoting greater agrochemical use. One extension agent explains that for decades Mexico's agronomy schools have trained extension agents in Green Revolution techniques and this is the model that most agronomists and extension agents

continue to promote today. “Agriculture [today] is very consumerist”; agronomists push farmers towards agrochemical solutions to every problem (Extension agent, Masagro Chiapas Hub, interview 7/29/16). The extension services offered by seed companies and their distributors rely even more so on the promotion of agrochemicals. As one extension agent observes, “[The company representatives] have huge apathy towards the environment. They solve problems by [telling farmers]: ‘Just apply fertilizer. Apply more!’” (Extension agent, Red Chiapas, interview 9/20/16).

4.4 Farmer Ambivalence towards the Green Revolution: Farm Profits vs. Farm Health

In interviews, farmers describe a mixture of both gratitude and regret for how the Green Revolution approach to farming has impacted their lives and environments. On the one hand, farmers admit that hybrid seed varieties have been integral to increasing their corn yields. In addition, agrochemicals have reduced the amount of manual labor needed to eliminate pest and weed problems. On the other hand, however, farmers express widespread discontent regarding the impact agrochemicals have had on their health (both personally and in their fields) and are perplexed by their dependence on an evermore-expensive suite of agrochemicals to get a successful harvest.

Many products farmers use display warning labels about product toxicity and the need to use protective masks, clothing, and gloves. Nonetheless, in visits to farmers’ fields, I observed repeatedly that farmers do not follow these guidelines. One product in particular, Semevin, stood out for its high toxicity and farmers’ lack of protective measures. Semevin, a product of Bayer-Monsanto, is a liquid insecticide that farmers apply to seeds prior to planting. The Semevin bottle clearly indicates that people must use “long-sleeved, waterproof overalls, waterproof gloves, protective eyewear, boots, hat, and a face mask with filter” when handling the product (label, Semevin 350 bottle).

I was able to experience the toxicity of the Semevin product directly in a visit to observe the corn planting process on a local farm in the Benito Juarez ejido. My visceral reaction to the fumes of the product alone nearly caused me to throw up. The farmer coated his corn seeds with the toxic liquid by mixing them together with a wooden stick (See **Figure 15)**. I then looked on with concern as the farmer and his hired crew of day laborers handled the treated seeds for hours without any protective gear. Within a short time, the farmers’ hands and faces were covered with the bluish-gray ash of the dried chemicals. Although the user instructions on the bottle recommend farmers use waterproof gloves and thorough hand washing before any other activity, none of the farmers did either. Farmers handled the seeds barehanded and did not wash their hands before stopping for a smoke break, a scratch of the nose, or a drink of water.

Figure 15 Farmer coating corn seeds with Semevin liquid insecticide without protective clothing.

Although farmers generally fail to use protective gear, they also voice uncertainty and concern regarding how agrochemicals are affecting their health. They observe that the increased use of agrochemicals locally has correlated with increasing incidence of cancer and other diseases among farmers. One farmer comments: "People are experiencing a lot of diseases like cancer due to all the chemicals that we use. Before our ancestors didn't do that. They used the hoe, the machete and didn't pollute so much. Not anymore. That is what is worrisome - so many chemicals" (Cesar, farmer interview 5/10/16). Another farmer says: "So many sicknesses are affecting human beings — so much cancer, so much diabetes — [and] they are happening today because we as humans, as farmers, are killing ourselves…With the changes in technology in farming and everything, don't you think? It has jeopardized everything. There is a lot of pollution and that is why there is so much cancer now because we use those products and we don't take care of ourselves; we don't protect ourselves" (Eugenio, farmer interview, Benito Juarez, 7/17/16).

In addition to health concerns, farmers are worried about the environmental impacts of their farming practices. Many farmers are aware of the toxic nature of the products they use in their fields and frequently describe the liquid pesticides and herbicides as "poisons [that] are destroying the earth" (Arturo, farmer interview,

Benito Juarez, 5/11/16). Repeatedly in interviews farmers would shake their heads in frustration, lamenting the environmental harm caused by the products they use on their fields. Some mention that the inputs poison the soil and water. Others worry that the chemicals end up creating a lower quality and less nutritious product. Still others deplore how agrochemicals have reduced soil fertility, eliminated the life in the soil, and affected local insect populations. As one farmer observes: "It is very clear where those agrochemicals are being used [because] all of the microbiology, all of the insects, are missing. Meanwhile when you go to a place where those products aren't used, you can tell. You see all the bugs getting fat, the butterflies. You see the balance as we call it, the equilibrium" (Extension agent, Red Chiapas, 9/20/16).

A common complaint of farmers is that corn yields have generally declined over the years while their reliance on agrochemicals has increased. Often times the drop in corn yields caused by depleted soil conditions combined with declining financial returns in corn will lead farmers to abandon corn farming altogether. As one farmer observed, the fields no longer produce as they did before, but rather appear tired from continual over-use (Cesar, farmer interview, Benito Juarez, 5/10/16). Other farmers note that "soil is dead" and, for the same reason, farmers are completely dependent on agrochemicals to get a crop (farmer interview, Benito Juarez, 5/11/16).

In sum, farmers continue to wrestle with the fall-out of the Green Revolution model of agriculture they have adopted. While farmers acknowledge the increased yields they have enjoyed through this model, they also struggle with the health impacts, biodiversity loss, environmental degradation, high costs of production, and uncertain markets that have accompanied the shift to an intensive GR mode of farming. As discussed in Part Two of this chapter, successful harvests on such degraded farmscapes are becoming increasingly uncertain as the climate changes and pest problems intensify.

Environmental Exposures Part 2: Ongoing Environmental and Climatic Change

4.5 Global Environmental Change and Mexico's Small-scale Farm Sector

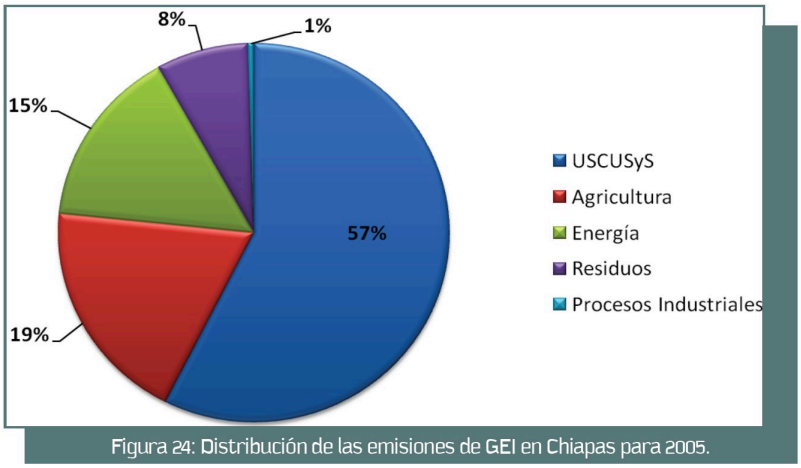
"Today, climate is the central factor for the viability of farming. We are just starting to observe large-scale climate anomalies, just barely. In the next 50 years, there are going to be drastic effects. The topic will continue to exacerbate because we are not reducing greenhouse gas emissions and the accumulation and increase in temperatures is generating new and more severe changes…If climate is not placed at the center of public policies and productive decisions, Mexico's agriculture will tend more and more toward failure."(Victor Suarez, ANEC director and agronomist, interview).

Mexico is a hotspot for climate change and faces significant challenges for adapting its agricultural sector to these changes. Since 1960, the country has registered an increase in mean annual temperature of 0.6 degrees Celsius and climate change is already having a significant impact on agriculture (SEMARNAT 2009). Climate models predict a consistent and augmenting trend toward drier and warmer conditions during the main corn-growing season (May through October) in southern Mexico (Bellon et al. 2011). Using different climate change models, Conde et al (1997) concluded that corn production in Mexico is highly vulnerable to both extreme climate events such as droughts or floods *and* climate change. "The moderate predicted changes in the next 50 years in Mexico equate to a 0.08 degree Celsius warming per generation in some maize-growing regions; nine times that previously experienced." (Hellin et al. 2014: 492). Mexico's official reporting on climate change suggests that corn yields in Mexico will continue to decrease as climate change accelerates. Already an estimated 25 percent of Mexico's farms have lost soil fertility and it is expected that climate change will only further exacerbate this problem (cambioclimatico.datos.gob.mx consulted on 12/21/18).

The *Programa Especial de Cambio Climatico* (PECC) lays out Mexico's plan for confronting climate change, including long-term emission reductions, mitigation (through changes to production and consumption); adaptation; and transversal policy (coordinating inter-institutional efforts). On paper, many applaud Mexico as having some of the most ambitious climate mitigation goals. However, in practice, some scholars argue that Mexico's climate change plans are still very general and lack proposals that attend to the specific needs of each region. Overall, there is a sense that these plans do not do enough to reduce the vulnerability of *campesinos* (Soares and Garcia 2014). In general, there is a need to increase understandings of how farmer vulnerability is linked to biophysical conditions as well as social, economic, and political processes occurring locally and regionally (Soares and Garcia 2014). I hope to contribute to filling this gap by detailing the factors that contribute to farmer experiences of double exposure and how these factors interact and compound one another.

In Chiapas, land use, land use change, deforestation, and degradation represent 57 percent of the state's contribution to greenhouse gas emissions (Chiapas Government 2011) (See Figure 16). Most forest destruction is caused as forests are converted to agricultural and ranching purposes. The second largest source of greenhouse gases in Chiapas is agricultural practices, including cattle ranching. The methane emissions of cattle and nitrous dioxide emissions from fertilization practices represent 19 percent of the state's emissions (ibid.). Other sources include fossil fuel-based transportation, solid and liquid wastes, and industrial processing (ibid.).

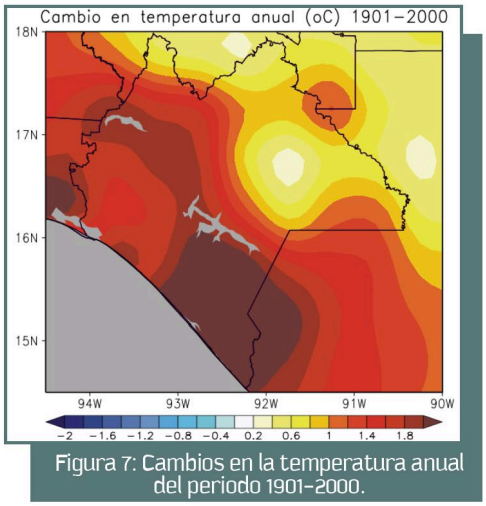
Figure 16 Sources of Greenhouse Gas Emissions in Chiapas, Mexico

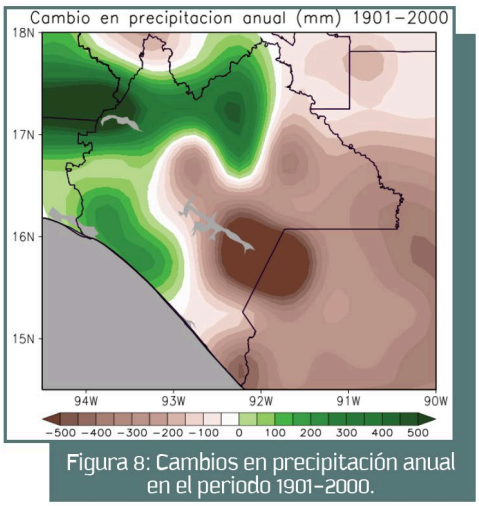


Source: Chiapas Government 2011: 52

The state of Chiapas has already registered an increase in the frequency and intensity of extreme meteorological events such as hurricanes, heat waves, droughts, and storms (Chiapas Government 2011). During the 20th century, Chiapas registered an increase in average annual temperature of 1.8 degrees Celsius and a decrease in precipitation of 500 millimeters in the lowland regions encompassing the study area (Chiapas Government 2011: 48) (See Figure 17). Based on the medium high emission scenario outlined by the IPCC A1B, the state of Chiapas anticipates an increase in average maximum temperatures between 3 and 3.4 degrees Celsius by the end of the 21st century (Chiapas Government 2011).

Figure 17 Changes in Annual Temperature and Precipitation in Chiapas, Mexico (1901-2000)



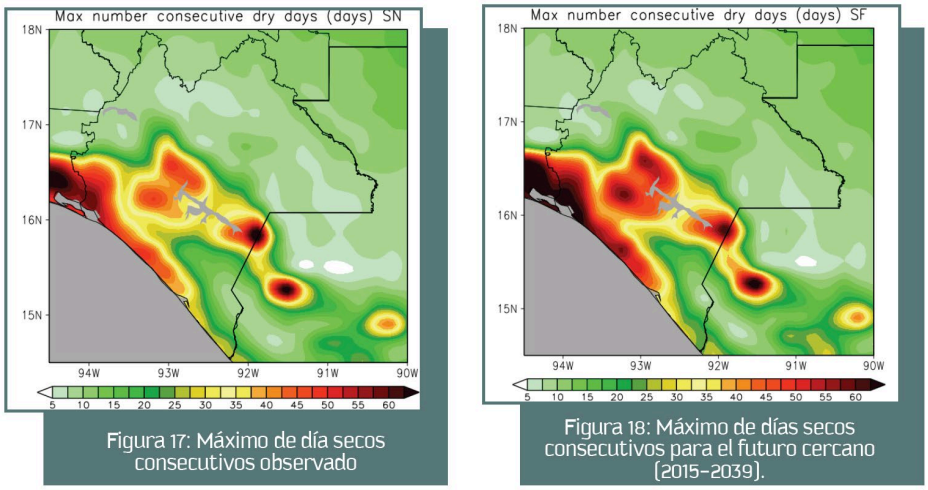


Source: Chiapas Government 2011: 48

The Frailesca and Fronteriza regions of Chiapas (the main areas of this research) are located at the heart of where increases in temperature are anticipated to be among the most severe (Chiapas Government 2011: 49). In the near-term (2015-2039), climate models anticipate an increase in average temperature of 2 degrees Celsius (Chiapas Government 2011: 49). Over the long-term (2080-2099), the anticipated temperature increase for this region is between 3 and 3.6 degrees Celsius (Chiapas Government 2011: 50).

Models of future climate scenarios in Chiapas anticipate a net reduction in rainfall as well as an increase in the number of days without rainfall, particularly in the Frailesca and Fronteriza regions where this research is focused. By 2100, climate models anticipate a decrease in precipitation in the study regions of between .7 and 1 mm per day (Chiapas Government 2011: 51). Between 2015 and 2039, climate models of the region predict between 30 and 50 consecutive days without precipitation, which represents an increase of 10 days and as many as 20 days for the Frailesca and Fronteriza regions (Chiapas Government 2011: 51) (See Figure 18). During El Niño years, declines in rainfall and increased incidence of drought are even more pronounced (Chiapas Government 2011).

Figure 18 Maximum Number of Consecutive Dry Days in Chiapas, Mexico (current and near future)



Source: Chiapas Government 2011: 51

In recent decades, Chiapas has shown evidence of increasing intensity and frequency of extreme climate events such as hurricanes, intense rainfall, drought, and heat waves (SMAHN 2011). From 2013-16, Chiapas experienced 3.5 consecutive years of drought, compounded by a severe El Niño phenomenon that lasted from 2014 until July of 2016. In 2015, the Mexican Drought Monitor (MSM) reported that 49.2 percent of the state of Chiapas was experiencing moderate to extreme drought (*Heraldo de Chiapas*, 9/2/15). As one extension agent observed, 2014 was a terrible year for drought and 2015 was even worse (Extension agent, Masagro Chiapas Hub,

interview 8/31/15). El Niño events generate drought in central and southern regions of Mexico whereas La Niña events tend to cause excessive rain. Climate models anticipate that these events will become more frequent over time (Cai et al. 2014). El Niño events are of particular concern for Mexico's corn producing sector since an estimated 77 percent of the nation's corn is produced in the central and southern regions where El Niño impacts tend to concentrate (SIAP 2012: 28).

One researcher from the University of Chapingo found that rainfed farmers throughout the Chiapas Lowlands have frequently experienced 70 to 80 percent crop losses in recent years, with 2015 being even worse than 2014 (Gomez 2015). My observations and interviews with farmers throughout Chiapas between 2015-16 confirm these higher estimates of yield losses among rainfed farmers. I suggest that Mexico's official reporting of crop loss through SIAP do not capture the full extent of yield decline and crop loss affecting farmers throughout the state, particularly during drought years.

As mentioned above, yield losses are related to numerous direct and indirect factors. It is therefore unsurprising that experiences of yield declines and crop loss vary from farmer to farmer, with some farmers suffering worse losses in 2014 and others in 2015. Even farmers with access to irrigation have reported much lower yields in 2014 and 2015 during the summer season. This indicates that although it can help, irrigation alone cannot completely buffer farmers from the impacts of extreme temperatures, drought, and other challenges such as pest infestations.

Section **4.6** recounts farmers' observations of climate change in the Benito Juarez ejido. A CONAGUA official in charge of the Cuxtepeques region of Chiapas (which includes the Benito Juarez ejido) confirms farmers' observations of change. Since 1981, average annual rainfall in the Cuxtepeques region has dropped from 1800 millimeters to 1500 millimeters in 2015, representing nearly a 17 percent reduction in annual rainfall (CONAGUA official, Cuxtepeques 101 irrigation district, interview 4/23/16). While hotter and drier temperatures broadly characterize the changes occurring in the region's climate, there have also been unusual cold extremes. The 2015 winter, for example, was the coldest winter the Cutepeques region had ever experienced, registering multiple days below 8 degrees Celsius (CONAGUA official, Cuxtepeques 101 irrigation district, interview 4/23/16).

4.6 Farmer Observations of Climate Change in the Chiapas Lowlands

Throughout the state of Chiapas, farmers confirmed repeatedly in interviews that climate change is no longer a distant possibility but rather an already present threat actively affecting farmer livelihoods. All farmers interviewed in Benito Juarez report having observed changes in the local climate over the last 20 years. Every farmer surveyed (N=33) agrees that drought, heat extremes, and climate variability have all increased. They comment that the rainy season now arrives later, is less consistent, and the overall amount of rain is greatly decreased. Other changes

farmers observe include increased storm intensity; increased weather extremes of hot and cold; more violent windstorms; and less water in rivers and reservoirs.

When asked to describe any changes they have observed in the climate over the last 20 years, farmers in Chiapas tend to list shifts in precipitation patterns first. Elders in Benito Juarez recall that the rainy season used to arrive reliably at the end of April and the rains would fall abundantly and consistently through October. The only interruption in summer rains would occur in mid-July in a dry period known as the *canicula* that would last for about 10 days. The rains were so reliable that farmers would plant their seeds around April 23rd when it was still dry because by April 25th the rains would arrive (Eugenio, farmer interview, Benito Juarez, 7/17/16).

Farmers also observe that the dry period known as the *canicula* is increasing in length and intensity. Whereas this hot, dry period used to last just one or two weeks, it is now commonly lasting three weeks or longer. During drought and El Niño events, the *canicula* drags on, threatening the summer corn crop. In 2014 and 2015, for example, the *canicula* lasted for over a month. Depending on the stage of plant growth and whether farmers have access to emergency irrigation deliveries, this dry period can stifle plant development and decrease crop yields. In worst-case scenarios, if the *canicula* arrives when the corn plant has entered its reproductive stage and cobs have begun to form it can result in significant or even total crop loss.

In general, farmers are struggling with an increasingly variable and unpredictable climate. Whereas farmers used to base their farming practices on traditional knowledge and observations of their natural environment, they find that increasing climate variability confounds their traditional knowledge about climate and farming. Farmers note that even when the rains do arrive, they are less consistent than before, falling in patches instead of soaking the region uniformly. For farmers, there is no doubt that these changes are evidence of ongoing climate change:

"I remember there used to be enough rain. It would start raining in April and it would keep going through October. Not anymore. It's weird. It won't rain all of June, or sometimes just part of June. [But in 2015] it rained through November and December. It was weird. Sometimes all of the rain that didn't fall in one month will fall in a single night. All of this lack of control in the climate is due to the same thing, the destruction we are causing as human beings, so much so that now the climate has changed" (Eugenio, farmer interview, Benito Juarez, 7/17/16).

Historically, farmers in Benito Juarez would interpret local signs and changes in the weather to establish their planting schedule each season. Of particular importance was the observation of the *cabañuelas*. Elders would monitor the weather closely during the first 12 days of the New Year (January 1st- 12th). Each day observed would indicate the weather and likelihood of rain for the calendar

month corresponding to that day's number. For example, if it was windy on January 2nd, it meant that the month of February would be windy. If it rained on January 5th, then farmers could expect the rains to begin in May (Mercedes, community member, interview, Benito Juarez, 2/17/16). In interviews, farmer after farmer explained that the *cabañuelas* and other observations by local elders used to provide all of the climate information they needed to secure a good corn harvest. Nonetheless, as reflected in the following quotes, the increasing climate variability in recent years has reduced the reliability of traditional knowledge for anticipating the weather:

"It used to be a sure thing. [The elders] would say it was going to rain from this date to that date, but not anymore. Due to how we are destroying [the environment] and the climate is changing…[that knowledge] is not as certain as it used to be" (Cein, farmer interview, Benito Juarez, 5/12/16).

"Everything has changed so much that even the elders' knowledge is no longer certain. The climate has just varied too much" (Javier, farmer interview, Benito Juarez, 2/4/16)

"You can no longer trust [in the cabañuelas] because everything is so variable. Suddenly there are terrible rains that fall hard and then there are horrible periods of drought. You cannot trust [in elders' knowledge] anymore" (farmer interview, Benito Juarez, 5/11/16)

Corn farmers in other counties describe similar frustrations. Farmers in Frontera Comalapa County along the Mexico-Guatemala border explain they can no longer rely on elders' knowledge when planting their crop. As one farmer explains:

"When we were young, it seemed that our parents were weather diviners. They always knew when the rains would come. They had a certain date for planting. [In the 1960s and 70s], our parents would announce the planting date sometime between May 3rd and 15th and [they would say that] in September the corn would be bursting. As if they were gods, that is what would happen! That is how it was. We had excellent crops and there were no pests. Now we don't anymore. Everything is uncertain. For the last two years, we haven't had any rain. The 2016 rainy season was non-existent. Even in September, the month when we should get a lot of rain, everything was dry" (San Caralampio Ejidal Council, Focus Group, 11/20/16).

It is clear that locals' traditional climate knowledge is increasingly unable to predict ongoing climate change and its effects on each crop cycle. This is particularly devastating for ejidal farmers who have relied on this traditional knowledge as their only source of climate information. As this knowledge has become less reliable, farmers frequently express feeling incapable of anticipating the weather each season and adapting their farming activities accordingly. Many suggest they are now

completely at the mercy of God. As one farmer observed, "Only the God above know how the weather is going to be" (Cesar, farmer interview, Benito Juarez, 5/10/16).

4.7 Farmer Observations of Other Environmental Changes

Farmers in Benito Juarez observe that changes in the climate come accompanied by other local environmental changes, including a greater prevalence of pest infestations, a loss of soil fertility, and a need for increased agrochemical use. Farmers insist they have to be more vigilant than before, constantly monitoring the health of their crop. There was agreement among the majority of farmers surveyed in Benito Juarez about the different environmental changes that have occurred locally over the last 20 years (see **Table 23**). All farmers surveyed (N=33) agree that months of drought, heat extremes, and overall climate variability have increased over the last decade. Over 90% have observed increases in storm intensity, number of pests affecting their crops, the amount of agrochemical inputs they must use to achieve a good harvest, and cold extremes. 91% have observed declining soil fertility on their farms.

Table 23 Farmer observations of environmental change between 2006-2016 (Benito Juarez ejido, La Concordia County, Chiapas) (2016)

Environmental Change	Trend Observed	Percent of Farmers Who Agree
Months of Drought	Increased	100%
Heat Extremes	Increased	100%
Climate Variability	Increased	100%
Storm Intensity	Increased	97%
Number of Crop Pests	Increased	97%
Amount of Inputs Required for a good crop	Increased	97%
Costs of production	Increased	97%
Cold Extremes	Increased	94%
Soil Fertility	Decreased	91%

Note: N=33 farmers. The survey asked 33 active farmers to describe what trend they have observed in different phenomena related to their farm production over the last 10 years (2006-2016). Farmers were asked to choose between "increased", "decreased", or "remain the same" in their answers. The table reflects the percentage of farmers who agree on the trend as noted.

Farmers explain that increases in drought and heat produce increase pest problems in their crops. The most common pests affecting corn in La Frailesca region are the fall armyworm (*gusano cogollero*) and the red spider mite, both of which thrive in drought conditions. The red spider mite causes leaves to dry out ("*chamusco*") and stunts plant development (Abraham, farmer interview, Benito Juarez, 5/2016). Farmers explain that the fall armyworm infestations used to only affect corn during the irrigated, winter crop. However, with the onset of hotter, drier conditions in recent years, farmers are now seeing extensive damage by the fall armyworm in the rainfed, summer crop as well (Eugenio, farmer interview, Benito Juarez, 7/17/16). The maize weevil (*gorgojo*) is a beetle that can also affect corn on the stock before it is harvested. Pests such as the maize weevil reduce grain quality and affect the price farmers receive for their crop at the end of the season. If farmers lack the liquid capital to control these pests as they arise, they risk losing their entire harvest.

Although most farmers report pest challenges related to increasing heat and drought, there are also reports of increased yield losses to linked to plant diseases that thrive with excessive humidity. The tar spot disease (caused by three different fungi, including Phyllachora maydis and Monographella maydis) is one such disease (Martinez and Espinosa 2014). In the Frailesca region, farmers recognize this disease as "*chamusco*" or "*mancha de asfalto*" because the disease dries the leaves of the corn plant and, in extreme cases, can stunt all plant growth (Martinez and Espinosa 2014). Tar spot disease is particularly common in farms that are under continuous corn cultivation and lack crop rotations or fallow periods (Martinez and Espinosa 2014).

Farmers observe that the increasing prevalence of hot, dry conditions is also increasing irrigation demands. This is increasing the value of land areas with reliable irrigation access. Soils rapidly lose its humidity in hot, dry conditions. In response, farmers rely on more frequent and greater quantities of irrigated water. "We are seeing that in the irrigated cycle we have to apply water more frequently because the land dries out very rapidly; it no longer holds humidity as it used to" (Eugenio, farmer interview, Benito Juarez, 7/17/16).

In the past, summer rains provided enough water to produce bountiful summer corn harvests. Irrigation water was only used in the winter when rains are scarce. Today, however, many farmers now rely on auxiliary irrigation water to get through the hot and dry summer months. Indeed, as discussed in more detail in **section 6.1**, having access to irrigation has become indispensable to farmers' ability to continue planting corn in the rainfed, summer season.

Overall, the many changes in the local climate and environment means farmers must be increasingly vigilant of their crop from seed to harvest. Whereas farmers recall that the plants used to "grow on their own," today that is no longer

the case. Now, crops require constant attention and well-timed interventions to ensure a successful crop (Julio, farmer interview, Benito Juarez, 12/11/16).

4.8 Extreme Weather Events, Dam Infrastructure, and the Future of Irrigation in the Cuxtepeques Region

Water managers observe that it is not only the increase of temperature extremes and drought that are of concern but also the increasing incidence of extreme weather events that wreak havoc on the dam and irrigation infrastructure that underpins agricultural and ranching activities in the Cuxtepeques region of La Frailesca.

The Portillo Dam is one of only two dams in the state of Chiapas that was built for irrigation purposes (**See Figure 19)**[20]. The dam was built in 1979 with 100 million cubic meters of holding capacity and a 50-year life expectancy. Originally, the dam was envisioned to transform the surrounding ejidos into a milk-producing region. It was to provide irrigation to 10,410 hectares of land across seven ejidos. By the time construction was complete, only 8,340 hectares of land were linked to irrigation access. As of 2016, only about 5,300 hectares actively access and use this irrigation water (CONAGUA official, Cuxtepeques 101 irrigation district, interview 4/23/16).

Figure 19 Map of Irrigated Regions of Chiapas

[20] Figure **1** regions with irriga are only two such dams: 1) Dr. Belisario Dominguez and 2) Portillo Dam (lower left). The light green area in the eastern part of the state is the San Gregorio Irrigation District that serves 11,227 hectares of agricultural land in Frontera Comalapa and La Trinitaria counties on the border with Guatemala (Region Hidrologica: XI Frontera Sur).

Extreme flooding and rain events such as Hurricane Stan in 2005 combined with deforestation in higher elevations affect the long-term life expectancy of the Portillo Dam. CONAGUA officials report that extreme weather events are occurring more frequently (CONAGUA official, Cuxtepeques 101 irrigation district, interview 4/23/16).These events deposit huge amount of debris from the upper river basin into the Portillo Dam, thereby reducing the overall holding capacity of the dam and increasing the risk of future flooding in the areas located below the dam. A CONAGUA official observes that water is becoming scarcer throughout the region. Although the Cuxtepeques irrigation district has not had to ration water use since 2001, he notes that water scarcity is increasing overall. Farms and households located outside the irrigation district or upstream of the Portillo Dam are drilling more and more wells to compensate for the lack of water (CONAGUA official, Cuxtepeques 101 irrigation district, interview 4/23/16). As people clear more trees and extract more groundwater, there is less water to fill the dam and more erosion when extreme weather events occur.

Officials and farmers alike fear that the life expectancy of the dam is nearing its end with no plan in place to replace it or recover the dam to full operating capacity. As one local farmer and fisherman explained, "[The decline in the dam's capacity] is worrisome and not just for the fishermen. The dam sustains the irrigation system. If there is no irrigation, we will no longer farm corn. It is worrisome because [the dam] is for cattle, for pasture, for corn and if it dries up everything will end. We would only have the rainfed crop and more poverty for our work. It is a worry because they say there are only some 8 or 10 years of life left in [the dam]" (Arturo, farmer interview, Benito Juarez, 5/11/16).

Experts project the Portillo Dam has until about 2029 until its infrastructure begins to severely deteriorate. However, because there are currently no funds allocated for building another dam (the cheapest option) or removing accumulated debris, experts anticipate that locals will continue to use the dam until its dying day (CONAGUA official, Cuxtepeques 101 irrigation district, interview 4/23/16).With limited funds and a lack of long-term planning for the region's water security, CONAGUA officials are focusing their efforts on more achievable changes such as increasing the rate at which excess water can be released from the dam to reduce flooding below the dam when extreme weather events occur (Jose Luis, director Cuxtepeques 101 irrigation district, CONAGUA, interview 4/23/16).

Discussion

Here, I have drawn attention to the ways in which present vulnerabilities facing small-scale farmers are linked to historical patterns of GR agricultural development and the transition to a neoliberal approach to agricultural input provisioning and extension services. As observed throughout this chapter, farmers in the Chiapas Lowlands are experiencing environmental changes linked to both the long-term impacts of Green Revolution farming practices and the onset of climate

change and other associated environmental changes such as increased incidence of plant disease, pests, and impacts on infrastructures like dams.

The environmental "fallout of the Green Revolution" described in Part One are integral to overall farmer vulnerability to the onset of climate change. The biophysical impacts of Green Revolution practices are now being felt in diminishing soil fertility, increased pest problems, and the need for evermore agrochemical applications. The "fallout of the Green Revolution" in the Chiapas Lowlands reflects the ways in which the extractive nature of intensive, capitalist agriculture steadily erodes the natural base upon which it depends (Giraldo 2018; O'Connor 2001). This is O'Connor's (2001) second contradiction of capitalism writ large. That is, the GR mode of production combined with the drive to remain competitive in the neoliberal context comes at the cost of farm sustainability and resilience in the context of climate change.

GR impacts in biodiversity loss, soil erosion, salinization, acidity, compaction, and overall loss of soil fertility are leading to stagnant or declining yields in farm systems globally, especially in corn, rice, wheat and soy (Giraldo 2018: 62). As explored in the next chapter, the self-destructive nature of capitalistic, GR agricultural practices is jeopardizing farmers' ability to continue farming in the context of global environmental change (O'Connor 2001). The superimposition of climate change upon corn farmers' already degraded farmscapes draws into sharp relief how vulnerability to climate change is linked to preexisting environmental realities. The struggles of the semi-commercial farmers documented in this study raise important questions about Mexico's continued pursuit of the GR mode of agriculture within the context of climate change and neoliberalism.

The "fallout of the Green Revolution" is not only biophysical, but also social and epistemological in nature. Just as the GR mode of production has marginalized traditional farming practices such as companion planting and crop rotations, it has also diminished traditional farming knowledge. Similar to observations made by Giraldo (2018), the case study from Benito Juarez reflects an ever-widening gap in the knowledge base and ideological orientations between old and new farming generations. In other words, an epistemological dispossession has occurred alongside the physical dispossession of farmers from their traditional seeds and farming practices (see Ch. 3). The Green Revolution has severed younger farmers' connections to traditional farming knowledge as they have been inducted into a GR ideology of production.

Although new farmers have embraced GR, productivist rationalities, they have also lacked proper training and extension services to ensure their crops and soils are cared for properly. As a result, there are now huge gaps in farmers' knowledge and ability to navigate ongoing environmental changes in their crops. With the onset of climate change, what little traditional farming wisdom still exists locally is being further marginalized as farmers find it no longer holds up to the

climate changes they are experiencing. At the same time, the privatized system of input provisioning and extension services means that most ejidal farmers lack guidance on how to respond to ongoing environmental changes; what services do exist lead farmers further into a never-ending agrochemical treadmill (Kloppenburg 2004).

In the next chapter, I explore how the "fallout of the Green Revolution" and "ongoing global environmental changes" occurring in the region combine with and are compounded by neoliberal political economic challenges. Together, these factors create corn farmers' experience of double exposure.

Ch. 5 Connected and Compounding Vulnerabilities: The Impacts of Double Exposure on Semi-Commercial Corn Farmers in Chiapas, Mexico

Introduction: A "Perfect Storm" Brewing

"We have had really good years of corn here, but the last two years have been terrible…This year my father invested a lot of money — he planted 7 hectares of corn but it's all for naught. It makes you so sad to see the corn there all dried up on the stock after all that effort to clear the land, to pay labor, to fertilize the plants and then to have nothing. We harvested very little this year. We had to buy corn to feed our family" (Lucy, corn farmer, Ocozoccoautla County, Chiapas, 1/23/16).

All four components of double exposure described in Chapter 3 and 4 present challenges to semi-commercial corn farmers. In this chapter, I apply concepts from political ecology to explore ways in which these factors intersect and compound one another, creating an increasingly untenable situation for farmers. Ongoing environmental changes play out on already degraded farmlands in a neoliberal context that has left farmers with little recourse or guidance other than that framed by the for-profit drive of *despachos* or transnational seed corporations. As one extension agent explained, the combination of drought, low corn prices, and the increasing costs of production is creating a "perfect storm" for farmers in Chiapas (Extension agent, Masagro Chiapas Hub, interview 8/31/15).

Because success and failure in farming is multi-factorial, distinguishing the precise causes behind farmer experiences of yield declines and crop loss is a complex endeavor that is ultimately beyond the scope of this study. That said, it is clear that farmers are facing a vicious cycle in which climate factors compound pre-existing problems related to degraded farmlands and neoliberal economic conditions. Of 33 active farmers surveyed, 91% report that the risks they face in production have increased over the last 10 years (**Table 24**). The landscapes of corn monocultures and degraded soils related to Green Revolution modes of production make farms particularly vulnerable to ongoing climate change, extreme weather events, and related pest infestations, plant diseases, and weeds. Relatedly, farmers' lack of liquid capital and the overall increasing costs of agrochemical inputs mean that, when crop problems arise, farmers often lack the economic resources and/or technical knowledge required to intervene in a timely manner to save their crop.

Table 24 Farmer observations of increasing farming risks (Benito Juarez, La Concordia, Chiapas)

Over the last 10 years, have the risks	Number of farmers	Percentage of

you face in production increased, decreased, or stayed the same?		farmers
Increased	30	90.9
The same	2	6.1
No Data	1	3.0
TOTAL	33	100.0

Note: N=33 active farmers surveyed in Benito Juarez Ejido

Farmer Concerns

Table 25 Farming concerns in order of importance (Benito Juarez, La Concordia, Chiapas) (2016)

Ranking of Importance	Farmer Concern
1st (tied)	Climate-related concerns[21]
1st (tied)	Pests
2nd	Receiving a sufficient market price for corn to cover costs of production
3rd	Achieving a successful harvest
4th	Costs of inputs
5th	Improve and expand cattle production
6th	Access to sufficient labor
7th (tied)	Ability to access inputs on time
7th (tied)	Farmer health

Note: N=33 active farmers surveyed in Benito Juarez who ranked their farming concerns in order of importance.

When asked to name their principle concerns regarding the future of their farm production, three concerns stood out above all others for the 33 farming households surveyed in Benito Juarez. Tied for first place were concerns related to climate and pests. These concerns reflect farmers' growing doubts about their ability to continue successfully farming corn in a context characterized by an increasingly variable climate and associated struggles with pest infestations. Concerns about receiving a sufficient market price for corn to cover their costs of production came in a close second in the list of farmer concerns. Overall, the list presented in **Table 25** demonstrates that farmers are worried about both biophysical challenges of production (i.e. climate and pests) *and* economic challenges (i.e. having sufficient capital to intervene to counteract problems as they arise).

5.1 Connected and Compounding Vulnerabilities of Double Exposure

5.1.1 Degraded Farmlands, Shifting Climate, and Technological Treadmills

The environmental impacts of the Green Revolution combined with ongoing climate changes mean that farmers must use ever-greater quantities of agrochemicals. Studies have demonstrated that Green Revolution agricultural techniques lead to a loss of biodiversity, soil erosion, salinization, acidity,

[21] Climate related concerns include concerns over drought, sufficient rainfall, excessive wind, and climate variability overall.

compaction, and overall loss of soil fertility that can lead to stagnate or declining yields (see Giraldo 2018). The law of diminishing returns means that farmers must use higher quantities of fertilizers to get the same level of plant growth. By some estimates, the yield per kilogram of nitrogen has dropped by 1/3 since 1961 when chemical fertilizer use was expanded worldwide (Grain 2009).

Small-scale commercial corn farmers in Chiapas recognize a general trend towards declining yields but often do not know the reason why. Farmers who have adopted the Green Revolution mode of production see no alternative but to apply an ever-greater amount of synthetic fertilizers to their fields in response. As one farmer explains: "Some 15 years ago it took less work. Now we have to fertilize more. Maybe the soil is tired or maybe the agrochemicals are not as strong. We have to apply more. Before I used to plant my corn and apply only one dose of fertilizer. Now I have to fertilize the fields three times to get a crop." (Abelardo, farmer interview, Benito Juarez, 5/10/16). The increased use of synthetic fertilizers not only increases the cost of production for farmers but also leads to further environmental harm. Nitrogen fertilizers impact waterways, creating dead zones, and pollute the air with nitrous oxide, a gas implicated in stratospheric ozone destruction and global warming.

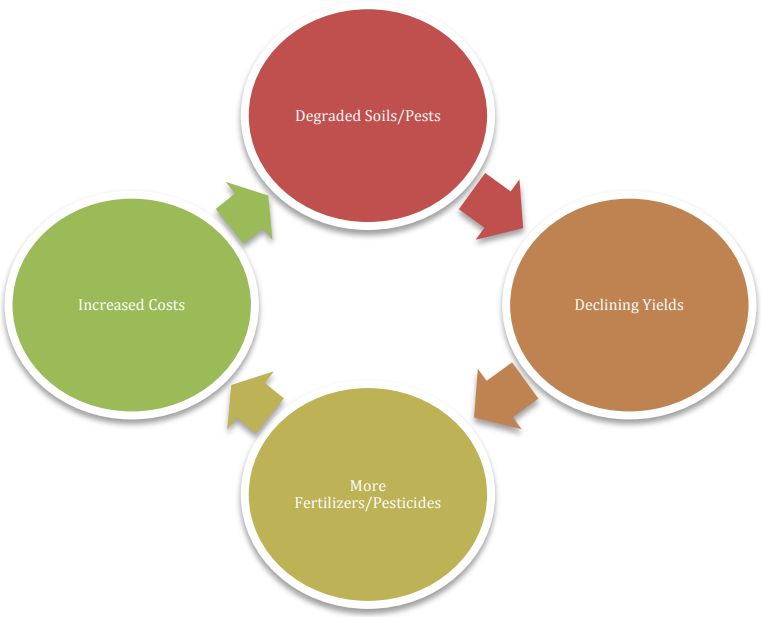
Farmers who have contracted extension services to evaluate the soil quality in their fields mention that the soils in Benito Juarez chronically lack calcium and tend to be very acidic. While soil nutrients are influenced by naturally occurring environmental factors, they are also deeply impacted by agricultural practices. For example, high soil acidity has been linked to excessive application of nitrogen fertilizers. Imbalances in soil PH can affect plant health and ultimately result in yield declines. Hence, the experiences of decreased yields and crop losses discussed in **Section 5.2** are undoubtedly magnified by ongoing climate changes but they are also linked to the legacy of Green Revolution farming techniques and the lack of effective extension services.

Increasing problems of pests, disease, and weeds and agrochemical use reflect a similar technological treadmill. Changes in climate can also stifle plant growth and contribute to increased pests, disease, and weed problems. Certain pests and disease thrive in extreme climate conditions, particularly drought. As discussed in Ch. 4, over 97% of farmers surveyed (N=33) note an increased prevalence of pests affecting their crops over the last 10 years.

To combat crop problems, farmers apply a greater spectrum of agrochemical products at higher doses. Not only do farmers report needing to use more inputs but — as discussed in greater detail in Chapter 3 — the cost of these inputs has also risen. As one farmer complains, "Some products cost 1700 pesos just to cover one hectare! If you don't apply it though, you can lose your whole crop in just 3 or 4 days." (Jose Mauricio, farmer interview, Ejido San Francisco, 10/6/16). Farmers find themselves on an "agrochemical treadmill" in which the costs of production

continue to increase along with the environmental and pest problems (Holt-Gimenez 2018) (see **Figure 20**). Given their depleted soils, increasing pest problems, and the lack of guidance and resources toward alternative techniques, farmers find no exit from this treadmill (Julio, agronomist interview, Villaflores).

Figure 20 Compounding factors of double exposure and Technology Treadmills



As one farmer notes, "If you do not intervene with preventative measures, you will almost always have problems. You have to apply treatments to save your crop because if you wait, the diseases can take out your crop in just a few days. But the treatments are very expensive. It seems like the companies put the disease - like the *mancha de asfalto* (tar spot disease) into the seeds because as soon as the plant starts to tassel the sickness starts. Within just 2 or 3 days it will dry out your whole crop. That's the business of the corporations – they sell you the problem and then sell you the solution" (Jorge Mauricio, farmer interview, Ejido San Francisco, 10/6/16).

5.1.2 Climate Change and Irrigation Demands

Shifts in precipitation patterns in La Frailesca region means that farmers must rely increasingly on a greater supply of irrigation water, not only in the winter, irrigated crop, but also during the summer season. As reflected in **Table 26**, of 33 active farmers surveyed in Benito Juarez, 21 (64%) farm fields with irrigation access. Typically, the ejido only delivers irrigation water during the winter crop when rainfall is scarce. However, in periods of summer drought, farmers connected to irrigation canals can pay a fee for emergency deliveries of irrigation water.

Interviews with farmers suggest that this practice of requesting emergency irrigation is becoming more common in Benito Juarez. 13 of 21 irrigated farmers (62%) surveyed in Benito Juarez report having requested emergency deliveries of irrigation water during times of climatic stress over the last 10 years. Farmers report that during the critical stages of development, their corn cannot survive more than a week without rainfall. Many farmers attribute their ability to achieve a harvest despite the extremely dry *caniculas* and overall drought conditions experienced in recent years to their ability to request emergency irrigation water.

Table 26 Increased reliance on irrigation among corn farmers

Farmer Reliance on Irrigation Water	Number of farmers	Percentage of farmers
Farmers w/ Irrigated Farmland	21 of 33 active farmers surveyed	64%
Requested Emergency Irrigation in last 10 years	13 of 21 irrigated farmers	62%

Note: N=33 active farmers surveyed in Benito Juarez ejido. Table indicates that 64% of corn farmers surveyed farm areas with access to irrigation. 39% of irrigated farmers have requested emergency deliveries of irrigation water over last 10 years during periods of climatic stress.

As discussed in greater detail in Chapter 6, farmers interviewed throughout the Chiapas Lowlands suggest a general trend towards reducing the amount of corn they plant in areas without irrigation. Nonetheless, while deliveries of emergency irrigation water may ease short-term problems for irrigated farmers, community members in both La Concordia and Frontera Comalapa Counties express concerns that this practice may not always be an option and may also jeopardize the region's long-term water security. In Benito Juarez ejido, emergency water withdrawals from the Portillo Dam reduce the overall amount of water stored in the dam and decreases water saved for the dry winter months. CONAGUA monitors the dam levels and must restrict water permits and emergency allocations when dam levels get too low. Although agricultural users get first priority over fish lagoons and ranchers during periods of water rationing, deliveries ultimately rely on sufficient water levels of the dam.

5.1.3 Increasing Costs, Yield Loss, and Dispossession

Greater needs for agrochemicals and emergency irrigation water increase both the costs of production and the environmental impact of those activities. Just as farmers need more agrochemical inputs than ever before in order to withstand ongoing crop problems, they have fewer resources with which to do so. Farmers must have access to money in order to keep up with fertilizing schedules and control crop problems as they arise. As one farmer observes: "Without money, people lose their crops because the weeds overtake the corn or they lack fertilizer and get lower yields" (Julio, farmer interview, Benito Juarez ejido).

For those farmers with access to credit, the concern is always whether the credit will be available on time and in sufficient amounts to counteract crop

problems. Credit or input subsidies offered through government programs such as PIMAF are notoriously late. For farmers accessing lines of credit through private *despachos,* problems also emerge when fellow group members get behind on loan repayments, causing new lines of credit to be delayed. In the summer season of 2016, for example, the line of credit for the Peloncillo Farmer Group in Benito Juarez was stalled for this exact reason and group members were unsure whether to plant or not despite not having financing for the crop secured. As one farmer expressed: "If we plant and then the money doesn't come through, the crop will fail and we will be the ones hung out to dry" (Javier, farmer interview, Benito Juarez).

For poorer farmers without any access to farm financing, keeping up with the laundry list of agrochemical inputs is even more challenging. Because most farmers now self-finance their operations due to a lack of credit access, they often do not have savings on hand to respond to problems as they arise. This lack of liquid capital can mean that farmers are unable to purchase the inputs necessary and in the time frame required to guarantee a successful harvest. Farmers describe the situation: "We have had the bad fortune of not having enough money for the chemical fertilizers to make the corn grow big and the liquids to fight the pests. If we don't have the money, we don't buy [the inputs]. Without inputs, the pests become a problem" (Antonio, farmer interview, Benito Juarez, 5/9/16). Another farmer confirms: "We need some kind of credit as an instrument when a pest attacks because sometimes when a pest attacks your crop you do not have money to apply the [pesticides] on time" (Manuel de Jesus, farmer interview, Benito Juarez, 7/15/16).

When farmers fail to keep up with fertilizer and agrochemical applications, they often harvest lower yields and, in extreme cases, risk losing their entire crop. The reduced yields farmers achieve and the low market prices for corn can fail to cover the costs of production and result in an inability to finance their crop the following season. Over time, these pressures can dispossess farmers of their ability to continue farming, thereby reducing their overall incomes and affecting their household food security (see **Figure 21**).

Figure 21 Increasing Costs, Yield Loss, and Dispossession Process for Semi-commercial Corn Farmers

5.1.4 Climatic Conditions Interrupt Proper Crop Management

Even when farmers are able to purchase necessary agrochemicals, weather conditions can still interrupt their ability to apply the inputs in time to avoid crop losses. Many agrochemicals require humid conditions in order to function. Fertilizers left unburied in periods of drought risk causing "fertilizer burn" or leaf

scorching of corn plants caused by the production of ammonia (Extension agent, Masagro Chiapas Hub, interview 7/29/16). Most farmers in Chiapas do not bury fertilizers but instead spread the fertilizer around the base of each corn plant. As result, applying fertilizers in hot, dry conditions can adversely affect their crop. Nitrogen in urea fertilizer is volatile and can be lost to the atmosphere during extended periods of warm weather or in times of excessive humidity. Volatilization not only causes fertilizers to lose potency thereby affecting overall yields but also produces water pollution and greenhouse gas emissions.

Similar to nitrogen fertilizers, many herbicides also require humidity (but not heavy rain) to be effective. If weed problems are not eliminated prior to the onset of drought conditions, farmers can be forced to delay applying herbicides, thereby increasing the risk that weeds will overtake their corn crop. One farmer struggled with this problem in the summer crop of 2016: "The grass is almost as tall as the corn because I could not fumigate due to the drought. When there is drought, if I fumigate, I end up burning the corn…Due to the dry conditions, we end up hurting the corn instead of helping it" (Abraham, farmer interview, Benito Juarez, 5/2016). As one extension agent explained, "When there is drought, there is nothing you can do; it is very complicated, you can end up damaging your crop…You end up losing yields to the weeds and to the impact of the drought itself" (Extension agent, Masagro Chiapas Hub, interview 7/29/16).

Even without climate change, the proper timing, amount, and method for applying agrochemicals is complex. Fertilizer requirements vary year-to-year depending on environmental conditions and farm practices. Now, with the onset of climate change, calculating when and how to apply agrochemicals is increasingly challenging. This is made worse by the dearth of effective extension services. Farmers lack guidance in how to address crop problems in harmony with the particular biophysical needs of their farms and the particular climatic conditions of each season.

In general, the farmers in Chiapas who rely on agrochemicals to control soil fertility, pests and weeds face increased risks when drought conditions prevail. Farms may need more or less fertilizer depending on projected rainfall. Prior drought conditions can lead to an accumulation of nitrogen fertilizers in the soil. Periods of excessive heat or humidity can complicate farmers' abilities to apply agrochemicals at the correct time in the plant's growth cycle. Rainfed farmers in particular struggle to apply inputs at the exact right time to coincide with rainfall. Because the volatilization process is activated by humidity, small showers (less than .5 inches) can actually make matters worse[22]. In the absence of technical assistance, farmers tend to apply inputs based on their best intuition and what they are able to afford rather than on a calculated evaluation of prevailing conditions and soil requirements.

[22] Source: https://extension.psu.edu/nitrogen-application-in-warm-dry-weather

5.1.5 "You always have to pray no one gets sick": Razor thin survival and ongoing dispossession

Within the context of double exposure, corn farmers in Chiapas are often operating within an extremely thin margin of safety with little to no room for unexpected emergencies. As one ejidal leader described, "The crisis of the farmer is that now all he is doing is surviving. It is no longer profitable" (Jaime, farmer interview 2/16/16). He continues, adding that people live on such a limited margin of income that any health crisis or emergency can cause farmers to sell their land and end up working as day laborers (*jornaleros*) (Jaime, ejidal official, interview, Benito Juarez, 2/6/16). Here farmers move from bare life as semi-commercial farmers to total dispossession of their livelihoods as farmers.

Throughout the course of fieldwork, people throughout Chiapas frequently recalled stories of farmers who spiraled into debt following a health crisis in their family and were forced to sell their land and abandon farming. As one farmer's wife commented, "You always have to pray no one gets sick. When people get sick that is when things can get lost. People are forced to sell their lands and people take advantage of them when they are in a hard spot; they pay them less than their land is worth. That is why you always pray never to get sick" (Norma, farmer's wife, Benito Juarez).

One farmer's story in Benito Juarez reflects why such fears are so common among farming families. Antonio was once a successful farmer. He had 17 hectares of land and 40 head of cattle. However, a sudden illness in the family forced him to sell all of his land and cattle to cover medical expenses. Following this loss, he was able to acquire two hectares of land from his father. He rebuilt a basic livelihood combining corn farming and work as a day laborer. In the 2015 summer crop, however, illness and loss struck again. Shortly after planting two hectares of corn, Antonio was afflicted by chicungunya, a virus akin to dengue, and was unable to work for 20 days straight. During that time, weeds and pests overtook his crop, resulting in an estimated 40 percent loss. Due to the low yields, the farmer was left with an 8,000 peso loan from a private lender that he was unable to repay. When I interviewed Antonio, he was concerned that the lender had frozen his property title that he had provided as collateral for the loan and was threatening legal action. Shaking his head dejected, Antonio explained that until he pays his debt and recovers his property title he cannot acquire additional financing to keep farming (Antonio, farmer interview, Benito Juarez, 5/9/16).

Stories similar to Antonio's were repeated across the rural towns I visited. While crises were often health-related, others also shared stories of debt accruing after several bad harvests often linked to extended periods of drought. To recover, farmers resort to selling any asset on hand, including their animals and farmland. Those left with no assets are forced to seek other sources of employment, often

times this means migrating to other cities or even to the Unites States in search of a new livelihood.

5.2 Declining Yields and Crop Loss (2014-2016)

In both in-depth and informal interviews throughout Chiapas, farmers repeatedly recounted stories of severe yield declines and crop loss in their corn crop in recent years, particularly during the abnormally dry summers of 2014 and 2015. As discussed previously, yield declines and crop loss are linked to multiple biophysical and socioeconomic stressors. As a result, farmers' experiences of loss are varied and attributing these losses to specific factors is beyond the scope of this study. While farmers themselves express uncertainty regarding the precise cause of their troubles, they easily name the multitude of factors that they perceive as increasing the risks of farming today. They identify a combination of factors affecting their farming outcomes, including degraded soils, poor management practices, seed choice, climate changes, and pest and weed problems.

Many farmers recall achieving higher yields in the past but then being unable to consistently replicate those results today. One corn farmer in Benito Juarez, for example, recalls that prior to 2011 he used to consistently achieve yields of 7-8 tons per hectare. Today, he says he is lucky to get 4-5 tons per hectare. He finds that each year he must apply more fertilizers but nonetheless continues to get lower yields (Reygiber, farmer interview, Benito Juarez, 6/28/16). Other farmers throughout the study sites shared similar declines, frequently describing drops in production from 7 tons/ha to 4-5 tons/ha.

Farmers observe that the decline in yields currently are linked to a confluence of factors. In a focus group with corn farmers in the San Caralampio ejido in Frontera Comalapa County on the Chiapas-Guatemala border, farmers attribute their yield declines to climate changes, increasing pest problems, and poor farm management. One participant explained, "Perhaps it is the climate and the soil. It's like the soil is tired. We used to always fallow the land from February through April. Now, we have the land in constant production; it never rests" (focus group, farmers, San Caralampio ejido). Farmers in the Benito Juarez ejido express similar concerns related to depleted farm soils: "[In the past] we had more yields with less inputs. Maybe it is because we have impoverished the soils. Some people's fields are so bad now that they don't produce any crop at all (Jaime, farmer interview, Benito Juarez).

Seed choice is also an important factor in crop yields. Farmers need to know the weather forecast each season to choose the seed that best matches prevailing conditions. As one retired extension agent explained, while hybrid seeds can be high yielding, they can also increase the risk of loss depending on the weather each season. He explains, "Sometimes we don't know if it will rain, if there will be a drought or excessive humidity. Some [seed] materials don't resist excessive humidity…There are some hybrids like Dekalb (Monsanto) that when it rains a lot,

the cob casing does not close and the grain will tend to rot" (Vidaul, former extension agent and farmer, Benito Juarez ejido, 7/17/16).

This study demonstrates that climate change adds another layer of risk to already degraded farmscapes. Changes in the local climate are influencing farming outcomes in dramatic ways. The interviews and surveys applied for this study included questions about farming activities and losses for the five corn crops harvested between the summer of 2014 and the summer of 2016. During this time period, Chiapas experienced severe drought conditions that were compounded by the meteorological phenomenon El Niño-Southern Oscillation (ENSO), commonly known simply as "El Niño." Because climate change projections for this region anticipate increases in drought, higher temperatures, and more frequent El Niño events, the hot, dry conditions of the study period reflect the conditions that will likely become the new normal. This study therefore provides important insights regarding the increased challenges farmers face in the context of ongoing climate change.

The changes farmers have observed in the climate and local environment correlate with yield declines and total crop loss in Chiapas. Yield declines have become particularly common in the summer, rainfed season, particularly among farmers without irrigation access. **Table 27** shows the percentages of farmers (both irrigated and non-irrigated) who reported some level of yield decline for the five corn crops harvested between Summer 2014 and Summer 2016. The columns represent farmers with irrigation, those without, and the overall total. Farmers with irrigation plant two crops each year (summer and winter). Farmers without irrigation do not have the water necessary to produce a crop in the winter and hence are listed as "Not Applicable" for the winter corn crop.

Table 27 Reports of yield decline among irrigated and non-irrigated corn farmers (Benito Juarez, La Concordia, Chiapas) (2014-16)

Farming Season	Irrigation	No Irrigation	Total % of Farmers Reporting Crop Loss
2014 Summer Crop	60%	83%	70%
2014 Winter Crop	81%	Not applicable	81%
2015 Summer Crop	85%	83%	84%
2015 Winter Crop	75%	Not Applicable	75%
2016 Summer Crop	73%	67%	70%

Note: Table 27 reflects the percentage of farmers surveyed in Benito Juarez who report some level of yield decline each farming season between 2014-2016. The number of farmers planting corn each season varies: 2014 Summer N=27; 2014 Winter N= 16; 2015 Summer N=25; Winter N = 15; 2016 Summer N = 20.

Literature on farmer vulnerability frequently cites access to irrigation as a key factor in reducing farmer vulnerability to climate change (Liverman 1990; Lemos et al 2016). While farmers without irrigation generally reported greater levels of crop loss than their irrigated counterparts, the survey results show that

irrigated farmers also suffered yield declines. As seen in **table 27,** at least 60%, and as much as 85%, of irrigated farmers surveyed reported some level of yield decline for every farming cycle covered in the survey. Interviews revealed that crop loss on irrigated fields can result from a number of causes including an excess of moisture, rotting of the cobs before harvest, or poorly managed pest or weed infestations.

5.2.1 Yield Declines and Crop Loss in Summer, Rainfed Corn Production (2014-16)

Table 28 presents the percentage yield decline estimated by the 27 of 61 farmers surveyed in Benito Juarez who planted corn in the 2014 summer season. Overall, non-irrigated farmers reported greater losses than irrigated farmers. 50 percent of rainfed farmers surveyed report at least a 50 percent decline in their harvest in the 2014 summer compared to their normal yields. Although to a lesser degree, farmers with irrigation also suffered losses. 7 percent of irrigated farmers reported over 50 percent yield decline. Another 33 percent of irrigated calculated lower yields by at least 25 percent compared to their normal harvests. Given the narrow profit margins small-scale commercial corn farmers rely on to make a living in farming, losses in expected harvests of even just 25 percent can significantly affect farmers' ability to recover the costs of farming, let alone make a profit.

Table 28 Percentage of corn farmers reporting partial or total crop loss (Benito Juarez, La Concordia, Chiapas) (2014 Summer Crop)

	0% Crop Loss	1-24% Crop Loss	25-49% Crop Loss	50-74% Crop Loss	75-100% Crop Loss
Irrigated Farms	40%	20%	33%	7%	0%
Non-irrigated Farms	17%	8%	25%	33%	17%
Total (% of all farms)	30%	15%	30%	19%	7%

Note: N=27 active farmers surveyed in Benito Juarez who planted corn in 2014 summer cycle. (Irrigated farmers N=15 and non-irrigated farmers N=12). This table shows the percentage of corn farmers reporting different levels of crop loss in the 2014 summer crop. Percentages are rounded to the nearest whole number.

Table 28 presents the degree of crop loss reported by the 27 households of the 61 households surveyed who planted corn in the 2014 summer crop. Overall, non-irrigated farmers reported higher degrees of loss than irrigated farmers. 17% of non-irrigated farmers lost over 75 percent of their harvest and 33 percent lost at least 50 percent of their harvest.

The summer of 2015 also brought substantial devastation to farmers throughout Chiapas. One farmer describes the effect of the hot, dry weather on their corn crop: "It was just too hot. It caused my production to drop by at least half if not more…we were able to break even but it doesn't leave you anything to eat. You have to look for another way. I covered my losses because I rent out my tractor and have another source of income that way" (Javier, farmer interview, Benito Juarez, 2/4/16). Javier — like many corn farmers in Chiapas— saw his production drop from an expected 6 tons per hectare to just 3. The heat-stressed corn plants produced small cobs and reduced the weight of their grain at final harvest.

Table 29 shows the yield losses reported by farmers surveyed in the 2015 summer corn crop. Farmer reports for 2015 were similar to the levels reported for 2014. Rainfed farmers again experienced higher losses than their irrigated counterparts. 33 percent of rainfed farmers surveyed reported at least 50 percent yield declines. Nonetheless, several irrigated farmers also reported significant losses: 23 percent of irrigated farmers lost at least half of their expected harvest in the 2015 summer.

Table 29 Percentage of corn farmers reporting partial or total crop loss (Benito Juarez, La Concordia, Chiapas) (2015 Summer Crop)

	0% Yield Loss	1-24% Yield Loss	25-49% Yield Loss	50-74% Yield Loss	75-100% Yield Loss	No Data
Irrigated Farms	15%	31%	**23%**	**15%**	8%	8%
Non-Irrigated Farms	17%	17%	**33%**	**25%**	8%	0%
Total	16%	24%	28%	20%	8%	4%

Note: N=25 active farmers surveyed in Benito Juarez who planted corn in 2015 summer cycle. (Irrigated farmers N=13 and non-irrigated farmers N=12). This table shows the percentage of corn farmers reporting different levels of crop loss in the 2015 summer crop. Percentages are rounded to the nearest whole number.

The 2016 summer cycle came on the tail end of El Niño. Forecasts provided by the state government and ejidal councils in Chiapas spread concerns that drought conditions would again dominate the season. Only 25 farmers surveyed in Benito Juarez planted corn in 2016 summer crop. At the time of the survey only 20 had harvested their corn. Table 4 shows that non-irrigated farmers suffered greater losses, with 33% reporting at least 50 percent loss in their summer corn crop. 36% of irrigated farmers reported between 25 and 49 percent loss and 9% reported 50 percent crop loss or more (see **Table 30**).

Table 30 Percentage of corn farmers reporting partial or total crop loss (Benito Juarez, La Concordia, Chiapas) (2016 Summer Crop)

	0% Yield Loss	1-24% Yield Loss	25-49% Yield Loss	50-74% Yield Loss	75-100% Yield Loss
Irrigated Farms	27%	27%	36%	9%	0%
Non-irrigated Farms	33%	33%	0%	11%	22%
Total Farms	30%	30%	20%	10%	10%

Note: N=20 active farmers surveyed in Benito Juarez who planted corn in 2016 summer cycle. (Irrigated farmers N=11 and non-irrigated farmers N=9). This table shows the percentage of corn farmers reporting different levels of crop loss in the 2016 summer crop. Percentages are rounded to the nearest whole number.

By examining how individual reports of yield loss vary each season, we can discern the farmers who have experienced more continuous losses from those whose experiences of loss are more variable. For example, 18 corn farmers surveyed reported crop losses in both 2014 and 2015 summer crops. 5 of these farmers reported at least 50% loss in both 2014 and 2015 summer crop, suggesting

that some farmers have experienced consecutive years of significant crop loss. For other farmers, however, experiences of loss have been more varied, with some reporting greater losses in particular seasons.

When comparing farmer reports from 2014 and 2015 summer crops, individual experiences of crop loss varied substantially. For some farmers, experiences of and the extent of yield loss reported were greater in the 2014 summer crop. For others, experiences of loss were greater in 2015. 2 corn farmers reported losses in 2014 but no losses in 2015. In contrast, there were 4 farmers who reported no losses in 2014 but then experienced losses for the 2015 season. The extent of crop loss among farmers reporting losses for both years also varied, with 6 farmers reporting at least 30% more crop loss in 2014 than in 2015. Conversely, 4 other farmers reported at least 30% more crop loss in 2015 when compared to 2014. This indicates that particular seasons can affect farmers very differently, perhaps due to different farm technology, crop management, planting dates, or quality of the farmland itself.

Although farmers attributed their losses to drought in both 2014 and 2015 summer crops, it is clear that the drought did not always impact farmers in the same way year to year. This range of experiences likely is due to a combination of factors. It may be related to differences in planting dates, soil conditions, and management practices across different farms and seasons. For example**,** at least one farmer in Benito Juarez was able to reduce the impacts of the 2014 drought on his crop based on the guidance he received from a private extension agent. However, in 2015 this same farmer ended up losing half of his harvest to drought due to a sudden lack of extension guidance. The range in experiences of crop loss may also relate to the subjective nature of survey data and the difficulty in recalling precise crop data for multiple years. Regardless of the factors at play, however, taken as a whole, the evidence gathered indicates that yield loss is becoming a more common experience for semi-commercial corn farmers in Chiapas. It reflects the great gamble that corn farming has become for small-scale farmers in the context of climate change. It also points to the importance of farmer access to information and guidance specific to each season and farm. Although drought conditions can affect plant development and, in extreme cases, can obliterate entire crops, proper planting dates, well-timed interventions with pesticides and herbicides, and overall changes in farm management can greatly reduce the risk of crop loss during drought.

5.2.2 Yield Declines and Crop Loss in Winter, Irrigated Corn Production (2014-15)

Most farmers with irrigation access plant an additional corn crop during the winter months using irrigation water. The winter crop is generally considered less risky by farmers even though pest problems tend to be more common. Farmers observe that as long as you intervene early to control pests, the winter, irrigated crop allows farmers to better control humidity levels and, because fewer farmers plant the winter crop, the price for winter corn tends to be higher. Nonetheless,

whether due to pests or unexpected climate events, yield declines still occur during the winter cycles, as evident in the tables below.

In interviews, farmers typically attributed losses in the winter cycle to excess humidity or heat, pests, and plant disease. Although the winters are typically dry, unexpected rainstorms falling upon already irrigated fields can dramatically impact plant development. In interviews, several farmers described losing over half of their expected harvest due to excess humidity. Other farmers attributed yield losses to periods of excessive heat during critical stages of plant growth. Despite regular watering, these farmers observed that the sun burns too hot, drying the crop and stunting its growth. In the 2014 winter crop, 44 percent of farmers reported yield losses of at least 25 percent (see **Table 31)**. Similarly, 42 percent of farmers reported at least 25 percent yield losses in the 2015 winter crop (see **Table 32**).

Table 31 Percentage of irrigated corn farmers reporting crop loss (Benito Juarez, La Concordia, Chiapas) (2014 winter irrigated corn crop)

	0% Yield Loss	**1-24% Yield Loss**	**25-49% Yield Loss**	**50-74% Yield Loss**	**75-100% Yield Loss**	**No Data**
Irrigated Farms	19%	31%	**38%**	6%	0%	6%

Note: N=16 irrigated farmers surveyed. Non-irrigated farmers do not plant the winter crop. Percentages are rounded to nearest whole number.

Table 32 Percentage of irrigated corn farmers reporting crop loss (Benito Juarez, La Concordia, Chiapas) (2015 winter irrigated corn crop)

	0% Yield Loss	**1-24% Yield Loss**	**25-49% Yield Loss**	**50-74% Yield Loss**	**75-100% Yield Loss**
Irrigated Farms	25%	33%	**42%**	0%	0%

Note: N=12 Irrigated farms that planted corn in 2015 winter. Percentages rounded to nearest whole number.

Irrigated farmers explain that their ability to plant a winter crop can be key to recovering after a bad summer harvest. However, several farmers have experienced consecutive years of crop loss in both crop cycles in recent years. Francisco, for example, an elderly farmer in Benito Juarez experienced successive cycles of crop loss in 2014. First, strong winds knocked over all 5 hectares of his summer crop, resulting in total crop loss on 3 hectares. Next, in the winter cycle an unexpected rainstorm pounded his fields right after he had irrigated, leading to a total loss of his winter harvest due to excess humidity. The insurance linked to the credit would not cover the total loss because they blamed Francisco for planting out of schedule. As a result, he not only lost all the effort, labor, and costs associated with planting the corn but also had to pay 24,000 pesos with interest to the lender (Francisco, farmer interview, Benito Juarez, 6/25/16). To cope with these unexpected losses, his family had to sell some cattle and reduce his acreage in corn production for the two following seasons until all his debts were paid (Francisco, farmer interview, Benito Juarez 6/25/16). Experiences such as Francisco's reflect

the growing need farmers have for accurate forecasts and reliable extension services to help farmers navigate increasing climate changes and variability.

5.3 Insurance and Farmer Vulnerability

Experiences of crop loss would be less detrimental if farmers had access to adequate insurance coverage. However, because most farmers interviewed and surveyed in Benito Juarez finance their production out of pocket, they do not have insurance coverage. Only farmers with access to formal financing are insured. To access credit through *despachos,* farmers are required to purchase both certified inputs and insurance, which often come pre-bundled together in technological packets of seeds, inputs, and insurance.

The few farmers in Benito Juarez who have access to formal lines of credit described negative experiences with the insurance coverage. Most insurance coverage only reimburses farmers in the event of total crop loss and does not compensate farmers for yield declines. Reimbursements for total losses only cover the cost of the loan, not the lost investments of time, labor, or foregone profits. Farmers end up in drawn-out battles with insurance companies when crop loss occurs. One farmer, for example, recalls planting 5 hectares of corn with a private line of credit in summer of 2014. Even though wind and drought virtually eliminated his entire crop, the insurance company would only cover the 3 hectares that could be declared a total loss. In the following winter, irrigated crop, the farmer had to reduce the area planted to just 2 hectares. When his entire winter crop got lost due to lodging in the wind, the insurance company again refused to pay, claiming that the farmer was to blame for planting his corn in dates outside of those stipulated in the insurance contract.

When I inquired how the farmer's family survived during that year of consecutive crop loss, the farmer simply responded: "Well, we suffered because I had to work to pay my debts. We don't buy clothes; we budget to get by. You suffer. Instead of chicken soup, you eat bean soup" (Francisco, farmer interview, Benito Juarez, 6/25/16).

Stories such as these are common among those who have attempted working with private *despachos* to finance and insure their corn crop. The stipulations of private lines of credit and insurance often limit farmers' abilities to change their farming strategies to adapt to changing conditions. For example, as the climate changes, farmers are compelled to change their planting dates in an effort to overcome periods of drought (see Ch. 6). However, as seen here, these kinds of changes can be used against farmers' insurance claims should they suffer unexpected losses. Similarly, loan requirements that farmers only use certain approved seeds and inputs also limits farmers' ability to experiment with alternative seeds and production strategies such as those proposed by the Red Chiapas (see Ch. 7).

5.4 The Importance of Ethnographic Research of Crop Loss and Yield Decline

Admittedly, calculating the extent of yield decline and crop loss occurring in the corn sector based on farmers' recollections is imperfect. Barring total crop loss, calculations of yield decline are entirely subjective and are based on each farmer's estimates of the difference between their expected yields and the actual yields achieved. That said, the frequency of total crop loss and yield declines reported and the correlation across informants in this study indicate a growing trend of crop loss. The deep ethnographic accounts of crop loss documented here differ dramatically from official reports.

Mexico's Agrifood and Fishing Information Service (Servicio de Informacion Agroalimentaria y Pesquera (SIAP)) manages crop production data for the Mexican government. The data gathered includes official reports of crop loss by region and year. Referred to as "*siniestrada*," this data only describes reported and verified instances of *total crop loss*. Although the data sets include overall changes in yield averages, it does not track the variability in production or yield declines linked to extreme heat, pests, or drought as experienced by particular farmers and regions.

SIAP (2018) defines "Siniestrada" as "an area planted in the agricultural cycle that registers total loss due to the impact of climatic phenomena or due to pests and disease" (SIAP 2018, author's translation). In addition, crop loss reports depend on accurate reporting of losses through one of the following: a SAGARPA delegation (DES), Rural Development District (DDR), or Center of Rural Development Support (CADER). Each office must provide a full report of the loss, including at least 2 photographs as documentation of the climate event on the affected areas.

Several Mexican newspapers reported on the devastation wrought by drought on Chiapan farmers between 2014-16 and confirm farmers' experiences of loss reported in this study. For example, the *Heraldo de Chiapas* describes the drought leaving "*milpas completamente acabadas*" (fields totally destroyed) (Heraldo de Chiapas, 9/2/15). However, official statistics do not reflect this devastation. Official SIAP reports of crop loss in corn production in the state of Chiapas between 2012 and 2017 are displayed in **Table 33.** Although 2014 and 2015 were years of extreme drought and crop loss, official SIAP statistics report only 4.7% and 6.4% total area of total crop loss for those years respectively (SIAP 2018). For La Concordia County, the main region of study for this research, SIAP data reports only 1 hectare of corn production with total crop loss of all acreage in corn between 2012 and 2017 (See **Table 34)**. This low number suggests that crop loss is severely underreported by the state, not to mention yield declines.

Table 33 Official reports of corn crop loss in Chiapas (2012-2017) (Source: SIAP 2018)

	CHIAPAS		
CROP YEAR	Corn Acreage planted (ha)	Total crop loss (ha)	% Total Loss

2012	705,241.70	175	.02 percent
2013	703,118.00	1,922.25	.27 percent
2014	696,878.10	32,426.40	4.7 percent
2015	702,864.31	44,879.50	6.4 percent
2016	684,462.92	0	0 percent
2017	690,829.30	1,187.00	.17 percent

Note: Source: SIAP 2018.

Table 34 Official reports of corn crop loss in La Concordia County, Chiapas (2012-2017)

	La Concordia County	
CROP YEAR	Corn Acreage planted (ha)	Total crop loss (ha.)
2012	20,625.00	0
2013	20,202.00	0
2014	21,288.00	1
2015	23,981.00	0
2016	22,027.00	0
2017	**21,765.50**	**0**

Note: Source: SIAP 2018. Table 34 documents the amount of corn acreage in La Concordia County reporting total crop loss between 2012 and 2017.

Fluctuations in corn yields are a critical factor for individual farmers, particularly those that rely on corn farming as a primary source of income and livelihood. Tracking these variations and their impacts on farmers' livelihoods is integral to our ability to understand the impacts of double exposure and resulting processes of agrarian change. While flush years bring great joy and a rush of new household purchases and farm improvements, consecutive years of yield declines — such as those observed in this case study (see **Section 5.2**) — amplify poverty, debt, and gradual dispossession by double exposure of land and resources. Certainly, the task of tracking individual farmer's yield data may well be beyond the purview of the national government. While imperfect, deep ethnography allows for this kind of data to be tracked at the local scale. The case study of Benito Juarez describes a cross-section of farmer experiences —including rainfed and irrigated; subsistence and small-scale commercial farmers — and points to processes of double exposure that are likely repeated across tropic regions.

The survey and interview data presented here about farmers' experiences of crop loss and yield declines in their farms demonstrates the importance of doing ethnographic research of this kind. My study suggests that the state government is not accurately documenting crop production and losses in Chiapas. Farmer after farmer in my study commented on the increased risks they now face as a farmer and shared painful stories of losing their crops to drought and pests. These experiences of vulnerability are not documented or visible within official state records. If a problem is not made visible, how can it be addressed?

5.5 Heightened Risks and Thwarted Adaptation in Neoliberal Farm Systems

The political economy of seeds, input provisioning, and extension services in Mexico is related to increased risks in the corn sector. At the same time, this approach to food governance forestalls transitions to more sustainable and resilient farm systems by allowing profit interests of private actors to trump the interests and needs of farmers themselves. My research reveals that semi-commercial farmers' dependence on transnational corporations and other private actors for seeds, inputs, and extension services in the Chiapas Lowlands hinders farmers' ability to understand and effectively respond to ongoing environmental changes in their farm systems. In this section, I explore how these dynamics contribute to farmers' experiences of double exposure by increasing economic vulnerability and limiting farmer access to different climate adaptation options.

5.5.1. Corporate Seeds

"As both foodstuff and means of production, seed sits at a critical nexus where contemporary battles over the technical, social and environmental conditions of production and consumption converge and are made manifest. Who controls the seed gains a substantial measure of control over the shape of the entire food system" (Kloppenburg 2010: 369).

While hybrid seeds promoted by transnational seed corporations initially brought yield gains to farmers, many find they can no longer achieve these same high yields today. Instead, corn farmers in Benito Juarez now regularly harvest between 2.5 and 5 tons per hectare. These lower yield levels near the amounts farmers remember achieving in the past using native landraces or open-pollinated varieties. For example, one farmer in Benito Juarez remembers harvesting 3.5 tons per hectare using a landrace variety of yellow corn (Eugenio, farmer interview, Benito Juarez). In the context of degraded soils, changing climatic conditions, and increasing input costs, farmers are beginning to question whether the benefits of using commercial hybrids still outweigh the increased risks and costs they represent.

Farmers originally abandoned their landrace seeds based on promises that hybrid seeds would produce higher yields and improve their livelihoods. Today, this promise now rings hollow for many farmers struggling with declining yields and profits. However, as discussed in the following chapter, even if farmers want to recover native landraces and reduce their reliance on purchased inputs and seeds, they are many barriers to doing so. Farmers have experienced a kind of 'in situ dispossession' (Giraldo 2018) of both landrace seed varieties and traditional farming knowledge. Landraces have all but disappeared in the region, making it difficult to recover seeds with highly productive qualities fit for commercial use. In addition, because farmers have been dispossessed of their expertise as seed savers, most farmers lack the technical knowledge and assistance necessary to manage landraces as a viable alternative to commercial hybrids.

As discussed in more depth in Chapters 6 and 7, many farmers are fed up with their dependence on corporations for seeds and inputs. Some farmers are now actively seeking to recover and improve landrace seed varieties as a strategy to reduce costs and reassert some autonomy in their farm systems. Farmers are realizing that with proper care, landraces can achieve yields as good or better than the declining yields they are currently achieving with commercial hybrids. As one farmer notes, "Hybrid seed is smaller [in height] and may win the landrace by half a ton or a ton and a half. If you get 5 tons in the hybrid, you get 4 tons of landrace…If we make an effort with landraces, we can improve them" (Transito, farmer interview, Benito Juarez, 7/17/16). Because of the dispossession that has occurred in farmers' native seeds and knowledge, it is a long road to recovering these alternatives and managing them as viable alternatives for farmers still seeking to make a living based around corn.

5.5.2 The Lack of Climate Information and Understanding

The corn farmers featured in this study are often painfully aware of ongoing environmental and climatic changes occurring in their communities. However, many also say they lack technical knowledge and understanding of how to adapt to and counteract ongoing changes. With traditional climate knowledge becoming less reliable given the rapid changes occurring, farmers are struggling with dearth of information about climate change and the lack of guidance regarding how to manage their farms accordingly.

The National Water Commission, CONAGUA, is responsible for maintaining climate data in Mexico. Several institutions, including the State Agricultural Secretariat, SEMARNAT (the National Secretariat of Environment and Natural Resources), CONAFOR (the National Forestry Commission) often convene meetings with ejidal leaders to spread information regarding the forecast for each farming season. From there, ejidal leaders are responsible for disseminating this information to farmers through announcements at ejidal assembly meetings (Eugenio, farmer interview, Benito Juarez, 7/17/16). Nonetheless, this system appears insufficient, as farmers repeatedly described having no source for climate information other than the general information screened on television. They lack access to information specific to their specific region and ejido. Overall, farmers interviewed lament the paucity of information regarding seasonal forecasts as well as more general information regarding how climate change will continue to affect the region and the future of farming.

Some private *despachos* offer advice to farmers based on seasonal forecasts. In addition, the distribution of technological packages is often contingent on farmers respecting stipulated planting dates. Of course, these services are available only to certain groups of farmers. In addition, these practices appear to vary by extension agent and office. One farmer in Benito Juarez, for example, describes receiving helpful guidance from a *despacho* during the drought in the 2014 summer season.

By adjusting his planting dates and interventions accordingly, he managed to attain a good harvest of 6 tons per hectare at time when many of his fellow farmers experienced significant crop losses. In 2015, however, this same farmer did not receive the same level of guidance. As a result, he ended up losing nearly half of his normal yields to drought and was forced to rely on off-farm income to make ends meet. When asked why there was such a difference in the assistance they received year to year, the farmer responded: "I think it varies depending on the extension agent, their ability and the *despacho* itself, whether they instruct [the agent] to give us the information and attend to us" (Javier, farmer interview, Benito Juarez, 2/23/16).

5.5.3 Privatized Extension and Maladaptation

Agronomists studying the impacts of Green Revolution farming techniques and climate change in Mexico recognize that farmers urgently need to recover the soil health of their farms. As one extension agent for Masagro explained, "You have to recover the soil because if you don't, no matter how much you apply the best fertilizer, the best liquids, the limits [of your soil health] are going to affect you. In a very powerful drought like the one last year [in 2015], farmers with compacted soils were the most affected. They are the first to see their corn die. That is where all the corn died" (Extension agent, Masagro Chiapas Hub, interview 7/29/16).

Despite the importance of soil health and fertility, most extension services offered by seed companies or private *despachos* do not attend to these issues. On their own, farmers may contract tractor services to disk plow their fields but this approach frequently fails to work at the depth necessary to break up layers of compaction, potentially making matters worse (Extension agent, Masagro Chiapas Hub, interview 7/29/16). Although there are many known techniques and technologies that can help recover soil fertility and build farm resilience — ranging from conservation agriculture to agroecology— these methods are generally not offered by private *despachos,* much less by corporate seed providers.

The advice input companies offer to farmers tends to focus on encouraging input purchases rather than recovering beneficial insects, microorganisms or soil oxygenation. As one farmer explains, "Corporations have told us that the soil is simply a substrate for production, that the soil needs agrochemicals, that it needs chemical fertilizers in order to get a crop. But in reality, the soil has life! It is just that with the use of agrochemicals in these fields, we have eliminated the life from the soil" (Julio, farmer interview, Benito Juarez). Farmers note that technicians employed by different corporate subsidiaries only offer chemical solutions to crop problems. One farmer explains, "We know that [the company technicians] are interested in promoting their products, so of course they tell us to just buy this or that liquid. And they're expensive, some are over 1500 pesos for just one liter of liquid. They give us pure poison to attend to our crop problems" (focus group, farmers, San Caralampio ejido).

Farmers distrust the advice of seed companies, but find they have no other source for guidance. The vested interests of private *despachos* and seed companies influence what services they offer, rendering them incapable of providing the assistance farmers need to improve farm sustainability and resilience. As a result, farmers lack simple and affordable strategies to transform their farming systems. Although this situation is already problematic for thousands of individual corn farmers, its implications go beyond the farm level and relates to the overall sustainability of food systems globally. The political economy of extension services influences how farming practices evolve and to what extent farming exacerbate or lessen the environmental impacts of their management practices. As climate change advances and concerns regarding long-term farming sustainability and food security amplify, the lack of a competent extension system in Mexico will have drastic implications for the nation's ability to feed itself and meet goals for climate mitigation.

Discussion

It is evident that double exposure (DE) is a challenge not only due to the direct impact of each DE factor but also the complex interplay between factors that further compounds the impacts of DE and complicates farmers' abilities to respond effectively. Evidence from La Frailesca region of Chiapas indicates that farmers are experiencing yield declines and crop losses that are not captured by official state farming data. As presented here, these losses are due to a confluence of factors linked to the political economy of privatized seeds, input provisioning, and extension services combined with contextual environmental vulnerabilities rooted in Green Revolution farming techniques and ongoing processes of environmental change. Together, these factors paint an increasingly complex terrain for farmers to navigate. Compounding all of the above is the lack of competent technical assistance to help farmers manage their crop in ways that ameliorate previous damages and increase farm resilience to ongoing environmental changes.

Clearly, there are many factors that influence farming outcomes and how vulnerable farmers are to the impacts of climate change. These include: access to liquid capital, irrigation, soil health, costs of production, adequate use of inputs, farmer knowledge, and access to meteorological data and technical assistance. Commercial farming, even on a small scale, is a capital-intensive endeavor. In times of climatic stress, access to liquid capital to pay for additional agrochemical applications or emergency irrigation deliveries can mean the difference between success and failure. Farmers interviewed throughout Chiapas cite their lack of liquid capital as a key factor in their experiences of crop loss. Accessing the capital and inputs necessary to save their crop can be a challenge or even an impossibility for low-income farmers. Many agrochemical inputs have increased in price, farmers' lack access to credit lines, and many do not have a method for bringing emergency irrigation deliveries to their fields whether via irrigation canals or water pumps. Other times, losses result when drought conditions impede timely pesticide or

herbicide applications. Because most farmers lack crop insurance, crop losses often go unreported and farmers are left to recover on their own, often resorting to selling assets or taking up additional wage work as day laborers (See Ch. 6).

While farmers are accustomed to good and bad years in farming, farmers experiencing consecutive years of low yields or even total crop loss are becoming more common in La Frailesca. Farmers without irrigation nearly always suffer the most. Those who farm the hillsides on the outskirts of the Benito Juarez ejido, for example, did not harvest anything for three years in a row due to drought (from 2013-2015) (Arturo, farmer interview, Benito Juarez, 5/11/16). Beyond those experiencing total crop loss, many farmers have been experiencing declining yields for several years. As a result, when asked about crop losses, many farmers did not report any losses in any particular cycle but are nonetheless repeatedly getting poor harvests. For example, many farmers did not report any losses between 2014-16 but nonetheless reported average yields of 2 to 3 tons per hectare despite investing at least 12,000 pesos or more per hectare.

Vulnerability literature has demonstrated that access to irrigation can make a significant difference in farmers' abilities to overcome periods of climate-related stress (Lemos et al 2016; Liverman 1994). This study reaffirms this finding but also reveals that irrigation access alone cannot resolve all of the biophysical challenges farmers face. In addition, my study demonstrates that not all extreme climate events affect farmers to the same extent. For example, while some irrigated farmers were able to achieve bountiful crops as high as 6-8 tons per hectare despite the extreme drought conditions of 2014 and 2015, other irrigated farmers suffered significant losses despite having access to irrigation. In the 2015 summer, for example, Reygiber, an irrigated farmer in Benito Juarez, struggled to counteract the impact of drought and pest infestations on his 6 hectares of corn. Even after applying emergency irrigation water, his corn plants would not grow. In the end, he harvested only 1.5-2 tons per hectare, more than 50 percent yield loss compared to his expected harvest.

Farmers are in desperate need of accurate climate forecasts and technical assistance to help adapt their farming systems to ongoing environmental changes. Most small-scale corn farmers are no longer covered by crop insurance. Those that are repeatedly cite difficulty in getting insurance companies to honor their claims. Insurance companies are notorious for denying farmers' claims of loss, particularly if the farmer is still able to recover a partial harvest. Any deviation from approved planting schedules can result in denial of coverage. In the absence of total loss, it can be difficult to discern the cause of yield declines. However, it is clear that declines in harvest quantities are becoming a chronic problem for farmers and a key factor diminishing the viability of commercial corn farming as a livelihood option.

The combination of yield declines or total crop loss, a lack of insurance coverage, and low market prices for corn means farmers are often unable to recover

the costs of production, let alone turn a profit. Farmers may be left with unpaid debts or exhausted personal savings that render them unable to finance farm production the following season. In addition, unforeseen events such as a sudden illness, a death in the family, or a cataclysm such as the earthquake that demolished homes across Chiapas in September of 2017 can also interrupt a farmer's ability to manage their crop[23]. Because corn farmers already live with such razor thin margins of income, these calamities can send rural families into crisis and result in total dispossession of their farming livelihood as they get forced out of agriculture.

[23] On September 8, 2017, the second strongest earthquake in Mexico's history, with an estimated 8.2 magnitude, violently shook southern Mexico, including the Benito Juarez ejido featured in this research. The earthquake affected some 585 houses in Benito Juarez, transforming many homes into irreparable piles of rubble.

Ch. 6 Responding to Double Exposure

Introduction

This chapter explores farmers' different responses to their experiences of double exposure over the mid- and long-term. By evaluating how farmers respond to double exposure (DE) given a narrow set of livelihood options, this study provides insights regarding how responses within one scale and time frame can further exacerbate environmental and social vulnerabilities at other spatiotemporal scales (Turner et al. 2003; Leichenko and O'Brien 2008). As explored below, some efforts to cope in the short-term can result in greater vulnerability in the long-term at different scales of analysis (Turner et al. 2003). For example, increased use of agrochemicals can further damage soil and water quality; farmer transitions to cattle production can contribute to increased greenhouse gas emissions; and growing trends of renting or selling farm land may lead to a re-concentration of land and resources under elite control.

In interviews with farmers, I took note of the common strategies farmers use to respond to experiences of double exposure and crop loss. I divide these responses between short- and long-term actions. Short-term responses describe the immediate adjustments farmers make to overcome challenges as they are occurring and in the farming seasons immediately following periods of yield loss or crisis. Often times these adjustments are short-lived and vary from season to season. For example, farmers may experiment with different seed varieties each season in search of stronger or more affordable material. In contrast, long-term responses refer to the permanent changes farmers make in their farming practices and land use choices. These may include reducing or exiting corn production altogether, experimenting with different activities such as livestock production, and choices to rent or sell landholdings.

6.1 Short-term Responses to Double Exposure

Table 35 lists the most common short-term adjustments farmers make in response to double exposure. This list is based on data gathered among 33 active farmers surveyed in Benito Juarez ejido. Adjusting planting dates and planting corn only in areas with irrigation have been the two most common adjustments farmers have made over the last 10 years. Other short-term strategies include changing seed varieties, increasing income from other sources, reducing the area planted in corn, renting "better" land, changing the inputs applied to their corn crop, and selling animals or other assets in order to overcome periods of crop loss and debt. I treat each of these responses in turn below, supplementing the survey data with information from interviews and observations in farming communities.

Table 35 Short-term responses to double exposure (Benito Juarez, La Concordia, Chiapas) (2016)

Short-term Responses to Double Exposure	Percentage of Farmers Surveyed
Adjust Planting Dates	76%
Plant Corn Only in Areas with Irrigation	64%
Change Seed Varieties	52%
Increase Income from other Sources	45%
Request Emergency Irrigation	39%
Reduce Area Planted in Corn	36%
Rent "Better" Land for Corn Production	27%
Change Inputs	27%
Sell Animals or Other Assets	18%

Note: N=33 active farmers surveyed in Benito Juarez Ejido, La Concordia County

6.1.1 Adjusting Planting Dates

Nearly all farmers interviewed throughout Chiapas and the majority of farmers surveyed (76%) in Benito Juarez describe changing their planting dates in response to ongoing changes in the climate, particularly in response to shifting summer rainfall patterns. As described in Chapter 4, in the past farmers in the Chiapas Lowlands would plant corn in late April or early May to coincide with the first summer rains. However, summer rains are now arriving later in the year and the dry period known as *canicula* is lasting longer than in the past. Farmers frequently cite the changes in the duration of the *canicula* as a key factor in their decision to delay planting dates or to forgo planting corn altogether.

25 of 33 active farmers (76%) surveyed in Benito Juarez describe changing their planting dates over the last 10 years. Most farmers describe waiting until June to plant; others wait as late as July. This represents an overall shift of at least 4 weeks in planting schedules and, in some cases, as long as 6 or 8 weeks compared to past planting practices. By planting later in the summer, the corn plant is smaller when the *canicula* hits and is not as vulnerable to lodging or yield losses linked to water or heat stress (Vidaul, farmer interview, Benito Juarez, 7/17/16).

Although most changes in planting schedules were noted for the summer corn crop, irrigated farmers also noted changing planting dates in the winter crop as well. Farmers have historically planted the winter crop in October. However, several irrigated farmers report that they now delay winter planting until November or even December in order to adapt to greater cold extremes experienced during winter months.

6.1.2 Plant Corn Only in Areas with Irrigation

Among farmers that have the option, there is a growing trend to only plant corn in areas with access to irrigation. Farmers are increasingly aware that planting in areas without irrigation increases the risk of crop loss in the context of an increasingly variable climate and more frequent drought. As one farmer explains,

"Pasture can handle days without rain but corn needs water every eight days. So now we focus on the irrigated areas because if it doesn't rain, you can request water" (Cein, farmer interview, Benito Juarez 5/12/16). Although farmers may not always need to request emergency deliveries of irrigation water during the summer, rainfed season, farmers prefer to have this option at the ready should they need it. 21 of 33 active farmers surveyed (64%) in Benito Juarez report planting corn solely in areas with irrigation access. 39% of active farmers report having to request emergency irrigation water at least once in the last 10 years to save their corn crop.

Many farmers must rent land in order to have access to reliable irrigation and reduce their farming risks. As one ejidal authority describes: "Now the way the weather is, all farmers are looking for areas with irrigation because they no longer trust in land without irrigation access. [People know] they are throwing their money away planting in areas without irrigation. Fewer people are planting in areas without irrigation." (Eugenio, ejidal authority and farmer, Benito Juarez, 7/17/16). Another farmer explains: "We have to take risks and farm. That is why I rent land where there is irrigation so I can ask for water in case it does not rain enough so that we can at least harvest something" (Cesar, farmer interview, Benito Juarez, 5/10/16).

Despite the widespread perception of the increased risks of relying on rainfed production, many farmers have no choice in the matter. In interviews throughout both La Concordia and Frontera Comalapa Counties, I encountered many farmers who continue to plant corn in areas without irrigation simply out of necessity. As discussed in Section 6.3**,** corn is often the only crop farmers know to grow and many feel they must continue to farm corn even if it means risking their whole crop by planting in areas that are only watered by the rain. In a focus group with farmers in the San Caralampio ejido of Frontera Comalapa County, for example, three of the seven farmers present described planting corn in areas without irrigation because rainfed land is all they have and corn farming is the only livelihood they know (Focus group, farmers, San Caralampio ejido). However, several farmers in the focus group also observed that the mounting debts they have accrued from consecutive years of crop loss between 2014 and 2016 may soon force them to stop farming corn altogether (Focus group, farmers, San Caralampio ejido).

6.1.3 Change Seed Varieties and Inputs

Experimenting with different seed varieties and agrochemical inputs is another common strategy among farmers. 17 of 33 active farmers (52%) surveyed in Benito Juarez described changing their seed varieties in response to environmental changes and crop loss over the last 10 years. Of those 17 farmers, 2 reported changing from a hybrid to a landrace seed variety; 3 changed from a landrace to a hybrid variety; and 12 described experimenting with a range of improved and hybrid seeds seeking to identify the seeds that are most affordable and highest yielding.

It was clear in interviews that semi-commercial corn farmers are becoming increasingly disillusioned with the high costs of hybrid corn production and the uncertain harvests related to shifting climatic and environmental conditions. As a result, there is a growing interest among some farmers to recover native corn varieties and other lower cost seeds and inputs to reduce the costs of farming. As demonstrated here and in other studies (e.g. Eakin 2000), in years of drought and poor weather, hybrid seeds often do not perform much better than non-hybrid varieties. Even in good years, some farmers view the overall yield gains of hybrids as unworthy of all the costs and impacts they now carry.

Eakin (2005) found that reserves of seeds that can be saved and replanted were a key strategy for navigating periods of crop loss for small-scale farmers in Central Mexico. Unfortunately, because landrace corn varieties have generally fallen out of use in lowland ejidos like Benito Juarez, this option inaccessible to most farmers interviewed. Numerous farmers interviewed regret having lost control of their seed stocks and express interest in recovering native varieties. In interviews, farmers in Chiapas described scrounging around locally or in neighboring towns to acquire landrace seed varieties at little or no cost. Others describe saving hybrid seeds from their previous harvests and replanting the seeds during lean times. Although farmers admit that replanting hybrid corn seed does not produce the high yields they would like, oftentimes it is the only option for hard-pressed farmers to be able to plant some corn. Particularly for those who rely on corn for household subsistence, some corn harvest is always better than none at all. Other farmers note that while replanting hybrid seeds may not produce a lot of grain, it offers a cheaper way to produce corn silage for cattle feed purposes.

Responding to the challenges of double exposure, some farmers are now reintegrating native corn varieties in their planting schedules as part of a strategy to reduce their costs of production. As explored in greater depth in Chapter 7, recovering landrace seeds and developing alternative, lower-cost inputs to reduce the use of purchased, agrochemical inputs is a key strategy behind new farmer organizations emerging in La Concordia County.

9 of 33 farmers (27%) reported using different kinds of agrochemical inputs in response to environmental changes experienced. Most farmers changed inputs in an attempt to control pest and weed problems and increase soil fertility. For some, the shift in inputs came as a requirement of a new kind of hybrid seed they adopted. Others described experimenting with different, more affordable products in an effort to reduce farming costs.

6.1.4 Increase Income from Other Sources

15 of 33 active farmers surveyed (45%) describe increasing income from other sources to compensate for losses in corn farming. In most cases, these farmers have shifted to an increased reliance on animal production and sales (see Section 6.2.3). 9 of the 15 farmers describe increasing cattle and milk production; and 2

increased their production of pigs and/or turkeys. Often times in nuclear households, women's labor compensates for shortages in farming income. In 2 households surveyed, families responded by increasing income through cottage industries such as homemade meals and cheese for local and regional sale. Still others surveyed reported increasing income through renting out their land or through day labor as construction workers.

My observations from time spent in different farming communities in Chiapas confirm these trends. In general, I observed that most men who are unable to make a sufficient living through semi-commercial corn farming or livestock production regularly rely on extra work as day laborers in other farms or industries such as construction. I also observed that women's ingenuity is extremely important to families' abilities to get through lean times. Women-led income strategies include not only cottage industries in bread making, handmade tortillas, homemade meals and cheeses, and cured meats but also work as direct sales representatives for companies such as Tupperware or Avon and day labor as maids and caretakers in wealthier households.

6.1.5 Reduce Area and Investments in Corn

While some farmers have the economic means to respond to double exposure by investing more in their corn production through the rental of better lands (see Section 6.1.6) or experimenting with new seed varieties, for many these options are out of reach. Instead, the easiest way for economically-marginalized farmers to respond to hard times is by reducing the amount they invest in corn, even if decreasing investments results in lower yields and continued economic hardship. Most often they reduce costs by either decreasing the land area planted in corn or by limiting their investments in fertilizers and agrochemicals.

During hard times, people reduce the land area they plant in corn. 12 of 33 farmers surveyed (36%) in Benito Juarez describe reducing the area of land they dedicate to corn production over the last 10 years. To compensate for this decline in farming activities, many choose to rent out their farmlands, take up work as day laborers, and/or increase their incomes through other means (often times relying on women-led endeavors such as commercializing homemade breads, cheeses, or meats).

When farmers are in a financial pinch or think the upcoming farm season looks uncertain, they often look to reduce their investments in seeds and inputs and revert to more subsistence-oriented production practices. This is particularly true for farmers who lack access to credit: "Without loans we cannot care for the milpa. We have to just make do with what [the corn] wants to give on its own and reduce the amount we farm to just what we need for our home consumption" (Francisco, farmer interview, Benito Juarez, 6/25/16).

Farmers in debt due to crop loss, low market prices, or some other crisis often lack the liquid capital necessary to invest in production for the following season. As a result, they will reduce the land area they plant in corn and limit investments in seeds and agrochemicals. For some, this is a risk-avoidance strategy, the logic being that the less you invest in corn, the less money you are likely to lose in the event of poor harvests. For others, it is a necessity as they literally do not have the money available to keep up with the agrochemical inputs required for a good crop. As one farmer describes: [In hard times,] I only manage to invest half of [what I should] because I don't have the money to invest in production" (Antonio, farmer interview, Benito Juarez, 5/9/16).

Depending on the farmer, reductions in the area planted in corn can be a temporary or a long-term response to double exposure. Following the drought and crop loss experienced in 2014 and 2015, for example, many farmers were hesitant or unable to invest in corn production in the 2016 summer season. Several corn farmers surveyed reduced their corn production by at least half in the 2016 season. Others decided to forgo production altogether. Of the farmers surveyed in Benito Juarez, there was an 11 percent drop (from 28 to 25) in the number of farmers planting rainfed corn between 2014 and 2016. Two of these farmers that left corn production in 2016 had irrigation; one did not.

In interviews, farmers described numerous reasons for decreasing the acreage in corn production in 2016. Some reduced their corn production due to high farming costs and low market prices and a general sense that corn is an increasingly losing endeavor. Others reduced their corn acreage out of fear that they would again lose their investments to bad weather and drought. Others simply did not have the capital necessary on hand to purchase commercial seeds and inputs after several consecutive seasons of low yields and limited income. Interview data suggests that while the decision to plant corn or not hinges in part on considerations of climate forecasts and fear of drought, in general the decision is more influenced by farmers' economic situation and the capital available to invest in farming after experiences of hardship.

Interestingly, although access to irrigation is often considered a key factor in reducing the risk of farming, **Table 36** demonstrates that even among farmers with access to irrigation there is an overall trend towards reducing the area dedicated to corn production. Nonetheless, it is also worth noting that this is not a unidirectional trend. Although most farmers overall are tending to reduce the amount of corn they farm, 3 respondents described increasing the area they dedicate to corn over the last 10 years.

Table 36 Changes in the area farmers planted in corn (2006-2016)

How has the area you plan in corn changed?	Irrigated Farmers	Non-Irrigated Farmers	Total # of Farmers
Increased	1 (5%)	2 (17%)	3 (9%)
Decreased	8 (38%)	4 (33%)	12 (36%)
The Same	11 (57%)	6 (50%)	17 (52%)
No Data	1 (5%)	0 (0%)	1 (3%)
Total	21 (100%)	12 (100%)	33 (100%)

Note: N=33 active farmers surveyed in Benito Juarez, La Concordia County, Chiapas. 36% of farmers answered that the area they dedicate to corn has decreased over the last 10 years (2006-16).

Most farmers interviewed in La Frailesca region describe observing a decline in the land area dedicated to corn production in La Concordia County. Many people anticipate that corn farming will continue to decrease into the future. As one extension agent observed: "Each year the quantity [of corn planted] has been dropping. Many people just break even with what they plant and harvest. In fact, many now basically farm just for home consumption. They plant their corn for their animals, to have food but they no longer farm with the intention of getting a good crop and selling it…You see this even more in the rainfed areas [without irrigation]. Those with irrigation will sometimes look to plant another crop that will give them better profits than corn" (Francisco, interview, extension agent, 9/20/16).

Many farmers explain that corn farming is decreasing in the region due to a combination of high input prices, depressed market prices, and climate uncertainty. Overall, the sentiment among farmers is that farming corn is no longer a viable livelihood option. As a result, while corn may form a part of a diversified livelihood strategy, for many it is no longer their only or primary means of income. The words of one farmer summarize the sentiment of many:

"[Farmers] are tired of the expense of agrochemicals. There are products they can no longer purchase due to the cost. There are products that sometimes cost 1,800 or 2,000 [pesos]. The value of 3 or 4 tons of production does not pay; it does not cover the investment. So a lot of people are leaving farming because they cannot find an alternative. They plant and end up losing. To come out losing, farming just does not make sense " (Julio, farmer interview, Benito Juarez 12/11/16).

The overall reduction in the number of people farming corn is not a phenomenon specific to Frailesca, but is also being observed throughout Mexico and other parts of Mesoamerica (Hellin et al. 2012: 76).

6.1.6 Rent "Better" Land for Corn Production

For those still committed to semi-commercial corn farming, there is a trend not only towards prioritizing irrigated farm parcels for production but also towards renting lands that are considered "better" and more fertile. 9 of 33 farmers surveyed (27%) in Benito Juarez, for example, report renting better land in response to

production challenges they have had over the last 10 years. In most cases, farmers report renting land they consider to be more fertile and with better access to irrigation. Farmlands located in the valley bottoms and near to riverbanks are particularly attractive. Farmers also prefer fields that are closer to where the irrigation canals originate as this positioning guarantees better access to irrigation water versus those located towards the end of the canal lines.

Given the litany of challenges corn farmers in Chiapas face today, it may seem contradictory that farmers continue to invest in corn production and are even willing to rent land in order to do so. However, as explored in more depth in Section 6.3, corn is often the only activity farmers know. Oftentimes, farmers turn to renting better land after experiencing crop losses on their own farmlands due to drought or soil degradation in their own fields. For farmers diversifying into cattle production (see 6.2.3), renting land for corn production allows landowners to dedicate most or all of their landholdings to cattle pasture. In these cases, cattle become the principal source of income and corn is merely a secondary activity. As long as there are fields available to rent locally, farmers can strategically choose when they plant corn depending on seasonal forecasts and/or their own economic situation. However, as ranching becomes a more widespread activity in places like Benito Juarez, there are also concerns that the best farmlands are no longer available as they are all slowly being transitioned to permanent ranching purposes (farmer interview, Benito Juarez, 12/5/16).

6.2 Long-term Responses to Double Exposure

In this section, I describe the long-term trends observed in the survey and interview data with farmers in Chiapas. Overall, there is a slow but steady trend of farmers abandoning corn as a principal source of livelihood. This is particularly true of younger generations who are tending to pursue off-farm futures. The youth that remain in production tend to gravitate towards livestock production rather than corn. In general, there is evidence towards increased livestock production among farmers in La Concordia County. This tendency towards ranching has been bolstered by public programs and corporate-led extension programs promoting turning "grain into meat" by using corn for animal feed. While there is some evidence of farmers experimenting with other crops, I find that most of this activity is being carried out by wealthier landowners or absentee companies who rent ejidal lands for cash crop production for export. These observations echo findings from studies of other regions in Mexico (e.g. Lutz Ley 2016).

6.2.1 Abandoning Agriculture

Historically, small-scale semi-commercial farming and ranching activities have characterized the ejidos located in the fertile Chiapas Lowlands. In a randomized survey of households in the Benito Juarez ejido, only one of 61 households surveyed did not have a history in their family of farming or ranching.

However, as reflected in the survey results below, the overall number of families practicing farming in Benito Juarez is on the decline.

Of the 61 households surveyed, only 33 households (54%) surveyed continue to farm today. The other 28 households (46%) no longer practice any agricultural activity or never have. **Table 37** shows the farming status of all households surveyed in Benito Juarez. 54% of the households surveyed are still actively involved in farming. 25% of households used to farm but have stopped farming altogether. 20% of households do not actively farm but have immediate family (either parents or siblings) who still farm. Only 2% of households surveyed have no history of farming in their family. Half of the 28 non-farming households surveyed report that their parents were the last people in their family to farm or ranch and that no extended family member farms today. Most of the 27 households that once engaged in farming but no longer do today used to produce corn, occasionally complemented by beans, squash, and/or rice. Only two households used to raise livestock (sheep or cattle) and one other household farmed watermelon, chilies, and tomatoes.

Table 37 Percentage of households involved in farming today (Benito Juarez, Chiapas)

Active Farmers	Households that have Stopped Farming	Households with Extended Family Member that still farms	Never Farmed	Total # of Households Surveyed
33 (54%)	15 (25%)	12 (20%)	1 (2%)	61 (100%)

Note: Table 37 is based on a random survey of 61 households in Benito Juarez, Chiapas. It shows the absolute number and percentage of households that: still actively farm, have stopped farming, still have an extended family member in another household who farms, and have never farmed. (Percentages are rounded to the nearest whole number.)

As seen in **Table 38**, of the 15 households that no longer have any extended family members who farm, most (9 of 15) stopped these activities in the 2000s. There are several reasons survey respondents gave to explain why their family stopped farming (See Table 39). 6 of the 15 households that have stopped farming did so when the main farmer in the household died or became too sick to continue farming. 5 households had to stop farming due to debt. Some attribute their debt to crop loss from pest problems; others claimed that profits from farming got so low that it no longer covered their loans and investments. 2 of these households affected by debt had to sell their landholdings in order to pay off their debts. Another 3 families chose to stop farming and sell their land so they could migrate in search of a better life and more reliable income; one family simply found better, off-farm employment. As seen in **Table 40**, of the 15 households surveyed that have stopped farming, 5 sold all of their landholdings; 2 now rent their land to other land users; and 8 never owned any landholdings.

Table 38 Year Households Stopped Farming (Benito Juarez, Chiapas)

When did your family stop farming?	1980s	1990s	2000s	2010s	Extended family still farms	No Farming History	Total
# people surveyed	1	2	9	2	12	1	28

Note: N= 28 ex-farmers surveyed in Benito Juarez, Chiapas in 2016. This table lists the year in which each of the 28 non-farming households surveyed stopped farming.

Table 39 Reasons households stopped farming (Benito Juarez, Chiapas)

Reason for Abandoning Farming	Death	Debt	Migrated	Found other employment	Health problems	Total Households that have stopped farming
# people surveyed	5	5	3	1	1	15

Note: N =15 households surveyed according to their reason they stopped farming. (Benito Juarez Ejido, La Concordia County, Chiapas)

Table 40 Land tenure after stopping farming (Benito Juarez, Chiapas)

Sold Land	Rent Land	Never Owned Land	Total
5 (33%)	2 (13%)	8 (53%)	15 (100%)

Note: N= 15 households surveyed in Benito Juarez and their land use after they stopped farming. (Note: percentages are rounded to the nearest whole number) (Benito Juarez Ejido, La Concordia County, Chiapas)

6.2.2 Youth Exodus from Agriculture

30 of the 33 active farmers surveyed in Benito Juarez have children. When asked whether they believe their children will go on to practice farming or ranching in the future, 50% responded "yes" and 50% responded "no" (See **Table 41**). Most of the parents that answered "yes," suggest their children will continue farming out of tradition but will not rely on it as a source of income or livelihood. Very few farmers interviewed believe their children could rely on farming or ranching as a viable livelihood into the future.

Table 41 Do you think your children will practice farming or ranching in the future? (Benito Juarez, Chiapas)

Yes	No
15 (50%)	15 (50%)

Note: N=30 farmers surveyed in Benito Juarez that have children

Most farmers interviewed and surveyed express a desire for their children to become educated and achieve off-farm professions. Many describe working hard now so that their children can avoid the suffering implicated in the life of a small farmer. As one farmer explains: "[We don't want] them to suffer as we have. We want [our children] to study, to seek out a way of life that is more peaceful" (Vidaul, farmer interview, Benito Juarez, 7/17/16).

Other parents observe that the youth have a different worldview today that is more oriented around profits and urban comforts. Whereas many elders in rural communities continue to express attachment to farming corn as a way of life and a tradition to be maintained, newer generations do not always share that sentiment. As one farmer explains: "For this [farm] work, you need to love *el campo.* The [young] generations today want to escape poverty on their first harvest" (Interview #39, farmer, Benito Juarez). Overall, the tendency is for youth to seek off-farm professions, particularly through migrating elsewhere. This trend towards an exodus of youth from agriculture means that the average age of farmers is increasing in Mexico, mimicking trends of other countries such as US.

Of course, not all of the youth exodus from farming can be attributed solely to double exposure. There are certainly many reasons youth seek other livelihood opportunities today, particularly those equipped with a high school education. Nonetheless, it is clear that the hardships that youth observe in the farm sector and which repel them from seeking such a future are more often than not rooted in processes of double exposure. Even the health crises that lead farmers to sell their land are ultimately linked to the neoliberal status of farmers today that leaves them without sufficient safety nets to overcome times of hardship. After observing these hardships (and often living them closely), many youth leave their rural communities in search of urban professions and presumably more secure livelihoods.

If youth return to farming in Benito Juarez ejido, they most often return to work in cattle ranching rather than corn. Panchito's story – a young man of 31 years of age – is emblematic of this pattern. After spending over 6 months on the US-Mexico border attempting to cross into the US, Panchito decided to return to his home in Benito Juarez and undertake cattle ranching. He explains: "I didn't like farming corn due to the hardships (*la chinga*) corn farmers experience. There is not enough income to be profitable. Farmers suffer more than what they earn. It is not viable" (Panchito, rancher interview, 6/28/16). Instead of farming corn as his father did, Panchito set out to become a rancher through "a partir" arrangements with local ranchers who provided him with pregnant cows in exchange for half of healthy calves born. Thanks to this arrangement, today Panchito owns a herd of over 60 head of cattle.

Repeatedly in interviews in La Concordia County, people shared stories of youth returning to their hometowns to purchase land and establish cattle ranches. Abraham, a young rancher from Benito Juarez, is a classic example. After migrating to the US at 21 years of age and working for five years, Abraham returned to his family home in Benito Juarez. He used the money he had saved abroad to purchase 12 hectares of land that he now dedicates entirely to cattle production (Abraham, interview 5/16). In another anecdote, a youth returned to the Tigrilla ejido in La Concordia County, purchased a ranch, and now has over 150 head of cattle (Manuel de Jesus, farmer interview 7/15/16).

6.2.3 Turning Corn into Cattle: Expanded Livestock Production in La Concordia County

"Many people have stopped farming. There are few people that still farm because it is no longer profitable…they get less and less…The majority are getting into ranching or ranching "a partir"…[a partir] is more profitable because year by year you have more and can create your own herd" (Francisco, farmer interview, Benito Juarez, 6/25/16).

"In ranching, the word says it all - ganado - it offers more stable ganancias (profits). In agriculture, to be honest, we do it as a pastime, like a habit that we have." (Cesar, farmer interview, Benito Juarez, 5/10/16).

It is not just the youth who are now replacing their cornfields with cattle in La Frailesca region. Many people are transitioning from corn as a primary, commercial crop to corn as part of a diversified livelihood strategy that is increasingly oriented around livestock and animal feed production. For example, whereas one farmer interviewed used to plant 10 hectares of corn in summer and another 7 hectares in winter, since 2010 he no longer farms corn on his property. Instead, he has dedicated all of his property to cattle production and now rents out 2 hectares of land from time to time to plant corn (Eugenio, farmer interview 7/17/16). He explains: "I farm just a small amount [of corn] for the same reason that our product is not valued. Since free trade came, it has ruined us. It is no longer possible to make an income. So we farm [corn] mainly for our own consumption" (Eugenio, farmer interview, Benito Juarez, 7/17/16).

Many now consider cattle as a safer bet than corn. Ranching provides multiple outputs in the form of milk, cheese, meat, and calves and offers increased flexibility as cattle can easily be sold off during hard times. There is a growing cheese industry in Benito Juarez oriented around regional demand in surrounding towns and the state capital. These local cheese makers purchase fresh milk daily from local producers, thereby providing a guaranteed daily income for ranchers. In addition, corn farmers that also have cattle are able to choose between various end uses for their corn. In years of poor market prices for corn, those with cattle can choose to process their corn as animal feed rather than sell it at a loss to *coyotes* or Maseca.

Cattle generate numerous short-term benefits that can help buffer farmers from experiences of crop loss and low market prices. Unlike hybrid corn seed, which must be purchased each year, cattle reproduce naturally and allow for continuous expansion of herd numbers without significant additional investments. Double-use cattle (or *ganado de doble proposito*) are used to produce multiple products, including milk, cheese, calves, and meat, which can be sold in local, regional, and international markets. As opposed to farming, which requires long periods of waiting between investing in production and final grain sales, cows provide a more regular source of income through daily milk sales. In addition, cattle are not as

vulnerable to climate extremes and can be sold in moments of need to cover gaps in income between farming seasons.

Many farmers have transitioned into ranching through a system known as "a partir" (or splitting). Wealthier ranchers provide lower-income farmers with a certain number of cows with the understanding that the farmer will care for new calves and turn over half of the healthy, weaned calves produced each year. As one farmer notes, even if it is through "a partir" arrangements, slowly but surely you can establish your own herd and income. By caring for the mother cows, farmers are also able to have a regular income through daily milk sales.

Extension agents in Chiapas observe a general trend towards farmers reducing or abandoning corn and transitioning into cattle production (Jesus, Extension agent, interview 9/28/16). Most cattle ranchers in Chiapas focus on calve production. Middlemen purchase the calves when they are about 7 months of age and transport them to northern Mexico where they are fattened. From there, they are often sent to the United States for finishing and slaughter (Jesus, Extension agent, interview 9/28/16).

There is also a growing trend among some ranches to undertake calve-fattening operations. Ranchers purchase calves weighing about 180 kg and then fatten them to 350 kg over a 6-month period (Jesus, Extension agent, interview 9/28/16). Historically, private landholders have been more active than ejidatarios in calve-fattening operations due to their access to credit and larger areas of land (Jesus, Extension agent, interview 9/28/16). However, it appears that ejidatarios are now finding ways to engage in these activities, as well.

The president of Benito Juarez ejido estimates that 60 percent of ejidal land is now dedicated to cattle and the other 40 percent to farming (Jaime, ejidal official, interview 2/6/16). Of 33 active farmers surveyed in Benito Juarez, 15 (45%) report raising cattle in addition to their corn production. 5 (15%) report increasing the area they dedicate to animal production over the last 10 years and have plans to continue expanding their herd numbers into the future. Only 1 farmer reported decreasing the land area they dedicate to cattle. None reported an intention to reduce their herd number. For households without much property, raising smaller livestock such as pigs and chickens is also a common and growing strategy. 5 farmers (15%) surveyed report raising pigs and 9 report raising chickens.

Table 42 Livestock production in Benito Juarez, Chiapas (2016)

	# of farmers	% of farmers surveyed
Raise cattle	17	52%
Have expanded the land area dedicated to ranching over last 10 years	5	15%
Have plans to expand herd	5	15%

numbers		
Raise pigs	5	15%
Have plans to expand pig production	2	6%
Raise chickens	9	27%
Have plans to expand chicken production	1	3%

Note: N=33. Based on random household survey of 33 active farming households (Benito Juarez Ejido, La Concordia County, Chiapas).

For those with the land and resources, ranching is an attractive alternative to what is seen as increasingly risky crop production. "Farmers are preferring cattle, even when prices are low. If you care for the animals, stay aware, each year they reproduce and you don't have to invest as much as you do in farming. If you care for the animals, it is a sure harvest. Compare it to agriculture. Sometimes in agriculture we want to harvest a lot but sometimes due to the lack of rain or some sickness affect the plants." (Eugenio, farmer interview, Benito Juarez, 7/17/16).

When asked about his hopes for the future, one farmer responded: "When necessary, I will plant corn…I am going to take better care of my animals. I am more at peace with my animals. I don't have to spend the day thinking about when to apply fertilizer, if there is a pest in the corn and when to fumigate. With my animals, I am at peace. Corn because it is our food, corn is our daily bread and that is why we plant it. I can't have my wife buying corn so we can eat, no. That is why we farm but my mind really is on my animals" (Manuel de Jesus, farmer interview, Benito Juarez, 7/15/16).

The promise of a more secure livelihood through livestock production has encouraged many farmers to transition part or all of their landholdings to permanent pasture for cattle grazing. Those with the means to undertake ranching activities are prioritizing ranching over corn production, relegating corn production to smaller areas or increasingly to rented plots of land when climate forecasts project a good year for farming corn. Whereas many farmers used to dedicate 5, 10 or 20 hectares to corn production in the past, today they may only farm 2 or 3 hectares, dedicating the rest of their landholdings to livestock production.

Such stories of taking land out of corn production and replacing it with cattle pasture were repeated in many interviews with farmers in Benito Juarez. One farmer, for example, has dedicated 16 of his 19 hectares to permanent cattle pasture, leaving only 3 hectares for corn production. Because he does not rely on corn as his main source of income, he plants the 3 hectares of corn solely when he chooses based on climatic and economic considerations (Vidaul, farmer interview, Benito Juarez).

Despite the benefits offered in ranching, the ability to undertake such strategies largely depends on each producer's economic status and access to

resources. As with corn farming, ranching varies from very small-scale and low technology use to large-scale, highly mechanized production. Similar to the barriers to crop diversification (see Section 6.2.6) ranching also requires upfront investments, expert knowledge, land and water resources, and market access. In interviews with households in Benito Juarez it became clear that wealthier families with larger landholdings are those benefitting most from ranching. However, through "*a partir*" and other efforts at farmer organizing (see Chapter 7) even small-scale landholders are increasing their involvement in ranching.

6.2.4 Corn for Silage

"People are leaving agriculture because the liquids, fertilizers and seeds are expensive. There are few people now that farm. Those that still farm corn are those that have cattle. They are making silage and investing it in cattle…They sell the milk, they sell calves and fatten cattle…It turns out better to turn your corn into meat because if we sell [the corn as grain] we sell it for cheap but if we give it as silage to the calves, well there is profit there" (Cein, farmer interview, Benito Juarez).

People widely suggest that the safest strategy for surviving as a farmer in La Frailesca is to combine corn *and* cattle production (Jaime, ejidal official, interview 2/6/16). Overall, there is a growing conviction among corn farmers that cattle can produce better results, particularly if the farmer is able to produce all of the animal's feed through a combination of pasture grass, grain feed, and silage.

One seed distributor explained the advantage of turning corn into silage to feed livestock: "Corn is a losing market. It is an open, unprotected market. If you get a good price, you are selling at 3,500 per ton. Say you get 5 tons out of a hectare. That's 17,500 pesos per hectare but you've spent so much on inputs that you are maybe getting at most 7,000 pesos of profit over a 9 month time period. That's nothing. Compare it to what you can get turning that into cattle feed. If you feed that 1 hectare of corn to cattle, you can fatten some 5 calves. In 9 months you can get 180 kilograms and each kilogram sells for 40 pesos. That means you can get some 56,000 pesos of profit with 5 calves compared to what you can get with corn?! The cycle of profit is much better in cattle" (Interview, seed distributor, 9/22/16).

Raising animals provides an alternative end use for corn as it can always be used as animal feed rather than grain sales. Producing both corn and livestock decreases farmers' dependence on variable corn markets and allows them to have greater agency in determining the end use of their corn. As one farmer explained when asked how he would use his hectare of white corn in 2016: "It depends. If the price is good, I will sell the corn. If not, I will leave it for the cattle" (Abraham, farmer interview, Benito Juarez, 5/5/2016). Increasingly, farmers describe farming corn for animal feed rather than grain sales: "We hardly sell the corn anymore. We use it to eat, to feed the pigs and cattle. Corn doesn't sell anymore" (Cein, farmer interview, Benito Juarez, 5/12/16).

Often times, this transition to ranching in La Frailesca region has been done in a haphazard manner without informed land management or weed control. Local officials admit that ranchers are in need of technical support to improve their livestock production. One official observes that most people ranch in an unorganized manner, allowing their animals to roam freely wherever and whenever they please without proper stabling or rangeland management (SAGARPA official, interview 2/12/16).

Although pasture is not as climate sensitive as corn, farmers observe that pasture grass often suffers in drought conditions, thereby increasing the need for silage. One farmer described the poor condition of local pastures in a ride through the local farms in 2016. Pointing to the scarce pasture grasses, he explained that ranchers can feed a lot more cattle with silage rather than just putting the cow out to graze. "They say you can produce up to 40 tons of corn silage on one hectare. If you need 3 tons to fatten a calf to a good weight for sale to the *coyotes* that take the cattle to Coahuila or wherever, well then you have enough to feed over 10 calves with just one hectare [of silage]" (Javier, farmer interview, 5/18/16).

6.2.5 Corporate-led Silage Production: "Turn your Corn into Meat"

"Si no puedes ganar con maiz, convierte tu maiz en carne."
If you can't make a profit in corn, turn you corn into meat.
-Dekalb slogan, subsidiary of Monsanto

In recent years, seed companies have recognized the increasing interest in livestock production among farmers and see it as an opportunity to encourage continued corn production in Chiapas. During my fieldwork in the Benito Juarez ejido, representatives from seed companies such as Monsanto's Dekalb franchise organized field days throughout the region not only to promote new seed varieties and their associated inputs but also to promote a new solution to struggling grain farmers: corn silage.

In an effort to encourage farmers to keep planting corn despite depressed market prices, corporate extension agents teach farmers that rather than sell their corn as grain, they should process their entire crop (stalks and all) into fermented corn silage to fatten cattle. Studies show that fermenting corn (particularly in the height of its 'milky' state) creates beneficial bacteria and proteins that can serve as cattle feed. While dry feed grass may have one or two percent protein content, corn silage can contain as much as 7-8 percent protein (Julio, farmer interview, 2/12/16). Additional nutrients from silage are of particular importance when cows are milking and ranchers lack sufficient pasture to meet their nutritional needs. The slogan Monsanto representatives use to promote this new solution is: "*Si no puedes ganar con maiz, convierte tu maiz en carne*" — If you can't make a profit in corn, turn you

corn into meat. The idea being that struggling corn farmers can achieve a value-added product by turning their corn into cattle feed and subsequently into meat.

Since 2015, subsidiaries of the Monsanto Corporation have arranged silage workshops with ejidal governments throughout La Frailesca region. Ejidal officials organize the details and ensure that the ejido receives invitations to attend the workshops. Although silage workshops clearly serve as promotion for its products, Monsanto has not had to foot the bill for all its efforts. Rather, by winning contracts with the state government to install modules of yellow corn for silage production, Monsanto's efforts (and their promotional benefits) have been subsidized by the government (Extension agent, Masagro Chiapas Hub, interview 7/29/16). Monsanto representatives organize workshops, establish demonstration plots, and even promote competitions between farmers to see who can produce the most silage per hectare.

Local farmers described the strategies seed company extension agents use to expand silage production in the region. Company representatives select the farms with the best soil quality and most convenient location to establish yellow corn, silage demonstration plots. Despite farmers' wariness towards seed companies, many will often still jump at the opportunity to work with Monsanto. Compared to having no supports at all, farmers find Monsanto's offer to receive discounted inputs and personalized training on how to process the grain into silage compelling. The silage workshops are effective in garnering farmer interest, particularly among those invested in calve-fattening operations.

One farmer excitedly explained to me that Monsanto had selected a hectare of his land for a silage demonstration plot in the 2015/16 winter crop. The company provided the seed, fertilizer, and even covered about 30 percent of the machinery costs. The farmer couldn't believe that with Monsanto's help he was able to process all of the stalks, leaves, and cobs on that one hectare into 35 tons of silage, enough food to feed his small herd for several months (Jaime, farmer interview, Benito Juarez, 5/8/16).

Other people, however, express concern about the long-term implications of Monsanto's efforts in the region. One farmer complained that in their silage workshops Monsanto representatives offered just enough information to get farmers hooked on their products, but failed to teach farmers all of the technical information, particularly the necessary safety protocols for storing and feeding silage to cattle (Julio, farmer interview, Benito Juarez). Without this information, farmers may unknowingly contaminate their silage and can even endanger their animals. Another farmer organizer observes that Monsanto's efforts are misleading in their claims that it is specifically Monsanto's seeds and product line that produce abundant and nutritious silage: "Monsanto says to do what they do. They say it is their corn that [makes the difference]. But really it is the process of making it into

silage that [the corn] ferments and creates protein and all of that" (Extension agent, Red Chiapas, 9/20/16).

The expansion of silage production also presents environmental concerns. Firstly, silage production further encourages continuous monocultures of corn. Farmers with irrigation are instructed to farm two cycles of corn each year without any period of fallow or crop rotation in between. As seen in Chapter 4, these practices will likely have cumulative effects in the long-term fertility and productivity of local farms. Second, the entire corn plant is removed (leaves, stalks, and cob) in silage production, leaving the soil uncovered, compacted, and devoid of organic material (Jorge Garcia, extension agent, director Masagro Chiapas Hub, interview 7/29/16). Scientists estimate that a corn's stalks and leaves house about 40-50 percent of the plant's nutrients. Leaving this *rastrojo* (leaves and stubble) on the field after harvest has been one of the primary recommendations of conservation agriculture as a way to maintain ground cover and promote nutrient cycling back into the soil. However, "[by harvesting the entire plant for silage] you don't have ground cover or organic material to re-mineralize [the soil]. This will become problematic because it is very extractive [and] destructive" (Jorge Garcia, extension agent, director Masagro Chiapas Hub, interview 7/29/16).

6.2.6 Crop Diversification

Mexico's neoliberal shift in agricultural governance was founded on a belief that opening the nation's agricultural markets would encourage competition, increase productivity, and motivate farmers to replace subsistence crops with crops for export (Yunez-Naude & Barceinas 2006: 225). However, despite these predictions, many farmers throughout Mexico have been unable or unwilling to diversify their production. With the exception of livestock, small-scale farmers in both Frontera Comalapa and La Concordia Counties have generally been unable to diversify their production. Although many farmers have experimented with different crops, farmers report that they nearly always end up at a loss in these endeavors. The evidence presented here suggests wealthier producers and absentee contract farmers dominate the crop diversification evolving in the region.

12 of 33 active farmers (36%) surveyed in Benito Juarez describe having experimented with other crops over the last 10 years in response to experiences of double exposure in their corn production (see **Table 43**). Farmers surveyed describe having experimented with beans, soy, watermelon, tobacco, tomatillos, sorghum, and rice. However, none of these efforts proved successful enough to induce permanent changes in production. Farmers point to a general lack of financing, technical knowledge, and market access to successfully diversify their production. As one farmer states: "In farming vegetables we first need more technical knowledge and since we don't know how to do it, well we end up broke" (Cesar, farmer interview, Benito Juarez, 5/10/16).

Table 43 Corn farmers' long-term responses to double exposure (Benito Juarez, Chiapas)

Long-term Responses to Double Exposure	% of Farmers Surveyed
Experiment w/ Other Crops or Activities	36%
Try Alternative Farming Techniques	18%
Rent or Sell Land	15%
Invest in New Technology or Equipment	6%

Note: N=33 active farmers surveyed (Benito Juarez Ejido, La Concordia County, Chiapas).

SAGARPA officials recognize that farmers only know corn and don't have the expertise or market access necessary to transition successfully to other kinds of crops. One SAGARPA official explained there are three factors to farmers' decisions to grow a crop: 1) Do they know how to grow it?; 2) Do they have a market for it?; and 3) What price can they count on? (SAGARPA official, interview 12/8/16). In most cases, the costs of production are higher than what farmers recover upon commercialization, thereby presenting greater risks than benefits to farmers.

Beyond the financial risk, farmers also note that environmental changes such as climate variability and increased pests also raise the risks of diversifying into other crops. Throughout both Frontera Comalapa and La Concordia Counties, farmers have experienced losses in beans, watermelon, and tomato production associated with pests and drought. Climate changes have made farmers more cautious about planting beans as they are considered at greater risk for weeds and pests under poor climate conditions. Products to control pest problems in beans, watermelon and other climate-sensitive crops are also prohibitively expensive for most small-scale farmers. As one farmer exclaimed: "I can't find a liquid for the bean pests that is cheaper than 2,000 pesos!" (Francisco, farmer interview, Ejido San Francisco, 10/6/16). Given these threats and expenses, farmers are hesitant to undertake diversification without safety nets and supports to offset the risks.

Watermelon provides a classic example of how a new crop can lead to negative results. In a story repeated throughout both La Concordia and Frontera Comalapa Counties, early experimenters with watermelon described the first year of production as a windfall — they had a bumper crop and were able to sell the melon at a good price. However, word about such success spreads quickly in farming communities and other farmers quickly decided to experiment with the same crop the following season. As a result, the market became flooded with watermelon all being harvested at roughly the same time. Unlike corn, which can be dried and stored for many months, watermelon must be sold fresh within a short time frame. Everyone ends up in competition with each other to sell their watermelon and the end result is that everyone ends up at a loss. One farmer described his experience of planting 10 hectares of watermelon: "That watermelon never went anywhere…We filled this house with watermelon from floor to ceiling. No one wanted watermelon. We gave it away. We could not pay for the transport to another city…Watermelon has its date [to spoil] and if that date passes it will rot. And watermelon is not a necessity; you don't have to eat it. It is a luxury" (Manuel de Jesus, farmer interview,

Benito Juarez, 7/15/16). After experiencing losses such as this, farmers once again return to corn or livestock as the only viable options for production.

The ability to successfully diversify production appears to fall along class lines. Diversification requires hefty upfront investments and multi-year plans of production. Local elites are the only ones with the necessary financial resources, land, and social connections to government, financing, and markets to successfully diversify production. For example, both Frontera Comalapa and La Concordia Counties are regions where tropical fruit trees can thrive. However, until now, only wealthy elites have developed these alternatives. As one corn farmer notes, "Agronomists have come here with soil management programs; they request we plant fruit trees instead of corn, but you have to think about it. If there is a lot of fruit, the price goes down and it's the larger, wealthier landowners that can plant more, get bigger fruit, and have better sales. But we could fail in fruit sales…That is why we stay with tradition, farming corn and beans" (Antonio, farmer interview, Benito Juarez 5/9/16).

In the Benito Juarez ejido, wealthier farmers are replacing cornfields with plantations of fruit trees such as mango, lime, and papaya. In the case of mango production, producers have formed their own associations to access government programs for subsidized drip irrigation systems and personalized extension services. While diversification into these markets can present its own set of risks, most elites venturing into these opportunities also have alternative sources of income to fall back on through their professional posts as doctors, lawyers, or government officials. In addition, they take advantage of thick social networks that connect them to urban centers, international product expos, and, ultimately, international markets for their products in places like Europe and the US. Fruit trees can also be vulnerable to climate extremes. For example, the mango crop in 2015 in Benito Juarez was devastated by extreme cold weather that decimated the crop. Although the wealthy families involved in mango production took a hit that season, interviews revealed that they also had access to other sources of income to overcome such losses.

Elite producers are often the source for new production ideas and technologies in rural communities. They are frequently among the first to introduce organic production methods as they respond to international market demands for organic products. As a result, many of the fruit tree plantations being established in Benito Juarez are organic. Other well-off producers are investing in improving the livestock genetics of local cattle herds. Still others are undertaking campaigns to establish tree nurseries and reforestation efforts. Historically, these elites have been integral to drawing down resources for local development in the form of schools, health clinics, and infrastructure. They are job creators, hiring many locals as day laborers on their plantations, ranches, fish lagoons, and farms. As a result, locals express mixed emotions about the power and influence of wealthy landowners in the community. Numerous interviewees lament the way that power and resources

are re-concentrating within the hands of local elites. However, in the context of double exposure and an overall sense of abandonment by the Mexican government, many locals rely on these elites not only for employment but also to resolve problems of local development and security that otherwise would not exist. For example, just during my 18 months of fieldwork, I observed how local elites were behind several local initiatives to establish sports teams, new community centers, and access to police patrols to deter cattle robberies.

Lower-income farmers do not have the same ease in accessing the resources and connections necessary for successful crop diversification. Without a guaranteed buyer, farmers are vulnerable to the powerful interests that control fresh produce sales throughout Mexico. Numerous farmers described in interviews a de facto "mafia" that controls the movement of fresh produce to national markets. These mafias decide who can sell what products where, effectively blocking new producers from entering domestic markets for fresh produce in city centers. SAGARPA officials recognize that the government has failed to support farmers in diversifying their production and connecting them with the markets necessary to ensure success (SAGARPA official, interview 12/8/16). Given these considerations, it is no wonder that even with all its respective challenges, farmers still consider corn to be their most trustworthy option. As one farmer notes: "Corn is our only hope" (Farmer interview, Benito Juarez, 11/24/16).

6.2.7 Experimenting with Alternative Farming Techniques

6 of 33 active farmers (18%) surveyed in Benito Juarez report experimenting with alternative approaches to land management in response to production challenges over the last 10 years. In 4 cases, farmers describe transitioning to no till agriculture, which reduces machinery costs but increases pest problems and relies on more manual labor. In 2 cases, farmers described experimenting with alternative and organic techniques through their membership in a local farmer association known as el Peloncillo Group. The strategies and impacts of this farmer association are explored in Chapter 7.

6.2.8 Land Rentals, Land Sales, and the Re-concentration of Land Ownership

The increased risks presented by double exposure means that farmers increasingly prefer to rent or sell their land to others rather than take on the risks of production in the context of high climatic and economic uncertainty (Extension agent, Masagro Chiapas Hub, interview 8/31/15). 5 of 33 active farmers surveyed (15%) in Benito Juarez report renting out or selling land in response to hardships associated with farming corn over the last 10 years. Similarly, all 7 of the 15 households (47%) surveyed who used to have property but have stopped farming describe having sold or rented out their agricultural lands since their families stopped farming (See Section 6.2.1). This tendency is a part of a slow dispossession by double exposure, a re-concentration of resource control, and land use changes locally.

There is a growing concern among some experts that experiences of double exposure in the corn sector is contributing to a re-concentration of land and resources under elite control in Chiapas (Extension agent, Masagro Chiapas Hub, interview 8/31/15). Repeatedly in interviews, residents of the Benito Juarez Ejido alluded to this process in their community. Although I visited several agrarian archives to research the history of property sales in Benito Juarez, I was unable to find compete information (See Ch. 1). As a result, I was unable to document the exact nature of how property and resources are being re-concentrated within the hands of local elites. However, between my own observations and the anecdotes shared in interviews, it is clear that several local elites have seized upon opportunities to purchase landholdings and water rights from disenfranchised farmers. While *caciquismo* has a much longer history in Benito Juarez than what I describe here, it appears that local elites continue to capture resources through ongoing land purchases and debt collection.

Although the process for land sales to external parties continues to be complex and therefore somewhat rare, internal land sales and rentals in Benito Juarez abound. It is common for local elites (or *caciques)* to serve as a source of informal credit for local farmers who provide land as collateral. When farmers suffer losses and are unable to repay their debts, these elites collect payment in the form of land. Similarly, local elites are often quick to buy up the farms of producers that have fallen on rough times or that have decided to leave farming altogether. One local describes a particularly well-known elite landowner in the region who is actively expanding and diversifying his landholdings and production in Benito Juarez: "He doesn't just buy a hectare here or there. No, he buys at least 5 or 10 hectares at a time and many of these big players do the same. So it's actually the middle class, the people with a good chunk of land that are disappearing and selling things off. Because the small landholders, the *campesinos* will keep plugging away on their one or two hectares" (interview, community member, Benito Juarez, 2/7/16).

In most cases of land rentals, people describe renting their land out as pasture for local ranchers. Occasionally, land is rented out "a partir" with the understanding that the harvest will be split between the landowner and the farmer upon harvest. There is also a growing trend of external parties entering the Benito Juarez ejido to rent land for short-term intensive production for export. One papaya producer, for example, has made deals with numerous farmers in Benito Juarez to rent their land for a period of 5 years - the average productive life of papaya trees. In interviews, several people raised concerns about the intensive use of agrochemicals on these plantations. This is a trend being repeated throughout the productive agricultural regions of Mexico (e.g. Wilder 2006) and raises important questions about the long-term environmental impacts of such intensive systems of production. As one extension agent explained, the tendency to rent out land complicates efforts to improve farm sustainability through conservation agriculture or other alternative

techniques promoted by programs such as Masagro (Extension agent, Masagro Chiapas Hub, interview 8/31/15).

6.3 The Staying Power of Corn

"To plant corn is to plant poverty. To harvest corn is to harvest poverty, but we are stuck with it. It is what we know" (Focus group, farmers, San Francisco Playa Grande, 10/6/16).

Contrary to expectations, the neoliberal turn has not resulted in the complete abandonment of corn as a source of subsistence and livelihood in Mexico. Despite the evidence presented in this dissertation about the ways in which double exposure presents seemingly insurmountable challenges to farmers, corn nonetheless has significant staying power and reflects a survivalist's logic for Mexico's ejidal sector. As such, while this study presents evidence of trends towards farm abandonment and a decreased reliance on corn as the principal income for semi-commercial, ejidal farmers in Chiapas, there are also many reasons to expect corn to continue to be a part of farmers' livelihood strategies into the future.

After observing the many challenges corn farmers in Chiapas face today, the obvious question that comes to mind is: Why? Why, given such hardships, would anyone continue to farm corn? Many researchers have been astounded by the staying power of corn among small-scale producers in farmers (De Janvry et al. 1997; Nadal 2000; Fitting 2006). Particularly after the ratification of the North American Free Trade Agreement, most scholars predicted that small-scale corn farmers would be forced out of production. However, even after decades of uneven agricultural development, neoliberal policies, and now climate change, corn persists not only as a means of subsistence but also as a key part of the livelihood strategies of many small-scale, semi-commercial farmers (Eakin 2005; Eakin et al. 2014). Small farmers have proven to be remarkably resilient despite tremendous downward pressure from liberalized grain markets, competition from large-scale, mechanized producers, and policies intended to facilitate economies of scale and the sale of *ejido* lands (De Janvry et al. 1997; Mercer et al 2012).

While there are many reasons to abandon corn, there are also many reasons for its persistence. Corn was first domesticated in Mesoamerica some 9,000 years ago and has been integral to the Mexican diet ever since (Bellon and Berthaud 2006). Even today, corn makes up over half of the daily caloric intake of low-income Mexican families (Clark et al 2012). The crop has profound significance within the spiritual and cultural practices of Mexico's many Indigenous and mestizo cultures. Given its manifold importance as a cultural, economic, and subsistence good, corn has a staying power and clear logic of survival.

Just as corn is highly prized by transnational agribusinesses as a "flex crop" that can be dedicated to a wide range of end uses, corn is also a key "flex crop" for low-income rural families. It is a "flex crop" in the sense that it can be used fresh,

processed into silage, or dried and stored for many months for future use or sale. When markets are depressed, farmers can choose to dedicate less corn for sale as grain and reallocate it to provide animal feed, household subsistence, or smaller sales by the kilo to regional and local buyers. Similarly, farmers can allocate more of their harvest for sale as grain or animal feed when market conditions are high. Whereas diversification into other crops such as watermelons or tomatoes present market risks and short shelf-life, corn can be destined to different uses depending on market conditions, family needs, and the feed demands of livestock (see Section 6.3). The flexible end uses of corn means that even in bust years, farmers can find other uses for their corn, which, if nothing else, provides a minimum level of household food security. Farmers can always find a use for any excess corn. That is not always the case for other crops. As one farmer commented, corn can be processed into any number of food products and animal feed, but there is only so much watermelon one family can eat (farmer interview, Benito Juarez).

Table 44 Top reasons for farming corn (Benito Juarez, Chiapas)

Ranking of Importance	Motivation for Farming Corn
1st	Provide food for family sustenance and food security
2nd	Source of income
3rd	Farming is a tradition and/or source of joy
4th	Provides animal feed

Note: N=33. Based on ranking provided by 33 farmers surveyed (Benito Juarez ejido, La Concordia County, Chiapas)

Table 44 lists the principal motivations for continuing to farm corn among farmers surveyed in Benito Juarez ejido. First in their considerations is that farming corn provides food security and sustenance for their families. Many implied that farming corn was a way to ensure their basic needs are met regardless of other circumstances and uncertainties such as market variability. Farmers have been burned by past experiences of market booms and busts in their experiments with other crops such as watermelon (see Section 6.2.6). This market-based insecurity is a key reason why, even in face of great adversity, farmers return again and again to corn.

Farmers name income as their second reason for farming corn. Again, the many ways corn can be harvested, processed, and sold, means that even when grain sales are low, farmers can often identify alternative ways to market their corn as silage, as corn on the cob, as homemade processed goods such as tortillas and tamales, or as animal feed. Third in their list is a commitment to farming as a tradition and source of joy. In interviews, several farmers described a deep emotional connection to working the land as a way of life. Lastly, many farmers find value in corn as a source of animal feed. As one interviewee observed, everything here can eat corn: chickens, pigs, cattle, and even the fish raised in lagoons! Other motivating farmers mention include: providing a source of employment for their community, producing food for others, and farming as a way to "keep busy."

Although farmers may be exasperated by the hardships they endure as corn farmers and are shaken by the uncertainty of ongoing environmental change, there is a widespread sentiment that corn is still their safest bet and only real option. As mentioned in **Section 6.2.6**, most farmers lack the capital investment, knowledge, and social and market connections necessary to successfully diversify into other crops. As a result, most continue to rely on corn. "In corn there is knowledge" (Cesar, farmer interview, Benito Juarez, 5/10/16). Even with the increased risks farmers now face in corn production, many continue to grow corn simply because it is what they know best and because it provides a foundation for home food security even when harvests are low or markets are depressed. As one farmer explains: "[We farm corn] because we do not know anything else" (farmer interview, La Tigrilla, La Concordia County). Another farmer elucidates: "Corn is a crop that sometimes does not work out but there is no other way to work. It is what sustains the entire family. In fact, we will grow old farming corn and caring for the animals" (Reygiber, farmer interview, Benito Juarez). Such sentiments were repeated time and time again in interviews.

Even as climate uncertainty and depressed market prices raise worries for corn farmers, corn is still considered less risky compared to other crops that are seen as even more vulnerable to climate extremes, pests, and unstable markets. As one farmer explained, "You can't lose with corn. Once you have achieved a harvest, you can't lose" (Javier, farmer interview, Benito Juarez, 2/4/16). Hence, even when faced with climate uncertainties and low profits, many farmers choose to continue planting corn as it forms the basis of their subsistence and is the only livelihood they know. As one older farmer who has suffered from both debt and crop loss responded when asked whether he would plant corn in 2016 summer crop: "That I will plant, I will plant. But before I plant, I will pray because we have no other option. We don't have the benefit of irrigation or a water pump to spray the crop if it is dry. Those of us who do not have [wealth], we must live by the grace of God" (Antonio, farmer interview, Benito Juarez, 5/9/16).

Corn's continued presence is also grounded in the strong moral economies of labor exchange, family networks, and community solidarity that still abound in the rural ejidos of Chiapas. In the Benito Juarez ejido, farmers without access to cash often participate in labor exchanges with their neighbors and family members. As one farmer explains: "Here we say that one favor is returned by another" (Nicolas, farmer interview, Benito Juarez). Those lacking the time or money to farm can make "*a partir*" arrangements wherein local acquaintance provide the time or money necessary to make their land or cattle more productive in exchange for half the season's production. The close-knit social networks of small rural communities provide social capital and trust.

During fieldwork, it seemed everyday I observed this moral economy in action: *"Young children are constantly fed at the homes of aunts and uncles; neighbors pass pots of food over fences. A rancher is too tired to milk his cows, so his friends step*

in to cover him, knowing he will return the favor next week. People loan each other tractors, motorcycles, and cars. People hitch rides and share advice. Those with idle lands let friends work small plots for a modest crop. While not everyone is able to thrive, there is a generally held view that everyone will survive, even if it requires occasional support from neighbors and family members" (Author's field notes, Benito Juarez). Of course, as resources become re-concentrated in the hands of local elite and fewer youth remain in farming, it is an open question whether these moral economies will endure into the future.

The combination of continued corn production and a variety of other local food production practices in Benito Juarez creates a food secure environment in the community even in times of economic stress. Corn underpins the entire local food system, providing for family subsistence and animal feed. It is processed directly as *elotes, tortillas, tostadas* and *tamales.* Animals fed on corn provide meat, milk, and eggs. This combined with the fruit from backyard trees, fresh fish from the local rivers and dam, the occasional hunted game (deer, armadillo, etc), and a variety of home cottage industries in bread and tortilla production create a fairly food secure context in this particular community. As one youth commented, "We don't need no Crusade Against Hunger here in Benito."

Overall, those that that still farm corn repeat their conviction that corn has been and continues to be "*lo primordial.*" This loyalty to corn is strongest amongst farmers with limited resources and education who view corn firstly as a means to daily food security and second as a source of income. For these farmers, corn means daily sustenance; it is what you can most rely upon and what you most need. Money comes and goes; money can cause problems, but corn means that when all else is lost you still have something to eat. As one farmer explained, "The input vendors earn all the profits. All our sales go to paying off the credit for seeds and inputs. But at least we have corn to eat. It is like a little savings. We don't have money, but we can eat" (Francisco, farmer interview, Ejido San Francisco, 10/6/16). In contrast, wealthier farmers do not generally express the same kind of attachment to farming corn. For this latter group, there is not the same pressure to ensure daily subsistence for their families as they always have financial resources on hand to purchase food as needed regardless of the season.

Clearly there are immense pressures that work against the long-term persistence of corn as a source of livelihood for small-scale, semi-commercial farmers. However, as seen here, there is logic of survival and a good deal of economic rationality and cultural tradition that all reinforce the staying power of corn. Seed vendors in Chiapas are well aware of the enduring power of corn. As one Monsanto distributor explained, "Unfortunately — or perhaps fortunately for us — many farmers here only know how to farm corn, so that is what they will keep doing. Sure, there are others who are going into cattle or vegetables or other crops, but there will always be corn in Chiapas because that is what farmers know best" (interview, Monsanto distributor, Villaflores, 9/28/16).

Discussion

While Chapter 5 describes the nuanced ways in which double exposure operates in Mexico's small-scale corn sector, this chapter examines the different ways that corn farmers are responding to the challenges of double exposure. It is clear that within the neoliberal context, the onus is on individual farmers to respond and adapt to experiences of double exposure. In other words, farmers have been left to fend for themselves, navigating as they are able to the many changes impacting their farm systems whether they be environmental or political economic. As established by numerous scholars, vulnerability is not merely defined by one's susceptibility to harm, but also one's inability to adapt given the socio-economic, demographic, and policy context (Adger 2006; Morton 2007; Leichenko and O'Brien 2008). In its current configuration, the neoliberal Mexican state has been unable to provide effective governance to limit small-scale farmers' vulnerability to double exposure or to generate feasible livelihood alternatives and adaptation. My research thus contributes to filling gaps in our understanding regarding how Mexico's neoliberal policies are failing to provide effective governance over the complex interconnections between food producers and the economy, environment, and changing climate (Clapp et al. 2018; Fieldman 2011).

Similar to other studies on farmer vulnerability and adaptation (e.g. Popke et al 2016; Lutz Ley 2016; Campos et al 2014; Conde and Ferrer 2006; Eakin 2005), this study reaffirms that pre-existing inequalities in people's control of resources, capital, and political clout not only create differential vulnerabilities to double exposure but also greatly influences the set of options for farmers to respond and adapt to ongoing stressors. For example, numerous studies have indicated the important role irrigation can playing in reducing farmers' vulnerability to periods of climatic stress (Liverman 1990; Lemos et al. 2016). My study confirms that access to irrigation is not only integral to farmers' ability to weather times of climatic stress, but is also key to farmers' ability to continue farming corn. As shown in this chapter, most farmers interviewed in both La Concordia and Frontera Comalapa Counties now avoid farming corn in areas without reliable access to irrigation if they can, even if this means having to rent land to do so. Of course, considering that about 77% of Mexico's corn is farmed without irrigation, most corn farmers do not have the luxury of relying on irrigation access as a means to reduce their farming risks (Turrent 2012).

In their study of climate vulnerability among farmers in Northeastern Brazil, Lemos et al (2016) demonstrate that access to irrigation, ownership of farming equipment, other sources of "climate-neutral" income, and personal savings are all associated with reduced climate vulnerability. In addition, households with higher incomes are more likely to invest in reducing future risk without affecting their current welfare (Lemos et al. 2016). Similar to Lemos et al (2016), the results presented here suggest that nearly half of corn farmers surveyed (45%) have

increased their reliance on other sources of income to counteract the losses they have experienced in corn.

Eakin (2005) provides a multiscalar, multistressor assessment of rural vulnerability to double exposure to political economic changes and climatic risk in three communities in Puebla and Tlaxcala in Central Mexico. In all three communities, farmers relied on livestock, seed reserves and their own labor to cope with crop losses. Other coping strategies included accessing emergency food rations, selling equipment, requesting informal loans, replanting, employment (other family members), employment (self, including migration), and livestock sales. My study confirms that many of these strategies are common among farmers in Chiapas as well, including the reliance on livestock, work as day laborers, selling assets such as equipment, and off-farm sources of income.

While researchers suggest that diversification into other crops or productive activities can be the livelihood strategy that offers the most rewards and can reduce overall vulnerability (e.g. Hellin et al. 2012), other studies find that diversification into cash crop vegetable production can increase farmer vulnerability due to the increased costs and risks of loss (e.g. Eakin 2005). My study demonstrates that the diversification into other productive activities available to farmers very much depends on their economic status and webs of social relations. Diversifying out of corn production requires access to knowledge, resources, and markets in order to be successful. While there is widespread interest among corn farmers to diversify their productive activities, there are many challenges to doing so. As a result, this study reaffirms conclusions of other authors that it is primarily larger, better-off farmers who are able to invest in crop diversification, new technologies, and markets and reduce their reliance on corn for both sustenance and income (Popke et al 2016).

As reflected in this study, successfully adapting to changing environmental and political economic conditions requires much more than simple individual, behavioral changes. Rather, producers need institutional supports to adapt to new economic and environmental realities. As seen here and in other rural case studies globally, farmers cannot be expected to simply adapt to market signals and changing environmental conditions without additional guidance and supports (Adger 2003; Leichenko and O'Brien 2008; Lutz Ley 2016). This study ultimately confirms Fieldman's (2011) conclusions that the root causes of social vulnerability and weak adaptive capacity are linked to neoliberal rules, practices, and institutions. Like Eakin (2005), I demonstrate the ways in which neoliberal agricultural policy actively hinders farmers' abilities to address climatic and other environmental challenges. As Eakin (2005) observes, the most viable adaptation strategy for small farmers facing environmental changes without access to credit, insurance, fair markets, or technical support may very well be outside of the agricultural sector altogether.

6.4.1 The Trade-offs of Different Responses to Double Exposure

Researchers must attend not only to how double exposure operates but also the respective trade-offs of any response to these challenges (Turner et al. 2003; Misselhorn et al. 2012; Vermeulen et al. 2012). Factors that lead to short-term security at one scale can have negative repercussions in other spatial and temporal frames. For example, although Liverman (1990) detected that access to irrigation can be a key coping mechanism for farmers to withstand periods of drought, the long-term impacts of irrigation use can generate other environmental impacts and vulnerabilities such as increased salinization and decreased productivity of soils (Sweeney et al. 2013; Lin et al. 2014). Similarly, while the adoption of modern seed varieties and technological packets may increase productivity and incomes at a narrow scale (Conde and Ferrer 2006), when replicated across broad scales, these shifts may introduce greater food system vulnerability by decreasing agro-biodiversity, augmenting environmental impacts, and increasing vulnerability to plant diseases and pests (Sweeney et al. 2013; Isakson 2014). Walker (2004) refers to the Green Revolution mode of agriculture based on intensive agrochemical use as "petrofarming" as it relies on oil-based technologies as well as mining of other non-renewable resources such as phosphorous. Just as farmers express mounting concerns over the extent of agrochemical use and risks of production, they find themselves trapped in a cycle of dependence on transnational corporations for evermore-expensive seeds, inputs, and expertise. This raises important questions about what constitutes appropriate farming technologies and adequate extension services in the context of climate change.

As Eakin et al (2014) demonstrate, the tendency of Mexico's agricultural policy to continue encouraging the adoption of hybrid seeds and technological packets among low-income corn farmers not only results in reducing the "*specific*" adaptive capacities of farmers (i.e. the ability to achieve subsistence through agriculture that is low-cost and low-risk) but also fails to develop "*generic*" adaptive capacities that increase farmers' overall incomes.

The corn farmers featured in this study suggest that the adoption of the intensive Green Revolution mode of agriculture based on commercial seeds and agrochemicals can become a threat to farmers' "generic" adaptive capacities when these activities lead to degraded soils, declining yields, and increasing incidence of crop loss. As a result, there is a tendency towards a reduced reliance on corn as a principal source of income and an interest in developing other activities (particularly cattle ranching) to counterbalance the risks of corn farming. In addition, as described in Chapter 7, there is a growing interest among farmers to develop alternative sources of seeds and inputs, suggesting that experiences of double exposure can also result in a Polanyian double movement wherein farmers use their agency to pushback against increasingly trying circumstances. This pushback is another example of how the reliance on transnational corporations for seeds, inputs, and expertise as the foundation of commercial farming in Mexico is

ultimately failing small-scale, ejidal farmers, particularly in the context of ongoing environmental change.

6.4.2 The Trade-offs of Replacing Corn with Cattle

Within the context of double exposure, livestock production is widely seen as the most accessible livelihood alternative for many disenfranchised corn farmers. Given limited options for crop diversification, many farmers have turned to livestock to diversify their production and reduce risks. This trend has been documented in several other studies of La Frailesca region of Chiapas (e.g. Keleman et al. 2009; Hellin et al. 2012; McCune et al. 2012) and raises questions regarding the implications of this shift for long-term sustainability and food security in Chiapas.

Increased cattle production in Chiapas is a part of an ongoing process wherein local and regional food self-sufficiency is replaced with feed grains and animal production for export markets. Studies in other regions of the world suggest that replacing the production of basic foodstuffs with livestock production for export can produce long-term consequences in a nation's ability to be food secure (see for example, Mitchell 2002). Although milk sales from ranchers in La Concordia County are typically destined for local and regional markets, most of the livestock itself is destined for export. The production of calves in Chiapas is but the first node in transnational commodity chains of cattle that stretch from southern Mexico all the way to the slaughterhouses in the United States and beyond. Ranchers in La Concordia County sell young calves weighing between 185-250 kg to *coyotes* with small, private trailers large enough to transport some 3 to 6 head of cattle to other commercial points where calves are quickly aggregated into larger orders. Calves are then moved to fattening operations where they will increase in weight to about 500 kg and then sold for slaughter. Profits get larger along the chain as it moves to the fattening and slaughter operations of northern Mexico and the U.S.

It appears that many ranchers in southern Mexico are now repeating patterns previously observed in northern Mexico's cattle industry. Studies of cattle ranching in the state of Sonora also document a transition from primarily agricultural-based production systems to a mixed strategy of agriculture and livestock production, with ranching becoming the primary commercial focus (Healy 1998). Healy (1998) describes how farmers became specialized in calving operations in northern Mexico in order to satisfy demands of North American markets. In such arrangements, ranchers sell the calves right before they enter the period of most gains in both weight and value (ibid). An evaluation of the distribution of risks and benefits along these chains of cattle production that now extends into southern Mexico is beyond the scope of this study but merits further research in the future. It appears that the riskiest and least lucrative steps in the cattle industry are increasingly relegated to southern Mexico while the greatest benefits concentrate among northern producers.

Despite the many benefits cattle can offer farmers on the short-term, livestock production have been identified as one of the most damaging industries and is highly implicated in environmental degradation and climate change. Poore and Nemecek's (2018) large-scale analysis of food products from farm to fork, for example, found that meat and dairy products provide just 18% of calories and 37% of protein but uses 83% of farmland and produces 60% of agriculture's greenhouse gas emissions. While some extension agents suggest that the transition from corn to cattle in Chiapas may result in a net reduction in the use of some agrochemicals (Jesus, extension agent, Villaflores, 9/28/16), these activities may also carry a larger ecological footprint in the form of greenhouse gas emissions, soil compaction, and climate change over the long-term. This raises the possibility that short-term, local adaptation strategies available to low-income farmers end up being maladaptive for the global system as a whole. As one local youth in Benito Juarez commented: "Ironically, what is the best choice locally maybe isn't the best choice for the region or the planet. Perhaps we need to consider the environmental impacts of all that cattle. Perhaps we need to consider the impact of sending all our production to other places" (Juan, interview, Benito Juarez).

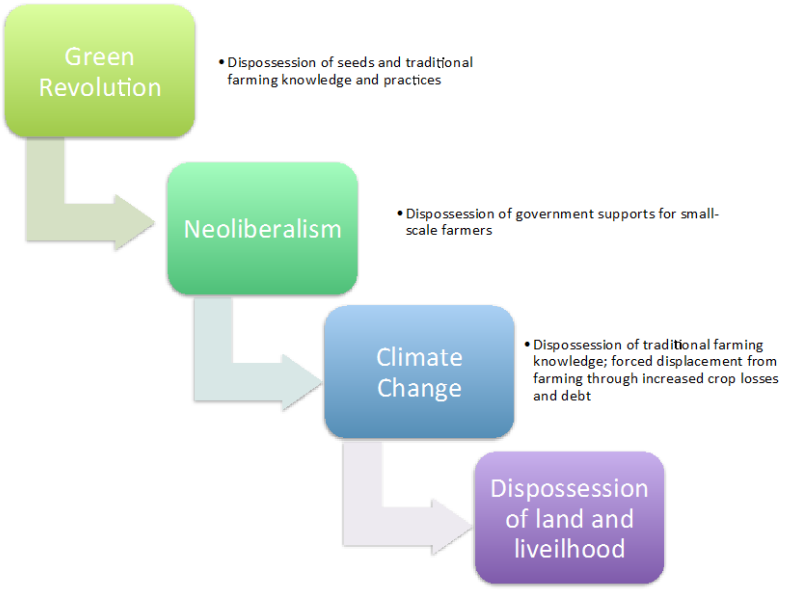
6.4.3 The Agrarian Question and Dispossession by Double Exposure

Scholars have observed that small-scale commercial corn farming communities in Chiapas and in other parts of Mexico sit uncomfortably between agribusiness and food sovereignty models of production (McCune et al. 2012). In other words, the agrarian question is very much alive in Mexico's rural south as farmers simultaneously engage with and resist capital accumulation processes. Farmers in communities such as Benito Juarez and San Caralampio are simultaneously isolated rural backwaters *and* communities embedded within larger capitalist food systems. Commercial production links farmers to external inputs and market pressures. However, at the same time, on the ground these commercial practices combine with moral economies and self-sufficiency practices that can be read as both resistance to the industrial model (see McCune et al. 2012) or as continued "self-exploitation" working in service of capital accumulation in the agrarian sector (Djurfeldt 1981; Kautsky 1988 reprint; Chayanov 1966).

Although corn continues to play an important role in the livelihood for many of the farmers featured in this study, the overall arc of change occurring suggests an ongoing process of dispossession by double exposure of semi-commerical corn farmers in Chiapas. As opposed to the abrupt dispossession that can occur through land or conservation grabs (see Li 2009; Borras et al. 2012), this research documents a slower, more "piecemeal" dispossession process (Li 2009). Like Giraldo's (2018) "in situ dispossession," this piecemeal dispossession occurs as the pressures of double exposure eventually squeeze corn farmers out of production due to a combination of excessive farming costs, soil degradation, yield losses, and debt.

Dispossession by debt occurs when smallholders are unable to access the capital necessary to compete of join new industry, and wealthier neighbors purchase their land and resources (Li 2009). In Chiapas this is occurring as crops fail or when market prices do not match production costs. Farmers left in debt may mortgage their property as they enter a downward spiral. As observed by Li, this study also shows how small-scale ejidal farmers can be "dispossessed through the very processes that enable other people to prosper" (Li 2009: 87). Wealthier farmers in Benito Juarez are better equipped to withstand the risks of farming and benefit in the good years.

Figure 22 Layers of Dispossession (Figure by author)[24]



Evidence presented throughout this chapter suggests that semi-commercial corn farmers are involved in a slow process of dispossession by double exposure. **Figure 22** provides a visual representation of the multiple layers of dispossession (both historic and ongoing) at play in people's experiences of dispossession by double exposure. Dispossession processes that began with the Green Revolution and were compounded by neoliberal policies are now implicated in current vulnerabilities and dispossession processes related to yield declines, crop failure, and a declining viability of small-scale farming. Most semi-commercial corn farmers in this study are now actively reducing the area they dedicate to corn, with many exiting agriculture altogether. Over time, farmers in crisis sell their land and resources to wealthier neighbors, thereby generating a slow process wherein ejidal lands are re-concentrating in the hands of local elites. Although never fully realized, the nation of small-scale agriculturalists originally envisioned in the Mexican

[24] Note: This figure is meant as a representation of the many layers that contribute to double exposure, not as a linear sequence of causation.

Revolution appears increasingly out of reach. This process of re-concentration of resource ownership suggests that agriculture within the neoliberal context privileges larger farm units (Brookfield 2007). Similarly, there appears to be an increasing trend for absentee investors to lease lands for several years to farm produce for export.

Ch. 7 Forging a New Path: Farmer Organizing in the Face of Double Exposure

"Ellos trataron de enterrarnos, pero no sabían que éramos semillas"

"They tried to bury us but they did not know that we were seeds"

--Mexican proverb

"Realization of food sovereignty is predicated in no small part on the repossession of 'seed sovereignty'" (Kloppenburg 2010: 370).

Introduction

Throughout the course of this research, it became clear that double exposure does not have a single, unidirectional impact on rural households. Responses to double exposure are not predetermined but rather vary, depending on each household's social networks, political capital, and economic resources. In the context of neoliberalism, farmers have had to navigate their response to increased environmental and economic uncertainty largely on their own. While there is evidence that double exposure is contributing to ongoing processes of dispossession of small farmers in Chiapas (see Chapter 6), there is also evidence that it is leading to new kinds of farmer organizations and strategies of production. This can be read as a kind of double movement in the Polanyian sense as farmers pushback against the double exposure processes that are rendering unviable their livelihood as farmers.

In this chapter, I explore the development of a farmer association in the Benito Juarez ejido, El Peloncillo de Camotal SPR (hereafter the Peloncillo Group). This association is linked to both regional and national networks that advocate for small farmers and promote alternative approaches to agriculture that increase farmer-based knowledge production, farmer-to-farmer solidarities, and the application of agro-ecological techniques to reduce farming costs and vulnerability. The experience of the Peloncillo Group demonstrates that just as double exposure may result in greater vulnerability, inequality, and environmental destruction, it also opens the possibility for new rural solidarities and even agro-ecological transformations to emerge.

7.1 Questioning the Corporate-Industrial Farming Model

Repeatedly throughout interviews, semi-commercial corn farmers in Chiapas expressed uneasiness and frustration with their current mode of production. On the one hand, farmers recognize and value the increased yields that can be achieved through the use of hybrid seeds, agrochemicals, and irrigation. Many see hybrid seeds and agricultural technologies as integral to modernizing their production

systems and making their farms more competitive. On the other hand, however, farmers also regret their reliance on corporations for inputs and lament the intensive use of agrochemicals on their fields. They express concern about increasing rates of cancer in their community and worry about how agrochemicals threaten the future, particularly for their children and grandchildren. As one farmer exclaimed: "We are neither caring for the earth nor our health, so what are we doing?!" (Alfonzo, farmer interview, Teopisca, 2016). Many farmers also communicate nostalgia about the loss of their native corn varieties, which many identify as having better qualities in taste and texture for local corn-based dishes such as *tamales* and *tortillas* than hybrid varieties.

Small-scale commercial grain farmers have become increasingly disillusioned with the Green Revolution approach to agriculture in the neoliberal context. Whereas Green Revolution technology may have initially increased grain yields, the lack of government support in the form of input subsidies and extension services has left farmers dependent on increasingly expensive seeds, inputs, and extension services. 97% of farmers surveyed in the Benito Juarez ejido report that the costs of production have increased over the last 10 years just as input subsidies have disappeared and the price paid for corn has decreased. Due to the low selling price of corn and the high price of corporate inputs, farmers are experiencing a double squeeze wherein the need to remain competitive sits at odds with the elevated costs and risks of crop loss due to environmental degradation, climate variability, and pests.

The combination of market uncertainty, environmental risks, and concerns about the long-term consequences of Green Revolution modes of production on personal, community, and environmental health are pushing some farmers to look for alternatives. Farmers once sold on the lofty promises of Green Revolution agriculture now seek ways to reduce their reliance on hybrid seeds and agrochemicals. They are exasperated by the privatized seed system and express interest in recovering open-pollinated varieties (OPVs) whose seeds can be selected and saved for future use. They long to recover their farms' soil fertility and want to learn how to effectively navigate the region's increasing climate variability. Overall, they search for strategies to reduce the costs and risks of farming and improve their bottom line.

As the challenges of both neoliberalism and climate change have increased, a growing number of small-scale commercial farmers have recognized that it is only through collective organizing and solidarity that such changes can be achieved. As the executive director of the national farmers' association ANEC (Asociación Nacional de Empresas Comercializadoras de Productores del Campo), Victor Suarez Carrera, notes: "Farmers cannot confront this complexity alone. Farmers must be organized at the local, zonal, regional, national and global level. Without organization, farmers cannot learn and confront this complexity" (Victor Suarez, director of ANEC, interview).

7.2 Case Study: The Peloncillo Group (Benito Juarez, La Concordia, Chiapas)

"Today in the campo there are a lot of problems. Many families are retiring from agriculture. Many have had to migrate and sadly, because there is no viability due to how we have devastated the soil, how we have removed the life it used to have. Today, we want to help in that sense to return a bit of life to the soil, to return a bit of hope to families that feel that the campo is no longer productive. We want to teach them…how the campo can be profitable, how to farm at a lower cost and, above all, to farm [in a way that is] healthy and free of agrochemicals." (Julio, Peloncillo Group, interview 12/11/16).

Slowly, new groups and networks of farmers are emerging throughout Mexico to counteract the challenges of double exposure. In 2012, a group of corn farmers in the ejido of Benito Juarez in La Concordia County of Chiapas established an SPR (*Sociedad de Producción Rural* or Productive Rural Associations) named "Cerro El Peloncillo del Camotal" (hereafter the "Peloncillo Group"). Although the pretext for organizing the group was to access lines of credit for productive projects, they have since expanded the mission and scope of their work to include agro-ecological techniques, weather monitoring, training of farmer agronomists, and the recovery of landrace seeds.

Today, the Peloncillo Group has 27 official members. Most members are small-scale, semi-commercial corn farmers and ranchers with landholdings that range from 2 to 27 hectares in size. As of 2016, the group was in the process of applying agro-ecological techniques on 100 hectares of irrigated land and had a line of credit for fattening 120 calves (interview, Peloncillo Group leader, 2/12/16). Most members manage their productive projects independently and are each responsible for repaying their individual loans and accrued interest. Nonetheless, the group has defined roles for each member and regular meetings facilitate farmer-to-farmer exchanges of knowledge, labor, and resources. The group's savings and mutual guarantees on loans also provide a safety net so that members have support if they are in danger of defaulting on loans or need immediate access to cash for emergency expenses.

The Peloncillo Group emerged out of a desire to collectively overcome political economic and environmental challenges. Their aim is to reestablish small-scale farming as a viable livelihood. In interviews, the group's members express a sense of abandonment by the government and an inability to thrive in the context of free markets, fierce individualism, and climate change. As one of the leaders of the Peloncillo Group describes:

"We are organizing because it is the only way out. [It is the only way] that we can help ourselves as farmers…The goal is to form a group to support farmers. Although this region appears rich, [this is] also a marginalized region, forgotten by the

government and it is very difficult to create a project on an individual basis because you don't know the institutions or sometimes you don't meet the government's criteria. Once [farmers] are organized there is more pressure and the situation changes. It is not the same to attend to just one farmer compared to attending to ten. They identify us more and that way we have been able to do things…The organization is to create, support, and advance and that is what we have been doing" (Julio, Peloncillo Group, interview 2/12/16).

The group also aims to provide technical assistance to their community that is not linked to seed corporations and that can help guide their responses to ongoing environmental changes. A leader of the group explains: "We are really forgotten by technical assistance [in Chiapas]…That is the goal of our organization. Above all to look for the technical assistance and to keep researching, to keep fighting against everything that we do not know." (Julio, Peloncillo Group, interview 2/12/16).

The group has focused on building productive strategies that simultaneously reduce the costs of production while also building resilience in local farms. With technical support and guidance from ANEC and the Chiapas Network (see more information below), the Peloncillo Group has expanded its activities to include: large-scale production of compost, worm castings, and biofertilizers; a meteorological station to track local weather; training of local youth to monitor seasonal conditions and soil fertility; demonstration plots to compare different seeds and crop management practices; calve-fattening and silage operations; and efforts to recover and reproduce high-yielding and drought-tolerant seeds that can be saved and reused each season. Combining climate and field observations with timely interventions using agro-ecological inputs, farmers in the Peloncillo Group are adjusting planting dates to accommodate climate changes, reducing the use of agrochemicals, rebuilding the life in degraded soils, and inducing crop resistance. These activities meet multiple goals simultaneously. They improve soil fertility and resilience, lower farming costs, improve information and credit access, and encourage solidarity among farmers (See **Table 45** for a list of activities).

The Peloncillo Group is part of a regional network of farmer organizations known as the *Red de Organizaciones Productivas y Desarrollo Rural Sustentable de Chiapas* (the Network of Productive Organizations and Sustainable Rural Development of Chiapas, hereafter "the Chiapas Network"). The Chiapas Network was founded as a non-profit organization (*Sociedad Civil)* in 2014 by a group of 9 farmer associations and cooperatives throughout the state, including the Peloncillo Group. The leaders of all 9 networks had been working with the same private loan office to access credit and realized that many of the problems they faced were shared across the different organizations. The loan officer suggested the groups unite as a network so they could work together on common issues, and apply for and share supports for productive programs and workshops (Extension agent, Red Chiapas, interview 9/20/16). As a network, the groups participate in farmer-to-

farmer exchanges and work together to develop alternative approaches to farming, including a range of agro-ecological methods. By aggregating their resources, efforts, and knowledge, the Chiapas Network aims to make small-scale farming and ranching a viable livelihood despite the challenges of double exposure and the increased competition from large-scale farmers in northern Mexico and beyond.

The Chiapas Network has aligned closely with the national organization known as ANEC (the National Association of Rural Farmers and Merchants). At the time of writing, the Chiapas Network had an application pending to become an official member of this national farmer association. ANEC formed in 1995 to defend Mexico's campesinos and campesinas from the threats posed by neoliberalism and the newly signed North American Free Trade Agreement (NAFTA). Their motto is "to defend peasant agriculture and build food sovereignty"[25]. Through policy advocacy, coalition building, grassroots organizing of farmer-to-farmer networks, and workshops on agro-ecological methods, ANEC endeavors to create a new agricultural paradigm that values peasant agriculture, recovers food sovereignty, and recognizes the individual and collective rights of all rural actors[26].

As of 2016, ANEC had 220 member organizations in 12 states with a total membership of about 65,000 small- and medium-scale farmers. Victor Suarez, the director of ANEC, explains that: "The small farmer [has been subject to] a strategy of disappearance and exclusion for more than 30 years…[ANEC] affirms that small farmers are not poor but rather they have been impoverished…We see the need to change from a model of what we call input-based agriculture to a model of agriculture of integrated knowledge…We characterize ourselves as an economic organization with social and environmental responsibility as our end goals" (interview, Victor Suarez, ANEC director). ANEC's work centers around generating two paradigm shifts: 1) To challenge the false paradigm that farmers do not have knowledge; instead, the network suggests that farmers are subjects of rights with great knowledge and productive potential; and 2) Rather than an inert medium, soil is a living ecoystem. "We argue that there is no agriculture that is not sustainable. If it is not sustainable, it is mining or industry but it is not agriculture" (interview, Victor Suarez, ANEC director).

Table 45 Farmer Organizing Activities in Chiapas, Mexico

Activities of the Peloncillo Group
Compost production
Vermicomposting and Worm castings
Biofertilizer production
Savings and Loan group
Applications for government supports and productive projects

[25] Source: http://www.anec.org.mx/articulos-anec
[26] Source: http://www.anec.org.mx/articulos-anec

Meteorological station to track local weather
Group projects such as calve-fattening and silage production
Farmer-to-farmer knowledge sharing
Activities through the Chiapas Network (Non-profit of 9 farmer organizations)
Recovery of high-yielding landraces of corn
Demonstration plots and seed comparisons
Soil analysis
Granulation machine for compost pellet production
Applications for state-funded productive projects and extension services
Farmer-to-farmer exchanges and workshops
Field testing of pasture grasses
Training of farmer agronomists
Training in ranching best practices and agroforestry
Lobby state officials for better treatment and safety nets for farmers
Activities through ANEC (the National Association of Rural Farmers and Merchants)
The MICI system of crop management
Extension services and trainings from ANEC agronomists
Lobby federal officials for better treatment and safety nets for farmers
Coalition building with other national farmer organizations

The Peloncillo Group accesses additional resources, projects, and workshops through the Chiapas Network as well as several private loan and extension offices and other farmer organizations regionally and nationally. For example, through its work as a non-profit organization, the Chiapas Network has secured funding from SAGARPA for technologies to be shared across the network's member groups, including soil analysis technology, bioreactors for biofertilizer production, and a granulation machine that can be used to make compost pellets from organic materials. With extension support from agronomists at ANEC and frequent farmer-to-farmer exchanges, the Chiapas Network has established comparison plots throughout the state to compare and contrast different approaches to crop management (conventional and agro-ecological) and different seed varieties (corporate hybrids and improved landraces). Through workshops, Peloncillo members have learned about nitrogen-fixing crops, crop rotations, climate monitoring, and seed selection. As members acquire this knowledge in soil and crop science, they also learn appreciation for the wisdom behing the traditional farming practices of their parents and grandparents that were based on diversity and crop rotations.

The network aims to help farmers reduce farming costs and reclaim some autonomy by recovering high-performing, landrace seeds. As one leader explains: "There are two principal reasons we are [seeking to recover native corn]. The first is that in recent years we have been very affected by drought in our rainfed corn production. Drought reduces yields and affects farmers' abilities to recover the costs of production. Sometimes this situation makes it so the farmer no longer has the resources necessary to farm the following season. The second reason is that we sincerely no longer want to depend on the commercial companies for seeds. There are many people in our community that have stopped farming because they do not have the money to buy seed and there is no longer native seeds like what our parents used to farm in the region" (Julio, Peloncillo Group, interview 2/12/16).

Through field trials and training farmers in seed selection and saving, the network has identified various landrace varieties of corn that produce yields as good or better than corporate hybrid varieties while also offering the added benefit of being savable for replanting the following season. In 2016, farmers in the Peloncillo Group were particularly optimistic about a landrace variety of white corn that was producing yields as high as 7-8 tons per hectare. They proceeded to plant 40 of their 100 hectares of corn with this seed for the 2016 winter corn crop. "Sometimes we undervalue [our native seed] because we say 'oh that little native seed is not going to produce' but in reality it does have good productive capacity and that is what we are looking for [in order] to make corn more profitable in the market" (Julio, Peloncillo Group, Benito Juarez 12/11/16). With time, the Peloncillo Group aims to save and distribute not only corn seed but also soy, peanut, and bean seeds that can further lower the costs of farming (Julio, Peloncillo Group, Benito Juarez 12/11/16)

As is the case throughout much of the state, many of the members of the Chiapas Network are betting on livestock production as a livelihood strategy that presents fewer costs and risks than crop production. Since the beginning of 2016, members of the Peloncillo Group have pursued calve-fattening and corn silage operations as a new livelihood strategy. As one member explains: "Farming is riskier. You risk more. If it doesn't rain in the rainfed season, you lose. Whereas with cattle, you have it there, you maintain it and that is the advantage of ranching" (Cein, Peloncillo Group, interview 5/12/16). By fattening calves, Peloncillo members diversify their income and increase their options regarding the end use of their corn crop. If market conditions are not attractive, farmers can choose to dedicate their corn harvest to cattle feed, thereby reducing their dependence on *coyotes* and corporations such as Maseca to sell their corn. Nonetheless, this strategy is not without its own set of risks as the market for fattened cattle also fluctuates.[27]

[27] In September of 2016, for example, farmers were deeply concerned about the falling prices for cattle. Members of the Chiapas Network had purchased the calves for fattening at the beginning of 2016 for 52 pesos/kilo. As of September, the price had dropped to 40 pesos and there was

The leaders of the Chiapas Network recognize that many farmers have turned to cattle without the proper training in how to care for cattle let alone sustainably manage land and water resources (Extension agent, Red Chiapas, interview 9/20/16). To support a more informed and profitable approach to ranching, several of the groups in the network are now working to field test different varieties of pasture grass. The network is also exploring how to produce their own salts and best practices to manage cattle pastures through agroforestry methods (Extension agent, Red Chiapas, interview 9/20/16). In addition, the Peloncillo Group has plans to use the cattle production to improve their compost production by collecting and composting the manure from their corrals (German, Peloncillo Group, interview, 12/8/16).

7.3 Transforming Farming Systems through Agro-ecology and Farmer Expertise

The Chiapas Network (and by association the Peloncillo Group) is seeking what can be described as an agro-ecological approach to farming. Rather than a linear view of production, they rely on an ecological approach to agriculture based on natural cycles and webs of ecological interaction. This work challenges the Green Revolution mode of agriculture that treats soil as a dead and passive substrate. Instead, soil is newly understood as a dynamic, living system. As one group leader explains: "In conventional agriculture, everything is about killing, destroying. The agriculture we are promoting and doing is different. Everything is about balancing, not killing" (Julio, Peloncillo Group, interview 12/11/16). Prior to resorting to agrochemicals, the network offers its members alternative sources of fertilizers and natural approaches to pest control. They use ecology, plant physiology, meteorology, and the power of observation to address issues of soil fertility, pests, and low harvests.

The Network has adopted soil and crop management strategies researched and promoted by ANEC agronomists. The hallmark of ANEC's extension work is the MICI system, which stands for "Integrated Management of Induced Crops" (*Manejo Integrado de Cultivos Inducidos*, hereafter MICI). MICI is what ANEC director describes as "a technological alternative to the Green Revolution model" (Victor Suarez, ANEC director, interview). It integrates knowledge from Mesoamerican agriculture, ethno-agriculture, Mexican school of crop improvement, agroecology, and advanced scientific knowledge in order to recover soil fertility and induce crop resistance. The system's goal is to achieve higher productivity at lower costs. Because the MICI system is based on constant monitoring of soil and plant health as well as changes in weather, it provides a holistic approach to crop management that can buffer against crop loss in periods of drought or pest infestations.

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uncertainty whether the prices would rise in time for farmers to sell at a high enough price to at least cover their debt payments (Francisco, interview, leader of Chiapas Network, 9/20/16).

The farmers who have adopted MICI see it as a promising path to reducing the costs of production and increasing farm resilience: "It's because of [the MICI system] that we think we are more competitive than the commercial model because we manage the crop according to its needs and nutrition. It is not only compensating according to what is happening with the weather but also the plant's nutrition. We balance things; we add inputs according to what the plant needs in different phases. This is no longer the agriculture we used to do in which we just threw the fertilizer [on the plant] and we didn't really know how much the plant actually required" (Julio, Peloncillo Group, interview 12/11/16). The members of the Chiapas Network not only attend trainings to learn about the MICI system of crop management but also pursue experimentation and study at their homes and farms in order to adapt the techniques to the particularities of each farm context (Extension agent, Red Chiapas, interview 9/20/16).

The Peloncillo Group produces a number of inputs on-site at their headquarters in the Benito Juarez ejido including compost, worm compost, and several biofertilizers. The application of these alternative inputs oxygenates the soil, undoing the compaction caused by years of conventional crop production. They provide humic and fulvic acids and repopulate the soil with beneficial bacteria. These inputs are offered at a fraction of the cost of conventional inputs, thereby helping farmers in the community who often lack the liquid capital on hand necessary to address fertility and pest problems when they need it most. Through applying no till or minimum tillage, farmers also reduce the amount of money they invest in tractor rentals and field preparation. By using natural pheromone traps to control pests, farmers reduce the application of pesticides. Over time, members report that using these methods have allowed them to reduce the amount they invest in chemical fertilizers, repellents, and pesticides.

Through a combination of agro-ecological crop management and a recovery of landrace seeds, the leaders of Peloncillo Group aim to reduce the costs of production by at least half while at the same time increasing yields. After several years of treating soils using the MICI method, several Peloncillo Group members are seeing savings in their farming costs, a reduction in their use of agrochemicals, and an increase in soil fertility. In November of 2016 celebrated having reached their goal of producing 10 tons of corn per hectare using agro-ecological methods (Farmer-to-farmer field day, the Chiapas Network).

Demonstration plots and farmer-to-farmer field days have been crucial to expanding the reach of the Peloncillo Group's work in the region. Having become accustomed to the Green Revolution model of production, many farmers are skeptical of the new strategies proposed by the group. As a result, the group's leaders have found that much of the battle is epistemological, requiring extra effort to convince farmers of the promising potential of alternative seeds and practices. "Today everyone depends on seed companies. It is now a common belief that if it is

not hybrid, it does not work and everyone around here plants pure hybrid." (Julio, Peloncillo Group, interview, 12/11/16).

It has only been in recent years — oftentimes after seeing the results the Peloncillo Group has achieved with recovered landraces — that other farmers have expressed interest in experimenting with the group's techniques and seeds. The group's comparative field trials provide a physical testament of their work that attracts new members. As one leader describes, "You must begin by showing" (Julio, Peloncillo Group, 2/12/16). Another group leader explains that the field trials "make you realize how important the soil is to the plant's growth, more so than the seed" (German, Peloncillo Group, interview, 12/8/16).

Perhaps just as important to the Chiapas Network's efforts to transform how agriculture is practiced in the region, is their effort to build farmer knowledge and expertise and train farmers as extension specialists. These efforts counteract several decades of agricultural development that has privileged the expertise of external agronomists and crop scientists. One of the main objectives of the Peloncillo Group is to acquire the knowledge and skills to become scientists and agents of change in their community.

The leaders of the Peloncillo Group demonstrate the way farmers can save money and improve crop management by acquiring their own agronomic expertise that matches their specific fields and crop needs. By experimenting with different inputs in comparative field trials, the members of the Peloncillo Group test the impacts of different interventions and agricultural products (whether conventional, organic, or homemade). Through further investigation of the exact ingredients in different products, the Peloncillo Group members learn the precise role of each ingredient and how it affects plant growth. All of this contributes to an empowerment of farmers through growing their own expertise and knowledge. As one leader explained: "It is difficult, but as we acquire more knowledge, we are becoming a little freer. In reality, that is what we are seeking: not to depend so much on the corporations" (Julio, Peloncillo Group, interview 12/11/16).

Most of the members of the Chiapas Network do not have the economic resources to pay for private extension services to improve their farms and yet the need abounds, particularly in the context of climate change. Since 2013, each group in the Chiapas Network has pooled their resources to invest in the training of at least one member of their group in MICI and other agro-ecological management techniques. Reflecting on what they have learned, one leader explained: "We are discovering little by little how our ignorance makes us dependent. Whatever they tell you, you believe it. And out of need, you pay for it. When you know things, you can compare. You can say, 'I don't want that. I'll take this because it will work for me.' But that requires knowledge" (Julio, Peloncillo Group, interview, 12/11/16). Although it has taken substantial personal and group sacrifices to achieve, the investment in these trainings are paying off. As a loan officer for the Chiapas

Network observes: “Now when you talk to one of [the trained farmers], you realize you are speaking with a trained agronomist” (Extension agent, Chiapas Network, 9/20/16).

7.4 Building Resilience to Double Exposure

“We are putting up a fight. We are going against the grain” (leader, Chiapas Network, interview 9/20/16).

“We believe that this [alternative] is feasible because we have done it and proven it. We want to show more than anything that it is viable to farm in a different way that is more balanced and, above all, without damaging the environment. Conventional agriculture is all about killing, polluting, and destroying. In contrast, the agriculture that we are promoting at this time is different; it is about balancing resources: climate, water, soil, seeds, food, and family economy.” (Julio, Peloncillo Group, interview 12/11/16)

Many of the Peloncillo’s Group’s strategies are helping farmers to overcome the compounding challenges of double exposure detailed in Chapter 5. Whereas conventional farms based on Green Revolution modes of production have degraded soils, generated higher costs of production, and increased the risk of crop loss in the context of climate change, the MICI system of crop management reduces costs while also building farm resilience (Victor Suarez, ANEC director, interview). For example, while the application of agrochemicals during drought conditions can increase the risks of crop loss, the MICI system’s use of organic inputs eliminates that risk:. “[These organic inputs] are not like agrochemicals. Agrochemicals, as you say, if it doesn’t rain, the agrochemicals evaporate and partly become gas; they also damage the plant. This process does not” (Julio, Peloncillo Group, interview, 12/11/16).

By focusing on soil and plant health, the MICI approach increases crop resistance to environmental conditions as they occur. Leaders of ANEC have verified that crops under MICI can resist drought conditions better than conventional crops (Victor Suarez, ANEC director, interview). Even when the climate is uncertain, the MICI system of management helps ensure farmers can still get a crop, at least enough to pay off their debts. As one of the leaders of the Chiapas Network explains: “The MICI technology is based on knowing the plant, knowing its systems of defense against drought, against pests. It is all based on the plant’s physiology…So if you have some problem in the weather, you know what the plant uses to overcome that and that is what you add to the plant. In contrast, the [conventional agricultural] system does not provide that…The agrochemicals don’t provide that. If the drought comes, well you’re done for. We have seen fields where the drought has hit and how they turn out. [However], where they use the MICI technology, the crop survives. The other [conventional approach] truly does not anticipate that, it does not

anticipate the weather, the climate." (Extension agent, Chiapas Network, interview 9/20/16).

Climate change is also a concern for the Peloncillo Group and a key motivation for their work building their local capacity to understand, anticipate, and respond to climate stressors. They have installed a local meteorological station and are supporting youth to acquire training in agronomy and climate science. Over time, the Peloncillo Group is growing its ability to provide climate forecasts and advice on how to plant each season. They are working to simultaneously induce vegetal resistance and recover soil health to buffer the effects of climate change, particularly in times of drought or excessive rainfall.

Members of the Peloncillo Group attribute their farms' increased resilience to drought and other extreme weather events to the agro-ecological methods they have applied in recent years. The difference in soil quality between different management techniques is palpable and easily observed in the group's comparative field trials. On my last visit to two of the group's cornfields in Benito Juarez – one managed using compost, vermiculture, and biofertilizers, and the other managed using conventional agrochemicals – the difference between the two was palpable. The soil on the plot managed using organic techniques was dark and spongy; the first corn leaves burst forth in a brilliant green. In contrast, the soil in the second, conventional plot was hard and compact; the young corn leaves struggled to push up through the tough, dry soil. The field's owner explained that this unmistakable difference between the plots, as well as the recovery of the native corn seed he has planted in the field, is what gives him hope for the future. He explains:

"The seed companies make us think there is only one option in farming, pushing us to buy inputs with them. But the reality is different. There are many processes available, such as producing compost, worm castings and worm leachate, and the use of certain bacteria that help to fix nitrogen in the soil. That is what we are learning…We believe that this [alternative] is feasible because we have done it and proven it. We want to show more than anything that it is viable to farm in a different way that is more balanced and, above all, that doesn't damage the environment" (Julio, Peloncillo Group, interview 12/11/16).

Over time, the Peloncillo Group's work is attracting greater interest from local farmers and ranchers in Benito Juarez and the surrounding region. Originally, most members joined the group in order to access better lines of credit[28]. Today,

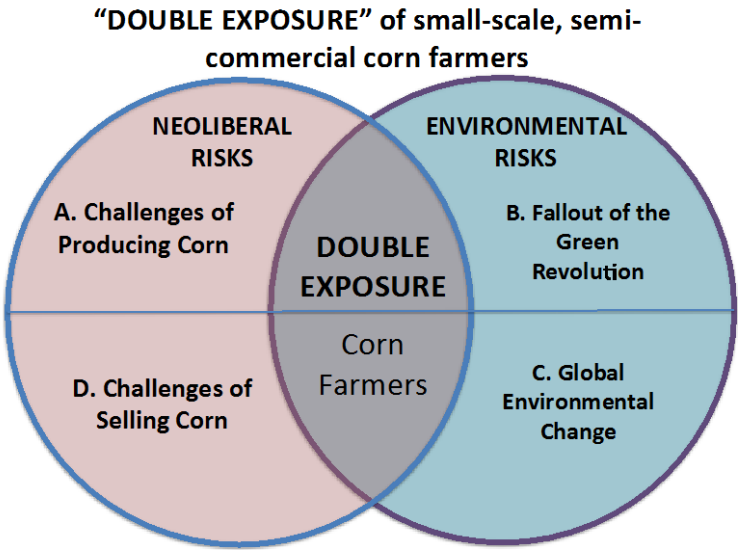
[28] Initially, the Peloncillo Group formed in order to access loans through a private extension office (*despacho)* to support their farming and ranching activities. Whereas most members of the group were previously ineligible for loans, as an approved SPR, the group was able to access private loans at an interest rate of 24 percent. Eventually, once the group established a good record of loan repayment, the group was recommended to access lower interest rates through Mexico's National Development Financial Office (*Financiera de Desarrollo Nacional,* hereafter FND for its Spanish acronym) at a 7 percent annual interest rate. Accessing low-interest government loans is no easy task

however, new members are not joining the group solely to access credit but also to experiment with the group's agro-ecological techniques and new seed varieties that promise to reduce farming costs while also helping to recover soil fertility. Faced with increased farming costs and decreased yields, members of the Peloncillo Group see the time is ripe for a change: "Now is the time to improve the soil to have better yields and decrease what we spend on agrochemicals, in fertilizers because if you don't fertilize the plant it does not grow or, if it grows, it grows yellow and does not develop" (Reygiber, Peloncillo member, interview, 6/28/16). As of December of 2016, the group was providing extension services to 40 local farmers and had shifted 40 of the group's 100 hectares of production to landrace seed varieties and MICI management.

Together, the many strategies used by the Peloncillo Group (and the Chiapas Network overall) address three of the four components of double exposure identified at the beginning of this study. That is, they address economic "challenges of producing corn" in the neoliberal context (Quadrant A of **Figure 23**) by reducing reliance on purchased seeds and agrochemicals; they rebuild soil fertility, thereby counteracting the "contextual environmental vulnerabilities" associated with the fallout of the Green Revolution (Quadrant B); and lastly, by increasing soil humidity and fertility and improving weather forecasts and crop management, the Peloncillo Group also reduces the risks of farming associated with "ongoing environmental changes," particularly climate change (Quadrant C). The only component that the group has been unable to address as of yet is the "challenges of selling corn" in the neoliberal context (Quadrant D). It remains to be seen whether the work applied to the first three components will be sufficient to render negligible the challenges of this last component.

for farmers in southern Mexico who are considered a high-risk population. To attain the direct line of credit with the FND, the Chiapas Network not only had to constitute as a Civil Society but also had to use the loan office of Rio La Venta as a co-signer guarantee for any credit accessed.

Figure 23 Double Exposure in Four Components



Discussion: Hybrid Paths to Farmer Autonomy

Stock et al (2014) argue that just as there are many expressions of neoliberalism in the global food system, there are also multiple kinds of farmer-led countermovements. This study documents a kind of double movement wherein farmer vulnerability to double exposure has pushed farmers to seek new ways of farming and paths to greater autonomy. The Peloncillo Group is harnessing the power of agro-ecology and solidarities with nested networks with other farming organizations to overcome several of the challenges related to double exposure. However, in practicing the self-reflexivity proposed by political ecologists (e.g. Edelman 2014), I temper enthusiasm for these counter-movements with sober recognition of their limitations and contradictions.

In contrast to dominant narratives that present farmers as either legitimators or resistors of neoliberalism, Stock et al (2014) suggest that the reality on the ground amongst struggling farmers is much more nuanced. Stock et al (2014) suggest farmers respond to neoliberal vulnerabilities by pursuing either "neoliberal autonomy" or "actual autonomy." The first hinges on achieving farmer autonomy through entrepreneurship and individualism (traits often identified with neoliberal rationalities – see Guthman 2008). "Actual autonomy," in contrast, hinges on united efforts to achieve collective interests (Stock et al. 2014). The authors admit that these categories are not entirely separate as individual interests can function to motivate cooperation (Stock et al. 2014: 414). Indeed, other studies of have perceived strongholds of autonomy can encompass forms and logics that morph between non-capitalist/non-neoliberal and capitalist/neoliberal (e.g. Tsing 2015).

In the case of the Peloncillo Group, I identify a third category beyond Stock et al.'s (2014) bifurcated formulation of "neoliberal" or "actual" kinds of autonomy: "hybrid autonomy." The case of the Peloncillo Group (and the larger Chiapas Network) cannot be easily categorized as reformist or radical but rather reflects a kind of "hybrid autonomy." In other words, the group's efforts can be read as both conforming to *and* challenging neoliberal logics.

In many ways, the network and its respective groups emulate the model for agricultural development as promoted by the Mexican Government and neoliberal ideologies: they self-organize as small farmer associations, share risks and provide collateral guarantees for lines of credit, and operate as small-scale farmer entrepreneurs. Most members of the Peloncillo Group, for example, are small-scale semi-commercial producers who have attempted to behave as well-disciplined neoliberal subjects. In recent decades, they have: sought lines of credit to finance their production, relied on commercial seeds and inputs, and exploited their natural and human resources in an effort to survive within an increasingly competitive farming environment. The motivation for forming the Peloncillo Group was not out of moral conviction, but rather out of necessity. The group's founders realized that they would not survive the ongoing pressures of neoliberalism and environmental change unless they organized a collective response to reconfigure the costs and risks associated with their farming practices.

Many of the Peloncillo Group members are driven more by practical concerns related to farm profitability than by the revolutionary ideals associated with agro-ecology and food sovereignty movements. As one leaders of the Chiapas Network explains: "I tell [the members of the Network], 'That's how you should see yourselves, as a rural business'" (Extension agent, Chiapas Network, 9/20/16). As a result, the group takes a very pragmatic approach, pursuing any and all opportunities that promise to reduce their production costs or increase their bottom line. Hence, just as the group has sought to reduce their production costs by integrating agro-ecological techniques and inputs, they have also attended workshops offered by subsidiaries of Monsanto, taken advantage of discount offers on corporate seeds and inputs, and have pursued livestock and silage production as more profitable livelihood strategies. For the leaders of the Peloncillo Group, all of these choices are ultimately about what is in the group's best interest: "Well you see that Monsanto thinks we are doing everything for them now since we bought their seeds and went to their workshops on how to silo the corn…But we aren't doing this for Monsanto. They don't own us." (Julio, Peloncillo Group, interview,5/8/16)

Despite their practical orientation, several of the Peloncillo Group's efforts also actively work against capital accumulation and neoliberalism in agriculture. Hence, just as there are dimensions of their work that can be read as conforming to neoliberal logics, so too are there aspects that can be read as building farmer autonomy and pushing back against neoliberal logics. After years of experiencing hardships linked to double exposure, members of the Peloncillo Group and the

Chiapas Network have decided that their only hope to survive is through collective organizing and the development of alternative production strategies. Their efforts to integrate agro-ecological practices and reduce their reliance on purchased seeds and inputs represents a threat (at least symbolically) to the corporate-dependent system that has been established for several decades in the semi-commercial farming regions of Chiapas. These efforts reflect the agency small-scale farmers still possess and the pockets of actual autonomy that can still be achieved through collective action. The Peloncillo Group and the other members of the Chiapas Network have identified collective strategies that reduce the costs of production, improve soil fertility and yield outcomes, and recover some autonomy in farming decisions, seeds, and inputs. More research is needed regarding how these initiatives affect labor demands, the concrete livelihood benefits they generate, and the level of state, financing and policy interventions that would be needed to sustain these initiatives over the long-term.

As the case of the Peloncillo Group and the larger Chiapas Network demonstrates, the impacts of double exposure on semi-commercial corn farmers are not pre-determined. Just as double exposure can contribute to ongoing processes of dispossession (see Chapter 6), they can also open possibilities for grassroots transformation (e.g. Carlisle 2015; McCune et al. 2012). A paradigm shift is underway among the members of the Chiapas Network who are questioning the Green Revolution mode of production and striving to recover farmer expertise and autonomy. However, as observed in other alternative food and farming networks (e.g. Bellante 2016), any effort to create an alternative eventually bumps up against the larger political economy in which the effort is embedded. In the case of the Chiapas Network, the path to an alternative mode of farming is thwarted by 1) state programs and corporate extension services that encourage continued agrochemical use; 2) increased labor needs of agroecological projects; 3) widespread dependence on Green Revolution modes of production; and 4) volatile and low priced corn markets.

Similar to Jakobsen (2018), this research finds that a broad and cohesive counter-movement has not emerged among farmers in southern Mexico[29]. As in other countries such as India, the changed political economic landscape under neoliberalism and the Long Green Revolution has caused a fracturing of rural classes, a 'relentless micro-capitalism' (Davis 2006), and disjointed responses to vulnerability. That said, the efforts of the Peloncillo Group and other members of the Chiapas Network suggest that farmers are still using their agency to work collectively and pushback against the downward pressures of double exposure in their own kind of Polanyian double movement. These organizing efforts are growing in response to the contradictions inherent to the capital system itself and its eroding

[29] The Zapatista movement is perhaps the best-known countermovement in southern Mexico, however that movement is based primarily on small-scale subsistence rather than (semi)-commercial farmers

effects on the social and ecological foundations that allow it to operate, particularly in the context of climate change (Giraldo 2018).

The Chiapas Network is putting into practice several of the strategies that researchers have identified as being most promising in helping small-scale corn farmers reduce their vulnerability, including participatory crop breeding, agro-ecology, and farmer-led extension (Altieri and Toledo 2011; Mercer et al. 2012; Isakson 2014; Hellin et al. 2007; Hellin et al. 2014; Landini 2016). In their efforts to pushback against the neoliberal, Green Revolution mode of production, farmers in the Chiapas Network are creating their own double movement that challenges processes of dispossession of farmers' seeds, resources, and knowledge systems and pushes against the dominant "common sense" about the right way to farm and the role of small-scale producers into the future (Kloppenburg 2010; Polanyi 1957; Gramsci 1988).

Conclusion

"Sí, es largo el trayecto. Ya sabemos que no será para este año ni para el otro, pero mientras vivamos, la esperanza sigue."

"Yes, the path is long. We know it won't be for this year nor for the next, but as long as we are alive the hope continues."
—Leader, Peloncillo Group (interview 2/12/16)

In this study, I have traced multiple interrelated processes of dispossession, double exposure, and resistance in the cornfields of the Chiapas Lowlands. I have described a Long Green Revolution in the corn-farming sector that has reduced agro-biodiversity, degraded farmlands, and dispossessed farmers of their traditional seeds, practices, and farming knowledge. Today, the Long Green Revolution continues to unfold within a context of neoliberal food governance and accelerating global environmental change. Dispossession processes among semi-commercial corn farmers have intensified as public farm supports have been restructured around privatized systems of financing and input- and service-provisioning. Together, multiple economic stressors have placed semi-commercial farmers in a precarious position wherein the drive to remain competitive sits at odds with the need to adapt to and mitigate environmental and climatic changes.

I draw on and deepen insights from the fields of agrarian studies, political ecology, and vulnerability studies. Using an agrarian political ecology and in-depth case study approach, I expand understandings of how double exposure is unfolding among the semi-commercial farm sector in Mexico that continues to rely on corn for their livelihoods. This work contributes to creating a nuanced understanding of how farmer vulnerability operates on the ground, its compounding factors, and how it is intertwined with longer histories of uneven development, larger political economic dynamics, and ongoing processes of global environmental change (GEC).

To structure my analysis, I divide the stressors of double exposure into 4 main categories: 1) Neoliberal risks of producing corn; 2) neoliberal risks of selling corn; 3) the fallout of the Green Revolution; and 4) ongoing processes of global environmental change. Chapters 3 and 4 describe each of these stressors and examine how they operate in the corn sector of Chiapas. My intensive place-based analysis draws attention to dimensions of farmers' struggles that are not captured by macro-analyses or official farming statistics. Yield declines and crop loss resulting from factors linked to both the fallout of the Green Revolution and climate change combined with increased production costs and depressed markets within a neoliberal globalized context means that corn is an increasingly losing endeavor for semi-commercial farmers. However, for many, corn continues to be their only accessible productive option. As reviewed in Chapter 6, there is a survivalist's logic

and a staying power of corn in farming communities struggling with double exposure.

Many agrarian studies scholars have documented the negative dimensions of the Green Revolution (e.g. Hewitt de Alcantara 1976; Shiva 1991). Critical perspectives on the social and environmental impacts of the Green Revolution identified early on that hybrid seed technologies are paradoxical in that they simultaneously produce abundance and scarcity (Lakshman 1993: 255). Hybrid seeds have been at the heart of an entire paradigm shift in agriculture that has destroyed prior practices and resources and replaced them with intensive production systems that allows for constant capital accumulation in agrarian spaces (Jennings 1988; Lakshman 1993; Kloppenburg 2004). This study expands these studies by demonstrating that Green Revolution technologies and modes of production are integral not only to farmers' economic vulnerability but also their biophysical vulnerability to ongoing environmental change, particularly climate change. The Long Green Revolution — which spans both pre-neoliberal and neoliberal stages of development — has dispossessed farmers of their traditional seeds, inputs, and farming knowledge in Mexico. In addition, it has created farm systems that are reliant on an increasingly expensive suite of corporate inputs and unsustainable practices that increase the risks of yield declines and total crop loss in the context of climate change.

I add to scholarship on the winners and losers of Mexico's current approach to food governance (Appendini 2014; Eakin et al. 2014). Whereas scholars have long understood the ways in which the Green Revolution has exacerbated social inequalities in the farm sector (Pingali 2012; Patel 2013), less research has examined how this legacy is being reworked in the context of climate change and neoliberalism. By making agricultural supports contingent on private property titles, credit worthiness, and minimum land extension requirements, Mexico has tilted the playing field further in favor of larger farms. I find the restructuring of agricultural programs since the 1990s has weakened farmer movements and undermined the ability of small, independent farmers to remain in production. In addition, crop losses resulting from years of prolonged drought are increasing the incidence of debt and farm abandonment. My research suggests these processes are exacerbating social stratification and processes of dispossession among small farmers, thereby eroding the legacy of small-scale agriculturalists so hard-won in Mexico's Revolution of 1917 and dramatically changing the face of farming in Mexico.

The reduction of state-led agricultural services in Mexico has left an institutional vacuum that is increasingly filled by transnational corporations such as Dupont and Monsanto. Now acting as the primary extension agents in the region, these actors encourage the adoption of new seeds, technologies, and intensified agrochemical use, all of which raise production costs, accelerate agro-biodiversity loss, and decrease resilience in local farm systems. As discussed in Chapter 3, the

onset of climate change and other environmental changes have further confounded traditional farming knowledge and increased the need for outside expertise. At the same time, privatization and neoliberalism have left small-scale farmers with limited to no access to extension services. Similar to Flachs (2016) and Stone et al's (2014) studies of the cotton industry in India, the commercial corn industry in Mexico is now dominated by multinational corporations. Farmers must navigate kaleidoscopic conditions in markets and technologies while also calculating for adverse climate scenarios. The "hobbled" neoliberal state is unable to fund and coordinate necessary adaptations in the rural sector. At the same time, the private and non-profit actors who have replaced state roles in development projects and extension services are at best insufficient and, often times even exacerbate the problems farmers face.

The tendency of capitalism to undermine the ecological conditions of its own reproduction is apparent throughout this study (Polanyi 1944; O'Connor 2001). As described in Chapter 2, this tendency is associated with processes of capital accumulation in agriculture that originated in the state-sponsored transition to the Green Revolution mode of production. It has been further intensified in the neoliberal context as farmers have been pushed to exploit their farms to the maximum in order to remain competitive in liberalized grain markets. This has further entrenched farmers' roles as "propertied labor" working for the enrichment of actors on either end of their chains of production. This study exemplifies Giraldo's (2018) observation that often times it is more efficient and less risky for capital to control certain territories indirectly, exploiting labor, knowledge and ecosystems through neoliberal agriculture (Giraldo 2018: 99). As demonstrated in Chapter 5, the profit orientation of the actors that now oversee Mexico's input provisioning and extension services often work against farmers' best interests and the need to transition to more sustainable farming practices. Farmers' experiences of declining yields and crop loss are a testament of the ways in which the onset of climate change upon already degraded landscapes accelerates ecological crises in agriculture and threatens farmer livelihoods.

I apply concepts from political ecology that emphasize the iterative relationship between human and environmental processes. I use this perspective to interrogate the nuanced interplay between different dimensions of vulnerability. In Chapter 6, I describe farmers' many responses to double exposure and examine the tradeoffs between short-term adaptations and long-term vulnerabilities at different scales of analysis. I detect a slow dispossession by double exposure wherein farmers reduce the area planted in corn, abandon farming and/or turn to renting or selling their land. The other side of this process is an ongoing re-concentration of ejidal resources into hands of local elites and absentee investors in crop production for export. In several cases, dispossessed farmers retained only a small fraction of land (if any at all), thereby shifting from a small-scale semi-commercial farmer to a micro-scale subsistence farmer and day laborer. This gradual squeezing out of the

middle peasantry is not new, but rather continues historical trends in the small farm sector (De Janvry et al 1995; Otero 1998)

The process of "dispossession by double exposure" identified in this study builds upon several layers of dispossession that have been underway for decades. This particular moment of dispossession unfolds upon a geographic landscape marked by centuries of uneven development and small farmer struggle. Double exposure merely intensifies and accelerates other ongoing processes of dispossession. This study documents the many strategies farmers use to cope with vulnerability. However, when unexpected crises hit, the thin margin within which most semi-commercial farming households are surviving comes into sharp relief. This study finds that dispossession by double exposure is a disparate process that is slowly unfolding throughout Mexico's farming communities. Sudden crises such as a health emergencies, natural disasters such as the earthquake that shook southern Mexico in September of 2017, or extended periods of drought can be the triggers that reveal the extent of rural vulnerability and push farmers to abandon agriculture completely.

By focusing on the experiences of semi-commercial, ejidal corn farmers, I draw attention to the inherent risks of expanding GR modes of production among small-scale farmers within the context of neoliberal agricultural policy and climate change. Although many of the farmers in this study represent the Mexican ideal of a small-scale, "modern" corn farmer, their increasing experiences of risk, loss, and dispossession serve as a warning to the pitfalls of this approach to agricultural development. In Mexico's northern states, other researchers have documented how double exposure and the increased risks of farming are related to a decline in small-scale crop production as ejidal lands are increasingly leased out to large companies for crop production for export (Lutz Ley 2016). This study indicates that a similar process may be underway in Chiapas as farmers reduce the area they dedicate to corn and increase the land areas they rent or sell.

I contribute to debates in the vulnerability and adaptation literature regarding how neoliberal systems of governance forestall transitions to more resilient and sustainable systems of production. I draw attention to an under-studied dimension of Mexico's neoliberal policies: the loss of seed sovereignty and the rising influence of private and corporate actors in the provisioning of seeds, inputs and extension services. Few studies have emphasized the linkages between smallholder vulnerability and the influence of transnational seed corporations and their subsidiaries. This research contributes to a growing body of research that identifies the ways in which transnational control of resources and productive processes actively hinders climate adaptation, mitigation, and overall social justice and sustainability (McCarthy 2004; Fieldman 2011; Clapp et al. 2017). Adger (2003) demonstrates that a well-functioning state is crucial to the design and implementation of effective climate adaptation efforts. Similarly, De Schutter (2011) explains that there is too little incentive in the private sector to invest in agro-

ecological initiatives that can help farms both adapt to and mitigate climate change. If Mexico (and any nation for that matter) is serious about transitioning food production to a new paradigm founded on sustainability and social justice, sooner or later the corporate control of its input provisioning and extension services will have to be restructured if not completely dismantled.

The case of the Peloncillo Group and other members of the Chiapas Network presented in Chapter 7 demonstrates how the pressures of double exposure can also lead to a double movement that pushes back against processes of capital accumulation and vulnerability in the agrarian sector. The agro-ecological practices and farmer-to-farmer solidarities implemented by the Chiapas Network are helping to undo three of the four main pillars of double exposure identified in this study: the risks of farming corn; the fallout of the Green Revolution; and the impact of ongoing environmental changes, particularly climate change. By recovering landrace seed varieties, developing alternative inputs, and investing in farmer training, farmers in the Peloncillo Group are recovering soil fertility on their farms, reducing the costs and risks of production, and developing their own base of farmer expertise to improve farming outcomes, increase farm sustainability, and buffer the impacts of climate change. Their efforts represent a Polanyian double movement that pushes back against capital accumulation processes and the overexploitation of both human and environmental resources in the food system.

After reaching a point of desperation caused by double exposure, the Peloncillo Group is rejecting parts of the corporate-controlled intensive model of agriculture and reclaiming farmer autonomy in production practices and land-use decisions. As explored in Chapter 7, this countermovement can be understood as building a kind of "hybrid autonomy." Parts of their efforts — such as their work to reclaim autonomy through the recovery of landrace seeds, soil fertility, and farmer expertise — can be read as counteracting neoliberal logics. However, there are important ways in which the Peloncillo Group's activities simultaneously resonate with neoliberal logics. I use the term "hybrid autonomy" to describe the ambivalent nature of this movement as both challenging and conforming to exploitative accumulation processes in agrarian spaces.

While the Peloncillo Group has taken important steps to decrease their vulnerability and increase their resilience to double exposure, they are still dependent on selling their corn within volatile, liberalized grain markets. In addition, the group relies on tremendous volunteer efforts and struggles to advance at a sufficient pace to counteract the many pressures of double exposure. As in other studies (e.g. Fieldman 2011; De Schutter 2011), this study demonstrates that despite good ideas for adaptation and community-based development emerging in civil society, ultimately all of these projects need policy support and funding to succeed. The proliferation of agro-ecological practices holds great potential for increasing the sustainability of farms (Altieri and Toledo 2009; Altieri and Nicholls 2009). However this paradigm shift still requires public support in the form of

extension services, storage facilities, rural infrastructure, credit and insurance, research and development, and capacity-building (De Schutter 2011). The experiences of organizations such as the Peloncillo Group in Chiapas demonstrate that feasible solutions already exist. While there may be no easy way to control for all of the changes that are to come, the Peloncillo Group shows that alternatives abound that can lower the costs and risks of farming in the era of climate change. Our task now is to spread these seeds of change and find ways to help them grow.

Future Research Directions and Closing Thoughts

This research suggests several avenues for future research. The growing prominence of livestock production as a livelihood strategy among small-scale farmers in Chiapas merits further investigation. This transition appears to enroll small producers in another transnational commodity chain with its own set of risks and benefits. Future questions related to this shift include: how are risks and benefits (be they social, economic, environmental) distributed along the transnational commodity chain of livestock running from southern Mexico to the United States and beyond? Will southern Mexico eventually mimic patterns observed in northwest Mexico where there is now more livestock than food crop production (Lutz Ley 2016)?

Similarly, the effectiveness of different efforts to counteract double exposure and dispossession in the small farm sector are deserving of further attention. How can efforts at recovering high-yielding landrace varieties improve farming outcomes? What are the long-term effects of rebuilding soils through agro-ecological management techniques such as those employed by the Peloncillo Group? How can current policies be transformed to support efforts to improve the sustainability of farm systems in the context of climate change?

The trends and outcomes observed in this study relate to larger discussions about the future of our food systems in the context of momentous environmental and social change. The seeds of future vulnerability in our food systems are already present in the fields and experiences of the corn farmers featured in this study. The small farm sector is considered essential to sustainably achieving global food security in the 21st century (FAO 2016). However, much work is to be done in understanding the political, economic and environmental factors challenging farmers' abilities to maintain — let alone improve — their production systems.

My deep ethnographic approach provides insights into the dynamics of vulnerability and dispossession that are already underway in Mexico's small farm sector. Like Fieldman (2011) and McMichael (2011), this research lays bare the linkages between current vulnerabilities to climate change and the neoliberal economic project and raises important questions regarding the extent to which the 'hobbled neoliberal state' can meet current and future food-related challenges. As countries navigate the compound challenges of achieving food security, climate

change mitigation, and rural sector protections, it is clear that the contradictions and impacts of the neoliberal processes of capital accumulation in the agrarian sector will have to be continually re-evaluated and negotiated. In the absence of new efforts to reinvigorate Mexico's seed, inputs, and extension services, this research identifies strong economic and environmental trends that reduce the long-term viability of small-scale farming and thwart transitions to more sustainable and resilient agricultural practices. Ensuring global food security and rural stability in the context of climate change requires we understand the challenges affecting farmer livelihoods and adjust agricultural policies accordingly. This research contributes to this vital task.

I write the final pages of this dissertation on the eve of a historic transition of power in Mexico's government. On December 1, 2018, Andres Manuel Lopez Obrador (AMLO), of the Morena party, will assume power as Mexico's first president that does not belong to either the PRI or PAN political parties. AMLO's Morena party not only secured the presidential election but also the majorities in both the Mexican Senate and the lower Chamber of Deputies. Even prior to taking office, AMLO has already demonstrated interest in creating a new paradigm for food and agriculture in Mexico. In April of 2018, AMLO signed the *Plan de Ayala Siglo XXI 2.0* with over 100 farmer organizations. This plan includes progressive proposals to promote the rights of farmers, laborers, youth, women, Indigenous communities, and related rights to food sovereignty, land and natural resources, and holistic public policies for the Mexican countryside. If AMLO's administration follows through with the vision presented in the *Plan de Ayala* document, it is possible that a new day will dawn on the Mexican countryside and many of the problems presented in this dissertation may become mere pages in history.

APPENDIX A: HOUSEHOLD SURVEY – ACTIVE FARMERS - BENITO JUAREZ EJIDO, LA CONCORDIA, CHIAPAS (2016)

A: DATOS DEMOGRAFICOS

	Genero	**Edad**	**Ejidatario**	**Estado Civil**	**Escolaridad**	**Religión**	**¿Cuantos Hijos?** (Rango de edades)	**¿Cuantos Nietos?**
Entrevistado/a								
Notas:								

Genero: Hombre (H); Mujer (M) **Ejidatario: (1)** Basico/capacitado; **(2)** Posesionario; **(3)** Avecindado **Estado Civil:** Casado (C), Soltero (S), Union Libre (UL), Viudo (V)
Escolaridad (nivel completo): (**1)** Ninguno; **(2)** Primaria; **(3)** Secundaria; **(4)** Bachillerato; **(5)** Universitario o superior; **(6)** No sabe/No responde

	Ocupación Principal	**Otros oficios o fuentes de ingreso**	**¿Recibe algún apoyo del gobierno?**	**Detalles de apoyo recibido** (cantidad, frecuencia, # hectáreas/animales/hijos)
Entrevistado/a				
Esposo/a				
Hijo/a #1				
Hijo/a #2				
Hijo/a #3				
Hijo/a #4				
¿Cuáles hijos viven en casa?			¿Cuantos nietos viven en casa?	
Notas:				

Apoyos: (1) Procampo/Proagro; (2) Progan; (3) Pensión para mayores; (4) Oportunidades/Prospera; (5) PAL (Apoyo Alimentario); (6) Otro (Especifica)

¿Trabaja usted como jornalero?	**¿En promedio, cuantos días por mes trabaja como jornalero?**	**¿En promedio, cuantos meses por año?**	**¿En donde trabaja?** (dentro del ejido o afuera)	**¿En que cultivos o actividades trabaja?**

B. MIGRACIÓN

		¿Alguna vez ha migrado?		Destino	¿Durante qué años?	¿Años total afuera?	¿Manda ayuda actualmente?		¿En qué invierte (o invirtió) las ganancias de su migración?	¿Piensa migrar otra vez?		
		Sí	No				Sí	No		Sí	No	Quizás
Entrevistado/a												
Esposo/a												
Hijos/as?												
Notas:												

Destino: (1) Ciudad en Chiapas; (2) Ciudad en México; (3) EEUU; (4) Otro (Especifica)
Inversión: (1) Construir Casa; **(2)** Bienes (carro, etc); **(3)** Terreno; **(4)** Maquinaria/Tecnología para producción **(5)** ganado

D. TENENCIA DE TIERRA

1. ¿Cuántas hectáreas de terreno tiene en total? (incluye todas las parcelas de la familia en el hogar) _____
   a. ¿En cuantas parcelas está dividido su terreno? _____ b. ¿Cuántas hectáreas están ubicadas fuera del ejido?_____
2. ¿Cuántas hectáreas tienen documento parcelario (Procede)? _____ 3. ¿Cuántas hectáreas cuentan con riego? _____
4. ¿Alguna vez ha comprado terreno? (S/N) _____ a) ¿Cuántas hectáreas en total ha comprado?_____
   b. ¿En qué año compró la última vez? _____ c) ¿Qué características tiene el terreno comprado? (eje: riego, ladera)_____
5. ¿Alguna vez ha vendido terreno? (S/N) _____
   a. ¿Cuántas hectáreas en total ha vendido? _____ b. ¿En qué año vendió la última vez? _____
   c. ¿Por qué razón vendió terreno? _____
6. ¿Alguna vez ha rentado terreno para expandir su producción agrícola o pecuaria? (S/N) _____
   a. En promedio, ¿cuánto terreno renta? _____ (ha.) mínimo_____ máximo_____
   b. ¿Qué características tiene el terreno que renta? (eje: riego, ladera) _____
   c. En los últimos 5 años (2011-2016), ¿cuantos ciclos de temporal ha rentado terreno? _____ ¿Y de riego? _____
7. ¿Alguna vez ha dado a rentar su terreno o ha hecho un arreglo de cosechas al partir? (S/N) _____ Especifique _____
   a. ¿En qué año empezó a dar rentado su terreno? _____ b. ¿Cuenta con riego? S/N_____
   c. En promedio, ¿cuánto terreno da rentado? _____ (ha.) mínimo_____ máximo_____
   d. En los últimos 5 años, ¿cuantos ciclos de temporal ha dado a rentar terreno?_____ ¿Y de riego? _____

e. ¿Por qué da rentado terreno? _____

8. ¿Alguna vez ha hecho trato con alguna compañía o persona ajena al ejido por el uso de su terreno? (eje. parcela demostrativa, plantación)? (S/N) _____ Especifique con quien, qué uso se dio, y en qué año _____

E. PRACTICAS DE PRODUCCION AGROPECUARIA

1. ¿Cuáles son sus cultivos o actividades productivas principales?
1._____2._____3._____
2. ¿Desde qué año practica cada actividad?
1._____2._____3._____
3. ¿Alguna vez ha experimentado con algún otro cultivo o actividad? Especifique_____
4. En promedio, ¿Cuánto terreno siembra en el ciclo de temporal? _____(ha.)
5. En promedio, ¿Cuánto terreno siembra en el ciclo de riego? _____(ha.)
6. En promedio, ¿Cuánto terreno dedica a la producción pecuaria? _____(ha.)

F. PRODUCCION DEL CICLO DE TEMPORAL DEL 2014 -- En el ciclo de temporal (2014), ¿qué uso dio a cada una de sus parcelas o parcelas rentadas?

# Parcela	Uso de Parcela	# hectáreas	Tenencia de Parcela	¿Tiene riego? S/N	¿Hubo afectación o siniestro? S/N	¿Qué afectación hubo? (Especifique)	¿Qué % del cultivo se perdió?	¿Qué clase de semilla sembró?	¿Qué color?	¿Qué marca de semilla sembró?	¿Quien le recomendó esta semilla?	¿Desde qué año usa esta variedad?	¿Está vinculada a contrato o acuerdo con empresa o despacho? S/N	¿Alguna vez ha asistido a un evento demostrativo o promocional de la semilla? S/N	¿Cuánto cosechó por ha.? (unidad)	¿Cuánto apartó para el consumo?	¿Cuánto apartó para animales?	¿Cuánto vendió en total? (unidad)	¿A qué precio? (unidad)	¿Con quien vendió?
1																				
2																				
3																				
4																				
5																				

Notas (Especifique acerca de afectaciones, contratos, etc.)

Uso: Cultivo (especifica); Pastizal (**P);** Monte (**M**); Dio Rentado (**R**); Rastrojo (**RT**) **Tenencia**: Propio (**P**); Rentado (**R**); Prestado (**PR**) **Clase:** Criollo (**C**); Variedad (**V**); Hibrido (**H**) **Color**: Blanco (**B**); Amarillo (**A**)

Afectación: (1) Helada/Exceso de frío; **(2)** Sequía; **(3)** Exceso de humedad/lluvia; **(4)** Viento; **(5)** Exceso calor; **(6)** Plaga; **(7)** Enfermedad; **(8)** Otro

Unidad: Toneladas (**T**) o Bultos (**B**); Grano (**G**), Mazorca (**M**), Elote (**E**) o Silo (**S**) **Venta: (1)** Coyote (Centroamérica); **(2)** Coyote (Venta a México); **(3)** Maseca; **(4)** Otro (Especifica)

Quien: (1) Amigo/familiar; **(2)** Empresa semillera; **(3)** Programa del gobierno **(4)** Ejido; **(5)** Organización campesina; **(6)** Otro (especifique)

G. PRODUCCION DEL CICLO DE RIEGO DEL 2014/15 -- En el ciclo de riego del 2014/15, ¿qué uso dio a cada una de sus parcelas o parcelas rentadas?

# Parcela	Uso de Parcela	# hectáreas	Tenencia de Parcela	¿Tiene riego? S/N	¿Hubo afectación o siniestro? S/N	¿Qué afectación hubo? (Especifique)	¿Qué % del cultivo se perdió?	¿Qué clase de semilla sembró?	¿Qué color?	¿Qué marca de semilla sembró?	¿Quien le recomendó esta semilla?	¿Desde qué año usa esta variedad?	¿Está vinculada a contrato o acuerdo con empresa o despacho? S/N	¿Alguna vez ha asistido a un evento demostrativo o promocional de la semilla? S/N	¿Cuánto cosechó por ha.? (unidad)	¿Cuánto apartó para el consumo?	¿Cuánto apartó para animales?	¿Cuánto vendió en total? (unidad)	¿A qué precio? (unidad)	¿Con quien vendió?
1																				
2																				
3																				
4																				
5																				

Notas (Especifique acerca de afectaciones, contratos, etc.)

Uso: Cultivo (especifica); Pastizal (**P);** Monte (**M**); Dio Rentado (**R**); Rastrojo (**RT**) **Tenencia:** Propio (**P**); Rentado (**R**); Prestado (**PR**) **Clase:** Criollo (**C**); Variedad (**V**); Hibrido (**H**) **Color:** Blanco (**B**); Amarillo (**A**)

Afectación: (1) Helada/Exceso de frío; **(2)** Sequía; **(3)** Exceso de humedad/lluvia; **(4)** Viento; **(5)** Exceso calor; **(6)** Plaga; **(7)** Enfermedad; **(8)** Otro

Unidad: Toneladas (**T**) o Bultos (**B**); Grano (**G**), Mazorca (**M**), Elote (**E**) o Silo (**S**) **Venta: (1)** Coyote (Centroamérica); **(2)** Coyote (Venta a México); **(3)** Maseca; **(4)** Otro (Especifica)

Quien: (1) Amigo/familiar; **(2)** Empresa semillera; **(3)** Programa del gobierno **(4)** Ejido; **(5)** Organización campesina; **(6)** Otro (especifique)

H. PRODUCCION DEL CICLO DE TEMPORAL DEL 2015 -- En el ciclo de temporal (2015), ¿qué uso dio a cada una de sus parcelas o parcelas rentadas?

# Parcela	Uso de Parcela	# hectáreas	Tenencia de Parcela	¿Tiene riego? S/N	¿Hubo afectación o siniestro? S/N	¿Qué afectación hubo? (Especifique)	¿Qué % del cultivo se perdió?	¿Qué clase de semilla sembró?	¿Qué color?	¿Qué marca de semilla sembró?	¿Quien le recomendó esta semilla?	¿Desde qué año usa esta variedad?	¿Está vinculada a contrato o acuerdo con empresa o despacho? S/N	¿Alguna vez ha asistido a un evento demostrativo o promocional de la semilla? S/N	¿Cuánto cosechó por ha.? (unidad)	¿Cuánto apartó para el consumo?	¿Cuánto apartó para animales?	¿Cuánto vendió en total? (unidad)	¿A qué precio? (unidad)	¿Con quien vendió?
1																				
2																				
3																				
4																				
5																				

Notas (Especifique acerca de afectaciones, contratos, etc.)

Uso: Cultivo (especifica); Pastizal (**P);** Monte (**M**); Dio Rentado (**R**); Rastrojo (**RT**) **Tenencia:** Propio (**P**); Rentado (**R**); Prestado (**PR**) **Clase:** Criollo (**C**); Variedad (**V**); Hibrido (**H**) **Color:** Blanco (**B**); Amarillo (**A**)

Afectación: (1) Helada/Exceso de frío; **(2)** Sequía; **(3)** Exceso de humedad/lluvia; **(4)** Viento; **(5)** Exceso calor; **(6)** Plaga; **(7)** Enfermedad; **(8)** Otro

Unidad: Toneladas (**T**) o Bultos (**B**); Grano (**G**), Mazorca (**M**), Elote (**E**) o Silo (**S**) **Venta: (1)** Coyote (Centroamérica); **(2)** Coyote (Venta a México); **(3)** Maseca; **(4)** Otro (Especifica)

Quien: (1) Amigo/familiar; **(2)** Empresa semillera; **(3)** Programa del gobierno **(4)** Ejido; **(5)** Organización campesina; **(6)** Otro (especifique)

I. PRODUCCION DEL CICLO DE RIEGO DEL 2015/16 -- En el ciclo de riego del 2015/16, ¿qué uso dio a cada una de sus parcelas o parcelas rentadas?

# Parcela	Uso de Parcela	# hectáreas	Tenencia de Parcela	¿Tiene riego? S/N	¿Hubo afectación o siniestro? S/N	¿Qué afectación hubo? (Especifique)	¿Qué % del cultivo se perdió?	¿Qué clase de semilla sembró?	¿Qué color?	¿Qué marca de semilla sembró?	¿Quien le recomendó esta semilla?	¿Desde qué año usa esta variedad?	¿Está vinculada a contrato o acuerdo con empresa o despacho? S/N	¿Alguna vez ha asistido a un evento demostrativo o promocional de la semilla? S/N	¿Cuánto cosechó por ha.? (unidad)	¿Cuánto apartó para el consumo?	¿Cuánto apartó para animales?	¿Cuánto vendió en total? (unidad)	¿A qué precio? (unidad)	¿Con quien vendió?
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2																				
3																				
4																				
5																				

Notas (Especifique acerca de afectaciones, contratos, etc.)

Uso: Cultivo (especifica); Pastizal (**P);** Monte (**M**); Dio Rentado (**R**); Rastrojo (**RT**) **Tenencia:** Propio (**P**); Rentado (**R**); Prestado (**PR**) **Clase:** Criollo (**C**); Variedad (**V**); Hibrido (**H**) **Color:** Blanco (**B**); Amarillo (**A**)

Afectación: (1) Helada/Exceso de frío; **(2)** Sequía; **(3)** Exceso de humedad/lluvia; **(4)** Viento; **(5)** Exceso calor; **(6)** Plaga; **(7)** Enfermedad; **(8)** Otro

Unidad: Toneladas (**T**) o Bultos (**B**); Grano (**G**), Mazorca (**M**), Elote (**E**) o Silo (**S**) **Venta: (1)** Coyote (Centroamérica); **(2)** Coyote (Venta a México); **(3)** Maseca; **(4)** Otro (Especifica)

Quien: (1) Amigo/familiar; **(2)** Empresa semillera; **(3)** Programa del gobierno **(4)** Ejido; **(5)** Organización campesina; **(6)** Otro (especifique)

J. PRODUCCION DEL CICLO DE TEMPORAL DEL 2016 -- En el ciclo de temporal (2016), ¿qué uso dio a cada una de sus parcelas o parcelas rentadas?

# Parcela	Uso de Parcela	# hectáreas	Tenencia de Parcela	¿Tiene riego? S/N	¿Hubo afectación o siniestro? S/N	¿Qué afectación hubo? (Especifique)	¿Qué % del cultivo se perdió?	¿Qué clase de semilla sembró?	¿Qué color?	¿Qué marca de semilla sembró?	¿Quien le recomendó esta semilla?	¿Desde qué año usa esta variedad?	¿Está vinculada a contrato o acuerdo con empresa o despacho? S/N	¿Alguna vez ha asistido a un evento demostrativo o promocional de la semilla? S/N	¿Cuánto cosechó por ha.? (unidad)	¿Cuánto apartó para el consumo?	¿Cuánto apartó para animales?	¿Cuánto vendió en total? (unidad)	¿A qué precio? (unidad)	¿Con quien vendió?
1																				
2																				
3																				
4																				
5																				

Notas (Especifique acerca de afectaciones, contratos, etc.)

Uso: Cultivo (especifica); Pastizal (**P**)**;** Monte (**M**); Dio Rentado (**R**); Rastrojo (**RT**) **Tenencia:** Propio (**P**); Rentado (**R**); Prestado (**PR**) **Clase:** Criollo (**C**); Variedad (**V**); Hibrido (**H**) **Color:** Blanco (**B**); Amarillo (**A**)

Afectación: (1) Helada/Exceso de frío; **(2)** Sequía; **(3)** Exceso de humedad/lluvia; **(4)** Viento; **(5)** Exceso calor; **(6)** Plaga; **(7)** Enfermedad; **(8)** Otro

Unidad: Toneladas (**T**) o Bultos (**B**); Grano (**G**), Mazorca (**M**), Elote (**E**) o Silo (**S**) **Venta: (1)** Coyote (Centroamérica); **(2)** Coyote (Venta a México); **(3)** Maseca; **(4)** Otro (Especifica)

K. SEMILLAS

1. ¿Usted siembra maíz criollo que se puede guardar y resembrar? (S/N) _____

Sí: a. ¿De que variedad y en cuanta área siembra? _____

b. ¿Qué cualidades tiene ese maíz? _____

No: c. ¿Cuándo fue el ultimo año en que usted sembró maíz criollo? _____

d. ¿De qué variedad sembraba?_____ e. ¿Cuánta área sembraba? _____

f. ¿Quién fue la ultima persona en su familia que sembraba criollo? _____ ¿En qué año lo dejó? _____

g. ¿Por qué dejó de sembrar esas variedades de semillas? _____

2. ¿En qué año empezó a usar semillas hibridas o mejoradas? _____

L. INVERSION AGRICOLA -- ¿En promedio, cuanto gasta por hectárea en lo siguiente?							
Renta de terreno (peso/ha)	**Preparación de terreno**	**Semilla**	**Siembra**	**Insumos**	**Riego**	**Cosecha**	**Total**

M. FINANCIMIENTO AGRICOLA

1. ¿Cómo financió su producción para el ciclo de temporal del 2016?

De propio bolsillo ____ Prestamos de conocidos ____ Crédito ____ Contrato con empresa ___ Remesas ___ Otro _____

2. Si utiliza algún tipo de préstamo, crédito o contrato, ¿cuales son los términos?:

Cantidad por hectárea _____; # hectáreas_____; Taza de interés _____% cada _____ (mes, 6 meses, año)

Notas:_____

¿Quien provee el financiamiento?

_____

3. ¿Desde qué año financia su producción de esta manera?_____

4. ¿Usted tiene alguna deuda atrasada por prestamos relacionados con su producción? (S/N) ____

Especifique:_____

5. ¿Usted ha tenido problemas con financiar su producción? _____

Especifique:_____

N. PRODUCCION PECUARIA

Actualmente, cuántos tiene de:	**Numero**	**# Vendido en 2016**	**Tenencia**	**¿Está asociado con un crédito? (S/N)**	**En los últimos 10 años, ha aumentado, disminuido, o sigue igual el # de animales**	**¿Tiene planes de aumentar, disminuir o seguir igual esta producción?**
Vacas de ordeña						
Toretes de engorda						
Becerros						
Sementales						
Puercos						
Gallinas/aves de traspatio						
Otro						
Notas:						

Tenencia: Propio (**P**); Al Partir (**AP**) **Cambios:** Aumentado (**A**); Disminuido (**D**); Sigue Igual (**SI**)

O. SINIESTROS Y AFECTACIONES

1. ¿Usted ha notado cambios en el clima local en los últimos 20 años? (S/N) _____ Especifique: _____

2. ¿En los últimos 10 años, ha aumentado, disminuido o sigue igual lo siguiente:			
	Ha aumentado	Ha disminuido	Sigue igual
Meses de sequía:			
Intensidad de tormentas:			
Extremos de frío:			
Extremos de calor:			
Variabilidad climática:			
	Ha aumentado	Ha disminuido	Sigue igual
Numero de plagas/enfermedades:			
La cantidad de insumos que requiere para una buena cosecha:			
Fertilidad de suelos:			
Los costos de producción			
Notas:			

3.¿En los últimos 10 años, cuales siniestros o afectaciones más graves ha habido en su producción? (empiece desde mayor afectación)					
Tipo de Afectación	Cultivo(s) Afectado(s)	¿Cómo le afectó?	¿Recibió alguna asesoría para resolver el problema? S/N (de quien)	¿Cuántos ciclos de los últimos 10 años le ha afectado?	¿Cuáles años?

P. ¿Cuál de lo siguiente ha hecho para responder a los cambios o afectaciones que ha experimentado en los últimos 10 años? (Marcar todos los que aplican e indica desde que año lo hace)

- ☐ Pedir riego de auxilio.
- ☐ Ajustar fechas de siembra. Especifique: _____
- ☐ Reducir superficie sembrado.

Especifique:_____

- ☐ Experimentar con otros cultivos/actividades. Especifique: _____
- ☐ Vender animales u otras posesiones. Especifique: _____
- ☐ Cambiar de semillas. Especifique: _____

☐ Cambiar de insumos. Especifique: _____
☐ Invertir en nuevo equipo o tecnologías. Especifique: _____
☐ Aumentar ingresos de otras fuentes (eje. Animales). Especifique: _____
☐ Dar rentado/vender terreno. Especifique (área; a quien; de riego o no?): _____
☐ Rentar mejor terreno. Especifique: _____
☐ Probar técnicas alternativas y/u orgánicas: Especifique:_____ _____
☐ Otro. Especifique: _____

Q. ¿Alguna vez ha hecho una reclamación al seguro por cosechas o animales afectados/perdidos? S/N _____
☐Sí: ¿En cuantos ciclos productivos de los últimos 10 años hizo reclamación? _____
☐ Sí, pero la aseguradora solo cubrió: _____
☐No: No, no cuento con seguro en mi producción ☐No: Tengo seguro pero nunca he tenido perdidas que reclamar
Especifique: _____
. ¿Usted cuenta con cobertura de precios por parte de Aserca/SAGARPA? S/N _____

R. ORGANIZACIÓN CAMPESINA

1. ¿Está afiliado con alguna asociación, unión de productores u organización campesina? (S/N): ____
Nombre de grupo(s): _____
Desde cuando es miembro: _____
Beneficios de asociarse: _____

2. ¿En cuales actividades ha participado en los últimos 2 años?			
	Talleres/cursos		Evaluaciones de parcelas/Extensión Técnica
	Intercambio de experiencias		Gestión de apoyos gubernamentales
	Créditos		Gestión de proyectos
	Marchas o protestas		Acciones para conseguir mejores ventas/precios

Especifique: _____
3. ¿Cuáles practicas o cambios ha adoptado desde que se unió a la organización/asociación? Especifique: _____

S. CARACTERISTICAS DE LAS ACTIVIDADES EN EL TRASPATIO			
	Sí	**No**	**# Variedades (aprox.)**
a. ¿Tiene árboles frutales en su traspatio?			
b. ¿Tiene cultivos medicinales en su traspatio?			
c. ¿Tiene hierbas comestibles en su traspatio?			

d. ¿Tiene alguna verdura u hortaliza en su traspatio?			
e. ¿Siembra algún tipo de maíz o milpa en su traspatio?			

T. PREGUNTAS ADICIONALES

1. ¿En los últimos 10 años, ha aumentado, disminuido o sigue igual lo siguiente:			
	Ha aumentado	Ha disminuido	Sigue igual
a. La cantidad de comida que produce para su propio consumo/familia			
b. Su calidad de vida			
c. Los riesgos de producción			
d. La contaminación en las parcelas del ejido			
e. El área que tiene en producción agrícola			
f. El área que tiene en producción pecuaria			

2. ¿Hay cultivos o variedades que antes producían en su familia pero que ya no? (e.g. frijol, calabaza): Especifique

3. ¿Cuáles son 3 cosas que le gustan de su producción y/o ventas actuales?:
4. ¿En orden de importancia, nombre las 3 cosas que mas se le complican o le preocupan de su producción y/o ventas actuales?

5. ¿Hay practicas o cambios en la producción agropecuaria o manejo de recursos naturales aquí en el ejido que le preocupan? (abierto): _____

6. ¿Cuáles son sus expectativas para el futuro de su producción? ¿Piensa cambiar algo? ¿Probar nueva tecnología o practica? ¿Vender/rentar tierras? ¿Seguir produciendo igual? ¿Diversificar su producción? (abierto):_____ _____

7. ¿Usted cree que sus hijos seguirán en la producción agropecuaria en el futuro? (S/N) _____ Notas:_____

¡GRACIAS POR COMPARTIR SUS RESPUESTAS PARA ESTE ESTUDIO! ¿Tiene alguna pregunta o comentario? (Anota abajo)

Notas Adicionales:

_____

APPENDIX B: HOUSEHOLD SURVEY – NON-ACTIVE FARMERS - BENITO JUAREZ EJIDO, LA CONCORDIA, CHIAPAS (2016)

Nota: Si no hay nadie en la casa que maneje o renta tierras en producción agropecuaria, favor de llenar los siguientes datos:

A: DATOS DEMOGRAFICOS

	Genero	**Edad**	**Ejidatario**	**Estado Civil**	**Escolaridad**	**Religión**	**¿Cuantos Hijos?** (Rango de edades)	**¿Cuantos Nietos?**
Entrevistado/a								

Genero: Hombre (H); Mujer (M) **Ejidatario: (1)** Basico/capacitado; **(2)** Posesionario; **(3)** Avecindado **Estado Civil:** Casado (C), Soltero (S), Union Libre (UL), Viudo (V)
Escolaridad (nivel completo): **(1)** Ninguno; **(2)** Primaria; **(3)** Secundaria; **(4)** Bachillerato; **(5)** Universitario o superior; **(6)** No sabe/No responde

	Ocupación Principal	**Otros oficios o fuentes de ingreso**	**¿Recibe algún apoyo del gobierno?**	**Detalles de apoyo recibido** (cantidad, frecuencia, # hectáreas/animales)
Entrevistado/a				
Esposo/a				
Hijo/a #1				
Hijo/a #2				
Hijo/a #3				
Hijo/a #4				
¿Cuáles hijos viven en casa?			¿Cuantos nietos viven en casa?	
Notas:				

Apoyos: (1) Procampo/Proagro; (2) Progan; (3) Pensión para mayores; (4) Oportunidades/Prospera; (5) PAL (Apoyo Alimentario); (6) Otro (Especifica)

¿Trabaja alguien en su familia nuclear como jornalero?	**¿En promedio, cuantos días por mes trabaja como jornalero?**	**¿En promedio, cuantos meses por año?**	**¿En donde trabaja?** (dentro del ejido o afuera)	**¿En que cultivos o actividades trabaja?**

B. MIGRACIÓN

		¿Alguna vez ha migrado?		Destino	¿Durante qué años?	¿Años total afuera?	¿Manda ayuda actualmente?		¿En qué invierte (o invirtió) las ganancias de su migración?	¿Piensa migrar otra vez?		
		Sí	No				Sí	No		Sí	No	Quizás
Entrevistado/a												
Esposo/a												
Hijos/as?												
Notas:												

Destino: (1) Ciudad en Chiapas; (2) Ciudad en México; (3) EEUU; (4) Otro (Especifica)
Inversión: (1) Construir Casa; **(2)** Bienes (carro, etc); **(3)** Terreno; **(4)** Maquinaria/Tecnología para producción **(5)** ganado

C. HISTORIA DE PRODUCCION (Anota respuestas atrás de la hoja si es necesario)

1. ¿Quién fue la ultima persona en su familia en trabajar en producción agropecuaria?
2. ¿Cuáles eran sus cultivos o actividades productivas principales?
3. ¿En qué año dejó de trabajar en la producción?
4. ¿Por qué motivo dejó de trabajar en la producción agropecuaria?
5. ¿Todavía cuenta con terreno propio?

___SI: ¿Cuánto terreno tiene en la actualidad?
¿Qué uso le da a su terreno en la actualidad?
¿Desde cuando le da ese uso?
¿Está vinculado a algún programa o apoyo monetario?_____ _____

___NO: ¿Desde qué año no tiene terreno?_____ ¿Cuánto terreno tenía? _____ ¿Qué pasó con el?_____

¡GRACIAS POR COMPARTIR SUS RESPUESTAS PARA ESTE ESTUDIO! ¿Tiene alguna pregunta o comentario? (Anota abajo)

Appendix C: Sample of semi-structured interview questions asked of corn farmers

1. *Name, Age, and Contact Info*
2. *Casado?*
3. *Hijos? Nietos?*
4. *¿Qué nivel de escolaridad tiene?*
5. *Donde nació? Origen de familia*
6. *Ejidatario basico, posesionario, o avecindado?*
7. *Cual es su profesión? ¿Cuáles son las fuentes principales de ingreso para su hogar? (trabajos, remesas, pension, etc.)*
8. *Alguna vez ha migrado a otro pais o otra ciudad? (donde/cuanto tiempo)*

A. AGRICULTURA

1. Formación: *¿Hace cuanto tiempo que trabaja en la producción agrícola o pecuaria? ¿Cuáles son sus cultivos o actividades principales?*

2. ***Land tenure:*** *¿Cuánto hectáreas de terreno tiene en total? (todo en ejido?)*

3. ¿De eso, cuantas hectáreas tienen riego?

4. ***Average farm area:*** *En promedio, cuanto terreno siembra en el ciclo de temporal? Y en el ciclo de riego? ¿Siempre ha sembrado la misma cantidad de terreno o varia? (por cuanto varia – cuanto has sido lo maximo y mínimo sembrado)*

5. ***Average ranching area:*** *En promedio, cuantas hectareas dedica a la producción pecuaria?*

6. ***Other crops:*** *Ha experimentado con otros cultivos o practicas productivas en el pasado? Cuales?*

<u>Land Rent, Purchases and Sales:</u>

6. ***Rent land*** *¿Alguna vez ha rentado terreno para expandir su producción agrícola o pecuaria?*

a. En los últimos 5 años, ¿cuantos ciclos ha rentado terreno?

b. En promedio, ¿cuánto terreno renta y por cuanto tiempo?

7. ***Rent out land*** *¿Alguna vez ha dado a rentar su terreno o ha hecho un arreglo de cosechas compartidas u otro tipo de intercambio por el uso de suelo a otras personas? En los últimos 5 años, ¿cuantos ciclos ha dado a rentar terreno? ¿Por qué?*

8. ***Company agreements:*** *¿Alguna vez ha hecho trato con alguna compañía por el uso de su terreno? (e.g. parcela demostrativa)*

9. ***Land sales:*** *¿Alguna vez ha vendido tierra? ¿Cuántas hectareas? ¿Cuándo, por qué y a quién?*

10. ***Land purchases:*** *¿Alguna vez ha comprado tierra? Cuanto y cuando? Por que?*

PRODUCCION

11. ***2016 temporal –*** *Cuanto y de que sembró? ¿Recibió algún prestamo de insumos, préstamo, o crédito para financiar sus actividades agrícolas? De quien? Condiciones?*

¿Depende de créditos para cada ciclo de producción? Si no, como financia su producción? ¿Cuándo fue el ultimo año en que recibió un credito?

Deuda - *¿Usted tiene deuda en la actualidad? ¿Su deuda está relacionada con la producción agropecuaria? ¿De que forma?*

¿Hay cosas que cambiará para su producción de este año (e.g. variedad de semilla, área sembrada, contrato, fertilizante, etc)? ¿Qué motiva estos cambios?

12. ***2015/16 riego -*** *¿Qué y cuanto cultivó? ¿Cuánto cosechó? ¿Hubo alguna afectación? ¿Cómo le afectó?*

Ventas: *A que precio vendió? Con quien? Precio bueno, malo, mas o menos?*

13. ***2015 temporal -*** *¿Qué y cuanto cultivó? ¿Cuánto cosechó? ¿Hubo alguna afectación? ¿Cómo le afectó?*

Ventas: *A que precio vendió? Con quien? Precio bueno, malo, mas o menos?*

14. ***2014/15 Riego -*** *¿Qué y cuanto cultivó? ¿Cuánto cosechó? ¿Hubo alguna afectación? ¿Cómo le afectó?*

Ventas: *A que precio vendió? Con quien? Precio bueno, malo, mas o menos?*

15. ***2014 Temporal -*** *¿Qué y cuanto cultivó? ¿Cuánto cosechó? ¿Hubo alguna afectación? ¿Cómo le afectó?*

Ventas: *A que precio vendió? Con quien? Precio bueno, malo, mas o menos?*

16. ***High and low harvests:*** *En los ultimos 10 años, cuanto ha sido el mejor rendimiento que ha sacado de temporal? Y de riego? ¿Cuánto ha sido el mas bajo rendimiento que ha sacado?*

En los ultimos 10 años, cuanto ha sido el precio mas alto que ha recibido por tonelada? Y mas bajo?

17. ***Seeds: ¿****En el ciclo de temporal (2016), de cuales semillas sembró?*

¿Donde consiguió la semilla? ¿La semilla está vinculada a algún contrato, programa de gobierno, o paquete tecnológico?

¿Desde cuando siembra esa variedad? ¿Quien lo introdujo a la semilla?

¿Cuáles características tiene la semilla?

Seeds: *Y en el ciclo de riego de 2015/16?*

18. ***Semilla Criolla:*** *¿Usted siembra algún maíz criollo? ¿Cuáles variedades? ¿Cuántas hectáreas de semilla criolla siembra cada ciclo y para que lo usa (venta/consumo)?*

19. Si no usa, ¿Cuándo fue la ultima vez que sembró maíz criollo? ¿Qué le motivó a dejar de guardar y reusar su maíces criollos?

20. ***Technology opinion:*** *¿qué opina de las nuevas semillas y tecnologias que se han introducido en la región?*

21. ***Input costs:*** *¿En promedio cuanto invierte en insumos para una hectarea de temporal? ¿y de riego?*
22. ***Labor costs and/or Machinery*** *– por hectarea temporal? Y de riego?*

23. ***Animales:*** *¿En el 2016, cuanto terreno dedicó a la producción pecuaria? ¿Cuantos animales tiene actualmente? ¿Cuáles productos vende? Con quien vende? Cada cuanto tiempo?*

¿Desde cuando cría animales? ¿Compra alimento para sus animales?

¿Tiene algún tipo de contrato, prestamo o apoyo vinculado a su producción pecuaria?

Increase animals? - *¿En los últimos 10 años, ha aumentado o disminuido su producción pecuaria? ¿de que forma y por que?*

¿Tiene planes de aumentar o disminuir su producción pecuaria en los próximos años?

24. ***Subsistence (autoconsumo):*** *¿Cuánto maiz aparta cada año para el servicio de su casa? ¿Cuales otros productos produce para el autoconsumo (incluye traspatio)?*

B. CLIMATE CHANGE AND DECISION MAKING

1. ***Climate changes -*** *¿Qué cambios ha notado en el clima local en los utlimos 10 o 20 años?*
2. ***More drought?*** *En los ultimos 10 años, ha aumentado, disminuido o sique igual (1. Aumento 2. Sigue igual 3. Disminuyó)*
    a. *Los meses de sequia (incluye canicula)*
    b. *Eventos de lluvias fuertes*
    c. *Variabilidad climatica*
3. ***Change Practices?*** *¿Cómo le han afectado estos cambios a su producción? ¿Hay cosas que ha cambiado en sus practicas agricolas debido a estos cambios?*

C. INFORMACION CLIMATICA

1. ¿Usted tiene alguna forma de anticipar los siniestros climáticos?

2. ¿Depende de algún conocimiento heredado de sus papas o abuelos para decidir como y cuando sembrar? ¿Puede ofrecer unos ejemplos?

a. ¿Ha habido años en que ese conocimiento le ha fallado por causa de variabilidad climática, plagas u otra razón? ¿Puede ofrecer unos ejemplos?

D. AFECTACIONES y PERCEPCIONES DE RIESGO

1. ¿En los últimos 10 años, cuales siniestros o contratiempos más graves ha habido para su producción? (empieza desde mayor afectación)

2. ***Insurance -*** *En los últimos 10 años, ¿alguna vez ha tenido que hacer una reclamación al seguro por cosechas o animales perdidos? ¿cuándo y por que?*

3. ¿Para usted, qué representa un año malo? (clima, mercados, programas) (abierta)

4. ¿Para usted, qué representa un año bueno? (abierta)

5. Tomando el caso del último año malo (por clima o por mercados, etc), ¿cuáles acciones tomó y cuales fueron las consecuencias para su economía, parcelas y/o animales?

E. PREGUNTAS ADICIONALES:

1. ***Conservación*** *¿Usted realiza practicas de conservación de suelo o agua en sus parcelas? ¿Cuáles? ¿Desde cuando? ¿Quién lo introdujo a la practica?*

2. Medioambiente *¿Cuales cambios ha observado en la calidad de suelo, agua, y fertilidad de sus parcelas en los últimos 20 años? ¿A que se debe esos cambios?*

3. ***Local ag changes -*** *¿Qué cambios ha observado en la producción agropecuaria o el manejo de tierras desde que produce en esta region (e.g. 20 años)? ¿Cuales y por que?*

5. ***Pests:*** *¿Hay mas o menos plagas ahora? ¿De que tipo y por qué?*

6. ***Challenges:*** *¿Cuáles son los 3 desafios mas grandes que tiene como productor? ¿Qué se podría hacer para resolver esos desafíos?*

¿Pensando en el futuro de su producción, cuál es su mayor preocupación ambiental? ¿Cuál es su mayor preocupación relacionada con el clima?

7. Expectativas Futuras *¿Cuáles son sus expectativas para el futuro de su producción?*

a. ¿Piensa cambiar algo? ¿Introducir tecnología? ¿Vender tierras? ¿Seguir produciendo? ¿Diversificar su producción?

b. ***Ejido -*** *¿Cuáles son sus expectativas para el futuro de la producción agropecuaria en el ejido?*

8. ¿En orden de importancia, cuales son 3 factores principales que influyen sus decisiones de cuales cultivos sembrar y cuantas hectáreas de cada cultivo sembrar? (e.g. pronostico de clima; crédito y/o financiamiento; precios del mercado) (Pide que haga lista en orden de importancia)

F. APOYOS GUBERNMENTALES Y NO GUBERNMENTALES

1. ***Apoyo gubernmental -*** *¿Recibe algun apoyo de parte del gobierno para su producción? (e.g. Procampo, Aserca, Progan) Desde cuando y en que cantidad?*

2. ¿De que forma influyen estos programas en sus decisiones de producción? ¿Sin este apoyo, cambiaría algo de su producción?

3. ¿Usted o alguien de su familia recibe otros apoyos gobernmentales (e.g. Prospera, pension, etc.)?

4. ¿En los últimos 10 a 20 años, piensa usted que han cambiado los programas agrícolas del gobierno?

a. SI: En que forma han cambiado? (Abierta) ¿Esos cambios en los programas le ha causado cambiar su producción o comercialización? ¿De que forma?

5. En los ultimos 10 años, ha aumentado, disminuido o sigue igual (1. Aumento 2. Sigue igual 3. Disminuyo)

a. La cantidad de comida que produce para su propio consumo

b. El costo de los insumos para producción

6. ***Contratos*** *¿En los últimos 5 años, usted ha tenido algún tipo de contrato para su producción? ¿Cuáles son las condiciones del contrato? ¿Cual es su experiencia con esos contratos? y ¿Cómo influyen los contratos en sus decisiones de producción?*

7. ***Mercados*** *¿Cómo han cambiado los mercados para sus productos en los últimos 10-20 años? ¿Hay cambios en los costos de insumos?*

8. ***Policy:*** *Si podría, ¿Qué cosas cambiaría dentro de la política y la economía de la producción agropecuaria? (nombra 3 en orden de importancia)*

G. ASISTENCIA TECNICA

1. ¿Alguna vez ha recibido asistencia técnica o capacitación de parte del gobierno, una empresa, o una organización? ¿Cuando y de que?

2. ¿Alguna vez en los últimos 10 años ha recibido apoyos en la forma de semillas? ¿Cuándo y de quien?

b. ¿Alguna vez ha recibido apoyos en la forma de insumos? ¿Cuándo y de quien?

3. Si tiene preguntas acerca del manejo de sus cultivos o parcelas, ¿a quien pregunta?

H. ORGANIZACIÓN CAMPESINA

A. Cambios Generacionales

1. *Si sus padres y/o abuelos también son o eran productores agrícolas, ¿Qué diferencias existen entre sus sistemas de producción de hoy y los sistemas productivos de sus papas/abuelos? (e.g. cultivos, rotación de cultivos, insumos/semillas, maquinaria)*
2. *¿Piensa que sus hijos seguirán con la producción agrícola en el futuro? ¿Por qué?*

B. Ejido:

1. *¿En qué año llegó su familia a la comunidad?*
2. *¿Qué beneficios adquiere a través del ejido para su producción agropecuaria?*
3. *¿Qué opina de la organización ejidal y su papel dentro de la productividad agrícola?*
4. *¿Cómo ha cambiado el ejido en los últimos 20 años? (e.g. ¿Hay mas ventas/compras de terreno?)*

C. Partidos Políticos

1. *¿Alguna vez ha recibido regalos de semillas, herramientas, fertilizantes o algún otro insumo de un partido político? (especifique que cosas, que partido, que años)*
2. ***Role of govt in Ag -*** *¿En su opinión, que papel debería tener el gobierno en promover la productividad, comercialización y distribución de productos agrícolas?*

D. Organización Campesina

1. ¿Sus pápas o abuelos pertenecían a alguna asociación campesina, programa, o agrupación de productores agropecuarios? Cuales?

2. ¿Pertenece usted a alguna asociación campesina, programa, o agrupación de productores agropecuarios? ¿Cuales? ¿Desde cuando es miembro?

3. ¿Cuáles son los requisitos de su participación en cada organización o programa?

4. ¿Cuáles son los beneficios de asociarse?

5. ¿Cuál ha sido la lección mas valiosa que ha aprendido a través de su participación en cada organización/programa?

6. ¿Qué le motivó a asociarse con la organización? ¿Ve su participación como una decisión económica, una decisión ambiental, como parte de un movimiento social, o alguna combinación? (Especifique)

7. ¿Cuáles practicas ha adoptado desde que se unió a la organización? De esas practicas, ¿cuales piensa que sean de beneficio ambiental? ¿Cuáles son de beneficio económico?

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