GEOs and Gender:
GEOs and What They Mean for Women Farmers in Kenya

by

Cassandra Demers-Morris

Submitted in partial fulfilment of the requirements
for the degree of Master of Arts

at

Dalhousie University
Halifax, Nova Scotia
November 2015

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Kenya is on the brink of becoming the fourth African nation to commercialize genetically engineered organisms (GEOs). The Water Efficient Maize for Africa (WEMA) program is expected to publicly release a variety of drought tolerant Bt maize seed as early as 2017. WEMA is marketing this technology as a means of improving food security among small-scale farmers in Kenya's arid zones. To date, little research has been conducted investigating the potential impacts of this technology for small-scale farmers, particularly women. This thesis uses Feminist Political Ecology as a theoretical construct in predicting the gendered implications of the commercialization of WEMA's GE maize seed in the Machakos and Kitui districts of Kenya. It argues that socio-political factors that limit women's access to key ecological resources are likely to restrict the benefits of GE technology.

LIST OF ABBREVIATIONS USED

AATF	African Agricultural Technology Foundation
ACTS	African Centre for Technology and Science
AGRA	Alliance for a Green Revolution in Africa
Bt	Bacillus Thuringiensis
CGIAR	Consultative Group on Agricultural Research
CIMMYT	International Maize and Wheat Improvement Centre
EFSA	European Food Safety Authority
FAO	Food and Agriculture Organization
FPE	Feminist Political Ecology
GDP	Gross Domestic Product
GE	Genetically Engineered
GEO	Genetically Engineered Organism
GM	Genetically Modified
GMO	Genetically Modified Organism
HR	Herbicide Resistant
HYV	High Yielding Varieties
IDRC	International Development Research Centre
KARI	Kenyan Agricultural Research Institue
KBDP	Kenya Biotechnology Development Policy
KOAN	Kenyan Organic Agriculture Network
MOA	Ministry of Agriculture
NAFTA	North American Free Trade Agreement
NBA	National Biosafety Authority
NGO	Non-Governmental NGO
OECD	Organization for Economic Cooperation and Development
PE	Political Ecology
PPP	Public Private Partnerships
RA	Research Assistant
TC	Tissue Culture
WEMA	Water Efficient Maize for Africa

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my gratitude to all those who supported me in the completion of this thesis. It was your help, guidance, and encouragement that made this research possible.

Thank you Dr. Matthew Schnurr for lending your expertise, for your revisions, and for your constant encouragement. As my thesis supervisor you were always available and eager to help. Thank you also Dr. Theresa Ulicki and Dr. Elizabeth Fitting for acting as second and third readers. Your feedback was invaluable to my paper. Thank you Nicole Drysdale for your words of encouragement and for helping me to stay on track.

I am also grateful to the African Centre for Technology and Science for your warm welcome and for your help in obtaining research approval in Kenya. In addition, this project would not have been possible without the invaluable help of my research assistant. Thank you for being a wonderful guide, for your work as translator, and for your insight. I would also like to thank all those in Kenya who participated in my research and those who helped me along the way-I will never forget your kindness.

Lastly, I would like to recognize my friends and family, whose constant support and encouragement have helped me to get where I am today. Alanna Taylor, thank you for the late night work sessions and for commiserating in the writing process. Last but not least, thank you Riley Morris, my life partner, for your company in Kenya, for your emotional and financial support, and for always believing in me.

CHAPTER 1: INTRODUCTION

Over the past fifteen years, Kenya has established itself as the East African hub for biotechnology research. By the turn of the century, it was poised to become the fourth African country to commercialize the use of Genetically Engineered Organisms (GEOs) after South Africa, Burkina Faso, and Egypt (Schnurr & Gore, 2015). In 2000, the country invested 2.6% of its GDP into biotechnology research, which is more than three times the average in sub-Saharan Africa (Smith & Harsh, 2007). Biosafety policies began the process of ratification in 2006, and in 2009 the country passed a permissive biosafety bill and established the National Biosafety Authority (NBA), an organization tasked with both promoting and regulating the use of GEOs (ISAAA, 2015; Kingiri & Ayele, 2009; Hall & Kingiri, 2012). It was not long after this that Kenya began conducting contained field trials for genetically engineered maize, sweet potato, cassava, and cotton (Njagi & Scott, 2008).

But in late 2012 these efforts were abruptly stopped. The Cabinet of former President Mwai Kibaki surprised everyone when they voted to ban the use and importation of GEOs after reading a controversial study headed by French researcher Gilles-Eric Séralini (Willingham, 2012). The Séralini study found that mice fed GE maize were more likely to develop cancerous tumours (Séralini, et al., 2014). Though the paper was eventually retracted (only to be republished in a separate journal in 2014), Kenya's Health Minister was heavily impacted by the study, having herself battled breast cancer. In 2012, she advised President Kibaki to ban the use and importation of GEOs (Schnurr, 2015a). A year later, Kenya elected a new president, Uhuru Kenyatta, and biotechnology supporters were confident the ban would soon be lifted. Three years later

the ban still remains in effect.

Many research groups and government officials have lobbied for a reversal of the ban, which has been criticized for slowing agricultural research efforts, stifling job creation, and increasing the risk of crop disease (Odour, 2014; Heuler, 2014; Grace October, 2013, Nairobi). These efforts proved successful on August 13th, 2015, when Deputy Minister (and former Agricultural Minister) William Ruto announced his intent to reverse Kenya's ban on GEOs in an effort to improve national food security. In an interview with the press he stated, "We will be removing the ban in one or two months. Already, government agencies concerned with biotechnology have agreed on necessary regulations and safety measures to be adhered to" (Ruto in Koross, 2015). Some researchers have estimated that GEOs will be commercially available within a year (Schnurr, 2015a)

Despite Kenya's renewed enthusiasm for the commercialization of GEO's, there are few studies dedicated to predicting their effects on small-scale farmers and fewer still that engage these farmers in their research (Falck-Zepeda, Horna, & Smale, 2008). Also, despite the many studies that demonstrate that new technologies can have varying impacts on men and women, the potential gendered impacts of GE seeds in Kenya remain critically under-explored. This thesis seeks to question the implications of this technology for small-scale female farmers. It centres on women's access to and control over ecological resources and asks how their realities are likely to be affected by the introduction of GE maize. Maize is a staple crop in Kenya, used in (among other things) the preparation of their national dish: ugali. My primary research question is: "What are the potential implications of the commercialization of GE maize seed for small-scale

women farmers in Kenya?"

This introductory chapter elaborates on the history of GEOs in Kenya and introduces the case study of the Water Efficient Maize for Africa (WEMA) program. It then examines the global debates surrounding the benefits and risks of GEO's, and elaborates on the implications of the technology for small-scale female farmers. Lastly, this chapter will discuss my research questions in greater detail and present an outline for the rest of the paper.

1.1 Defining Biotechnology and Genetically Engineered Organisms (GEOs)

The Organization for Economic Cooperation and Development (OECD) defines biotechnology as "the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services" (Beuzekom & Arundel, 2009). Their 2009 report also provides a list of biotechnology functions that include, among other things, genetic engineering. Thus, agricultural biotechnology (or "biotech") regularly refers to the deliberate manipulation of plant life. It is a term used to describe a spectrum of plant breeding methods, one of which is the creation of genetically engineered (or modified) organisms (Beuzekom & Arundel, 2009)

Campbell et al. (2009), define a genetically engineered organism (GEO) as "an organism that has acquired one or more genes by artificial means; also known as transgenic organisms" (p.16). Genetic engineering often involves manually inserting DNA into an organism (usually DNA containing a desirable trait such as drought or pest resistance) enabling rapid gene transfers between two species that could not be bred

naturally[1] (Campbell et al., 2009; WEMA, 2012). For example, bacillus thuringiensis (Bt) is a naturally occurring soil-dwelling bacterium that is harmful to certain species of insects although it is non-pathogenic to humans (Cranshaw, 2014). Over 150 species of insects are known to be prone to the effects of Bt, most of which are contained within the genus Lepidoptera, which includes the larvae of butterflies, moths and caterpillars. A number of different Bt strains exist and provide toxic effects towards other species such as mosquitoes, blackflies and midges (Extension Toxicology Network, 1994). Biotech companies have been able to insert the Bt gene into crops that do not naturally carry it, such as cotton and maize, in order to improve their insect resistance (Cranshaw, 2014). Farmers have been commercially planting GEOs such as these since the mid-1990s (Malinga, Gethi, & Ngari, 2010). [2]

1.2 The Case of Biotechnology in Kenya

Despite the ban, proponents of GEOs hold Kenya up as an example to be followed in the area of agricultural biotechnology development (Harsh, 2005). Former agricultural ministers Kipruto Kirwa (2003-2007) and William Ruto (2008-2010) paved the way for the introduction of GEOs by creating the Kenya Biotechnology Development Policy (KBDP) in 2006, and ratifying the Biosafety Act in 2009. These legislative documents were created with the aim of steering "the Kenyan government towards the development and safe application of biotechnology" (ISAAA, 2015). Then, in 2009, a National

[1] Genetic Engineering can be achieved not only by the insertion of foreign material into the DNA of an organism, but also through the alteration of DNA within a single organism (US National Library of Medicine, 2015).

[2] Although the term "genetic modification" (GM) is frequently used in place of the term "genetic engineering", GM can encompass a wider scope of plant breeding techniques (such as open pollination and hybridization- methods which are possible in situ).2 For the sake of this paper I will employ the term GEO/GE. However, given its popularity, my academic sources and study respondents often favoured the term GMO. Discretion was used in order to ensure that the methods discussed were congruent with modern (GEO) breeding techniques regardless of terminology.

Biosafety Authority (NBA) was created as the agency that would be responsible for promoting, regulating, and monitoring GEOs (Kingiri & Ayele, 2009; Hall & Kingiri, 2012). The Kenyan Agricultural and Livestock Research Organization (KALRO), formally known as the Kenyan Agricultural Research Institute (KARI), is the national agency charged with developing and conducting field trials on transgenic maize, sweet potato, cassava, and cotton crops (Njagi & Scott, 2008).

However, despite the strong calls from biotech supporters to commercialize GE seeds, many researchers question the legitimacy of Kenya's biosafety framework. Perhaps one of the largest issues present in the literature is regarding the supply driven nature of biotech governance in Kenya, an issue also experienced by her African counterparts. For example, as Smith and Harsh (2007) argue, Kenya's biosafety regulations and its biotechnology have developed concomitantly. The first trials on transgenic sweet potatoes in 1991 occurred in an era where biosafety regulations were virtually non-existent and it is only as the industry developed that regulations were written and ratified (Harsh and Smith, 2007). Today, the Kenyan government still employs a largely reactive approach to the industry by responding to pressures created by biotech companies, leaving critics questioning the degree to which the research agendas of invested parties have been formulating public policy (Harsh, 2005; Kingiri and Hall, 2012).

Schnurr and Gore (2015) have made similar arguments regarding biotechnology regulation in Uganda. In their article "Getting to 'yes': Governing Genetically Modified crops in Uganda", they examine the factors and relationships that shape biotech policy and governance. They find that the push towards GEOs in Africa has been largely supply

rather than demand driven. For example, in Uganda, "demand for experimentation and legislation have not come from farmers or even public representatives but rather as a result of a large volume of investment and support from external interests" (p.68). They discuss the role of multinational organizations and foreign-based development agencies in shaping Uganda's biotech policy, in determining research agendas, and in identifying agricultural priorities. Not only are foreign companies driving Uganda's agricultural reforms, but the local governance structures intended to regulate biotechnology are also responsible for promoting it. Schnurr and Gore (2015) use Kenya's National Biosafety Authority as an example stating that:

> …the dual role occupied by …[Kenya's] regulatory agency is problematic: it underlines the tension between the economic argument in favour of GM crops as a driver of agricultural development and the legislative obligation to regulate this technology …[M]embers are tasked with making crucial decisions around health and environmental safety while simultaneously championing the potential benefits of GMOs. As a result, it is impossible to determine where promotion ends and regulation begins (p. 65).

Muraguri (2010) similarly demonstrates how the same processes that formed biotech policy in Uganda has been occurring in Kenya through "public private partnerships" (PPPs). PPPs usually involve collaboration between private companies and public institutions. It is often assumed that each party contributes to the project and that the power is distributed evenly (Muraguri, 2010). In the case of biotech PPPs in Kenya, large international institutions or multilateral organizations, often in the form of foreign aid organizations, almost always represents the private sector (for a list of agricultural PPPs in Kenya, see Appendix A, table 3). KALRO often represents the public sector. As Muraguri (2010) explains,

> Typically, in Kenyan agriculture biotech PPPs, local (public) partners who are mainly from the Kenya Agriculture Research Institute (KARI) or resident International Agriculture Research Centres (IARCs) in collaboration with

> researchers from the North prepare proposals that are then funded by Northern donors who consist of the traditional development agencies, bilateral donors and increasingly private-not-for-profit foundations (Ikiara et al., 2004). Some of these proposals [that] are often invited by the donors are not competitive. In other words, the donors approach the scientists working in the research institutes and invite them to apply for funds for a specific project. The local private sector is rarely involved (p. 297).

Both policy makers and academics have praised these PPPs, however Muraguri (2010) argues that they have fallen short of their imagined goal of achieving food security, which can be explained by two main factors. First, international donors determine the length and depth of projects and little has been done to ensure the continuation of a project in Kenya once funding has dried up. Second, this distribution of resources creates a power imbalance that places the objectives of foreign institutions ahead of national objectives. As Muraguri states, "in the case of agriculture biotech PPPs in Kenya and in other developing countries, any inequality in power should, arguably, be in favor of the national public sector partner which, presumably, is the custodian of national goals such as the attainment of food security" (p. 298). Arguably, this power imbalance places significant policy influence in the hands of foreign companies that are very much invested in the success of their technology. In sum, the introduction of GEOs in Africa is being driven primarily by non-Africans.

However, to the dismay of these PPPs, the Séralini study in 2012 precipitated a decision by Kenya's Health Minister and President that would put a halt to their progress. Séralini et al. (2012) published a controversial two-year study in France designed to test the long-term health implications of Monsanto's GE maize (strand NK603) and Roundup (a herbicide). Monsanto had undertaken a similar 90-day feeding trial study in 2004 (Séralini, et al., 2014). Although Monsanto's study revealed signs of liver and kidney toxicity in the GE-fed rats, the European Food Safety Authority (EFSA) found these

differences to be “of no biological significance”. The EFSA concluded that NK603 maize was safe for consumption and authorized the product’s distribution in the EU (Séralini, et al., 2014). On the other hand, Séralini’s results indicated that Monsanto maize-fed rats suffered from severe liver and kidney damage and the early development of tumours (Séralini, et al., 2014). The study was heavily criticized by independent science groups (concerns ranged from validity of findings to proper use of animals in the study) and was eventually retracted from the scientific journal that published it, only to be republished in 2014 in a different journal (Willingham, 2012; Genetic Literacy Project, 2014). Regardless of the paper’s retraction, the Kenyan government banned the use and importation of GEOs perhaps as a result of the Health Ministers own personal experience with cancer (Schnurr, 2015a). In any case, President Kibaki stated that the ban was to protect Kenyan’s because the health effects of GE food were inconclusive (Owino, 2012). The decision surprised the Cabinet as well as the agricultural scientific community.

The ban was met with resistance by many of Kenya’s agricultural research groups and the National Biosafety Authority. The legality of the ban was even put into question when the permanent secretary of the Ministry of Agriculture argued that the Biosafety Authority needed to approve it, something that they never did (Steiber, 2013). In October 2014, 9 Members of Parliament pledged to attempt to lift the ban and, in a news article Honorable Wilbur Otichilo stated, “We are in the process of constituting a Parliamentary Select Committee, to independently gather information on GM food safety and ultimately advise the House and the Cabinet to lift the ban” (Genetic Literacy Project, 2014).

As time progressed, opposition towards the ban grew even more impatient. In 2014, Maize Lethal Necrosis Disease ravaged Kenya, and the Cereal Growers

Association says its continued prevalence could cut maize production by one third, affecting 70% of Kenya's maize farmers (Heuler, 2014). Critics of the ban believe that GE maize could curb the effects of the disease and increase food security (Heuler, 2014). Moreover, the ban has slowed research projects and discouraged agricultural scientists. As Odour (2014) states:

> There is an urgent need to lift the ban, which is a threat to Kenya's food security, and the agriculture biotechnology field in general, to nurture homegrown biotech skills. (…) The government recognizes biotechnology as a platform for creating jobs. However, the ban is hurting students registered and those graduating with biotechnology and related degrees since they are not sure of finding jobs when they graduate (Odour, 2014).

Both Grace, a WEMA representative at the MOA and Daniel, a representative from the NBA, revealed that the ban has also slowed progress on the WEMA project because administrators and researchers have been unable to import the germplasm needed to continue breeding GE maize (Grace, October 15th, 2015, Nairobi; Daniel, October 30th, 2013, Nairobi). As such, the media has heavily criticized the ban (Heuler, 2014; Willingham, 2012) and government and research groups have made several attempts to have it overturned.

On August 12th 2015, at the annual Bio-Safety Conference at the Kenya School of Monetary Studies in Nairobi, Deputy Minister (and former Agricultural Minister) William Ruto stated his intent to overturn the ban in 2 months' time. Here, Ruto said, "Various government ministries, departments and agencies concerned with biotechnology have already consulted and agreed on the necessary regulations and safety measures to be adhered to so that we can maximise on agricultural production, improve health services, conserve the environment and basically improve the living standards of our people" (Guguyu, 2015). Given this sudden and recent announcement, one can expect that the

work of Kenya's agricultural PPP's will be accelerated; GE maize may be available on the Kenyan market as early as 2017 making this research as pertinent and timely as ever (Guguyu, 2015). These events highlight the relevance of my study and the need to study the implications of such technology.

1.3 GEOs and Agricultural Intensification: The Debate

Despite Kenya's recent announcement to embrace the technology, the international community is still very much engaged in a lively debate surrounding the benefits and pitfalls of GEOs. The most cited benefit of using GE seeds is increased crop yield and consistent crop quality. This is because GE seeds can be designed to produce more fruit, withstand harsh weather conditions, or act as a biological pesticide (Malinga, Gethi, & Ngari, 2010; James, 2009). In 2010, the Food and Agriculture Organization (FAO) estimated that 925 million people worldwide were suffering from chronic hunger, the majority of whom live in sub-Saharan Africa (FAO, 2010). Researchers, scientists, and organizations that advocate for the dissemination of GEOs often cite these hunger statistics in attempts to demonstrate the failings of current agricultural systems in developing countries (Campbell & Reece, 2008; Stone, 2010). Since the use of GEO's are advanced as a method of increasing yields, many scientists have made somewhat Malthusian justifications for their use by stating that unless biotechnology is embraced in developing nations, food consumption needs will soon outpace food production (Bett, Ouma, & Groote, 2010; AGRA, 2012).

Moreover, Brookes and Barfoot's (2010) research argues that the increased use of GEOs globally can reduce greenhouse gas emissions by lessening the need for pesticides (Barfoot & Brookes, 2010). A reduction in the need for pesticides can also save money

for farmers as well as lessen the health and environmental risks associated with spraying a field (Huesing & English, 2004). GE also has the potential to make significant strides forward in the biofortification of staple crops. Biofortification is "the development of micronutrient-dense staple crops using the best traditional breeding practices and modern biotechnology" (Nestel et al., 2006, p.1064). In short, this technique allows for additional nutrients to be added to food and genetic engineering would allow for the transfer of genes with nutrients that cannot be added through natural breeding processes (Nestel et al., 2006). For example, a GE rice variety known as golden rice which contains beta-carotene and other carotenoids, is being designed to combat Vitamin A deficiency, one of the leading causes of blindness in Asia (James, Brief 41: Global status of Commercialized biotech/GM Crops: 2009, 2009).

Yet there are many who are apprehensive about this technological shift and argue that hunger and malnutrition are the result of poverty, politics, and the misdistribution of food rather than food scarcity (Sen, 1999; Holt-Gimenez, Altieri, & Rosset, 2006; Vanhaute, 2011; McMichael, 2009). The Indian Green Revolution, which occurred in the 1960s and 1970s and was characterized by a shift from traditional to modern agricultural practices, is often cited in this debate (Singh, 2000). New seeds known as high yielding varieties (HYV) were developed using modern breeding techniques (but not genetic engineering) and were sold in conjunction with inputs such as pesticides, herbicides, and commercial fertilizers. Despite an initial increase in the production of wheat and cereals (Mondal, 2015), Vandana Shiva argues that the Green Revolution precipitated a loss of biodiversity, a decrease in soil fertility, and an increase in farmer debt (Shiva, 1991, p.58). During a lecture at Dalhousie University in 2014 she argued:

> The term 'high yielding varieties' is wrong because none of these varieties are

> high yielding in and of themselves. They yield under conditions of huge irrigation and a lot of chemical input…so call them high response varieties- but of course high response varieties would have made the chemical issue come forward, and the spin was it was about feeding the world (November 12th, 2014).

Notwithstanding an increase in yields from HYVs [3], India is now experiencing agricultural decline[4] leaving some farmers with high-input costs, increased debt, soil degradation, water scarcity, and an increase in plant diseases (Guruswamy and Gurunathan, 2010; Centre for Education and Documentation, 2009).

Despite controversial evidence regarding the Green Revolution in India, it is still often considered a triumph. This perceived success has spurred enthusiasm towards an "African Green Revolution" which would be characterized by an increase in crop output, achieved mainly through commercial farming and the widespread use of biotechnology such as GEOs. The African Green Revolution embodies the idea that better agricultural technologies could solve the problem of rural poverty in Africa. Probably one of the most powerful players in this movement is the Alliance for a Green Revolution in Africa (AGRA).

AGRA was established in 2006 through a partnership between the Rockefeller Foundation and the Bill & Melinda Gates Foundation (AGRA, 2015). Today, AGRA has invested over $400 million in agricultural improvement efforts (Schnurr b, 2015) and obtains program funding from government and international institutions such as: The International Development Research Centre (IDRC), and the Consultative Group on Agricultural Research (CGIAR), the UK Department for International Development

[3] Between 1967-68 and 2003-2004 the production of wheat increased three-fold and the production of cereals doubled (Mondal, 2015).

[4] A report published by the International Food and Policy Research Institute states: "The crop sector grew by only 1.3 percent per annum in the 1990s, down from 4.8 percent in the 1980s, and has had negative growth in the early 2000s" (IFPRI, 2007,p. iii).

(DFID), African Union's New Partnership for Africa's Development (NEPAD), and Association of Europeans Parliamentarians for Africa (AWEPA) (AGRA, 2015). AGRA is currently operating in the "breadbasket regions" of 17 African countries and the development and introduction of improved seeds are part of AGRA's broader mandate of improving food security and alleviating poverty among African farmers (AGRA, 2015). It is important to note that although AGRA does not directly fund GE research, its founding institutions do. AGRA's programs generally focus on improving varieties of African carbohydrate staple crops such as cassava, cowpeas, sweet potato, sorghum, and maize. Their website states:

> African farmers have crop productivity below the global standard because they do not have access to improved adaptable seed varieties. Most of the available commercial seed varieties were developed and released more than 30 years ago, and they are now susceptible to several emerging challenges not limited to climate change (AGRA, 2015).

The Green Revolution mantra is spreading quickly across Africa. For example, in 2014 approximately 9% of the world's agricultural land was devoted to GEO's, and this figure was up 6 million hectares from 2013 primarily as a result of growth in developing countries (James, 2014). For instance, in 2014, Sudan, South Africa, and Burkina Faso increased their Bt cotton hectarage by approximately 46%. In this same year Cameroon, Egypt, Ghana, Kenya, Malawi, Nigeria, and Uganda all conducted experimental field trials on GE staple crops such as rice, maize, wheat, sorghum, bananas, cassava and sweet potato (James, 2014).

In contrast to the rosy predictions made by biotech supporters, there is much debate regarding the motivations behind the push towards an African Green Revolution. Much like how Muraguri (2010) has argued that agricultural PPPs are driving the push

for GE seeds in Kenya, Schnurr (2015b) has argued that they are driving the push for GE seeds in Africa as a whole. For example he states,

> Experimental programs have proliferated across the continent, including *Nutritionally Enhanced Sorghum* in Kenya, *Disease-Resistant Cooking Banana* in Uganda, and *Insect-Resistant Cowpea* in West Africa. Each of these initiatives follows a similar template. These are Public-Private Partnerships (PPPs), facilitated by intermediaries, in which the technology is given royalty-free to experimental programs undertaken by African scientists employed by government ministries….The result…is that critical decisions over the direction and focus of each PPP remains almost exclusively within the purview of these powerful actors, with few opportunities for farmers to shape and influence these experimental programs (Schnurr, 2015b p. 203).

Dr. Paul Richardson (2010) also argues that without a certain level of collaboration between farmers and scientists, a "Green Revolution" will fail. He challenges the top-down supply driven nature of agricultural PPPs in Africa by arguing that there is a large disconnect between the engineers (seed producers) and the end users (farmers). For example, his research on African rice farmers revealed that when they rejected a new seed it was not for lack of information, it was because (despite higher yields) the technology was labour intensive and failed to meet their needs. As Richardson (2010) states, "…a high-yielding crop type may be rejected in favour of a range of local low-yielding types, because the high yielding type does not fit local patterns of labour availability, or produces only at a single season, or has the wrong consumption or storage characteristics" (p. 10). The current modus of operandi for GE supporters is to exclude farmers until the delivery stage of a technology, which will, as Richardson argues, be the downfall of the African Green Revolution.

With regards to food security, Glenn Stone and Dominic Glover (2010), demonstrate how in 2006-2007 GEOs were widely covered in the media as a technology that could mitigate the effects of the food crisis and prevent the catastrophe from

repeating itself in Africa. Mosley et al. (2015) address this issue by showing how it was not low agricultural productivity which prompted the food crisis in Africa, but rather an array of neoliberal policies which directed funding towards the production of cash crops, removed supports for small-scale agriculture, and encouraged the use of supermarkets over informal markets. However, rather than being seen as the result of an export oriented market and high food prices, the food crises was (wrongly) considered to be a consequence of production deficiency. As such, the crisis lent momentum to the movement for a Green Revolution in Africa and there was a rebirth of the "technocratic focus on food production as the best way to solve global, and especially African, food insecurity" (Mosley et al, 2015, p.4).

In Mexico, many see the topic of GE maize as being intricately connected to this larger narrative of neo-liberal policies, free trade agreements, the monetization of agriculture, and even a loss of indigenous culture (Fitting, 2006). In fact, this topic has become so contentious that is has spurred national protests. For example, in 2002, 14 peasants' groups organized demonstrations calling for a renegotiation of the North American Free Trade Agreement (NAFTA), and "the immediate halt of GM corn imports" (Fitting, 2006 p. 18). The Campaign's slogan was "El Campo No Aguanta Mas" (in English: "The Countryside Can't Take it Anymore") (Fitting, 2006).

Lipton's (2007) research meticulously examines the climate in which "Green Revolution" technology (such as HYVs) has been successful, and concludes that these outcomes were contingent upon an array of socio-political variables. This theory is corroborated by Schnurr's (2012) research on Bt cotton in South Africa. In 1999- 2000 a group of British and South African researchers published a sequence of articles (based on

a single survey) that argued that Monsanto's Bt cotton had drastically improved the lives of farmers in the Makhathini Flats region of South Africa. This study became a catalyst propelling efforts to promote the use of GEOs throughout the continent. However, Schnurr's (2012) own research revealed that Bt cotton's success in the area was contingent on an array of political and environmental factors that were specific to that region and time. He argues that farmers were planting Bt cotton because there was a readily available market for it, rather than because it was superior to traditional crops. The market was supplied by a private enterprise entitled Vunisa Cotton (which also provided loans to cotton farmers). When these loans were removed from the region, Bt cotton farmers operated at a loss (Schnurr, 2012).

The debate surrounding GEOs has demonstrated that GEO seeds and agricultural intensification has the potential to both enrich and impoverish farmers. Given the controversial nature of this technology, it is important that research regarding its impacts on both male and female farmers be conducted - especially prior to launching an irreversible "Green Revolution" in Africa.

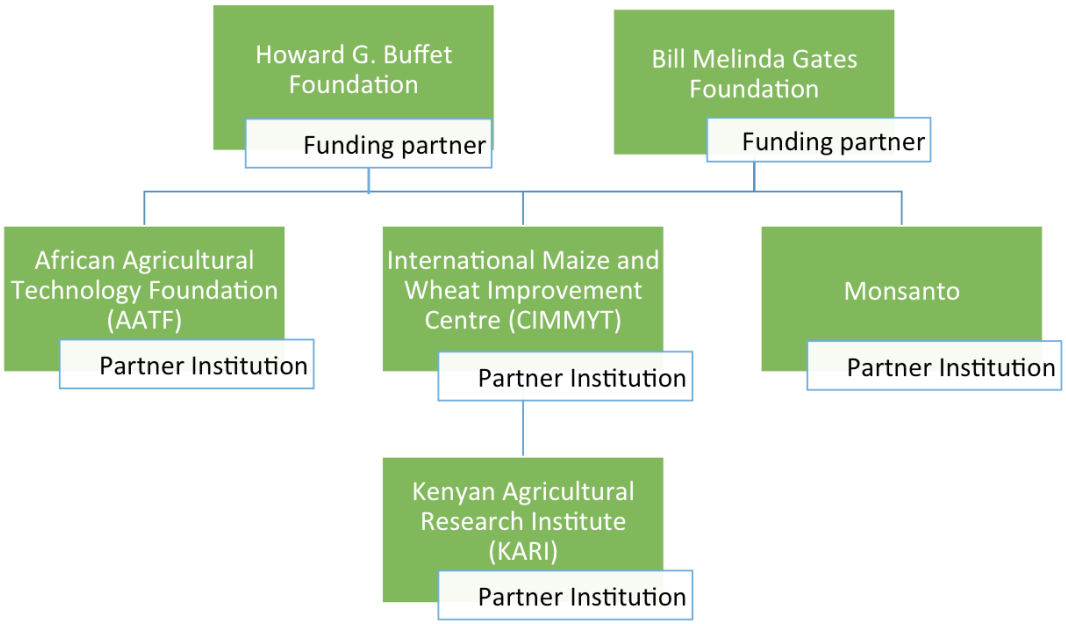
1.4 The Case Study

The Water Efficient Maize for Africa (WEMA) project is a public-private partnership managed by the African Agricultural Technology Foundation (AATF) (AATF, 2012). AATF is an international non-profit organization "that facilitates and promotes public/private partnerships for the access and delivery of appropriate agricultural technologies for sustainable use by smallholder farmers in Sub-Saharan Africa (SSA)…" (AATF, 2012). The Rockefeller Foundation, UKAID, and USAID are the original funders for AATF, however organizations such as Syngenta, PepsiCo, the Bill and

Melinda Gates Foundation, and the Howard G. Buffet Foundation have also directed funding towards AATF programming. For example, in addition to developing WEMA's water efficient and insect resistant maize seed, AATF is also working on creating striga (a parasitic weed) resistant maize, water efficient and salt tolerant rice, bacterial wilt disease resistant bananas, and high yielding hybrid rice varieties.

The WEMA project is a PPP managed by the AATF with funding partners (The Bill and Melinda Gates Foundation and the Howard G. Buffet Foundation) and international research partners (CIMMYT and Monsanto). WEMA also has local partners in five African countries Kenya, Mozambique, South Africa, Tanzania, and Uganda. Kenya's local partner institute is KALRO, a public institution (See figure below) (AATF, 2012).

Figure 1: WEMA's Organizational Structure (Demers-Morris, 2014)



WEMA's objective is "to develop drought-tolerant [and insect-protected (Bt)] maize varieties, adapted to improve yields under moderate drought stress. The long-term goal is to deploy these new varieties and make them available to smallholder farmers'

royalty free through local African seed companies" (AATF, 2012). Conventional hybrid varieties of drought tolerant maize were approved for commercial release in 2013, and transgenic GEO varieties are expected to be available by 2017. WEMA partners believe these seeds will improve food security for small-scale farmers and, in Kenya, the seeds will be marketed mostly to the arid and semi-arid zones in the eastern part of the country. David, a WEMA representative at the AATF confirmed this information during my field research (David, October 22nd, 2013, Nairobi).

The WEMA project has finished phase I (2008-2013), wherein confined field trials (CFTs) were conducted in Kenya, Uganda, and South Africa, and drought tolerant maize hybrids have been submitted to national performance trials in Kenya. Phase two (2013-2017) began in February 2013 and is focused on making this technology available to smallholder farmers (AATF, 2012). To date, phase II has been sucessful in such as 16 conventional hybrid varieties have been developed and approved for commercial release. The launch of one such variety called Drought TEGO (WE1101) has shown success in increasing yields among early adopters. For example, a press release published on WEMA's website states "Among 39 sites initially surveyed by AATF, DroughtTEGO resulted in an average harvest of 4.5 tons per hectare, more than double the national average of 1.8 tons per hectare in Kenya" (WEMA, 2014). The Figure 2 in appendix B outlines the chronology of the WEMA project and illuminates some of the accomplishments and objectives of phases 1 and 2. Figure 3 is taken from WEMA's webpage and shows a broader project tragectory.

1.5 Women and Biotechnology

Women make up just over 50% of the agricultural labour force in East Africa (Doss,

2011). Because informal and unpaid labour often get left out of statistical analyses, it is hard to know exactly how many small-scale or subsistence farmers are women. Despite the lack of an exact estimate, research suggests that in the rural informal sector women farmers dominate in numbers (Doss, 2011; FAO, 2011). Moreover, agricultural issues have been found to affect men and women differently due to the division of labour and household responsibilities, cultural norms, and access to agricultural and financial resources (Doss, 2011). Given their disproportionate roles in African agriculture, it is crucial to understand whether the new generation of GE crops being promoted as part of Africa's Green Revolution match up with the realities of the continent's female farmers.

An array of research has been conducted regarding gender and the adoption of biotechnology in Africa. Morris and Doss's (1999) research in Ghana revealed that women were less likely than men to adopt transgenic maize varieties due to a lack of access to key inputs such as land, labour, and extension services. Thus, when examining whether women and men will adopt a biotechnology, they urge researchers in this field to examine "both the technology itself and the physical and institutional context in which the technology is implemented" (Morris & Doss, 1999, p. 9). Horell and Krishnan (2006) studied female-headed households in Zimbabwe and stated "gender-based differences in access [to resources] …emerge as possible determinants of the lower productivity and agricultural incomes observed in female-headed households" (Horrell & Krishnan, 2007, p. 10). A study conducted by Turineh et al., (2001) concluded that male-headed households in Ethiopia were more likely to adopt improved wheat seeds than female-headed households. Sanginga et al. (2007) published similar results in Nigeria with regards to improved soybean technology (in Zambrano et al., 2011).

Gilbert, Webster, and Benson (2002) examined the relationship between agricultural extension workers and women farmers in Malawi. They found that when extension workers administered a nation-wide survey, only 270 (19%) of the total 1385 respondents were women, despite the fact that women account for nearly 70% of the full-time farmer population in Malawi. Gilbert et al., interpret the survey's results as proof that extension workers in Malawi ignore women by preferring to interact with male farmers (Gilbert, Webster, & Benson, 2002). Matin Qaim's research on non-pathogenic banana trials in Kenya discovered that men generally received and controlled farm-derived income, despite the fact that women were often responsible for managing the farms (Qaim, 1999). Both Qaim (1999) and Zambrano et al. (2011), found that female farmers frequently lacked crucial information regarding biotechnology.

The research highlighted above indicates that female and male farmers are treated differently by their agricultural communities, enjoy varying levels of access to ecological resources, and experience different levels of information regarding the risks and benefits of planting GEOs. It further reveals that women across Africa lack access to resources necessary to adopt biotechnology such as land, finances, credit, and extension services (Horrell & Krishnan, 2007; Hallman, Lewis, & & Begum., 2007; Qaim, 1999). Such prohibitive factors may also restrict women's abilities to refuse a biotechnological shift in agriculture. For example, if men are responsible for managing finances, purchasing farm equipment, and making business decisions, women may be left out of decisions regarding the adoption of GE seeds. Women may be less likely to invest in land that they do not formally own, and should the shift towards GEOs be costly, women's lack of credit opportunities could limit their adoption capabilities. Moreover, men may be

the first to be informed about this technology because they are more likely to attend an information session or talk to an extension officer (David, 2013).

The existing literature on this subject also describes a situation whereby men are regarded as being in control of commercial enterprises while women's roles in agriculture are often limited to subsistence farming. Ester Boserup alluded to this issue in the mid 1960's, refined her research in 1990s, and discussions surrounding this division of labour continues to exist in present-day publications (Boserup, 1965; Boserup, 1990; Doss, 2011; Hovorka, 2012; Alanna, October 8th, 2013). This is partly a result of women's perceived roles as homemakers and food providers while men are expected to contribute financially to the household. In the event that a shift towards GE seeds leads to mechanized farming or increases the commercial value of an agricultural enterprise, it is possible that women would lose decision making power on their farms. Since most land titles officially belong to men, they may take over associated work, decisions, and financial capital, because farming would transition from being considered a means of subsistence to a viable career.

1.6 Importance of Research

There is much to be gained from talking to farmers about a technology before it is commercialized. Addison and Schnurr (In Press) have been conducting research regarding GE matooke bananas in Uganda in anticipation of their commercialization. Their research has identified an array of intervening factors that affect farmer perceptions of and willingness to adopt new GE varieties, including geographical location, land size, and access to information.

Matin Qaim's (1999) research on non-pathogenic banana trials analyzed the

"preliminary benefits and impacts that could be brought about by the dissemination of tissue culture banana plantlets to resource poor farmers in Kenya" (p.iii). Although his study concluded that this biotechnology had the potential to significantly raise incomes for banana farmers, it also suggested a refinement of distribution mechanisms, an increase in agricultural extension services, and the proliferation of microcredit schemes. This *ex ante* research provided valuable insight into the factors that were likely to impact the project's success (high initial costs limiting resource poor farmers' ability to adopt, lack of information regarding new production techniques, and inefficient market distribution systems).

Falck-Zepeda, Horna, and Smale (2008) estimated the ex-ante impact and distribution of benefits from Bt cotton in West Africa. They argue that only two studies published between 1996 and 2006 address the potential economic impacts of Bt cotton in West Africa and that neither of these studies took into account damage abatement ("the proportion of the destructive capacity of the damaging agent eliminated by applying a given level of a control input") (p.191). Through their omission of damage abatement, these studies overestimated the benefits of insect resistant technology. Falck-Zepeda, Horna, and Smale's (2008) research advised decision makers of the risks and benefits associated with the adoption GE cotton and concludes that the benefits outweigh the risks, if only marginally.

Edmeades and Smale's (2006) work also demonstrates the importance of conducting ex ante research. For example, in Uganda scientists were preparing to undergo genetic engineering to ensure the propagation of strong cooking bananas. Edmeades and Smale's (2006) research goal was to determine the level of demand for

this technology among farmers. Their research proved extremely pertinent as it discovered two things: first, it helped scientists to understand which variety of banana to use as a "host plant" when creating the genetically engineered variety. In other words, their research helped seed developers to understand which traits were already valued and which seeds should be improved through genetic engineering. Second, they discovered that the recommended "host" plant was context specific, and that the traits it presented could have varying consequences depending on the adopting community. In their words: "By comparing the characteristics of agricultural households we demonstrate that the choice of one host variety instead of another can have social consequences for adoption, favoring one rural population compared to another" (Edmeades, 2006, p. 352).

Out of the many studies dedicated to predicting the impacts of biotechnology, few take place in developing nations and fewer still involve interviews with farmers. Among the studies that do, women are often left out of the conversation or the gender of respondents is not specified. Moreover, Bt cotton has been the subject of the majority of ex ante research, leaving much to be determined about staple crops such as maize (Falck-Zepeda, Horna & Smale, 2008). In the fall of 2013, at the time of my field research, WEMA had yet to make contact with farmers. No research was conducted in the target areas; there were no needs assessment, and no biotechnology information sessions for farmers (David, October 22nd, 2013). Furthermore, there has been no research conducted to determine the gendered implications of GE maize in Kenya, despite the fact that female farmers make up the largest demographic of WEMA's intended end users. Preliminary studies such as mine can help to anticipate the impacts of a technology and can help stakeholders avoid any negative implications they might have. By adding to the

body of ex ante studies in a way that has not been accomplished to date, my study contributes to our understanding of how a shift in agricultural technology can impact small-scale female farmers.

Moreover, my research adds to the more general literature on the socio-economic evaluation of GE crops for poor farmers. Like Edmeades and Smale's (2006) research on Ugandan cooking bananas and Schnurr's (2012) research on Bt cotton in South Africa, this research seeks to investigate the socio-economic factors that will determine adoption and success rates. It will assess the gendered implications of the commercialization of WEMA's GE maize by examining if women in the Machakos and Kitui districts of Kenya face any social or physical barriers that may impact their desire and ability to adopt, or benefit, from the new technology.

1.7 Research Question

My research centers on women's access and control over ecological resources and how their realities are likely to be affected by the introduction of WEMA maize. My primary research question is: "What are the potential implications of the commercialization of WEMA's GE maize seed for small-scale women farmers in Kenya?" In order to address to this question, the following sub-questions are posed:

1) How will women's realities play into the success/failure of the WEMA project?
2) Will WEMA seeds address food security issues among female farmers?
3) Are women farmers able and willing to adopt this technology?

In order to address the above questions, I conducted semi-structured qualitative interviews with 10 biotechnology experts, and 30 women farmers across the Machakos and Kitui districts (both of which are in WEMA target areas).

1.8 Chapter Outline

This introduction constitutes the first of six chapters. Chapter 2 introduces theoretical constructs employed throughout the thesis, including political ecology (PE), feminist political ecology (FPE), and feminist constructs of power. These theories help us to understand the socio-political variables affecting or causing environmental issues. Chapter 2 also provides examples of how others have utilized these theoretical constructs in order to understand the gendered and political characteristics behind environmental issues.

Chapter 3 discusses my research methods, scope, limitations, and ethical considerations. It provides interview site details, demonstrates the importance of having a research assistant, and describes qualitative research and snowball sampling, both of which apply to my research. It presents my research constraints and methodological challenges, and critically examines my own positionality and biases and how those may have impacted my research. Lastly, it discusses how my methods were congruent with those applied by PE and FPE researchers.

Chapter 4 contains my research results and analysis. It examines women's ability to access and control agricultural resources such as land, inputs (fertilizers and pesticides), labour, and credit. Subsequently, I discuss household economies and how people's bargaining capabilities within their households may influence their decision making power in their homes and on their farms. By exploring women's access to these

resources, we are able to better understand the issues that affect them in particular and predict how these gendered boundaries are likely to impact the outcome of biotechnology in Machakos and Kitui districts.

Chapter 5 is entitled "Additional Considerations" and discusses areas in need of further research. For example, it first discusses how access to water figured as an important part of my research, albeit one that warrants further examination in order to determine any gendered differences in access. Second, the linkages between GE adoption and women's access to information and agricultural extension services are examined. Third, I examine women's perceived willingness to adopt GE crops and its potential implications for WEMA maize.

Lastly, chapter 6 concludes by providing answers to my research questions based on the information presented throughout the paper. These findings underline the need to address the gendered productivity differentials in agriculture by increasing women's access to, and control over, ecological resources. Without such improvements, the perceived benefits of GEOs for small-scale female farmers are likely to be limited.

CHAPTER 2: FEMINIST POLITICAL ECOLOGY

2.1 Introduction

Feminist political ecology (FPE) "seeks to understand and interpret local experience in the context of global processes of environmental and economic change" while considering gender as a critical variable in shaping resource access and control (Rocheleau, Thomas-Slayter, & Wangari, 1996 p. 4). Prior to engaging in a thorough discussion of FPE, this chapter will begin by defining its root theory: political ecology (PE). Afterwards, it will briefly examine definitions of power that can be utilized by these theoretical constructs. Lastly, this chapter will draw upon other research that has utilized FPE in order to demonstrate how the theory can be used to answer my central research question.

2.2 Defining Political Ecology

The origins of political ecology date back to the 1970's when journalist Alexander Cockburn, anthropologist Eric Wolf, and environmental scientist Grahame Beakhurst, coined the term as a way of intellectualising the relationship between political economy and nature. As environmental concerns swelled during the late 70s and 80s, the term's popularity increased and it eventually evolved into a free-standing field of study (Paulson, Gezon, & Watts, 2003).

Blaikie and Brookfield (1987) argued that viewing political economy and ecology as intertwined opened up the door to new areas of analysis. For example, by examining the political nature of land fertility, Blaikie (1985) found that capitalist agrarian production and its reliance on crop surpluses contributed to soil degradation. Consequently, he argued that the decisions made by an individual farmer must be

examined in the context of wider society in order to be fully understood (Jones, 2008). PE promotes the incorporation of a worldview wherein everything is interconnected, and everything is political. It seeks to identify and understand the social, political, and economic forces behind environmental issues. As political ecologist Paul Robbins (2004) states,

> The difference between this contextual approach and the more traditional way of viewing problems…is the difference between a *political* and an *apolitical* ecology. This is the difference between identifying broader systems rather than blaming proximate and local forces; between viewing ecological systems as power-laden rather than politically inert; and between taking an explicitly normative approach rather than one that claims the objectivity of disinterest. (…) Political ecology, (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 (p. 13).

As an example, Robbins (2004) questions the apolitical and simplistic assumption that overpopulation in Kenya is leading to the destruction of wildlife habitat. Instead he argues that land tenure law, a competitive international market, and a high demand for food globally have all accelerated the conversion of grazing land to farmland. From this perspective, local and international political forces are integral to understanding the underlying causes of an environmental issue. The implications of using political ecology as a theoretical lens are significant, as suddenly the solution for dealing with a loss of wildlife can shift from the promotion of family planning to advocating for change in international food markets and local land policy.

Political ecology is interdisciplinary, and thus comprises of academics and researchers from the fields of anthropology, forestry, development studies, environmental sociology, geography, and women's studies (Bryant, 1998). Initially, PE focused mostly on issues of class, but soon scholars began questioning how other categories of power

could influence environmental outcomes, and the focus widened to include issues of gender, race, and ethnicity. Emphasis on these new foci prompted the creation of a new theoretical construct: FPE.

2.3 Defining FPE

In their renowned book, "Feminist Political Ecology: Global Issues and Local Experience", Rocheleau, Thomas-Slayter, and Wangari (1996) argue that FPE involves the examination of gendered relations of ecologies, economics, and politics in various communities around the globe. They state,

> While there are several axes of power which may define people's access to resources, their control over their workplace and home environments, and their definition of a healthy environment, we focus on gender as one axis of identity and difference that warrants attention (p.5).

The United Nations' (UN) definition of gender can help us to situate its importance in social science research and FPE. The UN's defines gender as:

> ...the social attributes and opportunities associated with being male and female and the relationships between women and men and girls and boys, as well as the relations between women and those between men. These attributes, opportunities and relationships are socially constructed and are learned through socialization processes. They are context/ time-specific and changeable. Gender determines what is expected, allowed and valued in a women or a man in a given context. In most societies there are differences and inequalities between women and men in responsibilities assigned, activities undertaken, access to and control over resources, as well as decision-making opportunities… (United Nations, 2015)

The definition above neatly summarizes why Rocheleau, Thomas-Slayter, and Wangari (1996) felt that gender warranted more attention in social science research and developed FPE. Gender is socially defined, context specific, and can impact individuals access and control over environmental resources.

FPE is a broad concept that opens the door to multi-scalar analyses of how

different genders interact with their environments and also how social, political, and economic structures shape environmental outcomes. FPE allows the questioning and challenging of patriarchal structures on household, national, and international levels, and incorporates a gendered analysis into decision making processes, particularly pertaining to environmental policy and practice (Rocheleau, Thomas-Slayter, & Esther, 1996). Such multi-scalar analyses have become a critical component of FPE because it was found that often international or national policy programs are implemented without an in-depth understanding of the lived realities of men and women on a household level. Alternatively, development policy and theory have also been critiqued for "blaming" the local, by mislabelling deeply political ecological issues as mismanagement of resources by local communities (Paulson, Gezon, & Watts, 2003). By examining issues on a household level, FPE connects what is happening on the ground with high-level development initiatives. As Molett and Faria (2013) state, "...much of the work in FPE pays close attention to struggles over household resources, gender divisions of labour and livelihood security as they unfold in everyday practices…Such interrogations are critical to understanding how global development policies such as…commercialized agriculture…impact men and women differently" (p. 118).

Another important feature of FPE is an emphasis on understanding women's access to, and control over, ecological resources including land, seeds, water, forests, food, livestock, agricultural technology, and information. A myriad of studies have found that power and politics have prevented women from either owning, controlling, or accessing environmental resources crucial to their physical or emotional wellbeing, their financial success, or their survival (Hovorka, 2012; Croppenstedt, Goldstein and Rosas

2013; Meinzen-Dick et al., 2011; Rocheleau and Edmunds, 1997). If left unaddressed, these political and gendered barriers are likely to interfere with the effectiveness of agricultural development programs and policies. Furthermore, if agricultural policy makers or NGOs do not understand the power-relations which structure everyday interactions at a household level, they run the risk of inadvertently strengthening and reinforcing the barriers which are preventing women from controlling and accessing resources. For example, after the success of the Grameen Bank in India, micro-credit schemes quickly became popular among development organisations. However, without an understanding of the gender-relations at the household levels, some programs did little more than add to women's already full workloads and increase tension and conflict at the participants' homes (Karim, 2008; Omorodion, 2007).

Bina Agarwal has been writing about issues of FPE for more than two decades. Her 2009 paper entitled "Gender and Forest Conservation: the impact of women's participation in community forest governance" found that when women were encouraged to join community institutions of forest governance, resource conservation and regeneration improved drastically. As Agarwal (2009) concludes, the social barriers that limited women's participation in forest governance were also limiting the impacts of forest conservation policy.

2.4 Power in FPE

While there are multiple definitions of power that feminist political ecologists may draw upon, Joanna Rowland's work is the most substantial and the most relevant here. The term *empowerment* is arguably ambiguous, yet extremely popular and can be found in many gender-oriented publications and gender and development projects (Parpart and

Kabeer 2010; Batliwala, 2007). In Rowland's (1997) quest to define and understand the term *empowerment* she felt it was important to define its root word *power.* She identifies four distinct forms of power.

First, **"power over"** involves the control of one party over another. This form of power can include manipulation and is characterized by a zero-sum relationship wherein one person gains power at the expense of another. As Lutrell et al., state "…the only way to gain [power] is to take it from the more powerful" (p. 6). For example, political empowerment in this sense may involve an increase in government representation of the poor relative to the rich, resulting in the election of new representatives for the poor creating a shift in power from one group to another (Lutrell et al., 2009 p.6). Rowland (1997) states, power over "may be responded to with compliance, resistance (which weakens the processes of victimisation) or manipulation" (p.13).

Second, **"power to"** is considered more "generative" and "productive" (p.13), and can include forms of resistance or manipulation. It can create new possibilities and actions without necessitating domination. It is the power that some people have to inspire and mobilize others to challenge and alter the status quo (Rowlands, 1997). As Lutrell et al., state, "[a] focus on "power to" has led to an emphasis on decision making…and…is the capacity to act, organise and change existing hierarchies" (p.7-8).

Third, **"power with"** involves a sum of people working together towards a common goal. This form of power allows people to motivate and fuel each other in their aims. In contrast to "power over", "power with" shows how power gained by one person can strengthen the power of others rather than taking away from it. As such, "power with" often involves the mobilisation of groups towards widespread and structural gains

for their members. And finally, **"power from within"** involves inner spiritual strength and a level of self-respect, as well as a respect for others as equals (Rowlands, 1997). Janet Townsend et al., (1999) referred to this form of power as "self power" or "self empowerment" and stated that "we do not think that anyone can empower another person...we think that it is possible to enable other people to do something, but not to empower them, not to give them power. If you give someone power, you can take it away: it is only if they take that power for themselves that it is theirs" (p.24). Essentially, power from within represents a belief in one's own capabilities and rights.

In order to understand power, it is also useful to examine the process by which one becomes *empowered,* that is to gain power in one or more of these four forms (Rowlands, 1997). The most commonly referred to form of power is "power over" (Rowlands, 1997) and perhaps the most acknowledged means of empowering someone is to bring them into decision making processes (Holland et al., 2007). In practice, empowerment is often perceived as entailing encouraged participation in political structures and the freedom to make social, political, and economic decisions. As Rowland states, "individuals are empowered when they are able to maximize the opportunities available to them without constraints" (p.13). However, this simplistic view of empowerment does not include an increase in "power to" and "power from within", both of which are essential to feminist understandings of empowerment. Naila Kabeer (1994) wrote extensively on the importance of "power from within" in examining household gender relations in developing countries. She urges that development organisations recognize the importance of power from within: "the multidimensional nature of power suggests that empowerment strategies for women must build on the "power within" as a necessary adjunct to

improving their ability to control resources, to determine agendas, and make decisions" (Kabeer, Reversed Realities, 1994, p. 229). As Rowland (1997) argues, giving the disempowered the opportunity to make decisions is not enough, there also needs to be a shift in their social status, in their own eyes and in the eyes of others:

> From a feminist perspective, interpreting 'power over' entails understanding the dynamics of oppression and internalized oppression. Empowerment is thus more than participation in decision-making; *it must also include the processes that lead people to perceive themselves as able and entitled to make decisions*...It involves giving scope to the full range of abilities and potential. As feminist and other social theorists have shown, societies ascribe a particular set of abilities to social categories of people. Empowerment must involve undoing negative social constructions, so that people come to see themselves as having the capacity and the right to act and influence decisions (p.14).

Adding to Rowland's work on power and empowerment, Naila Kabeer (2000) has written extensively on individuals' *"***power to choose"**. In attempts to discover how individuals make choices, and to measure the degree to which they are capable of such, researchers and academics have, in the past, favoured either an "agency" approach or a "structure" approach to decision-making (Luttrell et al., 2009). Borne out of classical economic theory, the agency approach assumes that human beings will always make calculated, rational decisions. It predicts that every individual makes (more or less unconstrained) choices that best suits their interests. In the case of a household, decisions are assumed to be unbiased, made collectively, and with the best interest of all members in mind. Later, it became clear that society did not fit neatly into this "agency" framework; economic theory was not comprehensive enough to explain the sometimes competing, irrational, uneconomical decisions that human beings made (Kabeer, 2000). Alternatively, social scientists wrote about a "structural" approach to power and decision-making, and argued that the rules, social norms, culture and policies that govern society

limit the choices individuals make in their everyday lives. This approach to analysing choices resulted in an array of studies that greatly overestimated complacency among marginalized groups, particularly women who often became cultural dopes, incapable of independent choice or action (Kabeer, 2000). In her book, "The Power to Choose: Bangladeshi Women and Labor Market Decisions in London and Dhaka", Naila Kabeer (2000), cites a study by S. Begum (1982) to illustrate this point:

> (Village) women feel no urge to view themselves with detachment in relation to their culture; they do not seem to display any conscious inclination towards analysis or objectivity in regard to their pursuits. They do not explain the reasons for doing what they do (…). They simply perform their 'duty' and behave according to custom (S. Begum, 1982 in Kabeer, 2002 p. 37).

Alone, both theories are problematic. Therefore, rather than viewing the two realms as contradicting one another many have chosen to view them as complimentary tiers on which empowerment can occur. In other words, most individuals express agency in the decisions they make everyday, however "rules or social forces (such as social class, religion, gender, ethnicity, customs, etc.) (…) limit or influence the opportunities that determine the actions of individuals" (Lotrell, 2009, p.9). As Kabeer (2000) states, "(…) [C]ritics of both traditions have helped to carve out a convergent middle ground in which the agency of individuals can be recognised without losing sight of the constraining structures within which they exercise their agency" (p.47). This method of viewing empowerment fits neatly within FPE, because it implies a worldview where our actions on the household level are impacted by larger socio-political forces and vice-versa.

The following section presents three case studies that demonstrate how an FPE lens and these understandings of power relations can uncover intersectional ties between social, political, and environmental issues.

2.5 FPE in Practice

Finding examples of FPE in practice can be difficult because, as Elmherst (2011) argues, the majority of research in this area does not self-identify as FPE. She states that "research bearing a 'family resemblance' to feminist political ecology may be found across a range of disciplines, focusing on substantive issues ranging from gendered resource access and property rights (water and land) to the dynamics of gender in policy discourse, collective action, and social movements" (p.130). Despite Elmherst's accurate observation, there is still a moderate amount of research that does identify with FPE- a few examples of case studies are listed below.

In their book *Feminist Political Ecology: Global Issues and Local Experience*, Rocheleau, Thomas-Slayter, and Wangari (1996) examined how the land registration process introduced in Mbeere, Kenya in the 1970s impacted the environment and gender relations on both household and community levels. As a result of these land policies, the majority of women in Mbeere were found to be "legally landless" while patrilineal customary practices placed control over land firmly in the hands of men. In addition, they found that socio-political circumstances and increased rural-urban migration meant that women in the Eastern region of Kenya were more vulnerable than men to the effects of drought and famine. Kenya's land reform policies inadvertently limited women's access to ecological resources and reduced women's power on their farms and in their communities (Rocheleau, Thomas-Slayter and Wangari, 1996).

In response to this imbalance, women's groups formed in some districts, and these created a sense of solidarity and added places for advancement. Some women's groups planted trees together, weeded fields, and offered credit. Other's established more long-

term income generating projects. For example, initially, produce from Mbeere was sold to intermediaries who would take it to the market. Eventually, however, a women's cooperative was formed which opened a store in Siakago, eliminating the need for intermediaries (Rocheleau, Thomas-Slayter and Wangari, 1996). As the authors stated, "the process involved extensive negotiation and paperwork with the chief and the town counsellors, all of whom were men. Most women did not know how to read or write and were at the mercy of the politicians, but ultimately they succeeded" (p136).

FPE is useful in understanding this case study. The privatization of land resulted in a change in women's access to and control over ecological resources, as well as a shift in gendered power relations. The new land policy subjected women to "power over" as men took legal ownership of land and resources. However, through the women's groups we see how women worked collectively to increase their "power with" to challenge the town councillors and create opportunities for themselves. "Power to" was the transformative power that they utilized to change local customs to allow themselves to open a co-operative. If this set a precedent for others, the agency of these women may have lead to structural empowerment by changing the cultural norms and expected gender roles in that community. By applying FPE, this case study shows how land policy coupled with rural-urban migration impacted gendered power relations and food security in Mbeere.

Another interesting case study that draws upon FPE comes from Hovorka's (2006) research into poultry farming. She examined the gendered aspects of rural-urban migration and agricultural land restructuring in Botswana. Her research found that a shift in Botswana's agricultural policy in favour of commercial and export agriculture coupled

with rapid urbanization has opened up opportunities for women in the poultry sector, and has increased their access to resources such as land. Increased government aid for entering into commercial agriculture has led to a (re)negotiation of gender roles in Botswana, and women's traditional roles as subsistence poultry farmers have made it easier for them to break into the commercial poultry sector (Hovorka, 2006).

Despite continued social and economic disadvantages in relation to men, women's participation in the commercial sector is now equal in numbers (Hovorka, 2006). Furthermore, women whose marginal positions prevented them from benefiting from the new agricultural policies have gained power in the countryside by beginning informal enterprises on their residential village plots. These women enjoyed easier access to water, have created a local market for their produce, and felt they were better able to juggle other income-generating activities with household and community involvement. Networks of informal poultry producers have formed to discuss best practices and provide on-farm technical support (Hovorka, 2006).

As Hovorka (2006) stated, "This article engages a feminist political ecology perspective in order to situate local experiences with urban agriculture within a larger context of agrarian restructuring and rural–urban transformation in Botswana" (p.208) She examines how gender sensitive agricultural policy has increased women's "power to" and agency by providing them with the land and opportunities for commercialization. In addition, women's increased role in the commercial poultry sector inspired women in the countryside to create small-scale enterprises within their homesteads, arguably increasing their "power with" and "power within". In sum, FPE helps us to understand that "it is important to recognise and demonstrate that gender is an integral part of and a

key element to understanding agrarian change and rural–urban transformation" (p. 209).

Kimura and Katano (2014) used an FPE approach in analysing the political and community level discourse surrounding the Fukushima nuclear reactor accident in Japan and its impacts for organic farmers. Their research revolved around three central questions: "[F]irst, what were the different understandings [between men and women] of radiation risk? Second, what influenced the creation of these differences? And finally, when different views about risks circulated, whose views were the **"**right**"** answer and whose were sidelined?" (p.109).

Kimura and Katano (2014) found that individuals perceived varying degrees of radiation risk and that households were often divided in their opinions regarding what was safe to eat. These varying interpretations of risks were shaped, in part, by national propaganda and political campaigns that characterized concern over radiation as irrational and hysterical, and reprimanded the (mostly female) consumers who were apprehensive about buying and eating food from the affected area. The same campaigns promoted a "hegemonic masculinity" associated with "control and normalcy" (p.113). As the authors argue, "[t]his way, the government and the mainstream media laid the ground for legitimizing a certain view as the **"**right**"** response to radiation threats to food; consumers and producers alike were not to worry and risk was to be considered negligible" (p.115).

FPE usefully helped answer Kimura and Katano's research questions by examining the social implications of a nuclear reactor accident through gendered, political, scale-sensitive lenses. They eloquently explain the importance of FPE in their research:

> While typical explanations of the social impacts of nuclear accidents on organic farmers might focus on the localized divergence in risk perceptions among farmers, FPE allows a more complex discussion through political,

> economic, and gender analyses. This is because FPE integrates social schisms at the local level to a larger political economy, and keys our attention to gender roles and identities in shaping disaster responses. FPE also pays attention to the agency of people in resource dependent communities. These three advantages, we argue, are critical in analyzing rural struggles in the aftermath of a nuclear disaster (p.109).

These three case studies are just a few examples of how a FPE lens can bring to light the social, economic, and political factors linked to issues of gender and the environment. In all three cases, FPE helped the researcher to understand how local power imbalances with relation to environmental resources had larger implications for national policies, programs, and markets. In the instances where women were able to correct these imbalances through an increase in "power with", "power to", and "power within", positive environmental outcomes where observed.

FPE shapes my research project in several important ways. First, it uses a multi-scalar analysis as it seeks to examine the potential effects of the global push towards genetically engineered organisms on small-scale female farmers in eastern Kenya. My research interviews span the international scale (WEMA is an international initiative), the national scale (experts in Nairobi working on a national level), and the local scale (farmers in Kitui and Machakos districts). Second, my research found that power imbalances along gender and class lines affected women's ability to access, own, and control land, finances, and agricultural technology and information. By combining expert opinion with personal observation, I conclude that gendered power relations in households and communities are creating production differentials between male and female farmers that are likely to influence the outcomes associated with WEMA's GE maize.

CHAPTER 3: METHODS

3.1 Motivations behind case study

My research began in the fall of 2012 at Dalhousie University in Nova Scotia, Canada. My case study grew out of an interest in the debate over the merits and pitfalls of using GEOs as a means of alleviating poverty and food security. As discussed in chapter 2, the division of labour, power relations, and access to resources all play a role in women and men's experiences with nature and agricultural change (Rocheleau, Thomas-Slayter, & Wangari, 1996). Yet, few studies exist that examine the potential gendered differences of new GE varieties. This led me to question the gendered implications of the introduction of genetically modified seeds. Given the burgeoning debate surrounding Kenya's impending decision regarding whether or not to commercialize GEO's, the country presented a timely and appropriate study case (Harsh and Smith, 2007; Kingiri and Ayele, 2009; Achia, 2013). It is out of these considerations that a desire to examine the potential effects of WEMA's GE maize seeds on women farmers in Kenya emerged.

3.2 Methods

I stationed myself in Kenya for a total of 11 weeks in the fall of 2013. The first 6 weeks were spent in the capital, Nairobi, where I organised interviews with experts in the field. These included representatives from the African Centre for Technology and Science (ACTS), the Ministry of Agriculture (MoA), the African Agricultural Technology Foundation (AATF), the National Biosafety Authority (NBA), and the Kenyan Organic Agriculture Network (KOAN). In addition, I interviewed a Master's candidate and teacher in Kitale (a town in the Rift Valley region of Kenya). The duration of expert interviews fell anywhere between 20 minutes and 1.5 hours long, and occurred during the

day either at the respondent's place of work or at a location of their choosing.

For the remainder of my time in Kenya I was based out of Machakos town in Machakos County. Machakos is a semi-arid zone with average temperatures ranging from 10.5 to 28.0°C throughout the year and typical annual precipitation in the order of 800mm (climate-data.org). Although I stayed in Machakos town, my research spanned both the Machakos and Kitui districts. These areas were chosen as study locales for two primary reasons: First, their dry climates and food insecurity makes them primary target areas of the WEMA program (David, October 22nd, 2013). Second, the majority of maize production in these areas is subsistence or small-scale and, again, WEMA is targeting small-scale farmers in particular with the aim of improving food security (WEMA, 2015). It is also relevant that the farms in my study be small-scale because, as was discovered during the first phase of my field research in Nairobi, women are responsible for the majority of small-scale agriculture (David, October 22nd, 2013). Internationally, small-scale agriculture has been defined in an ad hoc manner. However, according to Mugera and Karfakis (2013), the term often applies to farmers with a mean farm size of 2 hectares or less. Therefore, for the purposes of my study, "small-scale farmers" was defined as anyone with 2 hectares (5 acres) of farmland or less. This definition well suited my needs, as the average farm size of participants was around 1 hectare (or 2.5 acres).

During my stay in Machakos, I interviewed a representative from Inades-Formation (an agricultural NGO), two agrovet shop workers, and a total of 32 female farmers. The farmers were selected from three small towns in Machakos County (Kathiani, Mwala, and Masii) and from one town in Kitui County (Kitui town). Kitui was

chosen as a study location because it is the site of WEMA's contained GE maize field trials (David, October 22nd, 2013). Each farmer interview lasted approximately 20-35 minutes long and took place either in their farm, their home, or their yard during daylight hours. Table 1 (below) presents the distribution of farmers interviewed in each location within the selected study area. Figure 4 in Appendix B indicates the location of each study site.

Table 1: Distribution of Interviewed Farmers within by Municipality

Location	**Kathiani**	**Mwala**	**Massii**	**Kitui**
Number of participants	9	10	8	5

3.3 Site Details

Machakos County spans 6, 208 km^2, and has a population of approximately 1.1 million people at a density of 177 people per km^2. The County has a total of 264,500 households (Government of Machakos, 2013), and 48% of the population live in rural areas (KARI-McGill, nd). A hilly terrain characterizes most of the County and the local climate is semi-arid. As a result of the climate, drought resistant hybrid varieties of sorghum, millet, and maize are currently being purchased and grown. Most of the county relies on subsistence agriculture, however open markets provide farmers with the opportunity to sell their produce (popular items for sale include fruits, vegetables, maize and beans) (Government of Machakos, 2013).

Kitui County, has a population of approximately 1.0 million people. The sub-county, where I visited, is considered an arid zone, with high temperatures and only 40%

reliability of rainfall (World Food Programme and Republic of Kenya, 2011). Kitui town is 75 km east of Machakos town (Government of Kitui, 2014).

3.4 Qualitative Research

My research was qualitative, meaning it did not rely on statistical comparisons of cases, nor did it seek to represent data in numerically measurable terms. Instead, qualitative research gathers information in narrative forms "in order to describe or understand people and events in their natural setting" (Manheim et al., 2008, p.429). I developed a questionnaire designed to gather basic information regarding age, farm size, and maize production. My questions were also guided by the flow of conversation. This way, I was able to ask questions regarding their experience with, or around issues of biotechnology as well as their personal experiences with drought, food security, land rights, and decision-making.

As Turner (2010) states "much research involving qualitative methods undertaken in a cross-cultural setting involves the help of interpreters/research assistants…" (p.206). As it is largely the Kamba people that inhabit Machakos and Kitui (Eriksen and Lind, 2009), Kikamba was the language in which the vast majority of interviews were conducted. Given that I am not fluent in Kikamba, I enlisted the help of a research assistant (RA). I submitted a request for a female RA at the University of St. Paul's in Machakos town and it is through such process that I met Jane, an MA student in Community Development. The "methodological challenges" section of this chapter discusses some of the pitfalls of using a RA/translator in the field. That being said, as Jones et al., (2015) argue, one should not underestimate the value of a skilled RA either. Jane proved to be an invaluable asset to my research as her contributions extended

beyond bridging languages. Jane assisted in the selection of study sites and participants; she acted as a guide both geographically (in that she helped arrange transportation) and ethnographically (in that she taught me cultural appropriateness and ensured friendly and polite interactions). I am confident that without her knowledge, I would not have been successful in gathering such a large sample of farmers.

Both expert and farmer participants were selected using a snowball method, arguably the most popular method of sampling in qualitative research (Noy, 2008). Snowball sampling can be defined as the process by which participants are chosen based on contact information provided by previous participants. The process is, by nature, repetitive, as each participant directs you to another (Noy, 2008). When faced with a situation wherein a farmer participant could not provide a referral, my translator and I resorted to canvassing the area - we went door to door in search of female farmers. Although many expert participants were reached through snowball sampling, some were contacted directly via their websites.

Part of what distinguishes PE and FPE research is that it attempts to engage with multiple scales simultaneously (Mauro, 2009). Paulson, Gezon, and Watts (2003), note that many PE scholars "often start by identifying social differences and self-identifications that may be pertinent to environmental issues" (p.210). In my study, the social differences and identifications used were gender (women) and class (small-scale farmers), although I did not have the time and resources to examine both sides of these axes (i.e. I did not interview men or large-scale farmers). Furthermore, PE explores multiple study scales that incorporate different locales. PE researchers are tasked the responsibility of examining the interactions between each scale in order to determine

causality and effect (Paulson, Gezon, and Watts, 2003). My research involves three scales:

1. The international scale (WEMA is an international initiative)

2. The national scale (experts in Nairobi working on a national level)

3. The local scale (small-scale farmers in the Machakos and Kitui Counties)

Although I only interviewed on national and local levels in Kenya, I did conduct scholarly research regarding the international biotechnology agenda.

Lastly, PE and FPE are committed to conducting action-oriented research. Scholars in this area strive to produce meaningful research outcomes by presenting their results to those have the power to make change (Paulson, Gezon, and Watts, 2003; Blaikie, 2008; Blaikie, 2010; Rochelau, 1995). As Blaikie (2010) states,

> [PE] should be a continuous cycling of research, critique and dialogue between PE and outside actors… There are many ways in which to make PE useful to those who have leverage in decision making at different levels, such as small informal civil institutions, social movements, federations of resource users, NGOs, at the level of national ministries, and at sites of negotiation between national governments, BINGOs and international institutions (p. 231 & 236).

Although this paper is not in the form of a policy proposal, my hope is that it will provide valuable feedback to stakeholders including WEMA scientists, the Kenyan government, GEO experts, biotechnology companies, and students interested in issues of gender and biotechnology.

3.5 Fieldwork challenges

The following is a list of challenges that I encountered in the field.

Physical Limitations: While interviewing in Masii, Mwala, Kathiani and Kitui, I was traveling on foot with a translator. We had no means of contacting study participants

prior to our arrival, which meant that we interviewed women with farms (and homes) around the city centres. As Manheim et al (2008), argue a truly representative sample should be random and applicable to all residents in the study area. Unfortunately, my approach may have skewed the study results in favour or those living close to markets, roads, and urban centres making it difficult to generalize my findings to Machakos' most rural areas. Furthermore, Kitui's distance from Machakos and my translator's availability made it difficult to spend more than one day in the area, limiting the number of respondents we could gather from that town.

Interpretation: Although English is Kenya's official language the majority of my study participants have resorted to their local language, Kikamba, since leaving the education system. As previously mentioned, Jane acted as an excellent translator. However, as Wilson (2001) states, there is a "scientific tradition of social research that assumes that terms can be translated exactly, even though the difficulties of doing so are recognised" (p.319). He argues that cultural subtleties and meanings can often get lost in translation. Furthermore, research is often imbued with power imbalances between the researcher (government official, representative of a powerful institution or, in my case, white educated foreigner) and the participants, which can inadvertently allow the researcher to misinterpret and misappropriate data (Wilson, 2001). I tried my best to avoid this by encouraging Jane to translate exactly, and by giving her the opportunity to translate each response immediately after the participant had finished speaking. Furthermore, I discussed each interview with Jane after it had been conducted in order to avoid any misapprehensions. Although the nuances of some participants' responses may have been lost, I believe these efforts helped ensure an accurate understanding of their

meaning.

Time Constraints/ Interruptions: Given the nature of my research, it was important that all of our participants be women over the age of 16, and that no men be present during the interview. Although I conducted 32 semi-structured interviews, men (who were interested in my research) interrupted a number of them. We never encountered hostility from men or women, however these interruptions sometimes resulted in the cessation of an interview after having only asked some of the intended questions. Some interviews were also time sensitive because women had previous engagements, or were tending to their farms and children. Interviews that could not be completed often only resulted in the collection of demographic information.

Each of the three challenges listed here can be said to have impacted my research and study results and consequently each challenge was considered in my analysis. Nonetheless, efforts were taken to correct these challenges. For example, in an effort to triangulate data and compensate for partial interviews, I collected more farmer interviews than originally anticipated. Also, I spent a few minutes after each interview discussing results with my RA in order to ensure that I understood each participant's meaning and intonation. Although I was unable to compensate for the physical challenge of transportation, the farms that I visited met my research criteria: they were small-scale, female operated, and within the WEMA project's targeted area. As a result, I believe my research findings remain valid and central to the debate surrounding the commercialization of GEOs in Kenya.

CHAPTER 4: FINDINGS

4.1 Women's Access and Control Over Agricultural Assets: Lack of access to assets creates gendered productivity gaps

Studies indicate that across the globe women disproportionately lack access to a variety of financial and ecological resources resources, causing significant productivity differentials between farms belonging to male-headed households and those belonging to female-headed households. For example, relative to men, women have less access to land, fertilizer, water, credit, labour, human capital, information, and technology (Horrell & Krishnan, 2007; Quisumbing & Pandolfelli, 2009; Meinzen-Dick et al., 2011; Morris & Doss, 1999). These assets can increase people's choices and capabilities by providing sustenance and comfort as well as a means for economic growth. Therefore, one can argue that individuals' realities are, in part, shaped by their access and control over these resources (Sen, 1999). Meinzen-Dick et. al., (2011) emphasize this point by saying, "…understanding the gendered nature of asset distribution and how this influences individual and household livelihoods is essential to designing effective development policies and interventions" (p. 1). As a result, this chapter seeks to answer the following questions: what are the gendered differences in access and control over agricultural resources in Machakos and Kitui, Kenya, and how will these differences affect the introduction of WEMA's GE maize?

This chapter discusses land, pesticides and fertilizers, labour, credit, and household economies. Throughout the research process, land rights presented itself as a particularly salient issue, and one that has emerged in Kenyan literature as a gendered topic, warranting it a slightly larger presence in this chapter. Each section includes a brief

literature review regarding women's access and control over the asset, a summary of my research findings, its relevancy to WEMA maize, and its connection to FPE. This chapter concludes with a discussion surrounding household economics and decision-making. By accomplishing these goals, this chapter helps to answer my central research question by exploring the socio-economic determinants that could shape women's ability and desire to adopt biotechnology as well as the general outcome of its commercialization.

4.2 Land Security

The International Fund for Agricultural Development (IFAD, 2008) defines land tenure as "the rules, authorities, institutions, rights and norms that govern access to and control over land and related resources" (p. 27). Many land tenure systems in developing countries favour male ownership of land, placing women farmers at a marked disadvantage. Even in areas where legislation guarantees women's property rights, a lack of legal literacy or weak law enforcement can prevent women from exercising those rights (Quisumbing & Pandolfelli, 2009, p. 2). Sara Radcliffe (2013) alludes to the complex realities that can limit women's access to land in SSA. She states, "Law, development, political economies and culture represent overlapping, contested, and highly gendered arenas within which women's ties to land…are defined, realized and undermined" (p.2). Radcliffe's statement further substantiates that it is not only inadequate legal structures that can cause land insecurity. In many communities across SSA, local customary laws and practices that favour male ownership of land are regarded more highly than national regulations that demand gender equality. This is addressed in Burk and Jane's (2014) study tracking land ownership in Kenya, which stressed the vulnerability of widows in the Nyanza and Rift Valley provinces. There, customary law

could allow a widow's in-laws to reclaim or reallocate the land upon her husband's death (Burk and Jane, 2014).

In 2004, the World Bank stated that although women made up 70 percent of Kenya's agricultural labour force, they possessed only 1 percent of land titles, and only 5-6 percent of land titles were held jointly (in Ellis, et al., 2007). Ellis et al., (2007), stressed the importance of women's rights to land by arguing that women's lack of land ownership can impede their ability to participate in producer groups, receive remuneration for their labour, benefit from agricultural extensions services, and access formal financing mechanisms. This last point was particularly salient because according to their research, women in Kenya ranked a lack of access to finance as the largest constraint to growing their business (Ellis et al., 2007, p. xxii).

Dianne Rocheleau, well known for her work in FPE, published an article in 2001 that examined women's groups in Machakos, Kenya. Her research took place in the same district as my farmer interviews and alluded to the precariousness of land tenure among women. She found that budget cuts to the military led to high unemployment rates among men, who were already displaced from their villages due to lack of permanent work. This phenomenon led to an increase in migrant workers who seasonally worked in their hometowns as farm hands. The new social dynamic created a much larger percentage of unmarried women and mothers who, having not been provided access to land through marriage were frequently cast out of their natal communities and forced to work as part-time labourers in tea fields. As Rocheleau (2001) stated, "[t]hey were displaced persons, homeless by virtue of severed or incomplete ties to men, who in turn connected them to land, place, and community" (p.85).

Rocheleau (2001) found that over the course of a few decades, the elders made a decision to expand their definition of community to include the children of these women, allowing the young ones to stay with their grandparents while their mothers worked. Unfortunately, this change benefited only single mothers. Abused, abandoned and/or divorced women did not benefit from this decision, as they were once espoused into their husbands' families and were deemed homeless for having left. Women in these positions may have been forced to choose between either remaining in a hostile marriage or losing their farms. Rocheleau's work sheds light on the reality that in many cases women's rights to land continue to be defined by their relationship with men.

In recent years, Kenya has made legal headway in improving women's land security. In 2010, Kenya signed a new constitution into law that called for the establishment of a National Land Commission (Musembi & Kameri-Mbote, 2013). It calls for the "equitable access to land", "security in land rights", and the "elimination of gender discrimination in law, customs and practices related to land and property in land" (Kenyan Constitution. 60 (1). , 2010). As a result, women are now able to own and inherit land, and are legally warranted equal treatment to men (RRI, 2011). Although the new constitution has received high praise, very little research to date examines its implementation and whether it has impacted women's land tenure.

As discussed in Chapter three, one of the challenges of this research was identifying the many variables that could impact how the commercialization of GE maize will affect women farmers. Given the necessary brevity of personal interviews, land tenure was only marginally discussed with women farmers. Time constraints and a lack of knowledge regarding biotechnology among respondents meant that the direct

correlation between land tenure and the ability to adopt biotechnology was never fully addressed in the interviews. However, upon analyzing the data collected, it became clear that many of my respondents faced some degree of land insecurity. These respondents identified a desire to formally own their land, while at least two explained how land insecurity had directly impeded their ability to farm. Herein, I argue that the lack of land ownership that I encountered among women in Machakos could inhibit their success as farmers and, by extension, could limit their experienced benefits of GE maize or affect their ability and desire to plant it.

4.2.1 Research Results

During my research in Machakos, 29 women farmers were asked whether or not they owned the land on which they lived and farmed and only 3 of my respondents' names appeared on their land titles. The majority of land titles were held by grandfathers, while the respondent's husbands' was the second most popular response. Table 2 summarizes the results regarding the land titleholders.

Table 2: Land Title Holders in Machakos and Kitui, Kenya

Land title holders in Machakos and Kitui, Kenya					
Respondent's name only	Both her and her husband's name	Husband's name only	Grandfather's name only	Grandmother's name only	Brother's name only
2*	1	9	14	1	2

*One of these women took possession of the title upon becoming a widow

Although 15 respondents reported no qualms with having the title in someone else's name, 10 other respondents expressed discontent or a desire to have the title put in their name.

Perhaps the most blatant danger of having the land title in someone else's name is

that the titleholder has the power to sell the land without the occupier's consent. Such an event can significantly impede an individual's ability to farm and such was the case for two of my study respondents. When I asked Beatrice, a 68 year old farmer from Kathiani, about her feelings regarding having the land title in her husband's name, she responded "I'm not okay with it being in my husband's name because he has sold everything from that down there to here" she gestured to the land between her farm and the road, "…I am left with very little to cultivate, even though I paid for the land myself when I was young". Beatrice's husband married another woman, and she explained that he was no longer present to help her either physically or financially. Left with few support systems, Beatrice explained how important her land was to her by stating that if she did not plant on her farm she would suffer from hunger and would not make enough of an income to buy necessities such as soap. Another respondent in Kitui named Elizabeth nervously mentioned that she had encountered issues with having the land title in her brother's name, since he once sold part of her farm without her consent[5].

My research also indicated that widows might be particularly vulnerable to land insecurity. Most widows expressed a desire to have the land titles changed to their names, but a few of the women I spoke to had encountered delays. Sophia explained that her land was currently in her late husband's grandfather's name, but that she was unable to change the title to her name because another woman was holding the documents. Sophia, the owner of around 3 acres of farmland, described the scenario as a "serious problem". Another widow, Susan from Mwala, explained that her husband had passed just over a year ago and that although she would have liked to have the title switched to her name,

[5] Because it was clear that this particular respondent was uncomfortable discussing the issue, I did not press her for any additional details.

she had been unable to pay the fee. She explained that this was due to the fact that she has had to pay for her children's school fees all on her own.

Finally, the patriarchal tradition of passing down land to sons rather than daughters could be problematic for those women whose brothers could inherit the very land on which they live. With those whose land title remained in their grandfather's name there was a sense of waiting for his total land holdings to be divided up amongst his grandchildren. Two women expressed some concern regarding the fact that they were still waiting for the land to be divided into multiple titles for them and their siblings. One of these women had three brothers, and mentioned that her effort to have the land title put in her name would be difficult were not for her husband. When I asked her why, she simply answered, "because he is a man, they will listen" (Devon, November 19th, Mwala, 2013).

4.2.2 Land Insecurity and Biotechnology

Morris and Doss (1999) urge researchers in the field of agricultural biotechnology to examine "both the technology itself and the physical and institutional context in which the technology is implemented" (p. 9), in order assess the potential impacts of an agricultural improvement. Their research found that in Ghana, women were less likely than men to adopt improved maize varieties due to a lack of access to, and control over, key inputs such as land, labour, and extension services. This is because investing in agriculture is a risky undertaking; however, investing in agricultural land which one does not formally own involves even more risk. Because women make up a large percentage of farmers in the Machakos district, it is important that their land security be considered when predicting their ability and likelihood of adopting GE maize.

In the above-mentioned cases from Kenya, the relationship between land tenure and the potential impacts of biotechnology is indirect but crucially important. The majority of farmers in Machakos appear to be women subsistence farmers (David October 22nd, 2003, Nairobi) with limited income and tenuous land security. As will be discussed in the following section of this chapter, WEMA seed will be slightly more expensive than current hybrid varieties on the market, and will be marketed alongside inputs such as fertilizers and pesticides (Grace, October 15th, 2013, Nairobi; David, October 22nd, 2013, Nairobi). Therefore, a switch towards GE maize should prove more costly for farmers. However, women are less likely to heavily invest in land that they do not formally own. For instance, if a farmer were to take the steps necessary to purchase the "biotechnology bundle" and perhaps even take out a loan in order to do so, a sudden loss of their land could be devastating and lead to indebtedness. In other words, women may be less likely to invest in WEMA seeds because their precarious position relative to land tenure makes them less willing and able to assume the increased risk.

This scenario is examined in Goldstein and Udry's (2008) research that women in Ghana were less likely to leave their land fallow on alternating seasons, a practice that improves land quality over time, due to a fear of losing the land should it appear unoccupied. Tandon (2010) adds to this argument by stating "where farmers 'own' the trees that they plant, they are more likely to take a long-term interest in planting more trees" (p.507). Although she is using trees as an example, the same logic may apply to land and GE seeds. Where farmers *own* the land on which they plant, they may be more likely to take a long-term interest in investing in more land, improving soil quality, and borrowing the money necessary to purchase more expensive seeds, fertilizers and

pesticides. In the event that a farmer does require a loan in order to try the new technology, there is much less risk involved if there is the certainty that their land would not be co-opted by men or sold without their consent. As Nidhi Tandon (2010) states "there needs to be some assurance that the labour [and finance] invested in the land will secure a return over several harvests" (p.507).

With land ownership comes power and that power can be used to choose which agricultural technologies to adopt. Ownership of land can lead to financial growth (through one's ability to get loans, to sell land, or to rent it) as well as increased decision-making power. For example, Gladwin and McMillan (1989) refer to farms that are "provided" to wives or family members without the legal transfer of ownership as semi-autonomous, because the farms are still considered to be managed by the household head. Moreover, Gladwin and McMillan (1989) state that traditionally, among the Pokot people of Kenya, women were responsible for any decisions surrounding agricultural activities and were able to keep any resulting profit while men traveled with their cattle. Colonization, however, redistributed land by providing men with titles and agricultural inputs. This led to an increase in men's involvement in agriculture and caused conflicts regarding which crops would be grown, how much of the harvest would be surplus, and how financial returns were to be divided. Subsequently, they demonstrated how this same phenomenon of disruption occurs when agricultural development projects fail to consider the gendered nature of land distribution. For example, by approaching primarily men as heads of households and farm "owners", a seed multiplication project in Malawi resulted in women losing power over their groundnut industry for the year (Gladwin & McMillan, 1989). If WEMA maize is marketed to heads of households or land owners, it is likely

that men would assume a sense of ownership over the technology, or that women would miss out on receiving information first hand. This is relevant because, in addition to limiting women's financial ability to adopt, the phenomenon described above could limit women's bargaining power in the household when it comes to new breeding technologies.

4.2.3 Feminist Political Ecology and Land Rights

When asked if having the majority of Machakos' land titles in the hands of men could pose a problem, one farmer named Patience answered (in English) "Yeah of course, the men have the control. Like, you can't use the title deed for a loan or what. So usually men has got a say. It's traditionally like that, it's the culture" (Patience, November 14th, 2013). She alludes to how things are slowly improving by stating "But… my children know they won't be doing that practice- what we are practicing, because they have looked for their property with their husband. But us, the generation before me is different than mine now. Because me I worked, I looked for that property. But the other generation, this is for man, man, man, man" (Patience, November 14th, 2013). Patience's mention of "looking for a property" seemed to refer to couples purchasing land together, something that she argued was becoming more common. However, she explained that the generation before her only inherited land through patrilineal lines.

Patience's assessment that women are gaining in land rights with each generation is encouraging and Kenya's new constitution is intended to support this transition. Unfortunately, to date there has been little research conducted on the effects of the new constitution in eastern Kenya. Most research regarding gendered land rights in Kenya was published prior to the constitution and focus on women's limited access to land

(Ossome, 2014; Whitehead and Tsikata, 2003). Furthermore, my research found that age had no effect on women's entitlements to land- my youngest participants (three of them recently married) used and relied on land belonging solely to men. Unfortunately, women's rights to land continue to reflect their ties to men.

FPE urges us to look at women's access to, and control over, agricultural resources (Rocheleau, Thomas-Slayter, & Wangari, 1996). In the case of land rights in Kenya, it is the "control over" that is concerning. A brief engagement with Rowland's (1997) concepts of power can be made here. It became evident in my research that some women were subject to "power over" displayed by those in their communities who upheld patriarchal and traditional land values. For example where a brother, a grandfather, or a husband gains, a women loses her right to land and her ability to control the asset on which she lives and works. In my research, many women who wanted land in their name experienced difficulties and delays, and regardless of the form (competition for the land, monetary setbacks, or family disputes) it was evident that their status as women lessened their chances of taking control of their property.

FPE also helps us to understand how women's ownership of land in rural Kenya can have an impact on internationally funded development schemes such as the WEMA project. As discussed, women may be less likely to invest in WEMA's technology due to their more tenuous rights to the land. Moreover, as I will discuss further in the household economies section of this thesis, men are more likely to take control of an agricultural enterprise should it become commercialized or suddenly financially profitable (Doss, 2011; Hovorka, 2012; Alanna, October 8th, 2013).

In the event that the introduction of biotechnology more generally results in an

expansion in commercial farming, it is possible that women may lose control as well as access to their land and that men be the first to benefit. Again, to quote Molette and Faria (2013) "...much of the work in FPE pays close attention to struggles over household resources, gender divisions of labour and livelihood security as they unfold in everyday practices…Such interrogations are critical to understanding how global development policies such as…commercialized agriculture…impact men and women differently" (p. 118).

4.3 Soil, Fertilizer, and Pesticides

Cross-country data reveals that male-headed households apply more chemical fertilizer (a purchased product) than female-headed households (Croppenstedt, Goldstein, & Rosas, 2013; Gladwin, 1992). Udry (1996) observed this phenomenon in Burkina Faso, where he argued that the application of fertilizer contributed to a 30% productivity differential between farms owned by men versus those owned by women. In Malawi, married women used 45-62 percent more fertilizer than unmarried women (female-headed households). In fact, in term of fertilizer application, married women are very close to married men (67 percent of whom use fertilizer) (Uttaro, 2002). Peterman, Behrman, and Quisumbing (2010), reviewed 20 African studies that examine the use of purchased inputs (chemical fertilizers, pesticides, seeds, herbicides, mechanical power) among men and women over the last 10 years; 16 of the 20 studies concluded that men used more inputs than women (Peterman, Behrman, & Quisumbing, 2010).

Most researchers have hypothesized that women in developing countries apply fewer farm inputs than men because they lack access to credit, land, and labour (Croppenstedt, Goldstein, & Rosas, 2013). Even in studies where women and men are

farming the same crops, women often apply less fertilizer than men. Some scholars have posited that a lack of education and access to extension services can also prevent women from applying fertilizer (Croppenstedt, Goldstein, & Rosas, 2013).

In Kenya, the majority of chemical fertilizer is imported and local production is virtually non-existent. This increases the cost and decreases the availability of the product, limiting fertilizer application among small-scale and subsistence farmers (Ariga et al., 2008; Sheahan, Black, & Jayne, 2012). This is exemplified by a huge gap in fertilizer application rates between Kenya's western region in which commercial agriculture is prominent and its eastern/coastal regions that are mainly characterized by small-scale or subsistence farms. A report published by the International Fertilizer Development Centre (IFDC) indicates that "fertilizer adoption rates vary from 4 percent (Coast Province) to a high of 90 percent of households in the high-potential maize zones" (IDFC, 2012, p. 32). Sheahan, Black, and Jayne's (2012) research on eastern Kenya specifically leaves out Machakos and Kitui districts because farm sizes there are small and its low average rainfall and poor soil conditions make it "incompatible with fertilizer use on maize" (Sheahan, Black, & Jayne., 2012, p. 7)

A similar story exists with regards to pesticide applications. In 1992, Kenya was one of the highest users of pesticides in SSA. However 60 percent of applied pesticides were used on coffee, destined for export. In 1998, coffee prices fell while the cost of agrochemicals increased. As a result, many small-scale farmers could no longer afford pesticides (Partow, 1995). A study looking at 135 maize fields over 4 years found that uncontrolled stemborers were causing a crop loss of 13.5 percent, however, despite its widespread availability only 5 percent of smallholder farmers in Kenya said that they

used insecticides for stemborers (Gianessi, 2014). Moreover, there is some evidence that a gendered division of labour can also impact pesticide application. In Partow's (1995) study on Kenyan coffee farmers, men did most of the pesticide spraying while women were in charge of harvesting and picking crops (often exposing themselves to pesticide residues). If this division of labour represents an entrenched practice throughout Kenya, it could discourage female heads of households from applying pesticides, especially if they lacked the finances to purchase male labour.

4.3.1 Research Results

Although my research lacks comparative data regarding men's use of inputs, it does confirm that a small majority of women interviewed do not currently apply fertilizers and even less apply pesticides. 26 farmers were asked about their application of inputs and only 12 said that they regularly applied fertilizer. Two more farmers said that they apply fertilizer only when they can afford the extra expense. These tendencies are even further amplified when looking at insecticide applications. Out of the 26 respondents asked, only 8 said that they applied insecticides. Although I did not always directly ask the reason for deciding against the use of fertilizers and insecticides, 10 women stated, often without prompting, that it was the cost that was discouraging their use of inputs.

MoA worker Grace, assigned to the WEMA project, stated that farmers in dry areas often do not apply fertilizer due to poverty and a lack of education regarding proper application (Grace, October, 15th, 2013, Nairobi). While my respondents seemed aware of the benefits of fertilizer and pesticides, financial difficulties and inability to purchase inputs were a regular theme in my farmer interviews. One participant who had applied fertilizer said that it took 250KSH ($3.11 Cdn) to cover half an acre of land, meaning a

farmer with 2.5 acres (the average farm size of my respondents) would have to spend $CAD 15.55 to cover their entire land with one application of fertilizer. To contextualize this amount, a 2011 survey indicated that rural per capita income per day in Kenya is only 34.50 KSH, or about 0.50 cents CND (Onyeiwu & Liu, 2011). Moreover, the same study found that the issue of rural income was feminised since "90% of female headed households in Kenya live below $1 a day [USD]" (Onyeuwy &Liu, p.9, 2011) Considering 16 out of the 26 women asked were subsistence farmers and made no profit off their yields, fertilizer alone represents an expense on which a financial return on investment is unanticipated. They are unlikely to make that money back in crop sales.

My conversations with women farmers suggested they were quite well informed about the potential benefits and costs of fertilizers and pesticides. In fact, they expressed a real desire to be able to access these inputs. For example, a 68-year-old Kathiani woman mentioned that although she sprays her plants with insecticides before harvest she would like to also buy fertilizer, however she could not afford it. When Charlotte, a mother of three, was asked whether "women and men face different challenges as farmers" she responded with "income. Women don't have income to buy fertilizers or seeds". Ann a woman tending her field alone in Kathiani was asked the same question, and she answered with "We face different challenges than men, for example the financial challenge. Like now I have no money to buy fertilizers for this place. That field (she gestured to another field) has fertilizer but I am waiting for my husband to come so that I may put some on this field." She revealed that her husband worked full time in Nairobi and that when he visited he would give her the money she relied upon to farm. The story was similar in Kitui district. Elaine, a young farmer tending her parents' field, said, "I

plant the same way my parents did and I don't have the money for pesticides, or cows, or manure." 53-year-old Elizabeth kindly invited us into her home and explained, "there is a problem of the caterpillars. If you have money you spray [your fields] and if you don't you just leave them…I do not spray because I don't have the money to buy insecticides". Jessica, age 37, used manure because she can get it for free and cannot afford fertilizers. She also relies on her husband to be able to purchase inputs. When asked about who manages farm finances she said "the husband. When he goes and looks for money he brings it and then we go and buy the seeds or whatever we want".

4.3.2 Fertilizers and Pesticides and their Relationship with Biotechnology

Issues regarding access to and control over inputs are particularly relevant when discussing the potential for agricultural biotechnology to help small-scale farmers. WEMA seeds are being developed with the hope and intention that farmers will be planting them in conjunction with fertilizers and pesticides. As MOA officer Grace stated during our interview, "In the trials, we are using the recommended fertilizer under irrigation, simulating rain and drought. We have to also use insecticides to control for other insects than those targeted by the Bt" (Grace, October, 15th, 2013). She said that a handbook explaining recommended application of inputs would be handed out with WEMA seeds.

David, a representative from AATF, added to this by stating "We will promote a package. You will not have benefit of that product without having that package. The package includes fertilizer, proper weeding, proper planting, timely planting, how many seeds you put per hole, what is the plant population you expect… the seed performs as best as possible with all these in place, then you get your optimal production" (David,

October, 22nd, 2014, Nairobi). Bt maize is insect resistant and meant to reduce the need for pesticides, however, as mentioned the majority of my respondents are not applying *any* pesticides. Thus, to be able to apply the amount of inputs suggested in the WEMA handbook would require an increase in access, an increase in income, or an increase in credit availability- something that may not have been considered in the field trials. Although access to credit was identified as an important issue in WEMA's 2011 social audit report (conducted by the University of Toronto), I was unable to find any publicized information regarding whether or not WEMA is planning on increasing credit availability to farmers. If women are less able to apply inputs than men, then it follows that this technology could favour male farmers, or medium to large-scale farmers with higher incomes who are better able to follow the handbook and achieve "optimal levels of production". Conversely, widows will be least likely to afford inputs or new technology since they lack the extra income that would be brought in by their partners.

What's more, the brunt of the risks of this technology could be borne by those who do not adopt it. This is due to the way insects act and evolve. As already stated in the literature review, WEMA maize will be engineered to possess bacillus thuringiensis (Bt) toxins that kill pests. However, research indicates that insects have the ability to adapt immunity to Bt when exposed to high quantities of it. In their paper, Tabashnik et al., (2008) state that the "evolution of insect resistance threatens the continued success of transgenic crops producing Bt" (p.199). They argue that transgenic Bt cotton has not experienced large-scale crop failures mainly due to other insect control methods that have been implemented alongside these varieties such as the application of pesticides and the refuge strategy, which is the most popular method of delaying insect resistance

(Tabashnik et al., 2008). A refuge is an area of host plants without Bt toxins, planted near Bt crops in order to "promote the survival of susceptible pests" (p.199). In an interview, David, a WEMA representative at AATF, explained the process:

> You know, if you put everything at the Bt 24 hours, what happens is that you select against the most resistant insects, because you are killing the susceptible guys…you are skewing the population towards resistance. So to avoid that, what normally you do is you put a portion of the field with non-Bt materials so that susceptible insects eat it and survive, so that when they mate with the resistant ones there is recombination and they maintain the susceptibility in their children. That's the whole idea (David, October, 22nd, 2013, Nairobi).

David confirmed that without a refuge, insect adaptation is a risk. Unfortunately, convincing small-scale farmers to sacrifice some of their crop to the insects could be extremely difficult. As he stated, "We are coming into a landscape where farm size is very small; taking even a quarter of another ½ acre is so precious for the farmer*"* (David, October, 22nd, 2013, Nairobi). An absence of refuges can result in an uneven distribution of risk, whereby pests congregate on fields of farmers who have not planted the Bt maize. David recognized this risk by stating heavy-heartedly, "Maybe initially you will have other smallholder farmers who do not plant the Bt act as refuges, it might be that way…" (David, October, 22nd, 2013, Nairobi). He argued that one way of avoiding such a risk will be to encourage the application of pesticides, however he recognized that cost could sometimes be an issue. Again, this places small-scale women farmers, particularly widows, at the highest risk when introducing GE maize; if they choose not to adopt the technology (either for personal or financial reasons) and they cannot afford pesticides, they would be at a higher risk of having their fields devastated by insects.

Qaim and De Janvry's (2003) research on Bt cotton in Argentina focused on the degree to which a refuge is effective in slowing insect resistance and protecting fields.

Much like the US and a number of other countries, Argentina legally requires a refuge area when planting Bt. The official requirement states that 20 percent of a Bt field must be a refuge. Qaim and De Janvier (2003) concluded that, "a breakdown of Bt technology is very unlikely, if official refuge requirements are followed…. Rapid resistance buildup and associated pest outbreaks appear to be unlikely *if minimum non-Bt refuge areas are maintained* [emphasis added] " (p.21). Interestingly, they noticed that despite the fact that Bt crops reduced the need for pesticides by 50 percent and led to increased yields, small-scale farmers were not adopting the technology. More recently, Klara Fischer, Berg and Mutengwa (2015) have conducted research on Bt maize in South Africa and have determined that it is generally unsuited for small-scale farmers. With regards to refuges she states:

> Lack of transfer of information on Bt maize is found to be a key obstacle for successful adoption by smallholders. To successfully adopt Bt maize, farmers must be informed that it provides resistance to stem borers; and, for the sake of preserving the stem borer resistance, they need to be taught to plant a refuge of non-Bt maize next to their Bt crop. (…) Research shows that as a result of the current flaws in how information on Bt maize is transferred to smallholders, many smallholders planting Bt maize [in South Africa] are not fully aware of what makes it different from other hybrid maize and they often do not understand the purpose of refugia, nor comply with the demand to plant them (to some extent, the lack of compliance with refugia plantings also applies to large commercial South African farmers) (Fischer, Berg & Mutengwa, 2015 p.2).

Their research found that small-scale farmers did not comply with a number of the requirements that are necessary in order to benefit from GE maize. For example, not only did small-scale farmers not plant refuges, they also saved seeds for replanting and traded seeds with their neighbors. These farmers did not use the fertilizers and pesticides that were required in order to reap improved yields and therefore felt that the Bt maize seed was no better than the open pollinated varieties they were used to using. Klara Fischer, Berg and Mutengwa (2015) concluded that Bt maize did not address the physical or

cultural needs of small-scale communities in South Africa.

One cannot count on all small-scale Kenyan farmers taking up WEMA seeds; at least it is certain that not all will adopt them immediately. There is an array of studies suggesting that, on average, women are more risk averse than men--likely due to their tenuous positions as small-scale and subsistence farmers (Fletschner & Kenney, 2011). This means that women are more likely to avoid opportunities that offer high returns if they necessitate too much risk because their lack of access to, and control over resources could make it very difficult for them to recover losses. As Fletschner and Kenney (2011) argue, "Producers who are more risk averse are less likely to adopt new technologies, to undertake projects that are expected to offer higher profits but expose them to more risk, or to apply for loans that may cause them to lose the collateral they own" (p.6). Many of my respondents showed an interest in WEMA's GE maize, but stated that they would wait to see how others fair before adopting it themselves. This is their way of avoiding the risks associated with adopting a new seed, however once Bt maize is introduced, insects could congregate on the fields of these late adopters. Those who are unable to plant WEMA maize, purchase inputs, or who are risk averse – mainly female subsistence farmers – would serve as an inadvertent refuge.

4.3.3 Feminist Political Ecology and Access to Inputs

Bt plants are designed to be insect resistant and reduce the need for pesticides, saving farmers money and decreasing the environmental damage caused by toxic chemicals. However, FPE urges us to think about the issue of genetic modification holistically. What are the social, political, and economic factors that play into the scenario? Will certain classes or genders be negatively affected? Applying an FPE lens the issue of farm inputs

and biotechnology allows us to recognize that medium to large scale farmers are more able to afford inputs than small-scale, and men more than women, leaving small-scale women farmers the least able to fully benefit from this technology. Brian Dowd-Uribe's (2013) research uses political ecology to highlight this very issue in Burkina Faso. He discovered that Bt cotton's success in the region was a direct result of cotton company subsidies, loans, and a controlled market. He therefore concludes that the outcome a biotechnology is highly dependent on "the social context of production" which often benefits wealthier farmers at the expense of poorer ones. For example, referring to his study on Bt cotton in Burkina Faso, he states

> The potential risks associated with Bt cotton are likely to disproportionately fall on resource poor farmers. In the first year of adoption, many farmers refuse Bt cottonseeds out of concern for its high cost. Relatively wealthy farmers can more easily shoulder the risk associated with agro-climatic variability and afford the inputs necessary to garner a successful harvest. (…) If Bt cotton indeed primarily benefits relatively wealthy farmers, this would have important ramifications for its promotion as a poverty alleviation strategy (p. 9).

Much like Uribe's (2013) research (and other's that have been featured), FPE prompts us to think carefully about the context in which a new technology is inserted. GEOs and Bt crops may have shown to be successful in countries where minimum refuge laws can be maintained (and even in those countries adoption rates are often restricted to medium/large scale farmers) (Qaim & De Janvry, 2003), however small-scale female farmers in Machakos and Kitui districts have different needs and limitations that must be considered in order for WEMA maize to succeed in its goal of improving food security. For example, WEMA maize has the potential to increase yields as a drought resistance crop; however, the addition of Bt toxins without taking into account farmers' inability to plant refuges or apply pesticides can be problematic for WEMA's target audience of risk-

averse financially constrained women.

Rowland (1997) states, "individuals are empowered when they are able to maximize the opportunities available to them without constraints" (p.13). Unfortunately, women will not be able to maximize on the opportunity of GEOs because of the gendered and financial constraints that they already face. In the case of the women I spoke with, it was not a lack of information regarding inputs that prevented them from adopting; rather, it was poverty and a lack of access to these resources. If female farmers had access to fertilizers and pesticides they would be in a better position to adopt WEMA's maize and to optimize their yields by following the recommendations that are outlined in the handbook. In short, the constraints that female farmers currently experience will not disappear with the introduction of WEMA's maize and may even be exacerbated by it.

4.4 Labour

Udry et al.'s (2008) research in Burkina Faso cites a lack of labour in women's fields as a major hindrance to crop output. Similarly, Pender, Place, and Ehui (2006), found that female-headed households in Ethiopia use significantly less labour and ox power than male headed households[6]. In Malawi, Chipande (1987) hypothesized that it was a lack of land and labour that discouraged women from growing cash crops. He uncovered the paradox that women use less labour because they own smaller farms, yet women own smaller farms because they lack access to the labour necessary to farm at larger scales.

In Northeast Ghana, culture plays an important role in women's access to labour. Women are only able to utilize the labour of household members that are beneath them in

[6] This is in part a result of a cultural taboo which prevents women from using oxen for plowing (Pender, Place, and Ehui, 2006).

terms of both age and gender hierarchy. In these cases, unless a woman is a senior in a large household, she will have to purchase labour from outside her home. Having to purchase additional labour can be costly (Croppenstedt, Goldstein, & Rosas, 2013). Furthermore, there are some tasks, particularly those that are physically demanding, which are reserved for men only. For example, women cocoa farmers rely on male labour for tasks such as tree felling. Unfortunately, this is further complicated by the fact that these women cannot obtain male labour through labour exchange groups, as men and women's groups are segregated (Hill & Vigneri, 2009). Morris and Doss (1999) state that in many parts of SSA, women have difficulty obtaining labour that is traditionally "male", specifically in the areas of land preparation such as clearing, burning, and plowing.

Time burdens can also prevent women from devoting their own labour to their fields. Women are often responsible for managing a household, caring for children and the elderly, as well as cooking and cleaning, and quite often these tasks exist alongside farming. These time restraints can inhibit their ability to undertake labour-intensive activities such as manure collection or land preparation (Pender, Place, & Ehui, 2006). Tibaijuka (1994) found that a reduction in women's time burdens in Tanzania could lead to a 15 percent increase in labour productivity, a 44 percent increase in capital productivity, and a 10 percent increase in farm cash incomes.

4.4.1 Research Results

My research in Kenya corroborates some of the results discussed above. In the towns of Mwala, Masii, and Kitui, a cultural norm prevents women from owning and using oxen to plough their fields. Fourteen participants identified access and ownership of cows as

the greatest challenge women farmers face in their area. The following conversation with a farmer named Shayanne summarizes the situation facing many of these informants:

> There are different challenges with men and women farmers, because men own the cows. You know like people are cultivating with the cows, they belong to men. So if you are a woman, you have to go and ask for those cows to cultivate. Like here, we are very late because we didn't have the cows, we had to go and borrow (Shayanne, November 18th, 2013, Mwala).

Women's financial and time burderns are affected by their limited ability to own oxen. Most women complained about the costs associated with borrowing cows and argued that the delay in receiving them meant ploughing and sowing their fields late in the season. Women explained, to varying degrees, that in order to borrow cows they would have to exchange food, money, or labour. Hilda , a 50 year old farmer from Massii said "I do not have cows so I have to hire people to come and cultivate for me and I end up planting very late because I have to wait for people" (Hilda, November, 22nd, 2013, Masii). Another Massii resident, Danielle, a 35 year old with four acres of land stated "The problem of money to buy the seeds and money to hire the cows for cultivation [is the challenge I face]" (Danielle, November 21st, 2013, Masii). Esther explained that her husband was in charge of borrowing cows, and that in exchange for the livestock, he would plough the lender's field. She stated, "If the husband is not there, I can't go and look for cows and that is a problem" (Esther, November 18th, 2013, Mwala). A young woman in Kitui, age 20, stated "I have seen people use their hands to dig and cultivate so I have seen the problem of not having cows" (Rose, November 25th, 2013, Kitui). When asked if this is a cultural norm they would like to see changed, respondents unanimously answered "yes".

The issue regarding women's access to oxen is an example of how local gender politics can impact agricultural productivity. Women would likely experience increased

yields and income levels if they had access to labour saving technology such as oxen. Women would be able to plant on time, they would not have to resort to using their hands or crude tools, and they could save the money and/or food that is traditionally spent borrowing oxen and put it to other uses. In many instances GE crops have been shown to be a labour saving technology; however, it is questionable whether WEMA's GE maize will improve women's labour burdens in the Machakos and Kitui districts, especially considering the gendered relations that already place women at a disadvantage.

4.4.2 Labour and Biotechnology

Gardner, Nehring, and Nelson (2009) conducted a study in the US to determine how much labour is saved by adopting herbicide resistant (HR) soybeans compared to the traditional seeds. They found that by switching completely to HR soybean, farmers could reduce household labour by 14.5 percent or 94.5 hours a year. This is because HR soybeans lessen the amount of time spent weeding or applying herbicides, allowing part-time farmers to work another job or spend more time with their families. Huesing and English (2004) write that in China Bt cotton reduced the need for pesticide application by 60-70 percent, providing Chinese growers with "profit increases of about US$500 per hectare versus growers using conventional non-Bt varieties" (p.86). They argue that the $500 increased profit is a result of saved labour costs since farmers no longer had to hire people to spray the fields. They further suggest that labour reduction was the most important contributing factor to Bt cotton's uptake in South Africa. On average, for each hectare of land they had, farmers would spend a day spraying wearing little to no protective gear. Labour saved spraying was crucial to the crops widespread adoption rates (Huesing & English, 2004).

Regardless, the use of genetically modified crops does not guarantee a reduction in labour costs. Gouse, Kirsten and Jenkins (2003) argue that labour saved from reduced pesticide applications is offset by an upsurge in labour around harvest time thanks to increased yields. Moreover, as Addison and Schnurr (In Press) argue, if small-scale farmers are not already using pesticides, Bt crops would not save labour at all. In fact, their research in Uganda showed that HR crops are more likely to be of benefit to small-scale farmers than Bt crops as these women do not apply pesticides but spend a lot of time weeding. Bt crops may increase yields by protecting crops from certain strains of insects, however this can result in extra work for women around harvest time. Moreover, Addison and Schnurr (In Press) argue that in Uganda harvesting is primarily done by unpaid household labour, usually women and children, meaning that if the surplus crop cannot generate enough profit to hire labour it would increase time burdens for these household members in particular (Addison and Schnurr, In Press).

Addison and Schnurr's findings resonate with my own as women do much of the harvesting in Kenya and, as we have already determined, many do not apply pesticides. David from AATF elucidated this point by elaborating on the difference between women and men's roles in agriculture and emphasising the labour intensiveness of women's work:

> I think they farm the same except their roles are different… The man tends to decide what is planted. He tends to give the money to purchase and he actually purchases [the seeds] and brings them to the household. Women will assist in the planting and the weeding, and the children also. And also women are very pivotal in the harvesting. And of course using the grain to cook the famous Ugali...So for the processing part women's roles are heavy…the purchasing part is the men, the decision making part is the men (David, October 22nd, 2013, Nairobi).

David argues that women are responsible for the majority of on-farm labour while men are primarily responsible for decision-making. This places women at the highest risk of being affected should WEMA maize result in any increase in labour around harvest time. Also, if men are responsible for decision-making, for many women increased workloads may not be a matter of choice (although as will be demonstrated later this was not always the case for my respondents). Furthermore, given that women are disadvantaged with regards to owning cows and ploughing, their time and resources are already strained and any added labour would affect them disproportionately in relation to men.

Doss (2011) summarizes the importance of considering women's access to labour as a variable when predicting the impacts of biotechnology. She states:

> To understand whether technology will be adopted and, if so, how the costs and benefits of the technology will be distributed, it is important, first of all, to examine the availability of labour to the household. Different farmers will have access to labour, depending on their gender and status within the household and community. It will be important whose labour is used or saved with the new technology. Since labour allocations may be renegotiated with the introduction of new technologies, it is important to understand the other opportunities available to men and women, both in the agricultural and non-agricultural sectors (p. 2080).

Women's access to labour may influence whether they decide to plant GE maize once it becomes available and whether it will increase time burdens.

It is also worth considering that water efficient Bt maize is expected to increase crop yields by reducing pest losses. If farmers are able to sell this surplus to hire labour it could offset the cost of labour created around harvest time. It is unclear, however, whether this is likely to occur. Many of my study respondents only sold maize in cases of financial emergency, because the price it fetched on the market was considered too low to be profitable. Many women who did sell their crops on the market admitted to

struggling with low profit margins and wished to plant other more lucrative crops such as legumes. Unfortunately, drought (and in one instance birds) often prevented them from planting these income-yielding crops. For example, Emily from Masii stated "I am near the market so the roads are not bad but there is that problem of the price. They just buy it for low prices like 18 bob [cents] per KG or 20, so you just sell because of a pressing need"(Emily, November 21st, 2013, Masii). Danielle, said, 'If I harvest a lot I sell some, if I have small bags I do not sell…. I only sell when I have a problem because they buy it at very low prices in the shops" (Danielle, November 21st, 2013, Masii). Briana touched on this issue of an overcrowded market for maize by saying "I can make 3500 a bag when other people are not selling maize, during harvest time it is 1800 a bag because everybody has it" (Briana, November 21st, 2013 Masii).

My research found that the market for maize was crowded and it was often only sold in dire situations where farmers could use the small price it fetched. Moreover, in interviews with both the MOA and the AATF it was argued that increased food security was the aim of WEMA maize, rather than increased income. Therefore, it is unlikely that WEMA maize will generate a significant profit increase for small-scale farmers. As a result, it is doubtful that women farmers will be able to afford additional paid labour, and any added labour surrounding input application or harvesting would likely be placed on an already strained unpaid population.

My results suggest that drought tolerant legumes and pulses might be of greater use than maize, because women expressed a desire to plant these nutritious and profitable crops. For example, when asked whether there was anything they would like to do differently on their farm, 26 out of 32 farmer's responded that they wish to plant some

other crop than maize (all of the farmers I approached were already planting maize). My respondents' answers ranged from "vegetables to sell" to lentils, cassava, and watermelon; however, a lack of land, water, or financial capital was almost always cited as the reasons for not adopting these profitable crops. Esther from Mwala, said "If I could be assured that it would rain, I would plant something else on my farm" (Esther, November 18th, 2013, Mwala) and during a discussion with 5 women in Kathiani they exclaimed "if we get some water, we can plant fruits, vegetables and even beans!" (Focus group, November 15th, 2013, Kathiani). Susan from Mwala said, "I would like to plant lentils, but my farm is small" (Susan, November 19th, 2013, Mwala). Maize, though vitally important to Kenyans, is something that is already readily available and planted because of its ability to grow in comparison to other crops.[7] An increase in labour-intensive GE maize may do little to help women farmers in contrast to an increase in their ability to grow other more income-generating crops such as vegetables.

Klara Fischer and Flora Hajdu's research on the Massive Food Production Program (MFPP) in South Africa perfectly demonstrates how increased yields do not necessarily translate to poverty reduction or agricultural development. Their research showed how improved maize seeds provided to three villages in the Eastern Cape Province "did not perform well under small-holder conditions". For example, not only was the maize ill suited for local storage conditions, but locals also resented that the seeds were not designed to be saved, traded, or replanted. Moreover, the poorest of farmers

[7] A representative from an NGO in Machakos called Inades-Formation argued that women are already planting a "drought resistant" hybrid variety of maize and they are still unable to harvest in the April season due to a lack of access to water. Legumes and other high-profit crops usually require even more water, making maize the safer and easiest of the two choices (Jean, November, 2013, Machakos).

were unable to benefit from increased yields do to a lack of access to necessary inputs, technology, agricultural information, and labour. Fischer and Hajdu (2015) concluded: "The results indicated that generic support to agriculture, such as fencing and traction, were more sought after locally than new maize varieties, and that such support could make it easier for the poor and very poor households to plant their fields" (p. 311). My research revealed that women wished mainly to diversify their crops and experience increased access to water and oxen. An increase in labour saving technology would naturally increase their farming output and could also increase both their income and leisure time. While increased maize yields may help to improve food security during the April season, it may also add to women's time burdens.

4.4.3 Feminist Political Ecology and Labour:

Fischer and Hajdu (2015) conducted research on whether or not GE maize designed to increase yields led to poverty reduction among small-scale farmers in South Africa. Their research revealed that the realities of small-scale farmers were incompatible with Monsanto's GE maize seeds because (in part) a low yield was not the cause of these farmers' poverty. They cited a lack of labour as a more severe hindrance to farmers' success, stating, "…it might be said that labour was the most limiting factor to planting the field in poor and very poor households" (p. 307). This is because households that could not afford outside labour were often prevented from farming anything larger than their home gardens. Moreover, their financial vulnerabilities often left them accepting paid work from other members of their communities, further limiting the time they had to invest in their own fields. Fischer and Hajdu's (2015) research also shed some light on the importance of cows as a labour saving technology. For example, they state:

> …cattle had an even stronger effect on agriculture than the quantitative data indicate, as households owning cattle would plough their own fields first, resulting in those relying on borrowing cattle from others having to plant later than they wished. Ploughing late reduces yield and also runs the risk of the maize not ripening before being damaged by frost or eaten by cattle, which are eager to get into the fields to eat the maize stalks at the time of year when grass is becoming dry. While households without cattle and with little money to pay for ploughing most often failed to plant their field (…) the fact that many resource-constrained households still chose to pay for ploughing gives an indication of the value these households placed on ploughing their field. Working the field by hand is labour-intensive, which makes this a particularly challenging option in poor and very poor households (p. 307-308).

They argue that it is this lack of labour and cattle that make GE maize impractical for resource poor farmers since the seeds' requirement for inputs only added to their workloads. Since the socio-political situation of women in Machakos, Kenya is similar to that of resource poor farmers in South Africa (in that they are particularly disadvantaged in their ability to afford labour and own cows), it is possible that GE seeds will fail to address the needs of my respondents.

Recalling Rowland's (1997) four definitions of power, it becomes evident that gendered power imbalances are disproportionately affecting women's ability to access labour. For example, "power over" is expressed in women's inability to own oxen while a cultural taboo ensures male control over this livestock and, subsequently, the ploughing market. In this sense, men are exerting power over women in a zero-sum game. "Power over" can also be observed in scenarios where men are responsible for making agricultural decisions while women are responsible for any associated labour. Moreover, as pointed out in the previous section on inputs, women lack the ability to purchase inputs, due to, in part, gendered divisions of labour that keep them from paid positions. Although these examples demonstrate how power relations on household and community levels are skewed, to assume that Kenyan women farmers in general, and participants in this study in particular, are powerless would constitute a grave inaccuracy.

As will be discussed in the following section, many of my respondents did in fact state that they were responsible for making decisions regarding what to plant. Although it has yet to manifest into a tangible shift in rights and abilities, women displayed "power within" when asked whether or not they felt they should be allowed to own oxen. Every participant that was asked whether they would like to see this aspect of their culture change responded positively. As Kabeer (1994) states, "the multidimensional nature of power suggests that empowerment strategies for women must build on the "power within" as a necessary adjunct to improving their ability to control resources, to determine agendas and make decisions" (Kabeer, 1994, p. 229). Participants believed women should have a right to own oxen, showing that they possessed power within; perhaps an increase in "power with" could build upon it and spark a change in women's access. In other words, organised and concerted efforts among women and men to change this gender norm could lead to structural empowerment by challenging a cultural taboo and increasing women's rights to labour in their communities.

As Fischer and Hajdu (2015) demonstrate, an increase in labour access could greatly contribute to the success of GE maize by increasing farmer's ability to sow larger plots, apply chemical inputs, and plant and harvest in a timely manner. Additionally, the increase in yield would be a welcomed benefit should women farmers have access to additional labour around harvest time. Consequently, WEMA staff should communicate with small-scale female farmers in their target areas in order to understand how their socio-political realities are likely to impact the success of their technology.

4.5 Credit

Credit can be an important means for getting ahead financially. Fletschner (2008)

discovered that in Paraguay, households that had access to credit experienced revenues 25 percent higher than those that did not. This research also concluded that women had lower access to credit than men. Croppenstedt, Goldstein, & Rosas (2013) examined 8 countries in their study (Indonesia, Vietnam, Nepal, Malawi, Bulgaria, Guatamala, Panema and Ghana), and in each country female headed households received less credit (15 percent less in some cases) than male-headed households.

There are multiple causes for women's limited access to credit, one of which is their lack of assets (such as land) to place as collateral (Meinzen-Dick, Johnson, Quiaumbing, & et al., 2011). Also, some credit issuers require certain levels of educational attainment of their borrowers, which disproportionately penalizes women who are often the first to be removed from school. Another reason why banks prefer to lend to men is that they are considered to have higher returns on investment than women. According to a study in Sri-Lanka this return is 9 percent higher for men (Quisumbing & Pandolfelli, 2009). Furthermore, women are frequently considered less desirable borrowers, as their businesses are often in low-return sectors. Finally, their maternal roles in child bearing and rearing can interrupt their employment and ability to earn an income, making them more risky bank clients than men (Quisumbing & Pandolfelli, 2009; Croppenstedt, Goldstein, & Rosas, 2013).

It is worth mentioning that in regards to women's access to credit, an array of research surrounding micro-credit development schemes has emerged. This is partly a result of the establishment of the renowned Grameen Bank in India and its work (which has been regarded as highly successful) in providing small loans to women. Indeed, in the area of international development, micro-credit programs quickly became known as a

silver bullet for lessening gender inequality (Banyard, 2006). In more recent literature, an array of criticism regarding gender focused micro-credit programs has emerged (Karim, 2008; Omorodion, 2007). For instance, some programs in Nigeria and Bangladesh have been found to alienate women from their husbands by excluding men from the process, and many schemes have done little more than increase women's workload by encouraging women's involvement in paid labour (Karim, 2008; Omorodion, 2007). Research regarding micro-credit programs in Honduras yielded mixed results, concluding that women's ability to repay loans were largely dependent on the level of support received from male household members (Vonderlack-Navarro, 2010). Alternatively, the Self Employed Women's Association (SEWA) in India has been highly successful in its micro-credit programs, arguably because of training and capacity building sessions that they run along-side their lending schemes. SEWA helps to run locally appropriate enterprises such as a chapatti (flatbread) bakeries and dairy co-ops and seeks to improve women's access to child care, health care, legal services, housing and infrastructure (SEWA, 2009). In sum, internationally instituted micro-credit programs that do not address local culture or that do not understand the complexities of local gender relations (unlike SEWA) can, and often do, create new avenues of discrimination for women participants (Vonderlack-Navarro, 2010; Karim, 2008; Omorodion, 2007).

4.5.1 Research Results

A number of informants mentioned credit as a key obstacle to the adoption of new technologies. One respondent, Alyssa, brought up that she belonged to a women's group called a 'merry-go-round'. She proceeded to explain that it was a savings group between her and some other women nearby. Each month, she and the other members would

contribute a certain amount of money, and each month the "pool" would go to one of the members.

Merry-go-rounds, also known as Roscas, are rotating savings and credit associations (Gugerty, 2007). These informal financial institutions have gained prominence in the Kenyan media, and have caught the eye of development organisations such as CARE and multilateral organisations such as the World Bank (IRIN News, 2010). The University of Nairobi published an online article, which articulated that, although the merry-go-round concept has ancient roots and was originally used to help people save for weddings and funerals, it has evolved to include dynamic financial institutions (University of Nairobi, 2015). Merry-go-rounds come in different forms and operate to different capacities depending on their members and location. Some are strictly saving schemes, while others can offer micro-loans. A 2010 news report shows how a merry-go-round women's group called Msingi Bora helped women living in the Kibera slums send their children to school. The article explains how the group functions:

> Meeting weekly, the 23 Msingi Bora members each contribute 50 shillings (60 US cents), which is pooled for members to take loans from. At each meeting, the members also contribute 20 shillings (26 US cents) each - to be given to one member in what they term their "merry-go-round" as they draw lots to determine the order of receiving the money (IRIN News, 2010).

Of the women who belonged to a merry-go-round, three mentioned that in addition to helping them save, they could receive loans from the group and one even stated that the group had their own bank account. For groups without this loaning capacity, the pool is simply allocated to a different member each month[8]. Many

[8] Unfortunately, because of the seasonal nature of farm work, some members may receive their pools at less optimal times than others. To correct this, one of my respondents mentioned that her merry-go-round periodically changed the order in which members receive the pool to try and ensure fairness.

respondents said that they get together once a week with their groups, which could create a sense of personal belonging and understanding among members, as well as ensure that members are actively contributing. The loans in each group were limited to what the contributing members could afford, however, collectively these groups controlled a large sum. As The African Review (2013) states "…according to the Kenya Association of Investment Groups, [merry-go-rounds and likeminded informal institutions] control up to $1.1 billion of assets in the east African nation. This is about 10 percent of total deposits held by banks in the country" (Xinhua, 2013). Limited research has been conducted regarding the limitations of these informal savings groups. Seibel (2000) argues that NGOs, donor organisations, and microfinance institutions could increase the impacts of informal savings and credit groups (such as the merry-go-rounds) by working with them to formalize transactions and promote best practices. He cautions against this, however, in what he terms "repressive policy environments" which consist of high interest rates, high equity capital and collateral requirements, all of which discourage the participation of low-income households (Seibel, 2001).

These merry-go-rounds could have important implications on the introduction of WEMA's GE maize. Because they are locally inspired and funded initiatives, they bypass a lot of the criticisms that are often attributed to western designed micro-credit schemes and their informal nature allows women to access credit without the need to own land titles. The following section demonstrates how they could be key in helping women to adopt, and benefit from, biotechnology.

4.5.2 Credit and Biotechnology

A lack of access to credit has often been cited as a reason for women's lower adoption of inputs and biotechnology (Quisumbing & Pandolfelli, 2009; Croppenstedt, Goldstein, & Rosas, 2013; Doss, 2001). In their article, Arrends-Keunning and Makundi (2000) examine the costs and benefits of the Green Revolution in South Asia. With regards to credit, they wrote:

> … in Bangladesh, the cost per hectare of growing the new varieties was 60% higher than the traditional varieties because of purchased input costs. Without access to credit, farmers were unable to buy the inputs required for the new seeds. The relationship between moneylenders and small farmers became less traditional and more commercial, and many farmers became indebted. Governments tried to provide credit so that farmers did not have to rely on moneylenders, but these tended to favour large over small farms. Therefore, researchers began to question whether the Green Revolution had benefited large farmers at the expense of the small farmers (p. 325).

Access to credit has also been cited as the reason for Bt cotton's success in South Africa's Makhathini Flats. Schnurr's (2012) research revealed a monopsony situation where the cotton buyer also served as the sole lender. When these loans stopped, Bt cotton farmers operated at a loss, and adoption rate plummeted (Schnurr, 2012). Smale, Zambrano, and Cartel (2006) corroborate this argument by stating "contrary to expectations, it may have been the vertical integration in the cotton industry, with the monopsony of the local ginnery that also supplied seed and credit, which enabled success to occur in Makhathini Flats" (p.16). Qaim and Janvry's (2003), research on Bt cotton in Argentina found that small-scale farmers were not adopting the technology, in part, because of financial constraints. In their study, only medium to large-scale farmers were able to afford to make the shift to Bt cotton, due largely to their preferential access to credit. In Zilberman, Ameden, and Qaim's (2007) paper entitled "The Impact of Agricultural Biotechnology on Yields, Risks, and Biodiversity in Low-income Countries"

the importance of credit to small-scale farmers is highlighted, however they argue that too often small-scale farmers are unable to pay off their loans and end up in debt. They maintain that GE varieties have the potential to lessen the need for credit and lower debt by reducing the need for pesticides. However, they recognize that this works only if the GE varieties are affordable, and that farmers without access to credit have availability to cheaper, less effective seeds (Zilberman, Ameden, & Qaim, 2007). Therefore, small-scale farmer adoption rates reflect the balance between suitable credit options and the price of the biotechnology.

The dynamics that shaped outcomes in Bangladesh, Argentina, and South Africa seem likely to accompany the introduction of new biotechnology in other parts of Africa. Although WEMA seeds will be sold to farmers royalty-free, during my interviews with both WEMA representatives it was understood that these seeds would still cost more than their conventional equivalents. Exact price figures for WEMA's GE maize is not yet publicly available, however the need to purchase inputs in order to obtain "optimum yields of production" will represent an additional cost for farmers. Credit programs could help farmers afford WEMA seeds, labour, and inputs; however, they must be tailored towards small-scale farmers in order to be sustainable. My research shows that women in rural Kenya may have found a solution on their own; to ignore the merry-go-rounds or other grassroots micro-credit/savings programs would be imprudent. These women's groups could be invaluable to WEMA's success by ensuring that small-scale women farmers are able to afford the new technology. On the other hand, should commercial enterprises become the leading method of attaining credit among small-scale women farmers and WEMA seeds fail, women farmers could become indebted.

4.5.3 Feminist Political Ecology and Credit

Women's limited access to credit is a multi-faceted issue caused by their lack of ownership of assets such as land and livestock, their limited ability to engage in commercial farming or off farm labour, and their continued roles as mothers and caretakers. Viewed through the lens of FPE it becomes evident that gendered power imbalances disproportionately affect women's ability to access credit.

The merry-go-rounds were perhaps the most obvious example of displayed power amongst women farmers. Women displayed "power with" by working together in order to save money or take out micro-loans provided by their peers. These women identified access to financial resources as an issue and collectively worked towards alleviating the problem. Women's involvement in these groups also strongly displays "power within", since it has been organised by and for women who believe they should have an opportunity to save. In many cases, merry-go-rounds lack resources to scale up their influence and many cannot offer loans to members: however, these groups represent a real opportunity for women to take control of their finances, to increase their access to ecological resources, and to increase their agricultural productivity or quality of life. As demonstrated (and will be further discussed in the following section), financial security can help lessen the risk involved with adopting a new technology and control over financial resources can help women to make decisions regarding whether to adopt WEMA seeds independently by lessening their need to request funds from their partners.

In his research, Schnurr (2012) found that credit availability was integral to the success of Bt cotton in South Africa, and Dowd-Uribe (2013) had made very similar conclusions regarding the crop in Burkina Faso. However, another thing both case

studies have in common is that third party companies or banks that were provisionally associated with the biotech initiative provided the loans and subsidies. Once access to credit and subsidies were removed, small-scale farmers could no longer afford to plant Bt cotton and the crops' success declined drastically. From this, one can conclude that without accessible credit in rural Kenya, small-scale farmers will likely be unable to successfully adopt GE maize. As such, the merry-go-rounds present a unique opportunity. Not only could women's saving schemes provide low-income female farmers with the capital they would need to adopt WEMA's GE maize, but also being a grassroots initiative it could presumably be sustained indefinitely. Women who are dependent on third party handouts are at risk of subsidies drying up or credit offers expiring suddenly robbing them of their ability to plant expensive seeds and purchase inputs or labour. The Merry-go-rounds, on the other hand, represent a system that is already in place and one that is designed by and for its clients - it's a system that could greatly impact the success of WEMA's GE seeds and thus should be encouraged and supported.

4.6 Household Economies and Decision Making

Research has found that, contrary to classical economic theory, households do not act as cohesive economic units (Quisumbing, 2003; Padmanabhan, 2011; Kabeer, 1994). Often, household members make independent decisions, control separate incomes and assets, and make individual purchases (Flestchner and Kenney, 2000; Gladwin and McMillan, 1989). As Padmanabhan (2011) argues, "different members in the household act as autonomous sub-economies" (p.972). Kabeer (1998) defines sub-economies as "separate spheres where each individual controls their own income" (Kabeer, 1998 in Bock &

Shortail, 2006). However, power relations (that typically favour men) often determine the distribution of household finances and assets among members. Diana Flestchner and Lisa Kenney (2011) elaborate on this point by arguing that many development programs assume that spouses share similar goals and priorities when in reality family dynamics are complex and spouses often disagree. They explain how and why this can affect the distribution of resources within a household:

> Spouses can differ in how they want to allocate their resources, what they would like to produce, and how they prefer to spend the income they earn. Some individuals may be eager to try out new seeds or new technologies, tempted by potentially high returns. Others may feel reluctant to expose their families to the additional risk associated with these new activities…. When spouses disagree with each other, they will each try to steer the resources they control towards the allocations they prefer. They may refuse to share information with their partners; they may limit the labour they contribute to their spouses' activities; they may allocate more of their land, fertilizer or capital to activities in which they have more individual control; or they may choose not to fully pool the income they earn (p.8).

In many households in SSA, it is the husband who determines the distribution of household assets, leaving women with reduced income, labour, information, or agricultural resources (Padmanabhan, 2011). This lack of assets can limit women's bargaining positions and strip away their decision-making power (Fletschner, 2008). This power dynamic is perhaps evidenced by women's lack of involvement in commercial agriculture.

Although possible, women's decision-making power rarely translates to large-scale or commercial agricultural enterprises. As Doss (2001) argues, "A standard explanation for the division of crops by gender is that women are responsible for feeding the family and thus prefer to grow subsistence crops…it is difficult to tell, however, whether women grow lower-value subsistence crops because they have different priorities or because they have less access to land, inputs, credit, information or markets"

(p. 2077). In an interview, gender specialist Alanna argued passionately that women's heavy work burdens as mothers, farmers, and caretakers did not provide them with enough time to learn how to operate farm equipment or to expand into commercial farming or cash cropping. As a result, women were able to make most of the decisions regarding subsistence farms, but men take over decision-making in the event that a farm commercializes (October 8th, 2013). An unequal distribution of household resources relegates women to small-scale and subsistence farming, further limiting their opportunities for financial growth.

4.6.1 Research Results

In an attempt to address the issues described above and to situate them in my research, I asked questions focused on women's decision making ability in the farm, and their management of farm finances. The "management of farm finances" was described as the purchasing of seeds and inputs, or the management of income from the sale of produce. Though all of the women responded that they managed the farm, only half of the women living with their husbands reported that they had control over farm finances. Furthermore, only two respondents answered that they managed these finances together with their husbands, supporting the concept that often-household members represent individual sub-economies[9] (Padmanabhan, 2011). Often, the husband allocated funds towards seeds and inputs, or would purchase them himself. This dependency can leave women with less to bargain with should a disagreement arise. This is not to say, however, that women were voiceless in the matter.

[9] Sub-economies can be defined as "separate spheres where each individual controls their own income" (Kabeer, 1998 in Bock & Shortail, 2006).

When I asked "who decides what to plant on the farm", all but two women stated that they were the ones who made this decision. When I asked one farmer in Kathiani whether it was the men or the women in her area who would typically decide what to plant, she answered, **"**It's the women. Because you know what your family will need. Like maize, it has to be there throughout. Maize, beans, those are the staples…If you don't have that then you will die of hunger…" (Patience, November 14th, 2013). Interestingly, her answer supports the argument that women are the primary managers of small-scale and subsistence farms due to their roles as food providers. These farms are often considered part of managing a household, rather than a method of formal employment and because feeding the household and preparing food is still largely considered a woman's responsibility, decision making on these farms is relegated to women (Doss, 2001; Doss, 2011; Hovorka, 2012; Alanna, October 8th, 2013, Nairobi; Grace, October 15th, 203, Nairobi). As Alanna, gender specialist at the Ministry of Agriculture (MOA) states:

> Unless a household is female headed, men make most of the decisions. Women are usually in charge of making decisions regarding subsistence farms. In those small subsistence farms women are often allowed to decide what to plant, when, and how; men don't care much about that. But as soon as a farm becomes commercialized, men take over decision-making. Even if the commercialized farm includes the land that used to be the women's subsistence plots, men will suddenly make all the decisions. Anything that has to do with cash cropping or commercial farms, its the men. Men make financial decisions, and decide what to plant. Women lose their authority… (Alana, October 8th, 2013, Nairobi).

Grace, another MoA worker assigned to the WEMA project, also implies that women are mainly confined to subsistence agriculture by stating "Farmers are women, especially in the target area where the majority of farms are small scale, 1-2 ½ acres" (Grace, October 15th, 2013, Nairobi). During an interview, a representative from the National Biosafety

Authority stated, "…when it [maize] is in the regions where it is highly commercialized like in the rift valley, I think the participation of men then overrides [women]. Men probably participate more, where it is highly mechanized (that is large farms) there, women play a lesser role than the men" (Daniel, October 30th, 2014, Nairobi).

4.6.2 Biotechnology and Household Decision Making

What my expert and farmer interviews indicate is that the lived realities of farmers are power laden. Although most of the women I spoke with were able to make decisions independently regarding what to plant, experts suggest that this power is contingent upon their roles as homemakers. These household economies could affect the implications of GE technology in two obvious ways. The first relates to Flestchner and Kenney's (2008) argument that "when spouses disagree with each other, they will each try to steer resources they control towards allocations they prefer" (p.9). It is likely that some spouses will disagree about biotechnology. However, women have fewer resources to steer towards their goals; as mentioned only half of my respondents controlled farm finances regardless of the fact that they did all the farm work. This places men in a position of power when it comes to deciding whether to purchase a new seed technology such as GE maize. They may decide the technology is too expensive, or they may decide it is beneficial and purchase it without considering the added labour it can cause for their wives. In any case, those women who do control their own farm finances will have more to bargain with when deciding whether to adopt GE technology than those who do not. Adding to this dynamic is the issue of access to information. Although 14 out of 31 women asked said that they attend agricultural extension meetings and many agreed that women and men attend the meetings equally, David at AATF seems concerned that

mostly men will show up at the promotional workshops and information sessions. When asked whether he believed both men and women would attend and have the same access to information he responded that both would be invited, but that men would likely make up most of the attendees. He stated, "Because men tend to make the decision so if anything new is coming you will find more there…. You will find that even if you go to Kitui or Machakos and you call the group you will find women are fewer, some of them may be sitting there reserved a bit, so you have to make an effort to engage them" (David, October 22nd, 2013, Nairobi).

Access to information regarding GE technology is crucial when deciding whether or not to adopt, and second hand information is never as accurate as first. If husbands attend these meetings instead of their wives they are at an informational advantage and can then use this information to sway their spouses towards whatever decision they make. Moreover, David at AATF mentioned that sample seeds would be handed out to farmers who attend the meetings, which could place this technology directly in the hands of men instead of the women it is meant to target.

The second reason is one we have already touched upon, and so it will only be briefly addressed here. WEMA seeds in particular may not transform subsistence farms into large-scale commercial enterprises, however, the promise of higher yields and increased income may be enough to capture the attention of men who, until now, were not interested in agriculture. Should the introduction of WEMA maize transform farms into a money-making venture, it is possible men will take over some of the associated decision-making. It is also worth considering that if Kenya commercializes GEOs, WEMA seeds will not be the only option on the market, at least not for long, and (as

discussed in the introduction) there is a longstanding coupling of biotechnology and commercial agriculture (Brooks and Barfoot, 2010; Holt-Gimenez, Altieri & Rosset, 2006). Thus, if not consciously marketed towards men *and* women, the introduction of GEOs could push women off their farms and further limit their access to food and household resources, a phenomenon that occurred with the introduction of rice projects in the Gambia in the 1970s (Dey, 1981). In conclusion, women's limited access to household resources such as credit, land, labour, and finances decrease their bargaining power in relation to men. Should a conflict of interest arise surrounding whether or not to plant WEMA maize and how much to plant, men's "arsenal of assets" means their preferences are likely to prevail.

4.6.3 FPE and Household Economies and Decision Making

An engagement with the concepts of agency and structure can add to the discussion surrounding women's "ability to choose" biotechnology. My research revealed that women displayed agency in that every participant felt responsible for deciding what to plant on their farms. However, the degree to which their decisions were influenced by what was culturally expected of them remains uncertain. For example, my expert interviews and secondary research suggests that societal gender norms often keep women from engaging in commercial agriculture, limiting their agency to the realm of subsistence farming. Moreover, half of the study respondents revealed that their husbands controlled farm finances, leaving one to question the degree to which their ability to choose seeds will remain should a conflict of interests arise. For example, Kabeer (2000) argued that normative responsibility is often valued less than material power or, in other

words, women's unpaid labour contributions to a household often provide less bargaining power than members who contribute financially.

Women's decreased access to assets can lessen their bargaining power within the household and limit their decision making power. However, it is important to note that this dynamic will be very different for widows, and also that some partners may work together on their farms and make collaborative decisions. As such, women's ability to choose biotechnology will likely be context specific and will vary depending on their power within the household, which is determined, in part, by the social context in which they find themselves. Kabeer's (2000) research regarding women's choice to enter the labor force in Bangladesh and London corroborates this conclusion. She states,

> " the 'households' described in the women's testimonies (…) were largely made up of members of the same family, bound to each other by ties of blood or marriage, caring for each other and sharing projects in common, but whose ability to make choices and to influence collective decision making were significantly shaped by their contractually defined roles, resources, responsibilities and place within the family and the wider community" (p. 327).

Moreover, FPE promotes a multi-scalar analysis that connects household dynamics with public policy and international issues. By examining household economies and decision-making and connecting these with the possible outcomes of an internationally funded agricultural technology such as GE maize, this research deeply engages with FPE as a theoretical construct. It recommends that agricultural PPPs engage with their target audience (farmers) in order to gain a better understanding of their needs. The needs and desires of small-scale female farmers should better shape national agricultural policy and help inform the decisions of WEMA's international funding partners. The disconnect between agricultural scientists, seed developers, policy experts

and farmers can result in a technology which fails to meet its targets, increases work burdens, and further entrenches household gender divisions.

CHAPTER 5: ADDITIONAL CONSIDERATIONS

This chapter briefly discusses some key considerations that were not included in the previous chapter such as access to water, access to information and extension services, and respondents' perceived willingness to adopt WEMA maize. These three variables are crucially important when considering the impacts of GE maize, however, this research yielded interesting yet inconclusive results. More research is needed in order to determine the extent to which these issues are gendered, and the degree to which they will influence the outcome of the commercialization of WEMA maize. Nonetheless they are important to consider and understand as they help to contextualize my research and provide an avenue for future research.

5.1 Access to Water:

A lack of access to irrigation water is in part what inspired WEMA's creation and, as such, it was a theme throughout my research. In the dry eastern regions of Kenya there are two planting seasons: one in October, and one in April (Jane, November, 2013, Machakos). Most of my respondents were at the complete mercy of the rains, and almost every one of my respondents answered that they planted maize in April despite reaping little or no harvest. As one of my respondents from Mwala put it "In the April season there are no rains, so you just plant and you don't harvest. So we keep [crops] the from the December rains…to eat in the April season" (Diana, November 18th, 2013, Mwala). Beatrice, a 68-year-old farmer from Kathiani said "I harvest nothing when there is drought, and there is so much wasted because I ask people to come and cultivate. I buy the seeds but I harvest nothing when there is no rains" (Beatrice, November 15th, 2015, Kathiani).

There were three of my respondents who had water storage tanks and one respondent who owned a borehole. These women had slightly larger farms than the average (2.5, 3, and 5 acres for those with storage tanks and 4 acres for the participant with her own borehole); however, they all still identified drought and lack of water as an issue. For example, Patience in Kathiani has her own storage tank but said, "I wish I had a borehole, a constant water supply, then I can do more" (Patience, November 14th, 2013, Kathiani). Sophie also has a storage tank; however, she would fetch most of her water from an intermittent stream (Sophie, November 18th, 2013, Mwala).

There is much documentation regarding the importance of access to water in agricultural production and biotechnology adoption, as well as on the gendered dynamics of access to water (Crow & Sultana, 2002; Perumal, 2011). However, I chose not to focus on this asset in the previous chapter because my research revealed no gendered implications with regards to access. As Patience put it, "the challenges are the same [for men as they are for women]. If there is no water in my farm, it will be the same for the man, no water" (Patience, November 14th, 2013). I have no evidence to suggest that Kenyan women are less able to access water than men, and when asked what challenges women farmers faced in particular most answered with either " the financial challenge" or "the challenge of owning cows". None of the respondents asked had heard of a water users' association. It is important to consider, however, that I did not interview men and perhaps if I had, gendered issues regarding access to water would have emerged. It is also important to note that, although Sophie mentioned having to fetch water from an intermittent stream, the gendered implications of this added labour was underexplored in my research (Sophie, November 18th, 2013, Mwala). Regardless, it is important to be

cognisant of the fact that every respondent identified drought and water access as an issue, if not a gendered one.

Providing women with access to water and irrigation is likely the best way to combat drought on their farms, as it would increase their choices regarding what to plant instead of limiting their options to a few drought resistant and engineered seeds. It would increase yields and afford them an opportunity to plant more profitable water intensive crops such as watermelons and vegetables for which many of my respondents have shown an interest in growing. Of course, the power relations and structural constraints surrounding the provision of water and irrigation would also need to be investigated. Nonetheless, if WEMA maize proves drought resistant, and allows farmers to reap harvests in the April planting season, it seems likely it will spark a strong interest amongst women farmers and could improve food security during that time of year.

5.2: Information and Extension Services:

It is often hypothesized that farmers who do not adopt agricultural technologies are ignorant of them. A lack of access to information and extension services is regularly cited as a reason for biotechnology's low adoption rates among small-scale farmers (Qaim, 1999; Zambrano et al., 2011; Gilbert, Webster & Benson, 2002). What's more, it is often considered to be a gendered issue. Croppenstedt, Goldstein, and Rosas (2013) sum up the results of a couple related studies:

> In Ethiopia, 20 percent of women compared with 27% of men had been visited by an extension agent. In Ghana, the figure was much lower: 12 percent of male-headed households had received extension visits, whereas 2 percent of female-headed households had receive extension visits in one region, and zero percent had received extension visits in two other regions. Indeed, even in male headed households, only 2 percent of spouses received an extension visit…In Karnataka, India, 29 percent of land-holding male-headed households received an extension visit whereas 18 percent of female

headed households did (p.96).

My research revealed that in the Machakos and Kitui districts of Kenya, agricultural extension officers hold regular community meetings where they teach best practices and talk about seeds available on the market. Moreover, David from AATF confirmed that both public (hired through the MOA) and private (hired by seed companies) extension services will be utilized in the dissemination of GE maize, meaning contact with these individuals could greatly impact WEMA's success (David, October, 2013). However, attendance to agricultural extension meetings among my respondents was sporadic. Out of the 31 people asked, only 14 participants attended the meetings, 3 were called to attend but did not, and 14 were never invited. Interestingly, despite secondary research that suggests men are more likely to attend meetings, the issue of low attendance among did not seem to be a gendered one. In fact, it is likely that agricultural extension meetings are even female dominated. Patience, for example, said that they are called for a meeting every 2 months, and that it is mostly women who attend. Two other respondents mentioned that men and women attend the meetings equally. Nonetheless, attendance rates among respondents were still fairly low.

There are two alternatives that emerged as possible reasons for low attendance rates. One is that in some areas extension services may simply be unavailable. In Kitui, for example, only one respondent had even heard of agricultural extension meetings taking place. The other possibility is that farmers are being discriminated against based on income or plot size. Out of the participants that did not attend, 7 admitted that they knew the meetings were occurring but did not go because they were not called or invited to attend. Ann, a farmer in Kathiani, said "I don't go, because they only contact people

with 5 acres. So I just get that information from those with big farms, I don't go because I am not called, I have only 2 acres" (Ann, November 14th, 2013, Kathiani). Charlotte, another Kathiani woman, said, "I have no interaction [with extension workers]. They call the village but not everybody" (Charlotte, November 15th, 2013, Kathiani). However, it is unclear whether farm size is the reason these women were excluded from the invite list. A participant from Mwala named Sophie answered quite contrarily. She said, "I don't attend because I am not called. Chiefs come into the village and give seeds to the poor. They have a list of everyone who is in need, but I am not there" (Sophie, November 18th, 2013, Mwala). Contrary to Ann, Sophie, is suggesting that only farmers under a certain income bracket are invited to the meetings. The reasons behind farmers' exclusion from agricultural extension meetings are unclear and further investigation is needed in order to comprehend the social and political influences behind this phenomenon.

It is also worth noting that participants demonstrated a general lack of awareness regarding biotechnology and the Kenyan debate over whether or not to commercialize it. In fact, only 4 respondents had heard the term "GEO" before, and they admitted that it was over the radio during a program they were disinterested in. Even more problematic is the fact that there appears to be a lack of awareness about the technology among agricultural extension workers as well. Justin, a teacher and master's student had conducted a study in Western Kenya regarding farmer's awareness of biotechnology. Not only did his research reveal that farmers were generally unaware of GEOs, he also discovered the degree to which the extension officers administering his surveys were in need of information on the topic (Justin, September, 2013).

The implications of small-scale farmer's having access to information on the

introduction of biotechnology is significant. If WEMA utilizes agricultural extension workers as a means of spreading knowledge about GE maize, many farmers will be excluded, although it is uncertain on what basis. What's more, knowledge on the risks and benefits of this technology must extend beyond the scientific community in order to allow farmers to make informed decisions (Kingiri A. N., 2010). Small-scale farmers and agricultural extension workers should be brought into the conversations surrounding biotechnology *before* it is commercialized in order to ensure the technology appropriately meets their needs. Nevertheless, more research is needed to explore the gendered and socio-economic aspects of this lack of information before its full effects on the introduction of WEMA maize can be fully understood.

5.3 Women's Willingness to Adopt WEMA Maize

In developing countries, women are less likely to adopt improved seed varieties and GE technology than men (Zambrano et al., 2011; Croppenstedt, Goldstein and Rosas, 2013). However, there appears to be a consensus across the literature that this is a result of a lack of access to resources or an inability to adopt new technology, rather than a personal choice. Although women are less likely to assume the risk of a new technology, if they had improved access to resources that risk would be greatly minimized. In other words, there is not enough evidence to suggest that, all things being equal, women in Kenya would be less enthusiastic about GE seeds than men (Croppenstedt, Goldstein and Rosas, 2013).

My research revealed that as long as WEMA seeds are affordable, women would be interested in trying them. Out of my respondents, 13 said that they would be interested in trying the seeds, 7 said that they will either wait to see how their neighbours fare with

them or would plant a small portion of their fields to test the product first, and 11 respondents said that they were interested in learning more about the seeds. Participants' willingness to try something new and adopt these seeds was fairly high, meaning in WEMA's initial launch period uptake of the technology could also be high. On the other hand, uptake will likely depend on their access to the variables presented in the previous chapter, as well as how effectively information is provided to those small-scale female farmers that wanted to know more prior to purchasing GE maize. Zambrano's et al., (2011) research had similar results regarding women's willingness to plant BT cotton in Colombia. They found that women wanted greater access to information and resources, but where otherwise interested in trying a new seed.

CHAPTER 6: CONCLUSIONS

My research sought to answer the following question: "What are the likely implications of the commercialization of WEMA's GE maize seed for small-scale female farmers in Kenya?" Using FPE as a framework, I addressed this question by interviewing agents operating on a national scale as well as at a household level. This thesis discussed the power imbalances that exist along gender and class lines, and how these can affect women's ability to access and control land, inputs, labour and finances. It uncovered that gendered power relations in households and communities are creating production differentials between male and female farmers, which in turn are likely to influence the outcomes associated with WEMA's GE maize. A needs assessment (conducted by agricultural PPPs or the public sector) of women farmers in the Machakos and Kitui districts would unearth agricultural concerns that, if first addressed, would greatly improve WEMA's chances of success.

6.1 Summary of Results

In order to help answer my principal research question a list of three sub-questions were devised. Because no two women have the same rights and limitations, the results that I collected varied, making it difficult to draw definitive conclusions. Still, prominent themes and trends that help to address these sub-questions have emerged.

6.1.2 How can women's realities play into the success/failure of WEMA maize?

Women in the dry eastern regions of Kenya regularly experience drought, food insecurity, and financial insecurity. All of the participants planted maize during the April season, knowing their crops will likely fail. Not surprisingly, then, the majority of farmer

respondents indicated that they would be willing to plant drought resistant GE maize. If properly managed, and presuming there are minimal negative environmental and health impacts, WEMA maize could improve food security and benefit small-scale women farmers. Nonetheless, the socio-political power relations that prevent women's access to agricultural resources could limit their access, ownership, and control over biotechnology as well.

For example, women's limited ownership of land has restricted their access to credit (Fletschner, 2008) and has placed them in a precarious situation whereby decision making over their land can be taken away. This can lessen the incentive to adopt high yielding varieties by increasing risk and decreasing the financial freedom that may be required to make the shift to biotechnology. In addition, access to inputs among my respondents was limited. This can prevent them from being able to reap the same quality of yields that are being harvested during WEMA's field trials. Also, without taking into account farmers' inability to plant refuges or apply pesticides, the Bt toxin can be problematic for women who do not initially adopt the technology and suffer unusually high pest rates (without refuges insects will also quickly adapt to the Bt toxin). Furthermore, because most small scale female farmers are not currently applying pesticides, rather than alleviate labour, the WEMA maize will likely add to women's work burdens around harvest time (Addison and Schnurr, In Press; Gouse, Kirsten, & Jenkins, 2003). Access and control over financial resources can also play into whether or not women are able to adopt, or refuse this technology (Morris & Doss, 1999). That is why women's programs such as the merry-go-rounds can help in improving women's

options and providing them with the ability to more safely decide whether or not to adopt biotechnology.

6.1.3 Will WEMA seeds address food security issues among small-scale farmers?

It is possible that WEMA seeds will help to alleviate some of the food insecurity experienced by small-scale farmers: however, one might question whether it is the best approach to tackling the issue of hunger. Since women in Machakos and Kitui are primarily responsible for providing food, then it follows that increasing women's access to agricultural resources would greatly improve food security. Grassroots initiatives designed to improve women's access to land, bore holes, water tanks, oxen and labour, fertilizers, pesticides, credit and financial security would not only increase yields but empower women by allowing them to challenge systems of patriarchy. It would increase their ability to harvest more than just maize, allowing them to vary their diets and engage in cash cropping. Although cash cropping is traditionally a male dominated activity (Hovorka A. J., 2012), ownership over land would provide a sense of autonomy and would give women increased bargaining power, perhaps enabling them to maintain decision-making power regardless of farm income.

The changes suggested above can help to close the productivity gap between male and female-headed households and can increase food security. However, without addressing these underlying causes of food insecurity, WEMA maize's benefits are likely to be marginal.

6.1.4 Are women farmers able and willing to adopt this technology?

These results indicate that women are willing to try this technology, but they are wary to do so without additional access to information or some assurance that it works. In that

sense, women's willingness to adopt will depend on how WEMA representatives disseminate information. If WEMA chooses to utilize extension workers, it is likely that many farmers will be overlooked during informational campaigns.

Women's ability to adopt is another issue, one that is difficult to answer definitively. In part, it will depend on their access and control over ecological resources as has been discussed, however it will also depend on their ability to make decisions and allocate household assets. Out of the 21 married women I spoke with (excluding widows), only 6 women managed their own farm finances while another 2 managed them together with their husbands. Some of these respondents said that they would ask their husbands before purchasing new technology, which might limit the degree to which they are able to make independent decisions regarding biotechnology. Moreover, 9 of my respondents identified access to finances as an issue particular to women farmers. Nonetheless, other respondents answered that they have complete control over what seeds to buy. I would argue that women's ability to adopt the technology would depend on their bargaining power within their households, which can be increased through access to financial resources and physical assets such as land. Before creating GE seeds, we should adopt an approach that aims to close the productivity gap between men and women by improving women's access to resources that already exist. For instance, merry-go-rounds are one example of a program that helps increase women's access to financial capital and, by extension, other assets. Like-minded gender sensitive and locally inspired programs designed to increase subsistence farmers' access to water, land, labour, fertilizers, and pesticides would do a more thorough job at increasing food security than would GE maize seed, and should be a precursor to this technology.

Moreover, the methods undertaken by WEMA representatives when introducing this technology can also have a significant impact on women's bargaining power and ability to make informed decisions regarding whether or not to adopt the seeds. For example, a large number agricultural development programs have discriminated against women by identifying men as the head of the household. A rice irrigation project in Gambia, for instance, approached primarily men during their information sessions giving them a sense of ownership over the project. The result was that women were pushed out of their rice farms and lost decision-making power as well as a primary source of income (Quisumbing, 1994). In this respect, it is important that WEMA representatives recognize that subsistence agriculture is mostly managed by women, and go to extra lengths to ensure that women are being informed about the risks and benefits of this technology, not only their spouses. Efforts should be made to ensure that women are able to attend WEMA's informational workshops and have access to agricultural extension workers. If efforts are not made to include women in the discussion surrounding biotechnology, then in some cases men will take over related decision-making, although there is no way to know the extent to which this might occur.

6.2 Conclusion:

As a result of their gender status, women face particular challenges when it comes to farming. These challenges contribute to productivity differentials between male and female owned farms and limit women's involvement in commercial agriculture. Moreover, these same gendered circumstances can have negative implications on the commercialization of WEMA's GE maize. Without taking into consideration the lived realities of small-scale female farmers on a household level, internationally funded PPPs

could end up inadvertently strengthening and reinforcing the barriers that prevent women from controlling and accessing ecological resources. Perhaps the secret to improving food security is not as complicated as gene splicing technology - perhaps it involves drilling boreholes, improving market access, and increasing women's rights to land - perhaps it lies within women becoming "empowered with" and "empowered within". Achieving this will no doubt reverberate positively throughout agricultural systems as a whole, because as political ecology has taught us, everything is connected.

APPENDIX A: TABLES

Table 3: Modern biotech agriculture PPP's in Kenya as of July 2009 (Muraguri, 2010)

Table 3. Modern biotech agriculture PPPs in Kenya as at July 2009

Project	Initiative trigger/trait	Status	Collaborators/partners
Sweet potato engineered for disease resistance-Feathery mottle virus	The virus coat protein gene availability from Monsanto Diseases attack causing low yields	Contained laboratory and Confined Field trials	KARI, Monsanto, ABSP, ISAAA Michigan state university, Kenyan universities
Bt maize-IRMA project engineered for resistance to insects-African maize stem borers	Bt technology availability from Syngenta Pests infestation in particular maize stalk borers	Contained Laboratory & Greenhouse and Confined Field trial	KARI, CIMMYT, Syngenta, Rockefeller Foundation, USAID, Kenyan universities and Monsanto
Cassava engineered for Cassava Mosaic Disease (CMD) resistance-African cassava Mosaic virus and East African cassava mosaic virus	Disease infestation in particular the CMD reducing yields significantly The coat protein gene availability from Monsanto	Contained laboratory and greenhouse application has been pending for confined field trials	KARI, Danforth centre-USA, USAID, Cornell University-USA, ISAAA, Kenyan universities
Bt cotton engineered for Insect resistance-cotton bollworms (Bollgard I and II)	Declining production performance Bt technology availability from Monsanto Pests infestation in particular African boll worms	Contained greenhouse and confined field trials	KARI, Delta-pine South Africa, Monsanto, KIRDI, ISAAA
Transgenic Sorghum for resistance to *striga* parasitic weed	The availability of a collaborative research grant The persistence of parasitic striga weed in cereals growing areas in Kenya	Contained laboratory and screen house	Kenyatta University (Kenya), University of California Davis (USA)
Transgenic Sorghum for bio-fortification	Poor digestibility of sorghum Low nutrient content	Proof of concept	Africa Harvest, KARI, Pioneer Hi-bred, ICRISAT, UC-Berkeley, CSIR-South Africa, University of Pretoria, ARC-South Africa, AATF, CORAF, INERA-Burkina Faso
Drought tolerant maize	Persistent drought and resultant crop failures Availability of drought-tolerant trait	Contained laboratory trials planned for late 2009 Confined field trials planned for late 2009	AATF, KARI, CIMMYT, Monsanto, NARO-Uganda, COSTECH-Tanzania, ARC-South Africa, IIAM-Mozambique

APPENDIX B: FIGURES

Figure 2: Timeline of the development and operations of the WEMA project (Demers-Morris, 2015)

PHASE 1: Concept Developmet. Scientific/Technical Review. Product Development. Baseline Study				
2008	**2009**	**2010**	**2011**	**2012**
WEMA is formed.	Groundwork is laid for CFTs .	CFT's begin.	Decision is made to add BT to WEMA maize.	Kenya institutes ban on GE preventing importation of Germplasm.
PHASE 2: Product Deployment in Pilot Locations. Impact Assessment. Widescale Deployment. Exit Strategy				
2013	**2014**	**2015**	**2016**	**2017**
My field research begins; WEMA approves 16 hybrid varieties for commercial release including Drought TEGO; First CFTs with BT were harvested.	Community Outreach for GE maize was scheduled to begin.	AATF and WEMA submit Regulatory Approval Request for BT maize.		WEMA's drought tolerant BT maize is expected to be commercially available.

Figure 3: WEMA seed development timeline (WEMA, 2008)

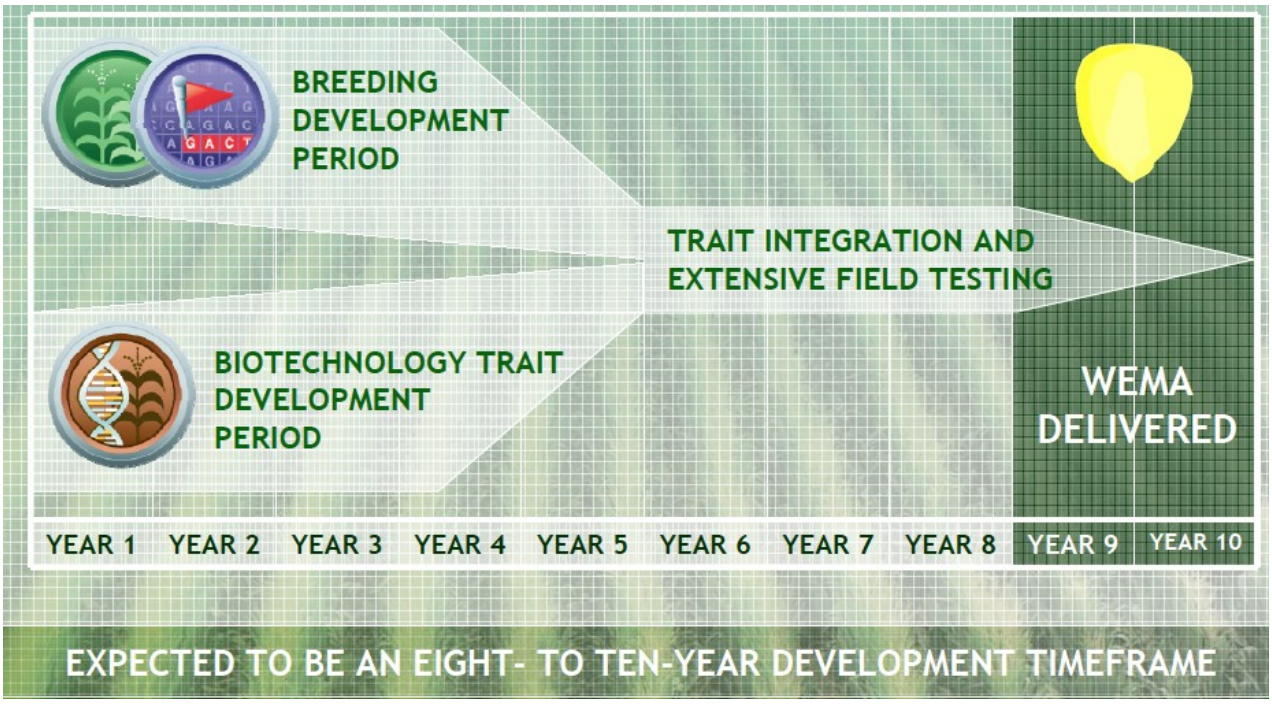
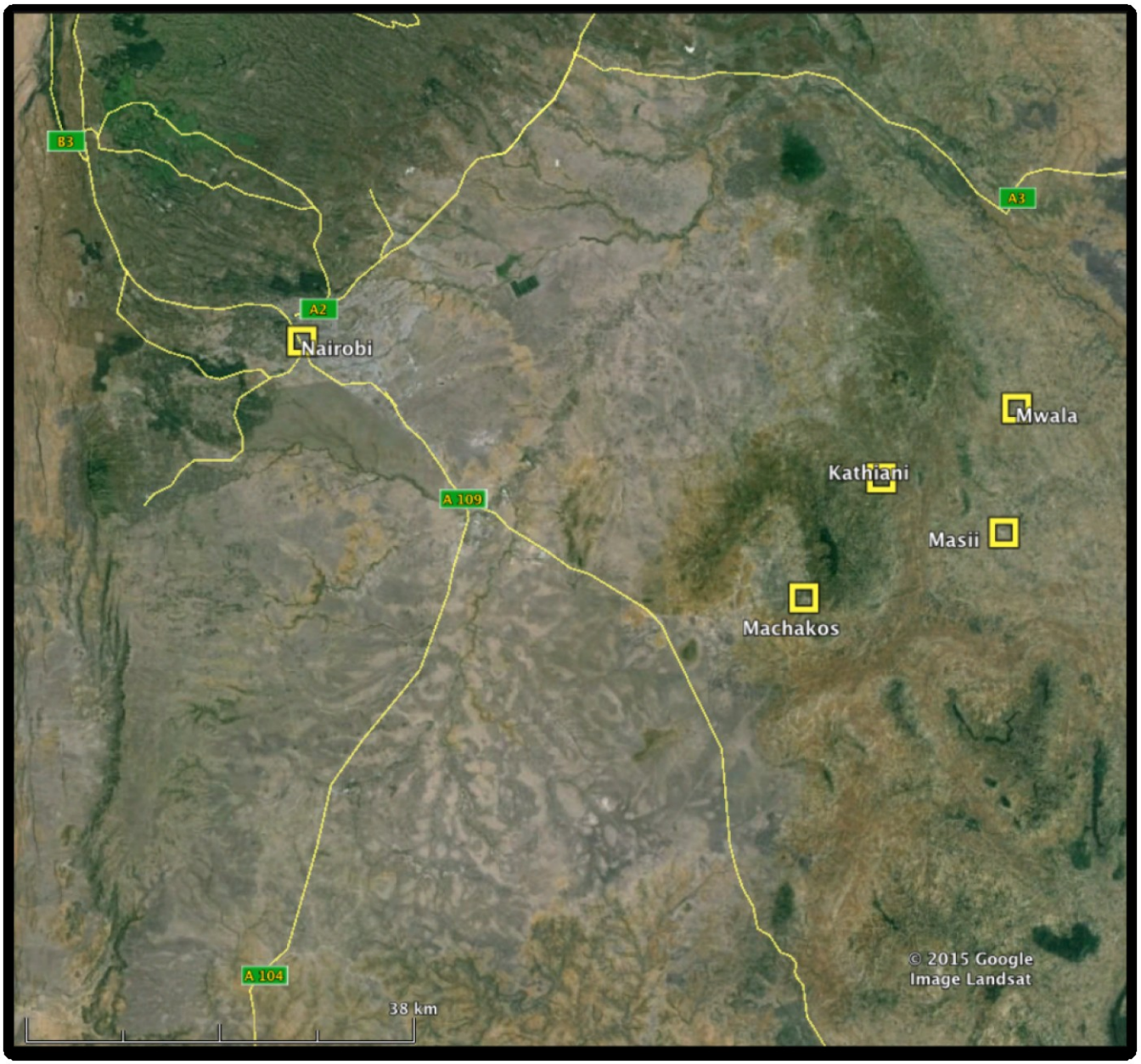


Figure 4: Map of Study Locations (Demers- Morris, 2015)



BIBLIOGRAPHY

AATF. (2012). *Water Efficient Maize for Africa (WEMA)*. Retrieved 02 11, 2015 from African Agricultural Technology Foundation: http://wema.aatf-africa.org/about-wema-project

AATF. (2012). *Who we are*. Retrieved 02 11, 2015 from African Agricultural Technology Foundation: http://aatf-africa.org

Achia, G. (2013, May). *Kenya's GMO ban has no legal basis, official says*. From SciDevNet: http://www.scidev.net/global/food-security/news/kenya-s-gmo-ban-has-no-legal-basis-official-says-1.html

Addison, L., & Schnurr. (In Press). Growing burdens: Disease-resistant Genetically Modified banana and the gendered implications for labour in Uganda. *Agriculture and Human Values.*

Agarwal, B. (2009). Gender and forest conservation: The impact of women's participation in community forest governance. *.Ecological Economics , 68* (11), 2785-2799.

Agarwal, B. (1989). Rural Women, Poverty and Natural Resources: Sustenance, Sustainability and Struggle for Change. *Economic and Political Weekly , 24* (43), 46-65.

AGRA. (2015). Retrieved 02 10, 2015 from AGRA: Growing Africa's Agriculture: http://agra-alliance.org

Alanna. (2013, October 8th). Gender Specialist, Ministry of Agriculture. (C. Demers, Interviewer)

Arends-Keunning, M., & Makundi, F. (2000). Agricultural Biotechnology for Developing Countries: Prospects and Policies. *American Behavioral Scientist , 44* (3), 318-349.

Ariga, J., Jayne, T., Kibaara, B., & Nyoro, J. K. (2008). *Trends and Patterns in Fertilizer Use by Smallholder Farmers in Kenya, 1997-2007. Tomego Working Paper No. 32.* Nairobi: Tomego Institute, Egerton University.

Banyard, P. (2006, December). The peace prize: the phenomenal success of Bangladesh micro lender Grameen Bank . *Journal of the Institute of Credit Management* , 46-47.

Barfoot, G., & Brookes, P. (2010). Global Impact of Biotech Crops: Environmental Effects, 1996-2008. *Graham Brookes and Peter Barfoot* , 76-94.

BBC News. (2013, 04 09). *Uhuru Kenyatta sworn in as Kenyan president.* Retrieved 02 10, 2015 from BBC News Africa: http://www.bbc.com/news/world-africa-22074481

Berry, S. (1989). Access, control and use of resources in African agriculture: An Introduction. *Afroca , 59*, 1-5.

Bett, C., Ouma, J. O., & Groote, H. D. (2010). Perspectives of Gatekeepers in the Kenyan Food Industry Towards Genetically Modified Food. *Food Policy , 35*, 332-340.

Beuzekom, B. v., & Arundel, A. (2009). *OECD Biotechnology Statistics 2009 By Brigitte.* OECD. Paris: Organisation for Economic Co-operation and Development.

Blaikie, P. (2008). Epilogue: Towards a future for political ecology that works. *Geoforum , 39*, 765-772.

Blaikie, P. M., & Brookfield, H. C. (1987). *Land degradation and society.* London, New York: Methuen.

Blaikie, P. (2010). *Should some political ecology be useful?* Association of American Geographers.

Bock, B., & Shortail, S. (2006). *Rural Gender Relations: Issues and Case Studies.* Oxford University Press .

Boserup, E. (1990). Economic Change and the Roles of Women. In I. Tinker, *Persistent Inequalities: Women and World Development* (pp. 14-24). New York University Press.

Boserup, E. (1965). *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure.* London: George Allen and Unwin LTD.

Bryant, L. R. (1998). Power, knowledge and political ecology in the third world: a review. *Progress in Physical Geography , 22* (1), 79-94.

Burke, W. J., & Jayne, T. S. (2014). Smallholder land ownership in Kenya: distribution between households. *Agricultural Economics , 45*, 185-198.

Campbell, N. A., Reece, J. B., Urry, L. A., Cain, L. M., Wasserman, A. S., Minorsky, P. V., et al. (2009). *Biology* (8th ed.). San Francisco: Pearson Benjamin Cummings.

Centre for Education and Documentation. (2009). *In India, the Green Revolution turns to brown: Impact of Chemical Technology.* Retrieved September 8, 2015 from http://base.d-p-h.info/en/fiches/dph/fiche-dph-7926.html

Chaudhary, A. K. (2013). Indian Agriculture: A Fresh Approach Towards Green Revolution 2.0' . *Journal of Business and Management , 10* (1), 50-57.

Chipande, G. (1987). Innovation Adoption Among Female-Headed Households. *Development and Change , 18* (2), 315-327.

Cranshaw, W. (2014, 08 05). *Bacillus Thuringiensis*. Retrieved 02 10, 2015 from Colorado State University Extension: ext.colostate.edu

Croppenstedt, A., Goldstein, M., & Rosas, N. (2013). Gender and Agriculture: Inefficiencies, Segregation, and Low Productivity Traps. *The World Bank Research Observer* , 79-109.

Crow, B., & Sultana, F. (2002). Gender, Class, and Access to Water: Three Cases in a Poor and Crowded Delta. Society & Natural Resources. *Society & Natural Resources , 15* (8), 709-724.

Daniel. (2013, October 22). Director of Technical Services at the National Biosafety Authority. (C. Demers, Interviewer)

David. (2013, October 22). WEMA Deployment Team Leader, African Agricultural Technology Foundation (AATF). (C. Demers, Interviewer)

Dey, J. (1980). Gambian Women: Unequal Partners in Rice Development Projects? *African Women in Development Process* , 109-122.

Doss, C. (2001). Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience. *World Development , 29* (12), 2075-2092.

Doss, C. (2011). *The Role of Women in Agriculture.* FAO, Agricultural Development Economics Devision. ESA Working Paper No. 11-02 .

Edmeades, S., & Smale, M. (2006). A trait-based model of the potential demand for a genetically engineered food crop in a developing economy. *Agricultural Economics , 35*, 351-361.

Ellis, A., Cutura, J., Dione, N., Gillson, I., Manuel, C., & Thongori, J. (2007). *Gender and Economic Growth in Kenya.* Washington: The World Bank.

Elmherst, R. (2011). Introducing new Feminist Political Ecologies. *Geoforum , 42*, 129-132.

Eriksen, S., & Lind, J. (2009). Adaptation as a Political Process: Adjusting to Drought. *Environmental Management , 43*, 817–835.

EuropaBio. (2015, 02 10). *What is Biotechnology.* Retrieved 02 10, 2015 from Europabio.org: http://www.europabio.org/what-biotechnology

Extension Toxicology Network. (1994, May). *Pesticide Information Profile: Bacillus Thuringiensis.* From Extoxnet : http://pmep.cce.cornell.edu/profiles/extoxnet/24d-captan/bt-ext.html

Falck-Zepeda, J., Horna, D., & Smale, M. (2008). Betting on cotton: Potential payoffs and economic risks of adopting transgenic cotton in West Africa. *African Journal of Agricultural and Resource Economics , 2* (2), 188-207.

FAO. (2010, 09 14). *925 million in chronic hunger worldwide. (U. Nations, Producer) Retrieved March 25, 2013, from Food and Agriculture Organisation of the United Nations: Media Centre: http://www.fao.org/news/story/en/item/45210/icode/*. From Food and Agriculture Organisation: http://www.fao.org/news/story/en/item/45210/icode/

Fischer, K., & Hajdu, F. (2015). Does raising maize yields lead to poverty reduction? A case study ofthe Massive Food Production Programme in South Africa . *Land Use Policy , 46*, 304-313.

Fischer, K., Berg, J. v., & Mutengwa, C. (2015). Is Bt maize effective in improving South African smallholder agriculture? *South African Journal of Science , 111*, 2.

Fitting, E. (2006). The political uses of culture: Maize production and the GM corn debates in Mexico. *Focaal—European Journal of Anthropology , 48*, 17-34.

Fletschner, D. (2008). Women's Access to Credit: Does it Matter for Household Efficiency? . *American Journal of Agricultural Economics* , 90-99.

Fletschner, D., & Kenney, L. (2011). Rural women's access to financial services: credit, savings and insurance. *ESA Working Paper No. 11-07* .

Food and Agriculture Organisation (FAO). (2011). *The State of Food and Agriculture: Women in Agriculture: Closing the gender gap for development.* Rome: FAO.

Gardner, J. G., Nehring, R. F., & Nelson, C. H. (2009). Genetically Modified Crops and Household Labor Savings in US Crop Production. *AgBioForum , 12* (3 & 4), 303-312.

Genetic Literacy Project. (2014, June 24). *Scientists react to republished Seralini GMO maize rat study*. Retrieved September 11, 2015 from Genetic Literacy Project: http://www.geneticliteracyproject.org/2014/06/24/scientists-react-to-republished-seralini-maize-rat-study/

Ghosh, P., Mookherjee, D., & Ray, D. (1999). Credit Rationing in Developing Countries: An Overview of the Theory. *A Reader in Development Economics* .

Gianessi, L. (2014, August). *The Importance of Pesticides for Growing Maize in Sub-Saharan Africa: International Pesticide Benefits Case Study No. 104.* From CropLife International: https://croplife.org/case-study/importance-of-pesticides-for-growing-maize-in-sub-saharan-africa/

Gilbert, Webster, & Benson. (2002). Gender Analysis of a Nationwide Cropping System Trial Survey in Malawi. *African Studies Quarterly , 6* (1,2), 223-243.

Gladwin, C., & McMillan, D. (1989). Is a Turnaround in Africa Possible without Helping African Women to Farm? *Economic Development and Cultural Change , 37* (2), 345-369.

Goldstein, M., & Udry, C. (2008). The Profits of Power: Land Rights and Agricultural Investment in Ghana. *Journal of Political Economy , 116* (6), 981-1022.

Gouse, M., Kirsten, J. F., & Jenkins, L. (2003). BT Cotton in South Africa: Adoption and the Impact on Incomes Amongst Small-Scale and Large Scale Farmers. *Agrekon: Agricultural Economics Research, Policy and Practice in Southern Africa , 42* (1), 15-29.

Government of Kitui. (2014). *Home*. Retrieved July 23, 2014 from The County Government of Kitui: http://www.kitui.go.ke/

Government of Machakos. (2013). *Machakos County Profile*. Retrieved July 23rd, 2014 from The official website of the government fo Machakos: http://www.machakosgovernment.com/MachakosProfile.aspx

Grace. (2013, 10 15). WEMA Regulatory Officer with the Ministry of Agriculture. (C. Demers, Interviewer)

Gugerty, M. K. (2007). You Can't Save Alone: Commitment in Rotating Savings and Credit Associations in Kenya. *Economic Development and Cultural Change , 55* (2), 251-282.

Guguyu, O. (2015, August 12). *William Ruto says ban on GMOs to be lifted in two months*. Retrieved September 11, 2015 from Daily Nation: http://www.nation.co.ke/news/William-Ruto-ban-GMOs--lift/-/1056/2829368/-/wwxu2a/-/index.html

Guruswamy, K., & Gurunathan, B. (2010). A Need for Organic Farming in India. *School of Management* , 115-126.

Hallman, K., Lewis, D., & & Begum., S. (2007). Assessing the Impact of Vegetable and Fishpond Technologies on Poverty in Rural Bangladesh. In I. M. Adato, & D. R. Meinzen, *Agricultural Research, Livelihoods, and Poverty: Studies of Economic and Social Impacts in Six Countries, .* International Food Policy Research Institute.

Harsh, M. (2005). Formal and Informal Governance of Agricultural Biotechnology in Kenya: Participation and Accountability in Controversy Surrounding the Draft Biosafety Bill. *Journal of International Development , 17*, 661-667.

Heuler, H. (2014, 11 12). *In Kenya, Calls Grow to Lift Controversial GMO Ban.* Retrieved 02 02, 2015 from Voice of America: http://www.voanews.com/content/in-kenya-calls-grow-to-lift-controversial-gmo-ban/2527833.html

Hill, R., & Vigneri, M. (2009). *Mainstreaming Gender Sensitivity in Cash Crop Market Supply Chains.* Food and Agriculture Organisation, The State of Food and Agriculture, Rome.

Holland, J., Brook, S., Dudwick, N., Bertelsen, M., & Yaron, G. (2007). *Monitoring empowerment in policy and programme interventions: Combining Qualitative and Quantitative Approaches', Q-Squared Working Paper No. 4.* University of Toronto.

Holt-Gimenez, E., Altieri, M. A., & Rosset, P. (2006). *Food First Policy Brief No. 12: Ten Reasons Why the Rockefeller and the Bill and Melinda Gates Foundations' Alliance for Another Green Revolution Will Not Solve the Problems of Poverty and Hunger in Sub Saharan Africa.*

Horrell, S., & Krishnan, P. (2007). Poverty and Productivity in Female-Headed Households in Zimbabwe. *Journal of Development Studie , 43* (8), 1351-1380.

Hovorka, A. J. (2012). Women/chickens vs. men/ cattle: Insights on gender-species intersectionality. *Geoforum , 43*, 875-884.

Hovorka, A. (2006). The No. 1 Ladies' Poultry Farm: A feminist political ecology of urban agriculture in Botswana. *Gender, Place and Culture , 13* (3), 207-225.

Huesing, J., & English, L. (2004). The impact of Bt crops on the developing world. *AgBioForum , 7* (1&2), 84-95.

Huesing, J., & English, L. (2004). The Impact of Bt Crops on the Developing World. *AgBioForum , 7* (1&2), 84-95.

IDFC. (2012). *Kenya Fertilizer Assessment.* Alabama: IFDC.

IFAD. (2008). *Improving access to land and tenure security. Policy .* Rome: International Fund for Agricultural Development.

IFPRI. *Developing Countries.* IFPRI Discussion Paper 00975, Poverty, Health, and Nutrition Division.

International Food Policy Research Institute (IFPRI). (2007, March). Withering Punjab Agriculture: Can it Regain Its Leadership? *IFPRI* .

IRIN News. (2010). *Kenya: "Merry-go-round" micro-finance keeps slum residents fed*. Retrieved July 10th, 2015 from IRIN: Humanitarian News and Analysis: http://www.irinnews.org/report/88795/kenya-merry-go-round-micro-finance-keeps-slum-residents-fed

ISAAA. (2015). *Pocket K No. 28: Kenya Biotechnology Development Policy Highlights* . Retrieved 02 10, 2015 from International Service For the Acquisition of Agri-Biotech Applications: http://isaaa.org/resources/publications/pocketk/28/default.asp

Iversen, M., Gronsberg, I., Berg, J. v., Fischer, K., Aheto, D. W., & Bohn, T. (2014). Detection of Transgenes in Local Maize Varieties of Small-Scale Farmers in Eastern Cape, South Africa. *PLOS one , 2* (12).

James, C. (2009). *Brief 41: Global status of Commercialized biotech/GM Crops: 2009.* InternatIonal Service for the acquisition of agri-biotech Applications. ISAAA.

James, C. (2014). *Global Status of Commercialized Biotech/GM Crops: 2014. ISAAA Brief No. 49.* Ithica, NY: ISAAA.

Kabeer, N. (1994). *Reversed Realities.* London: Verso.

Kabeer, N. (2000). *The Power to Choose: Bangladeshi Women and Labor Market Decisions in London and Dhaka.* London: Verso.

Karim, L. (2008). Demystifying Micro-Credit : The Grameen Bank, NGOs, and Neoliberalism in Bangladesh. *Cultural Dynamics , 5*, 5-29.

KARI-McGill. (n.d.). *Machakos County*. Retrieved July 23rd, 2014 from KARI-McGill Food Security Project: http://www.kari.org/karimcgill/machakos-county

KARI-McGill. (nd). *Machakos County*. Retrieved July 23rd, 2014 from KARI-McGill Food Security Project: http://www.kari.org/karimcgill/machakos-county

Kenya Open Data. (2014). *County Data Sheet: Machakos*. Retrieved July 23rd, 2014 from https://opendata.go.ke/facet/counties/Machakos

Kenyan Constitution. 60 (1). . (2010). *The Constitution of Kenya.* From World Intellectual Property Organisation: http://www.wipo.int/wipolex/en/text.jsp?file_id=207673#LinkTarget_21432

Kimura, A. H., & Katano, Y. (2014). Farming after the Fukushima accident: A feminist political ecology. *Journal of Rural Studies , 34*, 108-116.

Kingiri, A. N. (2010). Experts to the Rescue? An Analysis of the Role of Experts in Biotechnology Regulation in Kenya. *Journal of International Development , 22*, 325–340.

Kingiri, A., & Ayele, S. (2009). Towards a smart biosafety regulation: The case of Kenya. *Environmental Biosafety Research* , 133-139.

Kingiri, A., & Hall, A. *The Role of Policy Brokers: The Case of Biotechnology in Kenyaropr_573 492..522.* Review of Policy Research. RPR.

Koross, K. (2015, August 13). *State to revoke ban on GMO food*. Retrieved September 8, 2015 from Standard Digital: http://www.standardmedia.co.ke/article/2000172626/state-to-revoke-ban-on-gmo-food

Lipton, M. (2007). Plant Breeding and Poverty: Can Transgenic Seeds Replicate the 'Green Revolution' as a Source of Gains for the Poor? *Journal of Development Studies , 43* (1), 31-62.

Luttrell, C., Quiroz, S., Scrutton, C., & Bird, K. (2009). *Working Paper 308: Understanding and operationalising empowerment.* London: Overseas Development Institute.

Malinga, Gethi, & Ngari. (2010). *Commercializing GM crops in Kenya: Potential Risks and Possible Mitigation Strategies.* Kenyan Agricultural Research Institute & Egerton University.

Manheim, J. B. (2008). *Empirical political analysis: quantitative and qualitative research methods.* Longman Pub Group.

Mauro, S. E.-D. (2009). Seeing the local in the global: Political ecologies, world-systems, and the question of scale. *Geoforum , 40* , 116–125.

McMichael, P. (2009). A food regime analysis of the 'world food crisis'. *Agriculture and Human Values , 26* (4), 281-295.

Meinzen-Dick, R., Johnson, N., Quiaumbing, A., & et al. (2011). *Gender, Assets, and Agricultural Development Programs.* CAPRI Working Paper No. 99. International Food Policy Research Institute.

Mollett, S., & Faria, C. (2013). Messing with gender in feminist political ecology. *Geoforum , 45*, 116-125.

Mondal, P. (2015). *8 Major Economical Impact of Green Revolution in India* . Retrieved September 8, 2015 from Your Article Library: http://www.yourarticlelibrary.com/green-revolution/8-major-economical-impact-of-green-revolution-in-india/20952/

Morris, M., & Doss, C. (1999). *How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana.* EEA. merican Agricultural Economics Association.

Moseley, W., Schnurr, M., & Kerr, R. B. (2015). Interrogating the technocratic (neoliberal) agenda for agricultural development and hunger alleviation in Africa. *African Geographical Review , 1*, 1-7.

Mugera, H., & Karfakis, P. (2013). *Land distribution and economic development: small-scale agriculture in developing countries.* From http://www.ecineq.org/ecineq_bari13/FILESxBari13/CR2/p251.pdf

Muraguri, L. (2010). Unplugged!: An Analysis of Agricultural Biotechnology PPPs in Kenya. *Journal of International Development , 22*, 289–307.

Musembi, C. N., & Kameri-Mbote, P. (2013). Mobility, Marginality, and Tenure Transformation in Kenya: Explorations of Commuity Property Rights in Law and Practice. *Nomadic Peoples , 17* (1), 5-32.

N., S. D. (2008, 12 06). *Kenya prepares to approve biosafety legislation.* From SciDevNet: http://www.scidev.net/global/biotechnology/news/kenya-prepares-to-approvebiosafety- legislation.html

Navarro, M. J., Natividad-Tome, K., & Gimutao, K. (2013). *From Monologue to Stakeholder Engagement: The Evolution of Biotech Communication No. 45.* International Service for the Acquisition of Agri-biotech Applications (ISAAA), Brief 45. ISAAA.

Nestel, P., Bouis, H. E., Meenakshi, J. V., & Pfeiffer, W. (2006). *Biofortification of Staple Food Crops.* Symposium: Food Fortification in Developing Countries. Washington: HarvestPlus, International Food Policy Research Institute.

Njagi, D., & Scott, C. (2008, June 11). *Kenya prepares to approve biosafety legislation.* Retrieved July 5, 2015 from Sci. Dev. Net.: Bringing Science and Development together Throu: SciDev.Net

Noy, C. (2008). Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative Research. *Social Research Methodology , 11* (4), 327-344.

Odour, R. (2014, 10 29). *Ban On GMOs Hinders Local Innovations.* Retrieved 02 08, 2015 from The Star News: http://www.the-star.co.ke/news/article-190702/ban-gmos-hinders-local-innovations

Omorodion, F. I. (2007). Rural Women's Experiences of Micro-Credit Schemes in Nigeria : Case Study of Esan Women. *Journal of Asian and African Studies* , 479-494.

Onyeiwu, S., & Liu, J. (2011). Determinants of Income Poverty in Rural Africa: Empirical Evidence from Kenya and Nigeria. *African Economic Conference* .

Ossome, L. (2014). Can the Law Secure Women's Rights to Land in Africa? Revisiting Tensions Between Culture and Land Commercialization. *Feminist Economics , 20.1*, 155-177.

Owino, O. (2012, 11 30). *Kenya Bans Imports of GM Food.* Retrieved 06 3, 2014 from Environmental News Network: http://www.enn.com/environmental_policy/article/45281

Padmanabhan, M. (2011). Women and men as conservers, users and managers of agrobiodiversity. *The Journal of Socio-Economics* , 968-976.

Padmanabhan, M. (2011). Women and Men as Conservers, Users and Managers of Agrobiodiversity: A Feminist Social-Ecological Approach. *The Journal of Socio-Economics , 40*, 968-976.

Parpart, J. L., & Kabeer, N. (2010). *Choosing Silence: Rethinking Voice, Agency, and Women's Empowerment.* Gender, Development, and Globalization Program. MSU Board of Trustees.

Partow, H. (1995). The cost of hazards posed by pesticides in Kenyan export crops. *Pessticide Action Network; Pesticide News , 29*.

Paulson, S., Gezon, L. L., & Watts, M. (2003). Locating the Political in Political Ecology: An Introduction. *Human Organization , 62* (3), 205-214.

Pender, J., Place, F., & Ehui, S. (2006). *trategies for Sustainable Land Management in the East African Highlands.* International Food Policy Research Institute.

Perumal, D. N. (2011). Women's socio-economic [in]equality and gender [in]justice: Feminist reflections on the right of access to water in Mazibuko and Others v City of Johannesburg and Others [2009]. *Agenda 25(2) , 25* (2), 17-26.

Peterman, A., Behrman, J., & Quisumbing, A. (2010). *A Review of Empirical Evidence on Gender Differences in Nonland Agricultural Inputs, Technology, and Services in*

Qaim, M. (1999). Assessing the Impact of Banana Biotechnology in Kenya. *ISAAA Briefs No. 10. , 10*.

Qaim, M., & De Janvry, A. (2003). Bt cotton and pesticide use in Argentina: Economic and environmental effects. *Environment and Development Economics* .

Qaim, M., & Janvry, A. D. (2003). Genetically Modified Crops, Corporate, Pricing Strategies, and Farmers' Adoption: The Case of Bt Cotton in Argentina. *American Journal of Agricultural Economics , 85* (4), 814-828.

Quisumbing, A. R. (1994). Improving Women's Agricultural Productivity as Farmers and Workers. *The World Bank: ESP Discussion Paper Series , 37*.

Quisumbing, A. R., & Maluccio, J. A. (2003). Resources at Marriage and Intrahousehold Allocation: Evidence from Bangladesh, Ethiopia, Indonesia, and South Africa. *Resources at Marriage and Intrahousehold Allocation: Evidence from Bangladesh, Ethiopia, Indonesia, and South Africa , 65* (3), 283-327.

Quisumbing, A. R., & Pandolfelli, L. (2009). *Promising approaches to address the needs of poor femal farmers: resources, constraints, and interventions.* International Food Policy Research Institute, Poverty, Health, and Nurtition Division. IFPRI.

Quisumbing, A. R., Meinzen-Dick, R., Raney, T. L., Croppenstedt, A., Behrman, J. A., & Peterman, A. (2014). Gender in Agriculture: Closing the Knowledge. *The World Bank Research Observer* , 79-109.

Radcliffe, S. (2013). Gendered frontiers of land control: Indiginous territory, women and contests over land in Ecuador. *Gender, PLace & Culture: A Journal of Feminist Geography* , 1-18.

Richards, P. (2010). *A Green Revolution from below? Science and technology for global food security and poverty alleviation.* Wageningen University.

Robbins, P. (2004). *Political ecology: A critical introduction.* Malden: Blackwell Publishing.

Rocheleau, D. (2001). Complex Communities and Relational Webs: Uncertainty, Surprise, and Transformation in Machakos. *IDS Bulletin , 34* (4), 78-87.

Rocheleau, D. (1995). Maps, Numbers, Text, and Context: Mixing Methods in Feminist Political Ecology. *Professional Geographer , 47* (4), 458-466.

Rocheleau, D., & Edmunds, D. (1997). Women, men and trees: Gender, power and property in forest and agrarian landscapes. *World Development , 25* (8), 1351-1371.

Rocheleau, D., Thomas-Slayter, B., & Wangari, E. (1996). *Feminist Political Ecology.* London; New York: Routledge.

Rowlands, J. (1997). *Questioning Empowerment.* UK: Oxfam.

RRI. (2011). *Pushback: Local Power Global Realignment .* Washington: Rights and Ressources Group.

Rugg, J. (2013, 11 02). *There's a difference between GEO and GMO*. (S. C. Journal, Producer) Retrieved 02 10, 2015 from Sioux City Journal: http://siouxcityjournal.com/advertorial/siouxland_homes/there-s-a-difference-between-geo-and-gmo/article_b044ec4f-ec27-5634-9c00-e1b206272f9d.html

Schnurr, M. (2015b). GMO 2.0: Genetically modified crops and the push for Africa's green revolution. *Canadian Food Studies , 2* (2), 201-208.

Schnurr, M. (2012). Inventing Makhathini: Creating a prototype for the dissemination of genetically modified crops into Africa. *Geoforum* , 784-792.

Schnurr, M. (2015a, September 1). *The curious case of GMOs in Kenya.* Retrieved October 1, 2015 from Can Genetically Modified Crops Help the Poor?: http://gmosandpoverty.com/the-curious-case-of-gmos-in-kenya/

Schnurr, M., & Gore, C. (2014). Getting to 'yes': governing Genetically Modified Crops in Uganda. *Journal of International Development , 27*, 55-72.

SciDevNet. (2014, December 5). *Cultural change in Kenyan banana farming*. Retrieved July 10, 2015 from SciDevNet: http://www.scidev.net/global/farming/multimedia/cultural-change-in-kenyan-banana-farming.html

Seibel, H. D. (2001). Rural Finance: Mainstreaming Informal Financial Institutions. *Journal of Developmental Entrepreneurship , 6* (1), 83-95.

Sen, A. (1999). *Development as Freedom: Famines and Other Crises.* Oxford: Oxford University Press.

Séralini, G.-E., Clair, E., Mesnage, R., Gress, S., Defarge, N., Malatesta, M., et al. (2014). Republished study: long-term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize. *Environmnetal Sciences Europe , 26* (14), doi:10.1186/s12302-014-0014-5.

SEWA. (2009). *SEWA's services*. From Self Employed Women's Association: http://www.sewa.org/

Sheahan, M., Black, R., & Jayne., T. (2012). *Are Farmers Under-Utilizing Fertilizer? Evidence from Kenya.* Research Gate.

Shiva, V. (1988). *Staying Alive: Women, Ecology and Survival in India.* Zed Books.

Shiva, V. (1991). The Green Revolution in the Punjab. *The Ecologist , 21* (2), 57-60.

Singh, R. (2000). Environmental consequences of agricultural development: a case study from the Green Revolution state of Haryana, India. *Agriculture, Ecosystems and Environment* , 97-103.

Smale, M., Zambrano, P., & Cartel, M. (2006). Bales and Balance: A Review of the Methods Used to Assess the Economic Impact of Bt Cotton on Farmers in Developing Economies. *AgBioForum , 9* (3), 195-212.

Smith, J., & Harsh, M. (2007). Technology, governance and place: situating biotechnology in Kenya. *Science and Public Policy , 34* (4), 251-260.

Stone, G. D. (2010). *The Anthropology of Genetically Modified Crops.* Annual Reviews, Washington University, Department of Anthropology.

Stone, G. D., & Glover, D. (2011). Genetically modified crops and the 'food crisis': discourse and material impacts. *Development in Practice , , 21* (2-5), 509-516.

Tabashnik, B. E., Gassmann, A. J., Crowder, D. W., & Carrière, Y. (2008). Insect resistance to Bt crops: evidence versus theory. *Nature Biotechnology , 26* (2), 199-203.

Tandon, N. (2010). New agribusiness investments mean wholesale sell-out for women farmers. *Gender & Development , 18* (3), 503-514.

Tibaijuka, A. (1994). The Cost of Differential Gender Roles in African Agriculture: A Case Study of Smallholder Banana-Coffee Farms in the Kagera Region, Tanzania. *Journal of Agricultural Economics* , 69-81.

Turner, S. (2010). Research Note: The silenced assistant. Reflections of invisible interpreters and research assistants. *Asia Pacific Viewpoint , 51* (2), 206–219.

Udry, C. (1996). Gender, Agricultural Production, and the Theory of the Household. *Journal of Political Economy , 109* (5), 1010-1046.

United Nations Women. (2015). *Concepts and Definitions*. From United Nations Entity for Gender Equality and the Empowerment of Women: http://www.un.org/womenwatch/osagi/conceptsandefinitions.htm

University Health Network and University of Toronto. (2012). *WEMA 2011 Social Audit Report: Ethical, Social, Cultural, and Commercialization (ESC2) Audit Report for the Water Efficient Maize for Africa (WEMA) Project 2011 .* Sandra Rotman Centre.

University of Nairobi. (2015). *School of Business*. Retrieved June 10, 2015 from http://business.uonbi.ac.ke/node/1407

US National Library of Medicine. (2015, September 7). *Genetic Engineering.* Retrieved September 12, 2015 from Genetics Home Referene: Guide to understanding genetic conditions: http://ghr.nlm.nih.gov/glossary=geneticengineering

Uttaro, R. (2002). Diminishing choices: Gender, Small Bags of Fertilizer and Household Food Security Decision in Malawi. *African Studies Quarterly , 6* (1 & 2), 77-110.

Vandana Shiva Lecture. (2014, 11 12). Dalhousie University, Halifax.

Vanhaute, E. (2011). From famine to food crisis: what history can teach us about local and global subsistence crises. *The Journal of Peasant Studies , 38* (1), 47-65.

Vonderlack-Navarro, R. (2010). Targeting Women Versus Addressing Gender in Microcredit: Lessons From Honduras. *Journal of Women and Social Work , 25* (2), 123-134.

WEMA. (2012). *Home*. Retrieved June 15, 2014 from Water Efficient Maize for Africa: http://wema.aatf-africa.org/about-wema-project

Whitehead, A., & Tsikata, D. (2003). Policy discourses on women's land rights in Sub–Saharan Africa: The implications of the re–turn to the Customary. *Journal of Agrarian Change* , 67-112.

Willingham, E. (2012, 09 12). *Seralini Paper Influences Kenya Ban of GMO Imports.* Retrieved 11 26, 2014 from Forbes.com: http://www.forbes.com/sites/emilywillingham/2012/12/09/seralini-paper-influences-kenya-ban-of-gmo-imports/

Wilson, G. (2001). *International Journal of Social Research Methodology , 4* (4).

World Food Programme and Republic of Kenya. (2011). *Kitui Project Profile*. Retrieved July 23, 2014 from Cash: Food for Assets: http://ffa.kenyafoodsecurity.org/index.php?option=com_k2&view=item&id=244:kitui-project-profile

Xinhua. (2013, January 8). *What women can do...Kenyan men embrace 'merry-go-round' savings schemes*. Retrieved February 20, 2015 from Africa Review: http://www.africareview.com/Business---Finance/Kenyan-men-merry-go-round/-/979184/1660634/-/r6pwt1z/-/index.html

Zambrano, P., Maldonado, J. H., Mendoza, S., Ruiz, L., & Cardona, L. A. (2011). *Women Cotton Farmers: Their Perceptions and Experiences with Transgenic Varieties.* International Food Policy Research Institute, Environment and Production Technology Division. IFPRI.

Zilberman, D., Ameden, H., & Qaim, M. (2007). The impact of agricultural biotechnology on yields, risks, and biodiversity in low-income countries. *The Journal of Development , 43* (1), 63-78.