Genetically Modified Crops and Food Sovereignty: The Case of GM Matooke and Ugandan Small-Scale Farmers

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Abstract

A genetically modified variety of Uganda's staple crop, matooke, began being tested in field trials in 2010. A GM variety was introduced after the crop was attacked by a disease known as banana bacterial wilt in 2001. The GM variety is modified for resistance to this disease. This was possible due to the efforts of stakeholders in the public and private sector who believe the best way to improve African agriculture is through technological advancements such as genetic modification. This is known as the Second Green Revolution. This second green revolution has been met with some opposition due to the debate surrounding the suitability of GM crops within the African agricultural context. This study uses food sovereignty as an analytical framework through which to examine whether genetically modified matooke will prove to be a suitable option for empowering Ugandan small-scale farmers within their food system. A total of 42 documents were gathered from academic articles, Ugandan newspapers, and research institute publications & promotional materials. Data was coded to fit into the three main themes of food sovereignty which are 1) small-scale farmer 2) power 3) environment. A thematic analysis was then conducted. Majority of data indicates that GM matooke, as it is currently being promoted, is not the suitable option for Ugandan small-scale farmers. The theme 'environment' was the only one with results indicating that GM matooke could be suitable for Ugandan small-scale farmers. This is due to the fact that it protects their local crop from impacts of climate change while also reducing pesticide use. Under the two themes of small-scale farmer and power, findings indicate that GM matooke is being promoted under too many inaccurate assumptions. These assumptions leave small-scale farmers at risk of further marginalization. The key lessons learnt from this study are that there is a need for greater understanding of the African agricultural context and that effective strategies to get information about GM crops to small-scale farmers need to be developed.

Keywords: Genetically Modified Crops, GM Matooke, Food Sovereignty, Small-Scale Farmers, Uganda, Banana Bacterial Wilt,

List of Acronyms

AAFT	African Agricultural Technology Foundation
AGRA	Alliance for a Green Revolution in Africa
BBW	Banana Bacterial Wilt
FAO	Food and Agricultural Organization
GM	Genetically Modified
IITA	International Institute of Tropical Agriculture
PPP	Public-Private Partnerships
SCIFODE	Science Foundation for Livelihoods and Development

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1.Introduction

Overview

In 2006 the Alliance for a Green Revolution in Africa (AGRA) was formed, this was due to the recognition that a huge improvement in African agriculture was needed. The former UN Secretary-General, Kofi Annan, highlighted this need for agricultural improvement back in 2006 when he said there was a need for a uniquely African Green Revolution. AGRA's mission is to increase agricultural production and gain access to markets for African produce. (Alliance for a Green Revolution in Africa). Their agenda was supported by stakeholders in the private and public sector who had strong regrets over the fact that Africa was bypassed by the first green revolution (Schnurr, 2015). Through the combined efforts of these stakeholders and the Alliance for a Green Revolution in Africa (AGRA) a second green revolution is being promoted.

The second green revolution uses technological advancements as one of the ways in which to improve African agriculture. One such advancement is genetic modification. In order to introduce these genetically modified (GM) crops in different countries, a method of Public-Private Partnerships (PPP) was adopted. Through these partnerships, donor agencies act as mediators to help provide necessary technology to scientists, so they can execute trials. This technology is provided patent free (Schnurr, 2015). The African crops being targeted through this campaign are staple crops that were neglected during the green revolution of the 1960s. They are known as orphan crops (Schnurr, 2017). Uganda's local cooking banana (matooke) falls under this category. Once these orphan crops undergo genetic modification they can be referred to as second generation genetically modified crops (GM 2.0) (Schnurr, 2017). This thesis will refer to genetically modified matooke as a second-generation GM crop (GM 2.0)

A GM variety of Uganda's local crop, matooke, was developed. Matooke is considered important as both a staple food and source of income in Uganda (Karamura et al. 2010). It is an important cash crop especially in the rural areas. It accounts for almost a quarter of the national rural revenue (Kalyebara et al., 2006). Over 7 million Ugandans depend on the crop as a staple food (Kalyebara et al., 2006). A report by the Famine Early Warning System (2017) indicated that matooke accounts for 93% of banana production out of three popular varieties while also accounting for approximately 30% of the daily caloric intake in Uganda. These statistics show the importance of the crop to the society. This value placed on matooke as a source of food and livelihood made the option of testing a genetically modified variety a favored one after a disease known as banana bacterial wilt affected plantations.

In October 2010, Uganda began field trials of GM matooke. This was in an effort to combat the loses resulting from banana bacterial wilt (BBW) (Nordling, 2010). The disease causes banana plants to wilt, killing them and lowering harvests (Karamura et al., 2010). BBW spreads rapidly from one plant to the next. It can spread through insects or infected tools (Baggaley, 2017). In most cases, once the disease has impacted a plant it can spread throughout the whole plantation causing loss of all crops (Kalyebara et al., 2006). In 2001 the disease was discovered in banana harvests in the East African region. Within the first three years of the disease being discovered an estimated 30-50% of banana plantations in Uganda were affected. This disease has proved devastating for many Ugandans due to the high cultural and economic value placed on matooke (Karamura et al. 2010). Proponents of BBW resistant variety of matooke recognized the threat of the disease to the supply of matooke in the region. Initial stages of genetic modification involved including a gene, extracted from pepper, which is resistant to

the BBW (Addison, & Schnurr, 2016). Other forms of modification explored included improving the nutritional value of the bananas and improving taste (Kikulwe, Wesseler, & Falck-Zepeda. 2011). This thesis will focus on the variety modified to be resistant to BBW.

The Problem

The problem lies in determining whether GM crops are suitable for the African agricultural context. For many years' scholars have debated whether genetically modified crops will benefit those living in the global south. The debate is fueled by the multifaceted nature of impacts associated with GM crops. GM technology allows scientists to bring together genes from a variety of living organisms into one plant, this is done through genetic engineering. It is different from traditional cross-breeding methods in that the genes are inserted and not acquired through pollination, this makes production of GM crops faster than varieties gained through traditional cross-breeding (International Service for the Acquisition of Agri-Biotech Applications [ISAAA], 2017). The top three countries that cultivate GM crops are United States of America, Argentina and Brazil, these countries account for over three quarters of global GM hectares (Canadian Biotechnology Action Network [CBAN]. 2015). The US is the largest cultivator of these countries with 40.3% of global area producing GM crops (CBAN. 2015, pg. 7). While GM crops are highly beneficial for increasing yields and dealing with problems such as disease and drought, their benefits to small scale farmers are not always evident (Smale, 2017). Considering that small scale farmers make up the majority of farmers in the global south this is a significant problem. Issues such as these have contributed to the ongoing debates surrounding the suitability of GM crops in the African agricultural context.

2.The GM Crop Debate

The case for GM crops

Supporters of the introduction of GM crops in developing nations often cite the benefits this technology will have to yields and livelihoods as the reason to adopt it. Adenle (2011) writes an article that strongly favors the adoption of GM crops in poor African nations. Adopting GM crops in these countries is a chance to improve farmers lifestyles (Adenle, 2011). Adenle (2011), believes this will be achieved through improving yields which will then result in. poor nations being able to feed themselves. Yields are the amount of produce from an agricultural product (Food and Agricultural Organization [FAO], 2015). By adopting GM technology and producing at higher levels, Africa could be saved from hunger and gain improved health and economic conditions (Adenle, 2011).

Qiam & Zilberman (2003) echo Adenle's (2011) sentiments as they similarly promote increased yields and economic benefits as the main advantage of adopting GM crops. In their study they refute claims that the effects of GM crops on yields are small and benefits simply lie in pest reduction (Qiam & Zilberman, 2003). This is done through using the example of Bt cotton in India. Cotton in India was engineered for resistance to bollworm (Qiam & Zilberman, 2003). The study states that during field trials of the Bt cotton, yields of Bt cotton plants were 80% higher than those of non Bt cotton (Qiam & Zilberman, 2003). These yield improvements were attributed to the genes that had been engineered to resist the bollworm. This is because the two fields of Bt cotton and non-Bt cotton had been grown under similar conditions. The only difference that existed was that one field had crops engineered for resistance to the disease while the other had the non-GM variety (Qiam & Zilberman, 2003). With the backing of such findings, scholars firmly believe that GM varieties will benefit poor nations agricultural yields. In terms of

economics, Adenle (2011) believes that an increase in poor nations agricultural yields will result in increased income from selling excess produce. On the other hand, Qiam & Zilberman (2003) believe that the economic benefits lie in no longer having to continuously spend money on ineffective pest control methods.

Scholars who favour GM crops being introduced in Africa believe all that is needed for them to succeed is for African governments to accept the technology (Adenle, 2011; Paarlberg, 2010). Adenle (2011) strongly believes that for GM technology to fully benefit African nations there is a need for the trend of applying the precautionary principle to be abandoned. A precautionary principle approach to GM technology entails not producing the organism if there is no evidence to prove it has no adverse impacts (Paarlberg, 2010). This approach simply serves to hinder the benefits African nations could gain from GM technology (Adenle, 2011). Paarlberg (2010) echoes similar views as he warns against African nations trying to please their European donors by taking a harsh stand against GM technology. Instead, he suggests these nations come together and do what is best for them and their people in order to reap the maximum benefits of GM technology.

The case against GM crops

Social implications

The main objections to GM technology being advanced in poor nations are that it will take away smallholder farmer's control over their food system (Menezes, 2001; Holt-Giménez, 2011, Naylor 2017). The current food system is centered around ensuring all people have access to food through mass production. Nations have little control over this system of mass production as it is governed by international bodies such as the World Trade Organization. These organizations favour market access through imports and export subsidies (Menezes, 2001). Holt-Giménez (2011) classifies the combination of these aspects as characteristics that build a food

enterprise. A food enterprise focuses on pursing a neoliberal agenda, an agenda heavily centered on meeting the needs of multinational corporations through overproduction, monocultures and mass global production of industrial foods. Genetically modified crops are an intricate part of this model (Holt-Giménez, 2011, pg. 3).

Menzies (2001) indicates how this heavily neoliberal food system has been opposed by La Via Campesina, an organization of smallholder farmers fighting for the rights of peasant farmers within the food system. According to Menzies (2001), the fight by La Via Campesina includes opposing the proliferation of GM technology in poor nations. The organization sees the spread of genetically modified crops as another way in which corporations aim to have control of the food system. La Via Campesina believes that if GM technology is to benefit all nations the scientific methods on how to enhance crops should be shared freely and not be controlled by a few companies (Menezes, 2001). Naylor (2017) takes a stronger stance against GM crops than La Via Campesina and states that there is no room for GM technology within a food system centralized on small-scale farmer's needs. She believes that GM technology will simply reinforce inequalities found in the current food system.

While second generation GM technology in poor nations is being distributed without a patent attached to it, Naylor (2017) insists that adopting it should still be done with caution. Companies who own the GM technology have led countries to think that a technological fix is what is needed to solve agricultural problems in poor nations. Naylor (2017) does not believe that this is the correct approach. She indicates that when companies advertise GM technology as the solution to nations agricultural problems they create a gap that poor nations believe needs to

be filled. It is considered a gap as these nations do not have the technology themselves; a gap that would never have existed had the companies not introduced it (Naylor, 2017).

Yields

Scholars have warned against the advancement of high yields as being the main reason for poor nations to adopt GM crops (Schnurr, 2017; Sumberg 2012). Schnurr (2017), states that promoting high yields gives the impression that increased production is all that is needed to take care of poor nations agricultural problems. He believes that this is not the simple solution to the dire poverty and hunger in many nations. Among the proponents of GM crops, policy makers are usually the most in favour of the narrative that claims addressing yield gaps is the best solution to agricultural problems (Sumberg, 2012). The yield gap is the difference between the potential amount of produce that could have been harvested and that which ends up growing successfully and being harvested (Global Yield Gap Atlas). In both Sumberg (2012) and Schnurr's (2017) work the cautioning against an obsession with yield gaps is due to many underlying problems in agriculture that a pro-yield narrative fails to address. These underlying problems are related to issues such as economic and social inequalities within the agricultural sector in poor nations (Schnurr, 2017).

A case study proving that agricultural success is a result of addressing many of the underlying issues within the system, and not simply introducing a GM variety, can be found in the case of Bt cotton in India. While many policy makers and government officials took to media to praise Bt cotton for improved cotton yields, Kuruganti (2009) recognized that Bt cotton was not the only contributor to the success. Other elements which contributed to high yields were donations into irrigation programs by harvesting companies, improved rainfall patterns and a switch in seed varieties being used (Kuruganti, 2009). This shows how introduction of a GM variety did not succeed on its own but rather through improvements in other areas as well

(Kuruganti, 2009). This gives case study support to Schnurr's (2017) idea of tackling other issues within agriculture for overall success. These issues include problems pertaining to labour, access to markets and credit market failures.

In a 2016 symposium Addison and Schnurr highlight studies that have shown how poor nation's agricultural systems face problems relating to gendered issues within labour and access to markets. Negative gendered implications associated with labour are found in the case of Uganda. The southwestern region of the country is where most commercialized agriculture takes place, while the central and eastern lowlands are where small-scale subsistence farmers are found. The study anticipates that the farmers of the southwestern highlands will be most able to adjust to adopting a GM variety of their local crop as they have the economic means to adjust their labour pools (Addison & Schnurr, 2016). These commercialized farmers also have the necessary connections to continue to sell the new variety on the markets. For the subsistence farmers of the central and eastern regions, the case is very different. While their crop yields will increase, the source of labour required for harvest will have to be family members. By using family labour the poor become further marginalized as this is unpaid work and no direct profits are being generated. Along with this, the labour is often sourced from female family members as harvesting is seen as female work within the country. Simply increasing yields through introduction of GM 2.0 crops does not solve issues of labour access in poor nations but instead appears to exacerbate them.

Yet another issue facing poor nations agricultural systems is the inefficiency of credit markets. Ellis (2000) in a study that aims to highlight why there is a need for rural farming

communities to diversify their sources of income, points out how credit markets in smallholder communities do not serve the population well. Lack of knowledge about those borrowing money, risks of individuals defaulting on loans and the overall cost of building banks are part of the reason why credit markets are ineffective in rural areas. Without access to credit, many smallholder farmers cannot afford necessary agricultural tools and therefore their levels of production are impacted. This low rural credit availability often results in private moneylenders coming in. Due to the desperate need for financing, rural farmers sign into deals with these moneylenders. The resulting situation is that these small-scale farmers become trapped in a permanent state of owing money as they cannot afford to pay back what they borrowed. Additionally, interest on the borrowed money continues to increase. Ellis (2000) cites these as the reasons why small-holder farmers should look into sourcing cash from other sectors other than their agricultural work. This will help diversify their source of income and deal with issues such as access to finance. GM crops do not address such issues.

Overall, scholars stress that an improvement in yields through using GM crops is not the only solution needed in poor nations. Simply focusing on yields will prove to ignore many other problems such as availability of labour and access to credit markets. Failing to address these issues will leave the poor farmers in a disadvantaged position (Schnurr, 2017; Sumberg, 2012; Kuruganti, 2009).

3.Commercialization of GM Matooke in Uganda

The issues outlined in the previous chapter play out in the context of Uganda and GM matooke. The nation is facing several problems as they try to commercialize the crop. Due to the economic and cultural value placed on matooke in Uganda, finding a way to deal with the issue of BBW was a high priority for policy makers (Kikulwe, Wesseler, & Falck-Zepeda, 2008). Matooke feeds a majority of the nation with Uganda recording the highest per capita consumption of banana in the world (FEWS NET, 2017). Many of these bananas are consumed by farmers with only a third of total production being put out on the market (FEWS NET, 2017). When the bananas are sold both domestically and within the region, they bring in approximately US$ 6 million (FEWS NET, 2017). Given this information it is no surprise a GM variety was among one of the most favoured options for dealing with BBW (Kikulwe et al., 2008). Other reasons for this included the fact that alternative methods of dealing with pests and disease in the crop were failing. One of these failed methods was cross-breeding (Kikulwe et al., 2008). Cross-breeding failed after the discovery that the banana was sterile and needed genetic engineering in order to add genes that are resistant to disease. This discovery helped emphasize the need for a GM variety of the crop (Kikulwe et al., 2008).

Grey literature from Ugandan newspapers suggests high anticipation for commercialization of GM matooke. Tibasaaga (2015) says farmers are looking forward to the release of a GM variety so they can go back to planting matooke without the difficulties of dealing with BBW. What is immediately noticeable about the newspaper publications on commercialization of matooke in Uganda is the long timeline over which they have emerged. In

2010, journalist Linda Nordling released an article celebrating the first field trials of the BBW resistant variety of matooke. Seven years later in an article entitled *GM BWX-resistant bananas start their journey to the farmer*, the crops are said to almost be ready to make their way to farmers (Nantenza, 2017). What is not obvious from the title is the fact that this journey is only in phase two of tests which involves more field trials by scientist. These trials differ from the first based on the location at which they will be conducted (Nantenza, 2017). The question immediately turns to what is delaying the commercialization of the GM variety. Many scholars have aimed to answer this question over the years. Studies by Paarlberg (2010) and Schnurr (2015) all point to the issue of biosafety regulations as being a major hurdle in the efforts to commercialize genetically modified varieties.

Biosafety Regulations

In a 2015 article examining what the adoption of GM crops would entail for African countries, Schnurr highlights how countries are required to have a comprehensive policy on biosafety regulations by companies who own the technology. When this requirement is met the GM technology can be released (Schnurr, 2015). Problems arising from this requirement include the long-term goal that one African country will develop a framework that will be used all around the continent. Trying to apply one framework developed by a political body may result in conflicts of interest within the system (Schnurr, 2015). This occurs when those who are monitoring the biosafety are also the same governing bodies who want to see genetically modified crops succeed. Schnurr (2015) highlights how differentiating between bodies who are promoting the genetically modified crops and those regulating it is an important task that needs to be undertaken.

Paarlberg (2010) cites political dynamics between African nations and the wealthy nations of the global north as another factor that is complicating the biosafety debate in Africa. African nations are currently faced with the option of adopting biosafety regulations that follow a European versus an American model. These two nations differ greatly in how they approach the issue of genetically modified crops. European nations focus on a precautionary principle approach when dealing with GM crops. On the contrary the USA will still produce the organism if tests show no cause for concern. According to Paarlberg the great challenge faced by African nations is the desire to proliferate genetically modified organisms at an American level but with European regulations. The two do not match up well. African nations reliance on donor aid is what drives their desire to please European nations .At the time of Paarlberg's article, Africa's official development assistance from Europe was three times larger than that from America (pg. 611). This means that the opinion of European nations was held more highly than that of America. These political complications result in a failure to create a biosafety framework in a timely manner. Paarlberg (2010) insists that it is time African nations made decisions of their own and not try to please Europeans or Americans.

Uganda is currently grappling with its own biosafety bill. Uganda is a party to the Cartagena Protocol in Biosafety, an international agreement that dictates that the nation should have a functional national biosafety system (African Biodiversity Network [ABN], 2015). The Cartagena Protocol deals with transboundary movement, transit, handling and use of all living modified organisms (LMOs) that may have adverse effects on the conservation and sustainable use of biological diversity, also taking into account risk to human health (ABN, 2015, pg. 94). Uganda aimed to reflect these requirements within its biosafety bill and in 2008 they approved

the National Biotechnology and Biosafety Policy which encompassed requirements from the Cartagena Protocol. The law that is meant to operationalize this policy is known as the National Biosafety and Biotechnology Bill. It was proposed before parliament as early as 2013 (ABN, 2013). After many years of being debated in parliament the National Biotechnology and Biosafety Bill was passed in October 2017 and all that was needed was President Museveni's approval for it to be implemented into law (Ligami, 2017). Ultimately, Museveni refused to sign the bill on the basis that it needed improvements on aspects such as protecting indigenous varieties and labelling of GM products (Okuda, 2017). The current lack of a biosafety bill delays the ability of GM crops such as BBW resistant matooke to reach small-scale farmers.

4. The Study

This study aims to examine how adopting GM matooke impacts issues within the Ugandan food system. The guiding research question is "Can genetically modified matooke prove to be a suitable option in helping empower Ugandan small-scale farmers within their food system?" Through this main research question two key areas of study that arise are those of food sovereignty within Uganda and genetically modified crops in the country. A few sub questions within this include: 1) "What role do small scale farmers have in the nation's food system?" 2)"How does matooke fit within the nation's food system?"

These questions are examined using food sovereignty as the analytical framework. The reason the study uses food sovereignty is the ways in which food sovereignty theory, through its focus on marginalized and small holder farmer communities, best represents the farming population in Uganda. Food sovereignty provides a framework that would be most beneficial to Uganda's small-scale farmer community, this makes it helpful in helping answer the question. By using food sovereignty as the analytical framework GM matooke will be examined based on a theory tailored for the population it is meant to serve.

5.Food sovereignty: The origins and cases supporting the theory.

Food security vs Food sovereignty

The concept of food security first emerged after World War 1. During the war, European nations faced extreme food shortage issues and did not want the situation to repeat itself thus the concept of food security came about (Edelman, 2014). Food security was defined as a nations ability to provide adequate food to its population while maintaining national self-sufficiency (Edelman, 2014, pg. 963). However, as food shortages continued to worsen the definition changed in the early 1970s. The new definition of food security was the availability of global food supplies at all times to ensure a steady expansion of food consumption and to offset fluctuations in production and prices (Edelman, 2014, pg. 966). Some scholars immediately criticized this definition stating that it had lost focus on the individual and turned towards promoting production and supply. According to Edelman (2014), this was a deliberate attempt to synch with neoliberal attitudes that were becoming popular at the time. The move away from a focus on individuals brought about criticism of food security and the rise of food sovereignty as the alternative solution (Edelman, 2014).

Food sovereignty is a concept that deals with people's access to food with a focus on issues such as vulnerable populations and power dynamics at play within the food system (Edelman, 2014). It is commonly viewed as the alternative paradigm to food security. Food sovereignty has roots in government polices of many Central and Latin American countries. As early as the 1960s, countries like Nicaragua had government policies that included notions found in the present-day food sovereignty movement. Some of these notions include self-sufficiency

and national control of food supply (Edelman, 2014). The term food sovereignty itself was coined and popularized by a peasant farmer movement known as La Via Campesina (Martinez-Torres & Rosset, 2010). Definitions of what the term means have changed over the years due to shifts in political ideologies within the food system (Agarwal, 2014). The current definition of food sovereignty is:

> the right of peoples to be able to consume healthy and culturally appropriate food. This food should be produced in ecologically sound and sustainable ways through an agricultural system defined by the local people. Food sovereignty puts the needs of consumers and producers first rather than pursue the interests of corporations. It offers a way to fight and dismantle the current corporate food regime. Food sovereignty prioritizes local and national needs while assisting peasant farmers and family-based farms. It respects the right to land ownership and fights against any forms of oppression or inequalities (Agarwal, 2014, pg. 1248).

Martinez-Torres & Rosset (2010) state that, La Via Campesina promoted the ideals of food sovereignty as a means of opposing the negative impacts of neoliberalism. These negative impacts stemmed from neoliberal ideals which promote privatization and market profits. As business becomes privatized small-scale farmers no longer have the government support they earlier relied on to succeed. Their access to markets becomes limited as they no longer have the resources to compete. Holt-Giménez, & Shattuck (2011) support these assertions by Martinez & Rosset (2010) and go on to state that this failure to access markets phases out small scale farmers as they cannot compete with corporations. The neoliberal food agenda involves a focus on overproduction, monocultures and mass global production of industrial food for huge corporations to gain maximum profit. Food sovereignty will counter these impacts by ensuring that local foods and agricultural methods are protected while also giving control of the system back to smallholder farmers (Edelman 2014; Menzies 2001; Rosset 2008). The key to giving

control back to smallholder farmers lies in dismantling the system of deregulation, introduced by proponents of neoliberalism, that has led to current problems in the food system.

Food sovereignty also emphasizes how local farmers have vast knowledge about agricultural practices. By achieving food sovereignty, they will gain an opportunity to use their knowledge of the land and crops to improve agriculture (Rosset, 2008). To do this, neoliberal proliferation of agricultural technologies should be regulated, or other options should be considered. One alternative to agricultural biotechnology that has been proposed by scholars such as Rosset (2008) and Altieri (2009) is agroecology. Altieri (2009) takes a strong stance against agricultural biotechnology and prefers moving towards agroecology. Agroecology is the application of ecological knowledge to agriculture in order to create sustainable ecosystems (Altieri, 2009). This ecological knowledge is believed to be abundant in indigenous communities. Altieri (2009), strongly opposes the second green revolution being promoted by AGRA. He believes that by promoting agricultural technology such as GM crops, the biodiversity of many nations could be lost and their local crops could be drastically changed. Instead of opting for genetically modified crops it is best to turn to agroecology as this is empowering to small scale farmers and gives them control over their food. Giving control of food back to local farmers would be putting the food sovereignty theory in to practice. This is due to how the issue of who has control over food is key within the theory. Movements such as La Via Campesina would like to see this control in the hands of locals (Agarwal, 2014).

Food sovereignty: Criticism of the theory.

While many scholars who have studied the theory of food sovereignty credit it for its move away from a neoliberal system that is putting power in the hands of few individuals, some

criticism does exist. Edelman (2014) states that proponents of food sovereignty need to critically think about how applicable it will be to policy in different nations. The idea of localization within the theory is an example of a concept that may be difficult to turn in to policy. Localization within food sovereignty is an effort to promote the agricultural contributions of small-scale farmers. One question that arises is, how does one account for a local farmer who may have a desire to expand their business. According to Edelman (2014), in a food sovereign nation this might be difficult. Food sovereignty wants to keep food on a local level and limit exports and imports. Due to this, expansion capabilities would be limited. Agarwal (2014) echoes similar concerns as there is a questioning of how beneficial this localization will be to current farmers. Agarwal (2014) also points out how there is no clear mechanism on how families could opt out of a food sovereignty farming system which makes the theory difficult to put in to practice. For Edelman (2014) and Agarwal (2014) such issues highlight the need to define concepts within food sovereignty. These scholars believe that defining concepts may transform food sovereignty theory into a practice.

6.Methods

This thesis seeks to answer the question "Can genetically modified matooke prove to be a suitable option in helping empower Ugandan small-scale farmers within their food system?" The methods that used to do this are articulated in the following chapter.

Theoretical Framework

This thesis uses food sovereignty as the analytical framework. This is due to the way in which food sovereignty maintains a central focus on the small-scale farmer while dealing with food issues. The approach is relevant to the study as it aims to examine how suitable GM matooke is as an option for empowering small-scale farmers within the Ugandan food system. The way in which food sovereignty theory aims to centralize the small-scale farmer within a food movement makes it a useful analytical tool in achieving this paper's goal. From the definition of food sovereignty three main themes can be identified. These are: 1) small-scale farmer, 2) power (consumers and producers' vs corporations) and 3) the environment. These three themes encapsulate the broader commitment to food sovereignty as they give a concise overview of issues the theory aims to deal with. The themes are drawn upon while formulating a coding system for data gathering and later analysis

Applying the theoretical framework

Thematic Analysis

A thematic analysis is a method of identifying, analyzing and organizing different patterns of meaning (Nowell, Norris, White, & Moules. 2017). These patterns are typically characterized by shared ideas or an overarching framework that will aid in answering the research question (Nowell et al., 2017). This methodological approach is appropriate here because food sovereignty provides the study with a set of shared ideas that can then be organized and analyzed based on relevant themes. Within this study, this analysis is done through gathering

texts on GM matooke and coding them to fit within the three main themes of food sovereignty. The coding process is described below.

Coding

A deductive coding approach was undertaken. Deductive coding involves the analyst approaching data with a predetermined set of interests (Palys & Atchison,2014). In this thesis, these interests were the three main focuses of food sovereignty. These are: 1) small-scale farmer, 2) power (consumers and producers' vs corporations) and 3) the environment. The subtheme that emerged within the theme small-scale farmer was: 1) livelihoods. Within the theme power the subthemes were: 1) consumers and producers, 2) access to information, 3) biosafety, 4) food and 5) corporations. Within the theme environment the subthemes were: 1) climate change and 2)environmental sustainability.

These themes and subthemes guided thesis analysis. These themes were used to determine inclusion criteria for texts gathered under this study. Other inclusion criteria was that texts gathered were published between the years 2010 to 2017 and that they explicitly addressed the technology of BBW resistant matooke. An excel spreadsheet was formulated with the three themes as headings to keep track of gathered texts. The sources of texts for this thesis are academic literature, Ugandan newspapers and research institute publications and promotional materials. The reason for opting for texts beginning in the year 2010 is because this is when field trials for GM matooke in Uganda began. The databases used to gather these materials are listed in Appendix 1.

7.Findings and Discussion

The following section will highlight the literature gathered from academic articles, Ugandan newspapers and publications from research institutes as well as associated promotional materials. The inclusion criteria for texts from the above-mentioned sources is that they discuss BBW resistant matooke in Uganda and were published between the years 2010 to 2017. The texts were then coded to fit into the above-mentioned themes of food sovereignty and relevant subthemes. A total of 42 texts were gathered. 12 were academic articles, seven were from Ugandan newspapers, 17 were from research institute publications and six were from research institute promotional materials. The number of texts found within each theme are recorded in Appendix 2. While Appendix 3 indicates these findings broken down by sub-themes and source.

Small - Scale Farmers

In Uganda small-scale farmers make up 85% of the farming population. Small-scale farmers are farmers who typically cultivate less than one hectare of land and produce for family consumption (Development Research and Training, 2012, pg. 2). Small scale farmers are the central focus of the food sovereignty narrative (Rosset, 2008; Goulet 2009; Agarwal, 2014). Given the high proportion of small-scale farmers in Uganda and their key role in the food sovereignty narrative, results found under this theme are crucial in answering the research question. Data gathered falls under the sub-theme of livelihoods. The main concern within this sub-theme is how GM matooke may improve small-holders way of life. Through analyzing the data, it is clear that increased productivity associated with GM crops hinges on improving livelihoods through economic benefits.

Livelihoods

The impacts BBW is having on farmer livelihoods is a key focus amongst the data gathered. According to a newspaper report by Tibasaaga (2015), farmers are finding recommended BBW mitigation strategies expensive. Some sources are recommending farmers use a cleaning detergent known as JIK on their farming equipment, this detergent is expensive therefore not easily accessible for small-scale farmers (Tibasaaga, 2015). According to an online catalogue 5litres of JIK currently costs USD$10 (Supermarket.co). A 2016/2017 household survey indicates that the average monthly income in rural households is USD$82 (Kamonga, 2017). 67% of rural households that rely on agriculture for this monthly income state that they receive this money seasonally (Kamonga, 2017). Given this information it is clear why spending $10 on the detergent is not a favoured option among these households. A study by Karamura et al., (2010) further emphasizes the economic burdens of BBW. They state that the loss being suffered due to BBW is costing households an average of $200 per year. In light of these economic burden's being brought on by BBW it is no surprise three academic articles and seven research institute publications site economic benefits as being the main advantage of a BBW resistant variety. This could indeed be appealing to farmers who are finding current mitigation strategies too expensive. Within the findings these economic benefits are linked with increase in yields.

Kikulwe et al., (2011), Kikulwe et al., (2010) and Ainembabazi (2015) focus their studies on how GM matooke will reduce the price of banana making it beneficial to consumers. This price reduction is largely due to more produce being available on the market once a BBW resistant variety is adopted (Kikulwe et al., 2010; Kikulwe et al., 2011). Ainembabadzi (2015) describes these as benefits of flooded markets for consumers. The idea of more produce

translating to economic profits that benefit small-scale farmers is similarly found in annual reports of the AAFT and the IITA. The AAFT 2010 annual report states that matooke is a major source of income for farmers therefore a BBW resistant variety will increase yields which will translate into increased income for households. The IITA takes a similar approach in their annual reports from the years 2012 to 2015. They blame reduced yields resulting from BBW for economic loses in smallholder communities. It is important to note that these research institutes do not cite any specific figures when mentioning the losses incurred.

These findings expose the key assumptions underpinning the work of the AATF, IITA and three academic articles cited: that increasing yields will produce economic benefits that directly improve the livelihoods of small-scale farmers. While studies such as those by Qiam & Zilberman (2003), cited in the section on arguments for GM crops, provide evidence to the fact that GM crops are increasing yields, there exists evidence that questions whether there are any links between these increased yields and economic profits. Huang, Rozelle, Pray & Wang (2002) argue that economic benefits from GM crops are largely due to the crops' insect-resistant trait. Resistance to insects reduces labour for pest control and money spent on purchasing pesticides. Using the case of Bt cotton in China, farmers were said to save $762 per hectare each season as a result of minimized pesticide use (pg. 676). Furthermore, Pray, Huang, J., Hu, & Rozelle, (2002), state that success in Bt cotton yields is beginning to diminish the economic benefits of the GM variety as rising yields and expanding area are pushing cotton prices down. This is resulting in most profits going to the consumers, in the case of cotton, consumers are the mills that produce yarn and cloth. This data brings the argument that increased yields have economic benefits that improve the livelihoods of small-scale farmers into question. The data suggests that increased yields are more likely to bring about negative rather than positive impacts.

Ainembabadzi (2015) favours increased yields because they decrease the price of GM matooke for consumers due to more produce on the market. Considering that most rural consumers in Uganda double as producers this point is more of a negative impact than a positive one. 82% of rural farmers in Uganda are subsistence farmers meaning a portion of their produce is meant to feed themselves and their families (World Bank, pg.8). The consequence of markets being flooded by produce are best represented by the effects of surplus grain on the US markets in the 80s (University of Minnesota). As a result of too much grain on the markets the government had to subsidize farmers to keep price stable (University of Minnesota). Low market prices in the Ugandan agricultural sector would not benefit small-scale farmers. Additionally, the assumption that economic profits will have a positive impact on small-scale farmer livelihoods fails to take into account factors that might limit this group's access to economic benefits.

In a report compiled by a United Nations taskforce on eradicating hunger, participants emphasized the need to ensure equal access, rights and control over agricultural profits (United Nations, 2015). It is stated that there is need to recognize that women do not always have equal opportunities (United Nations [UN], 2015). Being aware of such inequalities is important in a nation like Uganda where women make up 18% of land owners despite making up 76% of agricultural labour force compared to 65% of men. Other statistics show that female literacy rates are 49% compared to 69% amongst men and female enrollment in secondary education is 85 for every 100 boys in secondary school. These inequalities exist because they are imbedded within the Ugandan social system. The results of this are that women are left in a disadvantaged

position and are always treated as inferior to men (Organization for Economic Co-operation and Development [OECD], 2015). The implications of this low status women are given is that they do not have control over how profits are managed nor, can they easily access them (Uganda Bureau of Statistics, 2016). These factors are a key piece of missing information in the promotion of economic profits from high yields benefiting the livelihoods of small-holder farmers.

Along with lack of consideration of factors that might impact access to economic benefits, a study by Karamura et al. (2010) highlights how other factors are combining with BBW to reduce banana production. This is an important argument to consider as it highlights other areas that may need to be improved before GM matooke can succeed in Uganda. Karamura et al., (2010) highlight this point by stating that while households affected by BBW were incurring a high percentage of production loss, unaffected households were also experiencing loss in production. This knowledge is important when trying to come up with ways to improve the livelihoods of Ugandan small-holder farmers. Scholar's such as Schnurr (2017) and Naylor (2010) criticize the preoccupation with technology as being the solution to poor nations agricultural problems. Such narratives fail to recognize that factors such as lack of access to land and limited government assistance to aid poor farmers are also playing a part in agricultural problems (Schnurr, 2017). In a study on how to put food sovereignty into practice in Uganda, Martiniello (2015) supports Schnurr's assertions. He stresses the need for government assistance in sectors such as land ownership, access to labour and acceptance of indigenous farming methods to improve on current agricultural conditions. Simply increasing yields without considering issues affecting small-scale farmer's livelihoods is not effective.

The majority of texts found within the sub-theme of livelihoods do not convincingly portray BBW resistant matooke as being a suitable solution for helping empower small-scale farmers within the food system. This conclusion is reached while analyzing the texts from a food sovereignty perspective. Goulet (2009) indicates how part of achieving food sovereignty is addressing the gender inequalities that exist in the current food system. The literature on livelihoods does not indicate that GM matooke will foster such change. Instead, whatever economic benefits will be generated will profit those, male land owners already profiting under the current system.

Power

Within food sovereignty discourse, the battle for power finds consumers and producers being positioned against corporations. This is based on the definition of food sovereignty provided by Agarwal (2014). Agarwal (2014|) articulates this struggle for power in stark terms: "food sovereignty puts the needs of consumers and producers first rather than pursue the interests of corporations," (pg. 1248). Goulet (2009) similarly indicates a power struggle as he states that food sovereignty requires the state to challenge neoliberal ideals while giving power back to peasant farmers. The theme of power is split into two parts consumer & producers and corporations. Each of these has their own relevant sub-themes.

Consumers and Producers

Producers and consumers are not easily differentiated in most smallholder agricultural communities. This is true for Uganda where rural consumers often double as producers (Kikulwe et al., 2011). 82% of small-scale farmers in Uganda are both consumers and producers (World

Bank, pg. 8). Due to this interconnected nature of producers and consumers data gathered under this sub-theme is concerned with issues pertaining to consuming matooke as well as matters concerning production. This section will begin by analyzing data gathered on small-holder farming communities and pertaining to both consumers and producers. These will include access to information, and biosafety regulations. After this the sub-theme of food which applies exclusively to consumers, will be examined.

Access to information

Based on academic articles that were gathered under the theme of food, small scale farmers have low concerns about impacts of GM matooke on human health (Kikulwe et al., 2011; Kikulwe et al., 2011; Kikulwe et al., 2014). Learning that rural consumers show little concern over the health risks associated with GM matooke brings about a questioning of the information they have about the technology. This is because many Ugandans became scared of the idea of GM crops after a 2012 publication by Seralini that linked GM crop consumption to cancer. These questions deal with how small-scale farmers in Uganda are accessing information about GM matooke. A study by Schnurr & Mujabi-Mujuzi (2014) finds many rural farming communities do have concerns over their lack of knowledge about GM matooke. The farmers feel they have limited knowledge about the source of GM matooke. Farmers in this study state that this uncertainty makes them more likely to stick with their old varieties (Schnurr & Mujabi-Mujuzi 2014, pg. 646).

Data gathered in this thesis indicates that there is a need for partnership between those developing the GM matooke technology and mass media outlets. This partnership will enable useful information about the GM variety to reach rural farming communities from a source that

they trust and can easily access. The Science Foundation for Livelihoods and Development (SCIFODE) is a Ugandan non-profit organization founded in 2006. The organization aims to harness scientific knowledge for the benefit of livelihoods and development. SCIFODE consists of Uganda scientists and science communication specialists. In their 2015 report, *Public Knowledge and Perceptions Towards Biotechnology and Biosafety in Uganda,* they state that they do not believe rural communities in Uganda are accessing adequate information about GM matooke. Valuable information is believed to come from the research institutes developing this crop. This report indicates that many rural farmers are gaining information on biotechnology from mass media such as radio. Mass media is ranked as the most trusted source of information with 34% of participants identifying this as their preferred medium (SCIFODE, 2015, pg. 19). However, SCIFODE states that there is currently not enough partnership between research institutes and mass media channels, meaning valuable information is not reaching farmers.

The issue of lack of access to useful information about GM technology is highlighted in the case of Tanzanian farmers. In a study conducted in 2010 by, Lewis, Newell, Herron, & Nawabu, 19 farmers and three agricultural extension officers were surveyed in order to understand the issues in local understanding of GM technology. Agricultural Extension Officers are council employees trained by the Ministry of Food, Agriculture and Cooperatives (MFAC) to oversee agricultural and livestock farming practices (pg. 409). During the time of the study Tanzania was working in collaboration with IITA to develop a GM variety of cassava. Results in this study found that only three respondents from the farmers had ever heard of the term GM technology. They all indicated that when they heard the term it was on the radio. Two Agricultural Extension Officers were found to misunderstand the concept of GM technology and

confuse it with cross-breeding. Lewis et al., (2010) indicate how a chance to talk to those who are developing the technology would allow farmers to ask questions and gain direct information. Furthermore, they criticize the Agricultural Extension Officers lack of knowledge due to the fact that these individuals undergo training with the MFAC and require certification before being sent into different communities. This study indicates how, similar to the case in Uganda, most farmers appear to be relying on the radio for information about GM technology. These radio outlets appear to be disseminating inadequate information.

SCIFODE (2015) suggests research institutes work hand in hand with mass media to ensure this information is reaching rural communities. Findings indicating that mass media is a key source of information on biotechnology are not unique to Uganda. A study done by Aerni, Phan-Huy, & Rieder, (2000) indicates that farmers in the Philippines similarly rely most on mass media for information on biotechnology. In their study Aerni et al., investigated factors influencing public acceptance of genetically modified rice. They found that perceptions on GM technology are formed by what is going on within the social environment. This means the day to day occurrences within, and around the farmers lives. The study found that this social environment is shaped by those who choose to speak up. In the Philippines it is mostly a coalition of NGOs who are against GM technology. They turn to the press to express this opposition. Due to mass media being the key source of information for rural farming communities, this ends up being the information farmers have most access to (Aerni et al., 2000). What this information shows is a need for research institutes to work hand in hand with mass media sources to keep smallholder farming communities well informed.

While investigating how information about genetic characteristics is relayed between seed providers and small-scale farmers, Tripp (2001) concluded that poor information distribution is one of the key factors weakening biotechnology's potential in small-scale farmer communities. Tripp (2001) highlights how farmer's limited knowledge about seed markets inhibits them from advocating for change. This is detrimental to the farmers as current seed markets are currently not serving them well. This is not likely to change with the introduction of biotechnology (Tripp, 2001). These concerns can be applied to Uganda as lack of adequate knowledge could have the same impacts on smallholder communities. Based on these findings and supporting evidence, GM matooke does not appear to be the ideal solution for empowering Ugandan small-scale farmers within their food system. This conclusion is based on an analysis from a food sovereignty perspective. Food sovereignty dictates that small holder farmers must be empowered and be given a voice within the food system (Rosset, 2008). Without access to adequate information small-holder farmers cannot make well informed decisions and their opinions will be left out of important policy debates (Tripp, 2001). This does not align with the goals of food sovereignty**.**

Biosafety

Five texts discussing biosafety were surveyed in this study. Materials from research institute publications, research institute promotional materials, academic articles and one newspaper article were all published before the passing of Uganda's biosafety bill in October 2017. These texts all deal with how the delay in signing of a biosafety bill is hindering the ability of GM matooke to be distributed to farmers. A researcher speaking to the Red Pepper in 2013 indicated that the scientists are doing all that they can to help solve the issue of BBW, what is limiting them is a lack of biosafety bill (Red Pepper, 2013). Biosafety bills are necessary as a

way of addressing concerns about biotechnology. They tackle issues such as safe handling and transfer of organisms (Kameri-Mbote, 2002, pg. 62). Jerome Kubiriba, the team leader on the GM matooke project, states that the scientists at the laboratories followed international regulations on the development of transgenic crops. This shows that the scientists are confident that GM matooke will be approved for commercialization soon all that is needed is for the biosafety bill to be ready.

One text was published after the October 2017 passing of the biosafety bill in parliament. Mwesigwa, writing for The Observer in November 2017, reports that the scientific community is celebrating the passing of the biosafety bill. The article highlights how the passing of the bill means trials can now occur in farming communities. Mwesigwa (2017) highlights that the final step in Uganda's long biosafety bill struggle is presidential approval. Presidential approval will put the biosafety bill into law. Ultimately, after the publication by Mwesigwa (2017) President Museveni rejected the bill in its current form and sent it back to parliament for revising (Okuda, 2017). The President stated that he is not ready to accept a bill that does not protect indigenous varieties (Okuda, 2017). Museveni also highlights concern over lack of clarification on GM labelling and lack of explicit language setting that the boundary for genetic engineering be limited to animals and plants and not include humans (Okuda, 2017). This comes as a surprise to most Ugandans as he had shown support for the bill even a month before it was passed in parliament. Museveni has been quoted saying the biosafety bill is long overdue and that he sees nothing wrong with the technology (Latigo, 2017; Lynas, 2017). Such actions have proved to be frustrating for many in the scientific community (Yurou, 2017). The chairman of the biotechnology consortium was quoted as saying "Why did they set up the National Agricultural

Research Organization if they don't want to listen to it?" He is expressing frustration over the fact that President Museveni continues to be influenced by NGOs that are against GM technology (Lule, 2018). A biosafety bill is crucial for Uganda as it will bring about the legal certainty needed to develop biotechnology research and move towards commercialization (African Biodiversity Network, 2015).

This analysis of data gathered on biosafety in Uganda does not portray GM matooke as the suitable option for helping empower small-scale farmers within the Ugandan food system. Without a legal biosafety bill, the nation is unable to commercialize GM crops, this includes matooke. Without being commercialized they do not serve the farmers any purpose. More importantly, the analysis highlighted President Museveni's concerns over losing indigenous varieties through genetic engineering. President Museveni's logic in rejecting the bill aligns with the ideals of food sovereignty. From a food sovereignty perspective, protecting indigenous seed varieties is crucial. Altieri (2009) aligns agroecology with the goals of food sovereignty on the basis that agroecology prioritizes small-scale farmers expertise through using their local varieties. If the current biosafety bill cannot guarantee such protections it fails to align biotechnology in Uganda with food sovereignty. Additionally, the issue of GM labelling is crucial in a food sovereign system as it allows producers and consumers to choose whether they want to consume GM crops. The importance of GM labelling for consumer autonomy is highlighted by Oh, & Obidimma (2014) as they examine the case of GM labelling in Kenya. They emphasize that labelling upholds the values of transparency and allows the consumers freedom of choice. Since Uganda's current biosafety bill does not meet these standards, it is not a suitable solution for empowering small-scale farmers within the food system.

Consumers – Food

Texts within the sub-theme food are concerned with how successful a matooke variety resistant to BBW will be in alleviating hunger in Uganda. Texts found deal with two main ideas of food availability and taste. Six of the texts collected from research institutes address a BBW resistant variety of matooke as being beneficial for food availability. One of these is by the AATF while the other five are published by the IITA. The overarching theme in these reports is science-based decision making. Firstly, the reports introduce the devastation being wrought by BBW then proceed to give detailed explanations of the scientific processes that can mitigate these impacts. Like the research institute reports, academic articles by Ghag & Ganapathi (2017) and Ortiz & Swennen (2014) go into detailed explanations about the scientific work going into developing a BBW resistant variety of matooke, showing that this can translate into potential benefits to food availability. In their article they cite increased yields as bringing about this increased availability. Ghag & Ganapathi (2017) go as far as stating that science is the key to solving the problems faced by small-scale farmers.

The key assumption in these science-based claims is that a steady supply of matooke is all that is needed to improve issues pertaining to food in Ugandan small-scale farmer communities. When judging access to food, the Food and Agricultural Organization (FAO) does not consider Uganda as failing to meet their consumption needs. This is based on the fact that most the population produces their own food therefore faces few obstacles when it comes to access. However, it must be noted that, for individuals to be considered as meeting their consumption needs the food they consume must be nutritious alongside being readily available and easy to access. (World Food Program). Ugandan diets fail to meet the need for nutritious

food. The reason for this is households in this region cannot afford to access a diverse range of food on the markets and so they rely on the matooke to meet nutritional requirements (Economic Policy Research Centre, 2010). A 2009 article by Harshbarger highlights the low nutritional value in matooke. The crop is low in protein therefore should be eaten alongside protein rich foods, matooke is also said to be low in Vitamin C and fiber. This information helps emphasize that matooke needs to be eaten alongside other foods in order to gain good nutrition. Without access to food other than matooke small-scale farmer households will not consume a nutritious diet. What this evidence indicates is that a constant supply of matooke is not all that it takes to improve food issues in Ugandan small-scale communities.

Newspaper articles, four studies by Kikulwe et al., (2010) Kikulwe et al., (2011), Kikulwe et al., (2011b), Kikulwe et al., (2014) and one study by Schnurr & Mujabi-Mujuzi (2014) chose to focus on whether a BBW resistant banana will be accepted by consumers. Acceptance of a GM banana in Uganda is based on nutrition[1], taste and use of pesticides (Kikulwe et al., 2010). Since this thesis deals with a BBW variety of the banana, only taste will be analyzed under the theme of food. According to Kikulwe et al., (2010) farmers are willing to pay for a GM banana if it tastes better. In a questionnaire about what aspects of matooke are most important to farmers, taste scored 89% (Kikulwe et al., 2010, pg. 404). Such high value is placed on the taste of matooke due to the huge role this crop plays in Ugandan diets. The average Ugandan eats 750grams to 1 kilogram of the banana a day (Harshbarger, 2009). 49 % of households in Uganda report that they consume matooke weekly. Altogether the crop makes up 11% of the food consumed in households (Economic Policy Research Centre, 2010, pg. 12). These statistics indicate how often matooke is being consumed and may help explain why

[1] A matooke variety is being modified for nutritional purposes but is not the focus of this study

consumers view improved taste as a benefit. A study by Aggarwal, Rehm, Monsivais, & Drewnowski (2016), indicates the role taste plays in consumption choices. The purpose of the study was to examine the importance of taste, cost, convenience, and nutrition in the US population's diets. The study found that a majority of participants considered taste as a key factor when choosing what to eat. Considering this information, benefits to taste are likely welcome by the Ugandan consumers since GM matooke makes up a large part of their diets. The data gathered on taste indicates that rural consumers are willing to accept GM matooke based on perceived benefits. This aligns with findings in a study by Gaskell et al., (2004) whereby widespread rejection of GM crops in European countries was found to be due to an absence of benefits rather than a perception of risk.

Based on data gathered on food, GM matooke will not be the simple solution helping Ugandan small-scale farmers. The advancement of this crop based on the fact that it will solve food issues for Ugandan smallholder farming communities is inaccurate. BBW resistant matooke does not address issues pertaining to nutrition. Simply advancing the crop based on increased availability does not adhere with ideals of food sovereignty as articulated by Agrawal (2014). It is said that food consumed under food sovereignty should be nutritious. BBW resistant matooke's failure to be a suitable option for small-scale farmers under this theme is unfortunate as its anticipated benefits are welcomed in the small-holder farming communities.

Corporations

Only two texts are gathered under this theme. One is a newspaper article from the Red Pepper while the other is the IITA 2014 annual report. Data gathered under this theme is concerned with the role corporations are playing in the process to commercialize GM matooke.

Food sovereignty aims to see corporations move from the forefront and give peasant farmers a chance within the agricultural system. Goulet (2009) indicates that one way this can be achieved is through nations taking control of the food system and regulating the activity of corporations within their borders. Whether food sovereignty's goal of removing corporations from their current position of power can be achieved through the introduction of GM matooke in Uganda is investigated under this theme. The main concerns identified in data gathered are worries over how access to seeds will be affected by the presence of multinational companies in the nation.

The first issue identified during data analysis is that of Intellectual Property Rights (IPRs). Critics of GM technology are skeptical about how the issue of IPRs will play out in the case of GM matooke. IPRs are intangible rights protecting commercially valuable products of the human intellect (Olusegun & Olubiyi, 2017, pg.258). Certain types of IPRs are widely recognized, in the case of GM crops these are patents. Patents are rights given to an inventor to prevent others from reproducing or selling their invention (Olusegun & Olubiyi, 2017). Due to the PPPs established within the Second Green Revolution, GM 2.0 technology is being sold patent free. Despite this, Giregon Oluput, a faculty member at Makerere University and a fierce critic of GM technology, is skeptical about corporation's ability to uphold the agreement on patent free technology. Oluput believes that once GM crops become popular, patents will be introduced. This data was gathered in a newspaper article published by Red Pepper in 2013. Despite such criticism patent free GM 2.0 technology seems to align with the values of food sovereignty. This is through allowing technology to be reused and farmers to exchange materials. All processes identified as essential in preserving farmer control over their seed networks, by proponents of food sovereignty such as Altieri & Toledo (2011).

However, while patent free technology appears congruent with the ideals of food sovereignty, the role of the formal seed sector within this system limits the extent of this sovereignty. In his criticism, Oluput highlights how the Second Green Revolution will introduce seed pricing too high for farmers to purchase. Data gathered from the IITA does indicate that a formal seed market will be used as part of the marketing strategy. IITA aims to use agribusiness to bridge the gap between science and the private sector. They advocate for a two-step process in the commercialization of GM technology. The first stage involves scientists developing the innovative technology. The second stage will aim to get this technology into the hands of businesses in order to help sell the seeds. The IITA is assuming that the African agricultural system is ready to accommodate privatized seed markets. AGRA is a proponent of the private seed network. In 2014 they signed a memorandum of understating with the African Development Bank to support the work of African seed companies (AGRA, 2014). Tripp (2001) states that leaving seeds to be distributed by businesses is an ineffective distribution method in small-holder farming. He emphasizes that IPRs have played a role in the success of private seed markets. With GM technology being sold without patents attached, repeat sales, in the context of African small-scale farming, could be difficult to generate (Tripp, 2001). Furthermore, forcing farmers to purchase seeds in the formal sector limits their control. This does not adhere with the ideals of food sovereignty. Scholars have suggested promoting farmer managed seed distribution as an alternative approach to corporate privatization of seed markets (Mayet, 2015).

Farmer seed networks transfer seeds and other agricultural materials such as cuttings and tubers through gifting, bartering or purchase (Coomes et al., 2015, pg. 42). Proponents of the Second Green Revolution often cite this way of acquiring seeds as the reason for low

productivity in African agriculture (Mayet, 2015). This is because they believe these seeds are low quality (Mayet, 2015). Coomes et al., 2015 challenge such claims by highlighting how institutes that favour this green revolution simply consider quality in terms of genetic attributes. They fail to take seed quality into account. Seed quality includes aspects such as the seeds ability to germinate, its health and freedom from contaminants (Coomes et al. 2015, pg. 43). The key idea behind favouring farmer seed networks is to allow for seed sovereignty. Seed sovereignty gives farmers access to appropriate seeds that they have control over while also recognizing their ability to openly trade these seeds (Mayet, 2015). From a food sovereignty perspective this approach is the most appropriate.

While promoting food sovereignty, Altieri (2009) states that turning to agroecology allows farmers control over their local varieties and a position of power within the food system. Seed sovereignty promoted by farmer to farmer markets is also a key element of agroecology as it helps farmers exchange knowledge about suitable varieties (Altieri & Toledo, 2011). While patent free technology aligns with ideals of food sovereignty, the role of the formal seed market within the system is a negative impact. Formal seed markets do not uphold the values of farmer control over their agriculture. It is likely the formal sector will play a huge role in the distribution of GM matooke in Uganda as this method is so highly favoured by AGRA, a key player in the Second Green Revolution. Proponents of food sovereignty value the knowledge that is found in farmer seed networks and believe these enable farmers to have control over production (Coomes et al., 2015). With GM matooke being distributed through formal networks it cannot uphold the requirements of food sovereignty. This makes it an unsuitable option for empowering small-scale farmers in the Ugandan food system.

Environment

Five of the gathered texts can be classified into this theme. Rosset (2011) indicates how peasant farmers are currently falling victim to the impacts of climate change. This is through the way in which changing climate is bringing about extreme weather conditions which in turn is adversely affecting productivity. Morton (2007) gives evidence to this in a study that emphasizes the impacts of climate change in small holder communities. The study found that significant reductions in production are resulting from less consistent rainfall. Alongside such impacts smallholder farmers find it difficult to adapt to the impacts of climate change as government offers them very little assistance (Morton, 2007). Proponents of GM 2.0 crops believe that the solution to issues of climate change lie in GM varieties. This is due to the way in which GM varieties can be engineered to resist impacts of climate change, for instance droughts (Wawa, 2016). Data gathered under this theme was concerned with the environment through dealing with the issue of climate change and environmental sustainability.

Data on climate change was found in one research institute publication. This was in an annual report by the IITA. The report states that matooke is being further threatened by the onset of climate change. The report attributes this threat to the lack of genetic variety that currently exists in the banana. Without genetic diversity all varieties of matooke are said to be at risk of being wiped out by drastic weather conditions. This is because extreme weather conditions exacerbate impacts of pests and diseases. Once the banana is modified to withstand these the risk is removed (International Institute of Tropical Agriculture, 2015). FEWS 2017 indicates that periods of high rainfall increase the incidence of pests and disease such as BBW. This shows how erratic weather conditions leave matooke at high risk of increased infection. The IITA believes that the risk of matooke becoming extinct due to climate change can be minimized by a

genetic variety. This is through the way in which a genetic variety will remove the risks of high infection during periods of high rainfall.

Protecting the environment through sustainable practices has been identified as one way to minimize the impacts of climate change. Academic articles gathered under this theme indicate an awareness, amongst farmers, about the need to protect the environment. In a study by Kikulwe et al., 2010, farmers say they would welcome a GM variety if it guaranteed they could stop using pesticides. Farmers realize that pesticides are harming their soils and worry how this could impact future productivity (Kikulwe et al., 2010). IITA is the only research institute that makes mention of an environmentally sustainable approach to agriculture. This is in an annual report published in 2011. They indicate how they have an agrobiodiversity program that aims to promote growth in sustainable agriculture through use of biological resources. Genetic engineering for pest resistance has proved to be beneficial to the environment, Bt cotton in India was observed to improve soil fertility through minimized use of pesticides (Qiam & Zilberman, 2003). Given this information, BBW resistant matooke is likely to enhance environmental sustainability through minimizing pesticide use.

Overall, the data gathered on the environment indicates that measures to adapt to the impacts of climate change are being taken. Taking all aspects of data gathered under the theme environmental into consideration, it appears GM matooke would be a suitable option for helping combat environmental issues and thus helping empower Ugandan small-scale farmers. From a food sovereignty perspective, protecting local varieties is essential in helping small-scale farmers (Agrawal, 2014). Research institutes have shown that this variety is helping GM matooke from

being wiped out by impacts of climate change. This is positive as the GM variety guarantees the crop can continue to exist.

8.Conclusion

This study set out to examine whether GM matooke can prove to be a suitable option in helping empower Ugandan small-scale farmers within their food system. This was done from a food sovereignty perspective. The reason food sovereignty was considered the best approach is due to its focus on bringing the needs of small-scale farmers to the centre of the current food system while dismantling cooperate control. Scholars such as Naylor (2017) indicate strong opposition to the introduction of GM crops in poor African nations based on the argument that GM crops cannot align with the ideals of food sovereignty. While some findings in this study indicated that GM matooke has potential to be a suitable option in empowering Ugandan small-scale farmers within their food system, majority of findings do not support this claim.

Under the theme of small-scale farmers, findings indicate that GM matooke is being promoted under too many inaccurate assumptions, making it unsuitable for this population. These assumptions pertain to the links between increased yields and economic benefits to small-scale farmers. Research institutes along with some scholars fail to consider the inequalities, for instance gender and education, that could hinder access to these benefits. Data surveyed in the theme power further highlights the issue of inaccurate assumptions as research institutes such as the AAFT and IITA assume availability is all that is needed to improve food consumption. This is not the case, the problem with Ugandan food consumption lies in the low nutritious value of matooke, an issue BBW does not address (Harshbarger, 2009). Furthermore, the theme highlights that Uganda needs to improve its biosafety bill in order for it to serve smallholder farming communities well. This conclusion is based on President Museveni's refusal to sign the biosafety bill. Findings in the theme of power also indicate how small-scale farmers have little

access to accurate and useful information about GM technology. Without accurate information farmers are limited in their ability to participate in policy decisions that may impact them (Tripp, 2001). This does not adhere with the ideals of food sovereignty, which aim to see small-scale farmers actively participate in policy debates. Further indication that GM matooke is not the suitable option for empowering Ugandan small-scale farmers within their food system is found in the theme of corporations. While some positive impacts such as ability to recycle planting materials exist as a result of patent free technology, the existence of formal seed markets within the system limits food sovereignty. Formal seed markets do not allow farmers to trade knowledge and planting materials freely. This does not uphold values of food sovereignty which promotes farmer to farmer seed markets (Altieri & Toledo, 2011). The theme environment is the only one that showed strong evidence that GM matooke can be a suitable option for empowering Ugandan small-scale farmers within their food system. This was through emphasizing how GM matooke protects a local variety from the impacts of climate change in a sustainable way.

Overall the implications of these findings are that small-scale farmers are at risk of being further marginalized by the introduction of a GM variety that is resistant to BBW. Without access to information farmers are sidelined from policy discussions and cannot partake in important dialogue that may affect them. Furthermore, there is a risk that the economic benefits that will be generated from GM matooke may not reach the population that needs them the most. This is evidenced by statistics indicating that, despite making up majority of Ugandan small-scale farmers, women have little control over the land. The result of this is profits go to men who are already benefitting from the system (Ugandan Bureau of Statistics, 2016). This could increase disparities between those who are well off and the poor.

Lessons learned from these findings and their implications are that there is a need for more knowledge about the African agricultural context and that strategies that help get information to small-scale farmers need to be developed. The most suitable way these lessons can be applied is through research institutes partnering up with mass media outlets that have direct access to small-scale farmer communities or scholars with relevant knowledge. Many scholars have stressed the need to be well versed in what causes agricultural issues in poor nations before providing solutions. Research institutes could read these studies or collaborate with the scholars who have published them for better results. In terms of getting information out to small scale farmers SCIFODE (2015) similarly suggests partnership as the solution. SCIFODE (2015) believes research institutes partnering with the radio stations that small-scale farmers are engaging with will help to ensure adequate and accurate information is reaching this population. Overall this highlights the need for some improvements before GM matooke can help empower small-scale Ugandan farmers within their food system.

Through using food sovereignty as an analytical framework, the thesis helps add to existing knowledge on how food sovereignty can be operationalized. Furthermore, lessons learned in this study help to enhance academic audience's understandings of the complexity of the African agricultural sector. For African policy makers, this study helps to highlight the important considerations that must be made when governing on GM 2.0 technology. These considerations involve assessing the role policy can play in making domestic agriculture suitable for GM 2.0 crops which in turn will help nations to gain maximum benefits from the technology.

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Appendices

Appendix 1: List of databases used to gather these materials

Academic Articles:
Novanet

Ugandan Newspapers:
Daily Monitor
New Vision
Red Pepper
The Observer

Research Institute Publications and Promotional Materials:
African Agricultural Technology Foundation
International Institute of Tropical Agriculture
National Agricultural Research Organization
Science Foundation for Livelihoods and Development

Appendix 2: Table showing number of texts found within each theme

THEMES	Small Scale Farmers	Power (Consumers and Producers vs Corporations)	Environment
NUMBER OF TEXTS FALLING WITHIN THE THEME	26	27	5

Appendix 3: Table showing findings broken down by sub-themes and source

	Livelihoods		
Small Scale Farmer	6 Academic Articles		
	14 Research Institute Publications		
	4 Ugandan Newspapers		
	2 Research Institute Promotional Materials		
	Food	Access to information	Biosafety
Power (Consumers & Producers)	6 Academic Articles	0 Academic articles	1 Academic article
	6 Research Institute Publications	1 Research Institute Publications	1 Research Institute Publication
	5 Ugandan Newspapers	0 Ugandan Newspapers	2 Ugandan Newspapers
	1 Research Institute Promotional Materials	0 Research Institute Promotional Materials	1 Research Institute Promotional Materials
	Seed Industry		
Power (Corporations)	0 Academic Articles		
	1 Research Institute Publications		
	2 Ugandan Newspapers		
	0 Research Institute Promotional Materials		
	Environmental Sustainability	Climate Change	
Environment	3 Academic Articles	0 Academic Articles	
	1 Research Institute Publication	1 Research Institute Publication	
	0 Ugandan Newspapers	0 Ugandan Newspapers	
	0 Research Institute Promotional Materials	0 Research Institute Promotional Materials	