ASSESSING SOCIO-ECONOMIC IMPACT OF FALL ARMYWORM ON SMALLHOLDER MAIZE FARMERS IN EHLANZENI DISTRICT, SOUTH AFRICA

By

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Declaration

I, Ayabulela Mkosana declare that the dissertation submitted by me for Masters in Sustainable Agriculture at the University of the Free State is my own work and has not been previously submitted to any institution/faculty.

24 January 2020

Ayabulela Mkosana Date

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Table of Contents

Table of Figures

List of Tables

List of Abbreviations and Acronyms

DAFF Department of Agriculture, Forestry & Fisheries

DARDLEA Department of Agriculture, Rural Development, Land and Environmental Affairs

CSA Climate Smart Agriculture

FAO Food and Agricultural Organisation

FAW Fall Armyworm

IPM Integrated Pest Management

UFS University of the Free State

Abstract

Fall Armyworm has become an invasive pest to smallholder maize fields in the low veld region of South Africa putting the farmers at risk of food insecurity and reduced household incomes. This study was conducted to determine the spread of Fall Armyworm, socio-economic impact on smallholder maize farmers and the coping strategies in the management of Fall Armyworm in Ehlanzeni district. Survey questionnaires were administered to a randomly selected sample of 70 respondents. Questionnaires were distributed to 70 participants who were willing to respond and provide information on the Fall Armyworm invasion. The results showed that Fall Armyworm has been increasing at an alarming rate in the community of Lowveld and has spread across the whole region causing damage on leaves, stem and feeding on the maize cob. The following socio-economic impacts were identified; decreased production costs, increased job opportunities, decreased income generation, yield target not achieved and poor quality on the maize harvested.

Less than 10% of the participants received assistance in the management of Fall Armyworm and the farmers lost a lot of money trying to control Fall Armyworm through pesticide application. Most participants were not coping financially and food security was threatened in the households. The participants think the intervention of the government is the solution in the management of Fall Armyworm. The researcher has recommended crop diversification to ensure food availability throughout the year; Crop rotation to limit pest and disease concentration, adoption of Integrated Pest Management and stopping the dependency on government for farming management.

CHAPTER 1: INTRODUCTION

1.1 Background

Maize is a diverse grain crop originating from Mexico (Bonavia, 2013) and the staple food for over 300 million African smallholder families (FAO, 2018). Developed countries consume maize in the form of eggs, meat and dairy products (second cycle produce). It is the most important grain crop in South Africa and is produced in various environments throughout the country (Plesis, 2013). Most South Africans consume maize directly as breakfast cereal and in a processed form as ethanol and starch.

The study is conducted in Mpumalanga, an area geographically located in the north-eastern parts of South Africa, a subtropical region and a farming province. A variety of crops are grown for food security and commercial purposes.

The Department of Agriculture, Fisheries and Forestry (DAFF) reported Fall Armyworm (FAW) outbreak on maize and later on potato crops in Mpumalanga (Farmers' Weekly, 2019). Fall Armyworm (Spodoptera frugiperda) is a Lepidopteran pest of the family Noctuidae (Plant Health Products, 2018). It is a pest of more than 80 species causing damage to maize, vegetables, sugarcane, cotton and other economically important crops (FAO, 2018). It is native to North and South America (FAO, 2017) but has spread to all Sub-Saharan African countries.

In South Africa, Mpumalanga province, Fall Armyworm has been found to be wide spread on maize plantations in Ehlanzeni district. The invasion of Fall Armyworm caused a huge destruction on food production with yield losses and crop damages. Most damage is caused by the larvae stage of the pest; the moth can fly up to 100 kilo metres at night, making it difficult to control and a possible occurrence of multiple generations in a year especially under favourable conditions.

In February 2017, in the Lowveld parts of Mpumalanga- Ehlanzeni South, FAW damages were specified on maize with 10559 ha, approximately 26 397 tons affected under dryland for smallholder farmers. In 2019 reports of Fall Armyworm have been increasing at an alarming rate.

When climatic conditions are favourable for FAW, it can cause up to 100% crop losses on maize if not well managed (IRAC, 2018). FAW is invasive to over 80 plant species, but maize is the preferred host plant (IRAC, 2018). FAW can feed on maize solely if it is continuously

available (Farmer's weekly, 2019). Yield losses as a result of FAW are influenced by planting season, region and production practices (Smith, 2019).

1.2 Statement of the problem

FAW has become a serious invasive pest affecting crop production in most parts of sub-Sahara Africa (SSA) (FAO, 2018). The pest has been reported to cause yield losses of up to 53% of annual production of maize in an average of a three-year period (FAO, 2018). The outbreak of FAW has also been reported in South Africa where Mpumalanga is one of the most affected provinces (DAFF, 2018). Maize is the most preferred host plant species of FAW which is a staple and commercial food crop in Mpumalanga province of South Africa. The negative consequences of FAW infestation have been reported in other parts of the continent (FAO, 2018), but little research has been conducted to understand the distribution and socio-economic impact of FAW in Mpumalanga province, particularly Ehlanzeni district. The study focuses in Ehlanzeni district because it is the subtropical region and is expected to have a wide distribution of FAW. FAW is a notoriously difficult pest to control and control is effective only if done while the larvae are small (Farmers'Weekly, 2019). The larval stage is the most destructive stage of FAW (Farmers'Weekly, 2019). There is currently scanty literature on the distribution and socio-economic impact of FAW infestation on farmers in Ehlanzeni district, Mpumalanga. This study addresses this research gap. The study seeks to determine the distribution, socio-economic impact and coping measures that have been employed by the smallholder farmers to mitigate the risk of FAW.

Several techniques were reported for the management of FAW in literature but chemical control was reported as the main effective method (Farmers' Weekly, 2019). DAFF issued a list of registered pesticides as emergency control (DAFF, 2018), but this is not the case with the Lowveld farmers. These farmers opt for cheaper pesticides because it is what is affordable for them. Insect pests hinder food security and poverty alleviation on smallholder farmers because of their restricted and limited means (Amusan & Olawuyi, 2018). Most farmers are resource limited, making them more vulnerable to FAW. Currently, no research has been conducted to determine socio-economic impact of FAW on farming communities in Mpumalanga province, South Africa. This study addresses this research gap by the assessing the distribution of FAW, socio-economic impact and coping mechanisms that have been used by farmers to mitigate the risk of FAW infestation in Ehlanzeni district, Mpumalanga.

1.3 The purpose of the study (Aim)

The purpose of this study is to assess the socio-economic impact of FAW and coping measures for FAW infestation for increased household income and food security.

1.4 The objectives of the study

1.4.1 Overall objective

The main objective is to assess the socio-economic impact of fall armyworm on smallholder maize farmers in Ehlanzeni district, South Africa.

1.4.2 Sub-objectives

1. To assess the distribution of FAW infestation in Ehlanzeni district, Mpumalanga province, South Africa
2. To determine socio-economic impact of FAW on smallholder maize farmers in Ehlanzeni district, Mpumalanga province, South Africa
3. To determine coping measures by maize farmers towards FAW infestation in Ehlanzeni district, Mpumalanga province, South Africa.

1.5 The research questions

1. What is the current spread of FAW in Ehlanzeni district, Mpumalanga province, South Africa?
2. What is the socio-economic impact of FAW on maize smallholder farmers in Ehlanzeni district, Mpumalanga province, South Africa?
3. What coping measures farmers in Ehlanzeni district, Mpumalanga province, South Africa, have implemented against FAW?

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Maize is both the major grain feed and the staple crop for South Africans and it is considered the most important grain crop in South Africa (DAFF, 2018). However, the invasion of Fall Armyworm (FAW), *Frugiperda Spodoptera*, classified as a quarantine pest could be a threat for food security. FAW is a devastating and destructive pest causing a major concern for food security, a serious invasive pest affecting crop production in most parts of sub-Sahara Africa (SSA) (FAO, 2018). The pest has been reported to cause yield losses of up to 53% of annual production of maize in an average of a three-year period (FAO, 2018). The outbreak of FAW has also been reported in South Africa where Mpumalanga is one of the most affected provinces (DAFF, 2018). Maize is the most preferred host plant species of FAW which is a staple and commercial food crop in Mpumalanga province of South Africa.

The negative consequences of FAW infestation have been reported in other parts of the continent (FAO, 2018), but little research has been conducted to understand the distribution and socio-economic impact of FAW in Mpumalanga province, particularly Ehlanzeni district. The study focuses in Ehlanzeni district because it is the subtropical region and is expected to have a wide distribution of FAW. FAW is a notoriously difficult pest to control and control is effective only if done while the larvae are small (Farmers'Weekly, 2019). The larval stage is the most destructive stage of FAW (Farmers'Weekly, 2019). There is currently scanty literature on the distribution and socio-economic impact of FAW infestation on farmers in Ehlanzeni district, Mpumalanga. The study addresses this research gap. The study seeks to determine the distribution, socio-economic impact and coping measures that have been employed by the smallholder farmers to mitigate risk of FAW.

Mpumalanga is a South African province situated in the borders of Swaziland and Mozambique. The area is considered a subtropical region. As expected of a subtropical climate the region produces a diverse crop variety ranging from field crops to vegetables and fruits. FAW has been found in maize at a wide range on smallholder farmers in Ehlanzeni district. Due to this outbreak the impact and the extent of damages on crop production was questioned.

2.2 The Implications of Fall Armyworm in maize

Fall Armyworm has the potential to cause maize yield losses of 21 to 53% annual production of maize in a three-year production in Africa, in the absence of control measures taken (UKAID, 2017). FAW has an impact on a number of aspects on household livelihoods on; natural capital through yield losses and the ability of agricultural land to respond to shocks; financial capital through increased production costs and decreased income; the assets of the household. International trade is also affected where the border to Swaziland or Mozambique is just a few kilometres away. There is a high risk of introducing the pest to other countries (UKAID, 2017). It has also been reported to be threatening Asia's maize producers—mostly small-scale farmers who depend on crops for food and to make a living. This is a threat that cannot be ignored (Kadiresan, 2019).

Fall Armyworm reproduces and causes significant crop damage, reducing yields needed to meet food, fuel and fibre demand (Monsanto, 2018). The Centre for Agriculture and Bioscience International (CABI) identifies major impacts that may emerge in Africa due to FAW: yield loss of 8.6 -20.3 metric tonnes if pest is uncontrolled, damage to the seed potentially impacting the availability of the seed to farmers and economic viability to private seed sector; Substantial environmental and human health issues arising from the use of hazardous chemicals putting the risk on the consumption on production environment; Increased danger to natural enemies and predators further impediment of FAW control; and High risk of exposure to chemicals for women and children as they are more involved in agriculture (Prasanna, et al., 2018).

FAW poses a threat to food security for Africa. The pest damages vegetative and reproductive parts of the crop hindering further growth (USAID, 2017). It has been reported that FAW creates opportunity for crop losses and devastation to farmers (Hardke, et al., 2015). It is widely agreed that FAW is the most damaging crop pest, feeding on over 80 host plant species including maize, sugarcane as well as other crops (UKAID, 2017). In a recent study conducted in Argentina, Fall Armyworm has been found to feed on 356 host plant species in 76 families rather (Montezano, et al., 2018).

Fall Armyworm is now a major global problem (CIMMYT, 2019). Populations of FAW may continue to increase because adult moth is a strong flyer and will find more host plants to host on (Rice, 2017). Although maize affected by FAW is considered safe to eat, it is susceptible to

aflatoxin presence (Rice, 2017). Low levels of infestation at certain growth stages may not cause much yield losses (Rice, 2017). Most farmers state that FAW results in yield reduction, loss of farmer income, capital loss which is an economic loss, labour required, increased production costs due to costs for control (Isak, et al., 2019).

It is a double trial for farmers. For one, there is a surge in expenditure and concurrently, there is a distinct fall in the crop yield. One farmer has suffered a 10% loss in profit in the last year—translating into a production loss of 0.5 to 0.75 tonne per ha. Owing to this damage caused by the worm and the concurrent dearth, maize that earlier sold at Rs 12,000 per tonne is now being sold almost at Rs 19,000 per tonne. The yield has dipped drastically owing to drought and infestation. This is expected to continue, or get worse in 2019. As a result, India will have to increase the import of maize. The shift to imports in the world's seventh largest maize producer, which typically exports to Asia, highlights the breadth of the crop losses due to FAW (Sangomla & Kukreti, 2019).

Farmers may be forced to put up productive capital (for example, cattle, sheep and goats) for sale — that is, distress sales of assets — so as to cope with income shocks arising from crop failure (as in the case of losses caused by fall armyworm infestation). Such a scenario directly impacts on smallholder farmers, thereby limiting their purchasing power on health, education and other non-food consumption expenditure (Amusan & Olawuyi, 2018). At the global level, such impacts have direct consequences on the economic and social status of the population generally, which by extension can trigger an increase in the traded agricultural commodities' prices (Amusan & Olawuyi, 2018).

2.3 Fall Armyworm on Food security in Sub-Saharan Africa

A 2018 report from the Democratic Republic of Congo indicates that 45% losses are due to Fall Armyworm and have resulted in 0.9 million tonnes of maize in the 2017/18 production season (IPPC, 2018). The Food and Agriculture Organization indicated that FAW ravages the crops all year long provided that the climate is tropical and subtropical which means that there will always be crops that the pest will feed on (Xinhua, 2018). Maize is the world's first rank cereal and Fall Armyworm possesses a major food security threat.

Kenya lost up to 20% of its projected maize yields, equivalent to 7.5 to 8 million bags of grains. This was enough to feed the citizens for two long months. In Ethiopia, more than 0.6 million

ha of maize was damaged last year. Uganda was infested too. By mid-2017, the worm was present in all its 127 districts, causing 15 to 75% crop loss (Sangomla & Kukreti, 2019). An estimated 450,000 million tonnes of maize worth $192 million was hit (Sangomla & Kukreti, 2019). Tackling FAW infestation is vital for food security in Africa. In Sub-Saharan Africa, a region already ravaged by drought and food shortage, the larvae attack can leave 300 million people hungry, warns Bukar Tijani, FAO assistant director-general and regional representative for Africa (Kadiresan, 2019).

The chart below illustrates the consumption of maize in South Africa. Maize is used as food and feed in the country (DAFF, 2018).

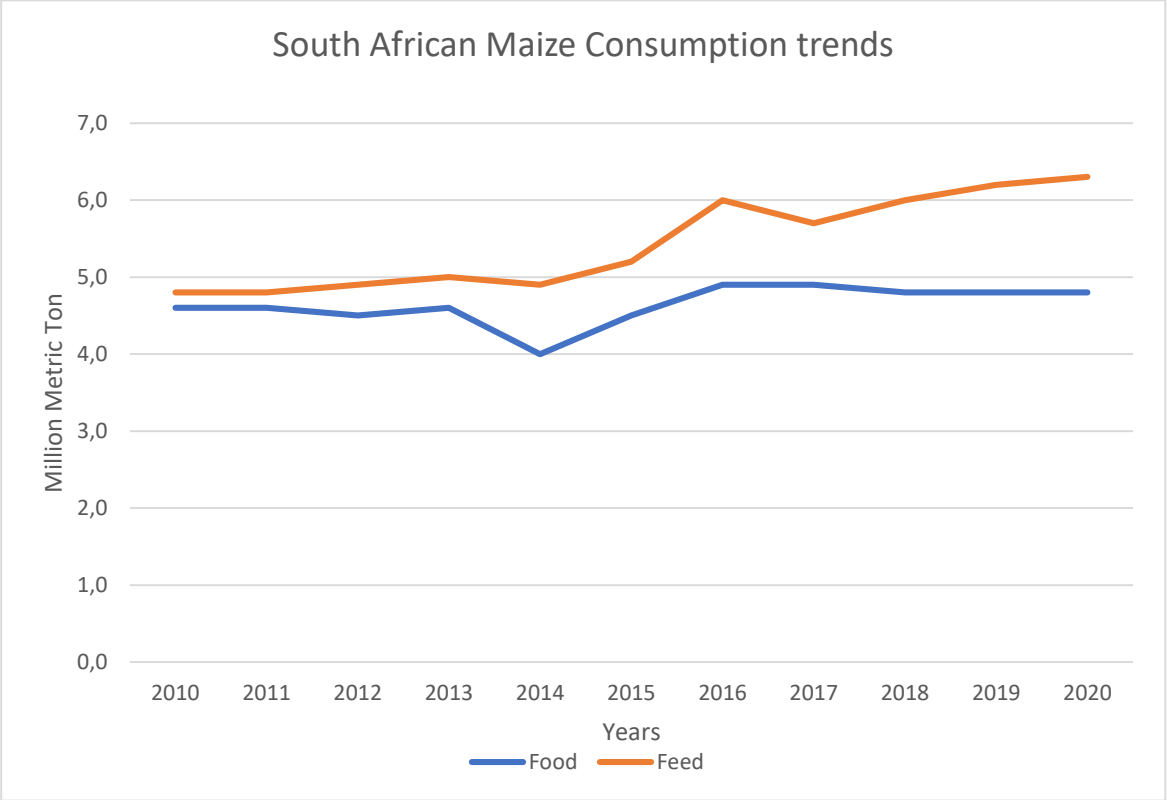

Figure 1: South African Maize Consumption Trends

A critical examination of the economic dimension revealed the pronounced vulnerability of smallholder farmers. This is explained by the fact that smallholder farmers are limited in terms of resources and coping mechanisms with climate risks and shocks such as fall armyworm

infestation (Amusan & Olawuyi, 2018). The effect of these shocks can translate into reduction in income, depleted savings, market access, difficulties and trade interruption as well as negative impact on food supply. In summary, the cumulative effect can lead to the total erosion of livelihoods, and an increase in hunger and malnutrition across the African continent and globally (Amusan & Olawuyi, 2018).

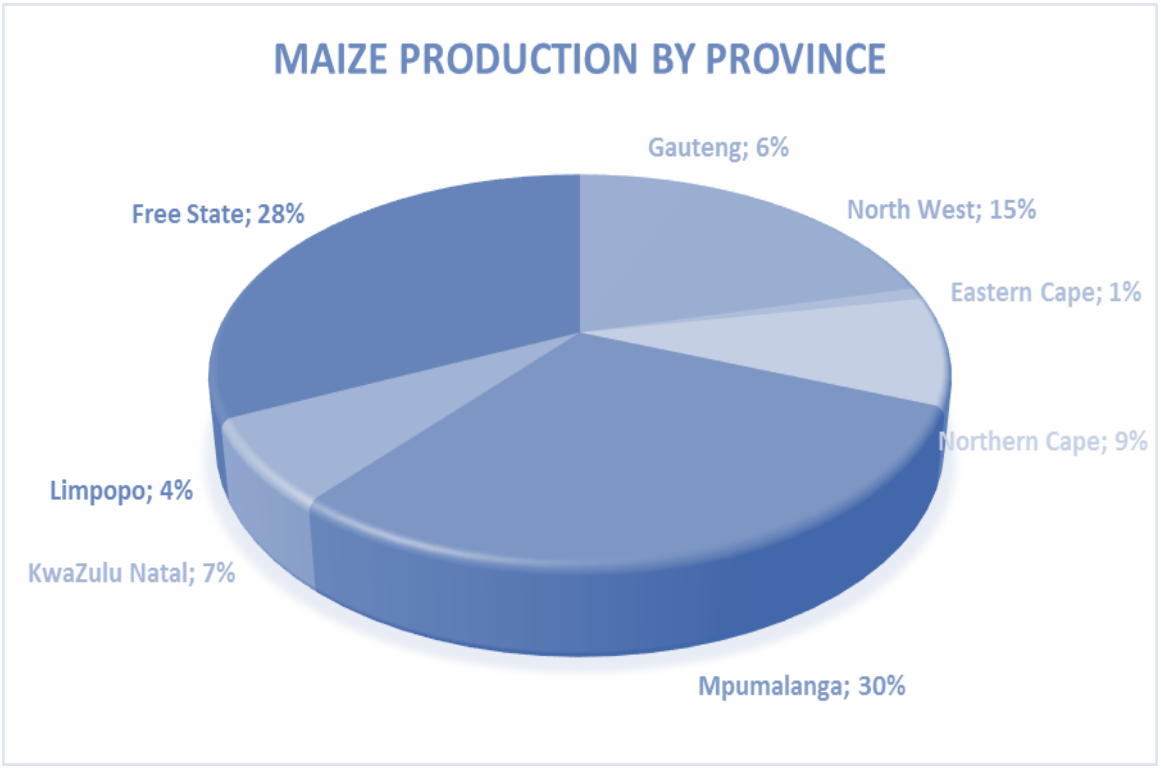

Figure 2: Maize Production by Province

Mpumalanga produced 30% of maize in the country and is the highest producing province (DAFF, 2018) as per the chart above. This illustrates the importance of maize in the province.

2.4 Farmers' Response to Fall Armyworm

Many farmers did not know what to do, only 40% carried out interventions to limit infestation due to lack of knowledge on both farmers as well as extension workers (FAO, 2018). FAW has upset the precarious economy of small and marginal farmers, a thousand of farmers demanded replacement crop from the government of Armoor and Nizambad division (Sangomla & Kukreti, 2019). One farmer from Nyagatare district of Rwanda applied pesticides on 12 ha of

maize which cost him over $1,100. In December 2017, government authorities at Embu, located 120 km northeast of Nairobi, hired men to manually kill the caterpillars. FAO also partnered with the government in a pilot project to try out new control methods. None of the measures, however, proved effective (Sangomla & Kukreti, 2019).

Most of the farmers have learnt how to deal with it by collecting and destroying caterpillars and young moths as well as by spraying pesticide on the infected maize (Hitayezu, 2019). In the communal sub-sector, pesticide application to combat FAW was very limited, as pesticides are generally not widely used by smallholder farmers in Namibia and their ability to access it is also very limited. Those who used pesticides did largely not wear the full range of protective gear, and overall knowledge on pesticide use was low (FAO, 2018).

In the article published by Food and Agriculture Organization of the United Nations, 2018 it is stated that; the most common intervention carried out by farmers on all crop types was handpicking the pests off their crops (FAO, 2018). Other common interventions included early planting, the application of ash, Neem and pesticides as well as replanting. The perceived degree of success of these interventions varied. About one quarter of households would have liked to carry out additional interventions, most notably applying pesticides and planting early. The main reasons for not doing so were the costs related to these interventions as well as the time required in the case of early planting.

Only 17 percent of affected households engaged in any type of coping mechanism in response to the FAW attack, which indicates that the impact of the attack on households' food and livelihood security up until August 2017, when the assessment was conducted, was limited. The most commonly adopted coping strategies included the sale of more unproductive animals than usual, the spending of savings and begging. As the assessment was conducted just after the harvest period, it is likely that these strategies are related to additional expenditures to replant, rather than issues of FAW-driven difficulties in accessing food (FAO, 2018).

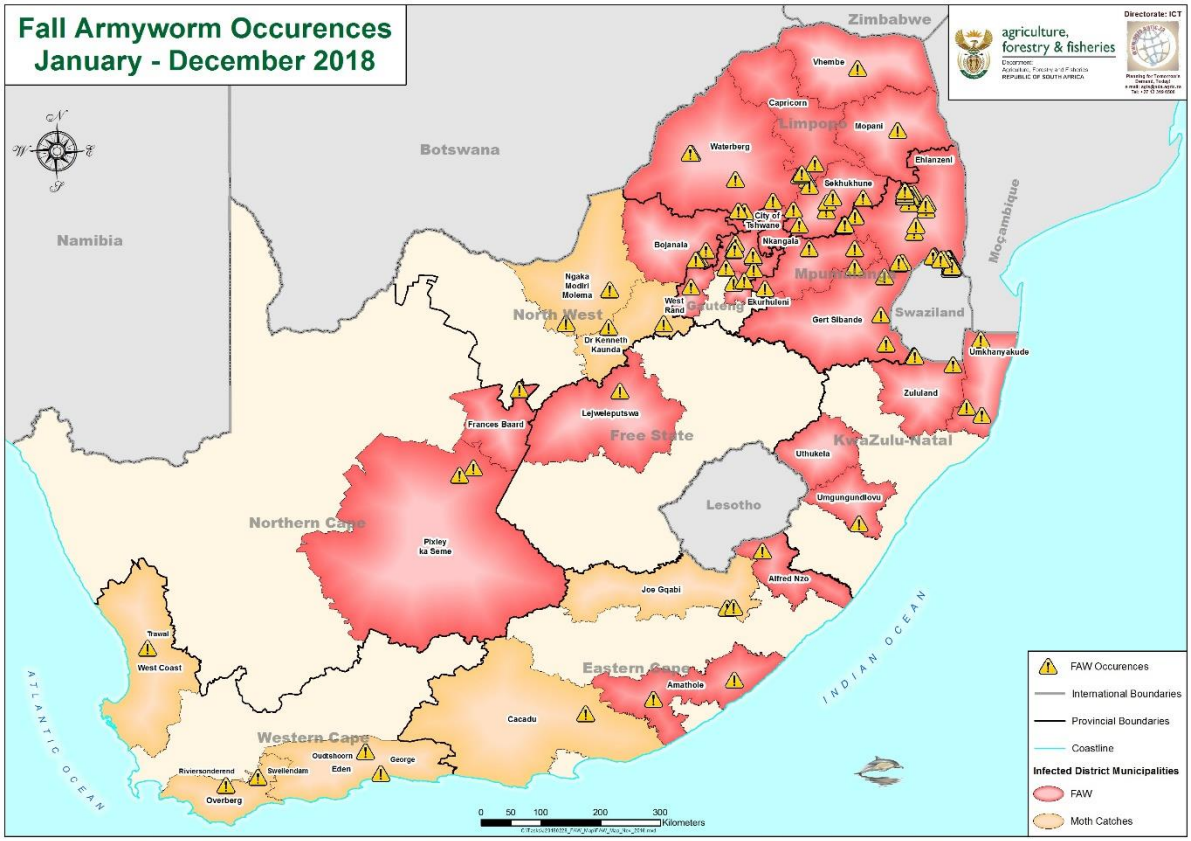

Figure 3: Fall Armyworm occurrences in South Africa, 2018

(Source: DAFF,2018)

2.5 Fall Armyworm distribution in South Africa for the 2017/18 production season

In the 2018/19 season there were more reports such as in the Western Cape while some areas did not detect such as the Highveld areas of Mpumalanga. The contributing factor could be climate change effects including the growth and infestation of insect pests in agricultural landscapes across Africa, threatening farmers' productive capacity. Insect pests' response to climate change and its implication for food security are causing growing concern (Amusan & Olawuyi, 2018). This background shows that coping measures to FAW have been well documented in other parts of Africa but less is documented about how smallholder farmers in Southern Africa particularly Mpumalanga province respond to FAW infestation. This study addresses this knowledge gap.

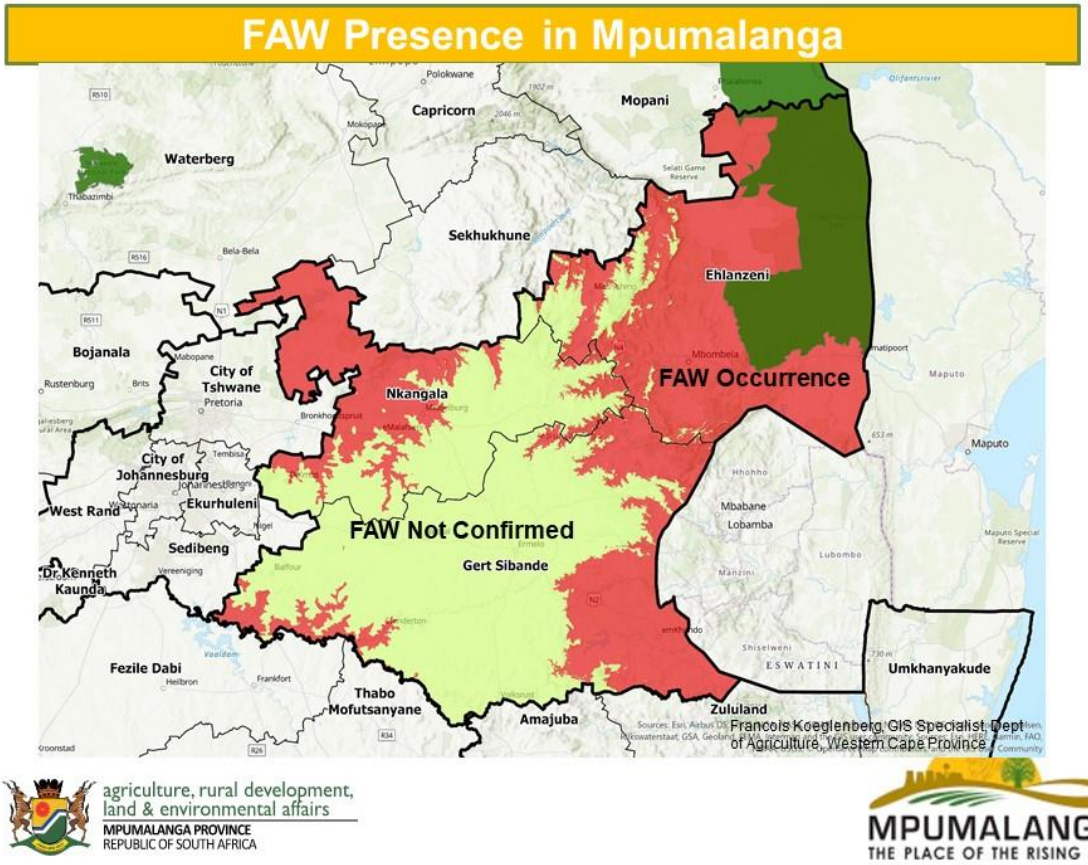

Figure 4: Current Spread of Fall Armyworm in Mpumalanga

The figure above represents a heat map for Fall Armyworm status in the province of Mpumalanga during the 2018/19 production season where Ehlanzeni district is located. As shown in the figure, FAW occurrences are visible in whole of the Lowveld where the study was undertaken. The part shaded green on the map is the Kruger National Park.

2.6 Fall Armyworm Management

It is likely that FAW will be a part of farming in the future and management strategies must be coordinated collectively by all parties affected (Prasanna, et al., 2018). There is a variety of methods that can be used for the management of FAW but it is important to adopt a strategy that is suitable for that particular area (FAO, 2018). Biological control, Chemical control and Use of genetically modified crops containing BT genes have been used by the Americans and proven to be effective.

One of the most effective approach is Integrated Pest Management. This approach is used to suppress pest populations for economic purposes without harming the environment and the humans. IRAC, 2018 explains that Bt technologies in maize are the most effective control method but will not be sustainable in the future because they must be coupled with an insecticide program therefore a durable approach to control FAW should cater not only maize but other crops as well. In a research conducted in India the review concludes that synthetic chemicals should be the last resort but only applied at 50% damage, FAW management should involve keeping the plant healthy by increasing resistibility power of plant itself in such case manage soil nutrient along with soil health by increasing humus content and use of wild type or local variety is best way to avoid FAW attack. (Chhetri & Acharya, 2019).

Small-scale farmers can do handpicking of the pest regularly, destroy severely affected plants and spray water and sugar solution; it will not completely eradicate the pest but will limit infestation (Anon., 2017). In most cases the choice of using chemical control (pesticide) depends on the cost of the treatment, size of the area and action threshold for household level. Purde University states that; the application of insecticides is not economical for the control of FAW, it should be applied when the infestation is severe and the crops are under stress. Those are cases where 75% of crops exhibit whirl feeding damage, the larvae are less than 35mm long and the crops are under a lot of stress. Furthermore, spot treatments may be justified when high levels of damage in isolated areas have been found. It should be noted that FAW Fras becomes heavy that it creates a plug that inhibits penetration of an insecticide in the whorl where the larvae may be feeding.

The bad side of chemical control is that the crops may develop resistance against FAW and be ineffective (UKAID, 2017). In a small area as Mpumalanga with smallholder farmers, an attempt to chemical control has been frustrating. Farmers felt that it is costly and labour intensive. Lack of knowledge plays a role as well in buying proper pesticides. Farmers found themselves buying the pesticides that are only affordable without considering the pest itself. Also, smallholder farmers may be unable to access genetically modified maize because it is too expensive. UKAID, 2017 strongly recommends Integrated Pest Management, which minimises the use of pesticides. An Integrated Pest Management tip points an inspection for small white egg-shaped structures on the larvae should be conducted before treatment, these are eggs of a fly and indicates that the larvae will stop feeding and soon die (Purde University, 2009).

Sustainable management of FAW starts with prevention and the key steps to reduce infestation of FAW include; Use of high quality seed, Avoiding late planting and Increase plant diversity in the plot (FAO, 2018). There are many biological control organisms and some might be introduced by the Americans (Rice, 2018). However, the pest has been described as highly destructive and fast spreading, for this reason it cannot be eliminated once it has infested the country (IPPC, 2018).

CHAPTER 3: METHODOLOGY

3.1 Research design and instrument

A cross-sectional survey research design was used. This type of design measures the outcome and exposure in the study participants (Cherry, 2019).

3.2 Unit of analysis and sampling procedure

The study used cluster random sampling technique. This method allows the researcher to select from an unknown total population, when the sample cluster is geographically convenient and natural in a particular population (The Study.com Team, 2013). The farmers belonging to different municipalities (clusters) were selected randomly to participate in the study. 60 smallholder maize farmers were then identified as the sample representing Ehlanzeni district. 10 Key Informant Interviews (KIIs) from Ehlanzeni district were used to provide expert information on FAW. The KIIs were purposively selected from district's department of agriculture. This group of people could demonstrate knowledge using their professional experiences.

3.3 Data collection techniques

Data was collected by means of questionnaires as a primary technique. Questionnaires were administered to participants to determine perceived socio-economic impact of FAW on smallholder maize farmers in Ehlanzeni District. Key informant interviews were also conducted with extension agents and subject matter specialists to triangulate the findings of the study. Observations were made on maize fields. The purpose of the observation was to determine distribution of FAW in farmer's fields as well as the social status of the community.

3.4 Data analysis and interpretation

Quantitative data were analysed using SPSS version 25. Frequency tables and descriptive statistics were used to summarise findings of the study. Qualitative data collected was analysed by Content Analysis method. This analysis method is ideal for a study that has limited literature or research and new insights can emerge (Sharif, 2011).

3.5 Ethical considerations

Ethical clearance to conduct this study was sought from the University of Free State Graduate School and approved by the General Human Ethics Committee. Permission to conduct the study was requested from the local office of the department of agriculture in Ehlanzeni district. Consent to conduct the study was obtained from the participants and participation in the study was voluntary. Participants were at liberty to withdraw from the study at any point of time. The researcher ensured that confidentiality of the respondents was maintained for example through anonymity of the respondents and that the responses from the study would only be used for the purpose of the research study.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Demographic information

The findings indicated that the smallholder maize farmers in Ehlanzeni district were almost balanced in numbers as males were 50,8% while females were 49,2%. Youth involvement (between 21-35) in agriculture or farming sector is very low and the study shows a number less than 5%. The elderly in each household is mainly involved in farming activities fulltime. The youth's perception of agriculture is that it is a tough and outdated sector and does not have opportunities (Michelle, 2018). The majority of the participants of the study were above 61 and represented 47,5% of the total participants while the youth (25-30 and 31-35) represented only 1,7% and 3,4% respectively. Older people have the responsibility to feed their households and cut down monthly food expenses as 96.6% indicated that they have dependants with only 3.4% without dependants. The findings also revealed that 97,3% of the farmers were African/Black and only 1,7% were Caucasian/White however, the researcher discovered that this racial group was farming at a large scale strictly for commercial purposes and agribusiness. It was expected of the African domination in this community because it is a rural area influenced by racial segregation which transpired during the colonial times in the country. The level of education for farmers that participated in the study was between Grade R and Tertiary level with 43,3% followed by those that never went to school at 33,3%. These findings reveal a clear picture of how smallholder farmers are vulnerable to fluctuating systems of farming as they lack advanced knowledge. Continuous education is important for farmers to make them aware of the recent developments or shocks or agricultural related changes happening across the globe (New Worlds Project, 2018). Only 3,3% of farmers have a tertiary qualification and is a huge disadvantage in farming. The majority of farmers had more than 20 years farming experience (57,6%). Only 8,5% of the farmers have less than 5 years farming. This can be explained by the fact that most of the farmers left school at a very early age and opted to make a living through farming. The charts below indicate the age and education level of the farmers for Ehlanzeni District.

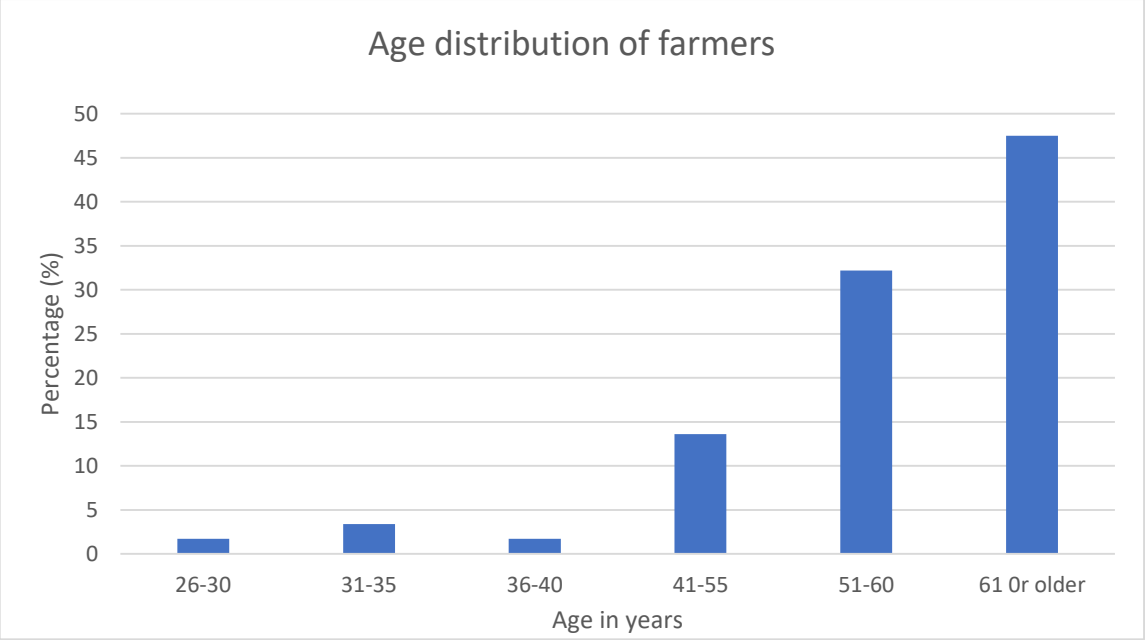

Figure 5: Age distribution

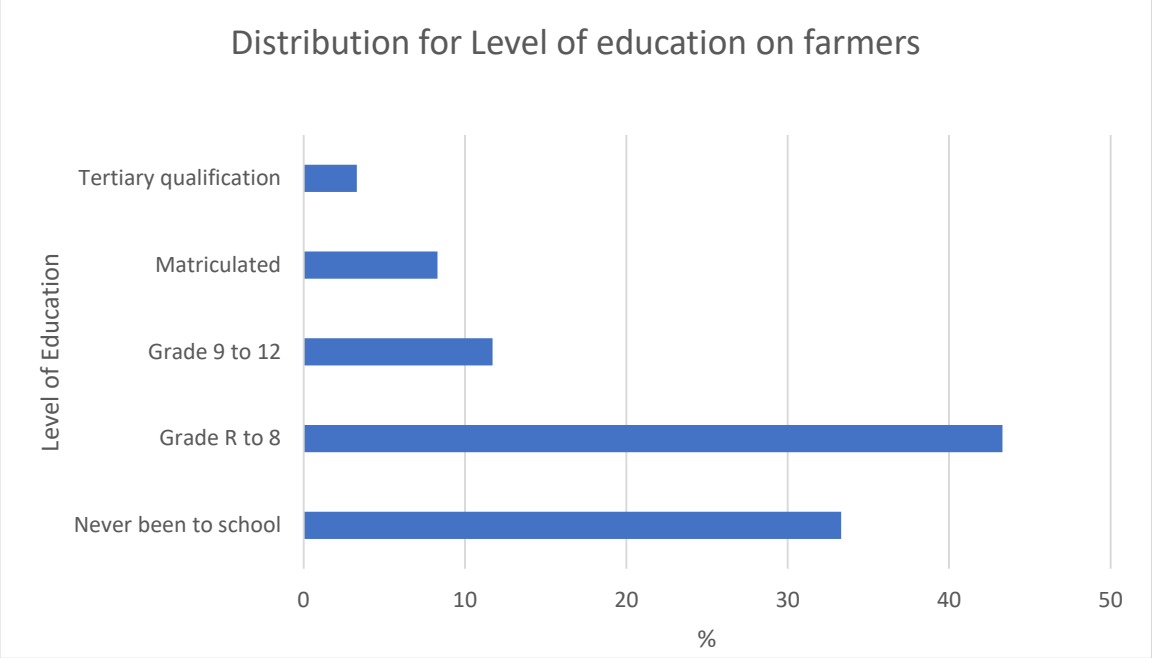

Figure 6: Level of education

Table 1: Summary of demographic information

		Frequency	Percentage
Gender	Male	30	50,8
	Female	29	49,2
Age	26-30	1	1,7
	31-35	2	3,4
	36-40	1	1,7
	41-50	8	13,6
	51-60	19	32,2
	61 or older	28	47,5
Race	Caucasian/White	1	1,7
	African/Black	59	98,3
Highest Level of Education	Never been to school	20	33,3
	Grade R to Grade 8	26	43,3
	Grade 9 to Grade 12	7	11,7
	Matriculated	5	8,3
	Tertiary Qualification	2	3,3
Number of farming years	Less than 5 years	5	8,5
	More than 5 years, but less than 10 years	7	11,9
	More than 10 years, but less than 20 years	13	22,0
	More than 20 years	34	57,6
Dependants	Yes	57	96,6
	No	2	3,4
Number of dependants	2	3	5,3
	3	1	1,8
	4	8	14,0
	5	8	14,0
	6	9	15,8
	7	3	5,3
	8	7	12,3
	9	3	5,3
	10	6	10,5
	11	1	1,8
	12	3	5,3
	15	1	1,8
	16	2	3,5
	18	1	1,8

4.2.1 The Distribution of Fall Armyworm

Fall Armyworm has spread across the community of Ehlanzeni District. During farm visits in 3 villages (Plaston, Mzinti and Middelplaas) before the interviews were conducted, 29 farmers expressed concerns on the devastative pest that was destroying maize. The farmers in this area explained that Fall Armyworm infestation was increasing at an alarming rate. The FAW had spread across Mzinti village and a sample of 20 farmers was used for scouting where 45 ha was found with FAW. A further 7 farmers was sampled at Middelplaas village and 22 ha were found with FAW infestation. The 2 farmers sampled at Plaston village had 8 ha infested with FAW. A total of 75 ha was infested with FAW during scouting by the researcher and the farmers. Although some parts of Ehlanzeni district had been receiving technical advice from the department of agriculture on the management of Fall Armyworm farmers still do not know how to control or avoid Fall Armyworm. Some participants explained that Fall Armyworm has been increasing despite the handpicking and had been in the maize crops from vegetative stage to maturity.

4.2.2 Number of hectors (ha) infested by FAW

The majority of the farmers had 1-4 ha of maize as represented on the table, 17 farmers had 1-2 ha and 18 farmers had 3-4 ha of maize infested with FAW. The results reveal the highest infestation at 30% for farmers with 3-4 ha of maize. The results revealed a total of 204,5ha of maize were infested by FAW.

Table 2: Number of ha infested by FAW

	Frequency	Percent
Less than 1 ha	9	15,0
1-2 ha	17	28,3
3-4 ha	18	30,0
4-5 ha	9	15,0
6-7 ha	7	11,7
Total	60	100,0

Based on Table 2 above, the distribution of FAW was then calculated using the frequency and the number of ha that the farmers indicated. For example, the formula for calculations on Table 3 was derived as follows;

Distribution of FAW= Valid ha infested by FAW x Frequency

=0,5 x 9

= 4,5 ha

Distribution of FAW= Valid ha infested by FAW x Frequency

= 2 x 17

= 34 ha

The number of ha was then added and summed to a total of 204,5 ha.

Table 3: Distribution of FAW in ha

Ha infested with FAW	Valid ha infested with FAW	Frequency	Distribution of FAW in ha
Less than 1	0,5	9	4,5
1-2	2	17	34
3-4	4	18	72
4-5	5	9	45
6-7	7	7	49
Total distribution of FAW in ha			204,5

4.3 Socioeconomic Impact of Fall armyworm on Smallholder Farmers: Maize production

Smallholder farmers in South Africa have limited access to credit, insurance and market to sell their produce (Loeper, et al., 2016). This limitation has a socio-economic impact on these farmers when disasters or outbreaks occur. The findings on socio-economic impacts are discussed in detail below, characterised as production costs; schools; job opportunities and income.

4.3.1 Production costs

Based on the results, the majority of farmers at 56,7% thought FAW had decreased production costs. The participants explained that the damage was excessive, there was nothing left on the field, and when FAW infested the maize fields the farmers were sceptical to continue with production with a foreign pest invasion. This led to an increase in production costs due to the fact that the pest was unexpected and new methods and practices needed to be explored and implemented. This has reduced growth margins of smallholder farmers in Ehlanzeni district.

4.3.2 Job opportunities

The majority of farmers (42.1%) revealed that Fall Armyworm invasion has increased job opportunities. Extra labour was necessary for removal of damaged crops, re-planting, weeding, pesticide application and scouting, 10.5% farmers strongly agree but 5,3% farmers were neutral. Farmers (35.3%) who disagreed and who strongly disagreed (7.0%) thought Fall Armyworm invasion decreased job opportunities explained that some of the labourers had to be retrenched because the assumption was that profits would be lost.

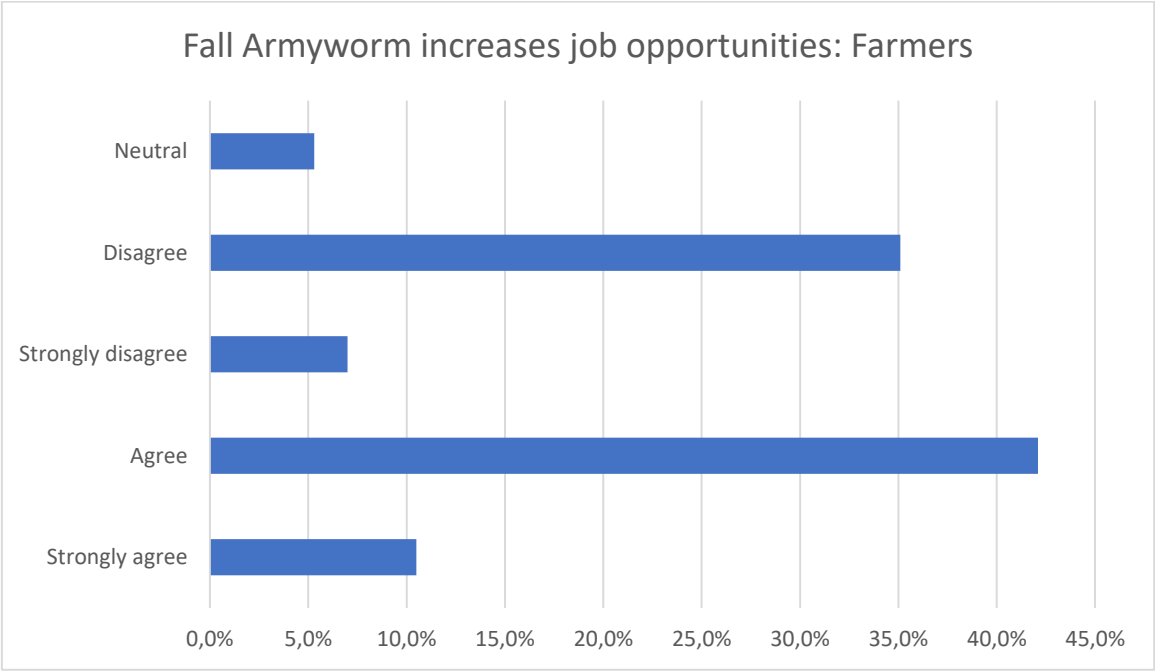

Figure 7: Impact on Job Opportunities

4.3.3 Schools

Farmers interview disagree that the Infestation of FAW led to school drops in the community. However, those that agreed; 25.4% and strongly agreed 11,9% explained that money for school fees was used due to increased costs of production inputs as a result some children could not finish school and were forced to drop out. 52.5% of the farmers disagreed and 3.4% strongly disagreed that FAW had an impact on school drops while 6.8% farmers were neutral on the matter.

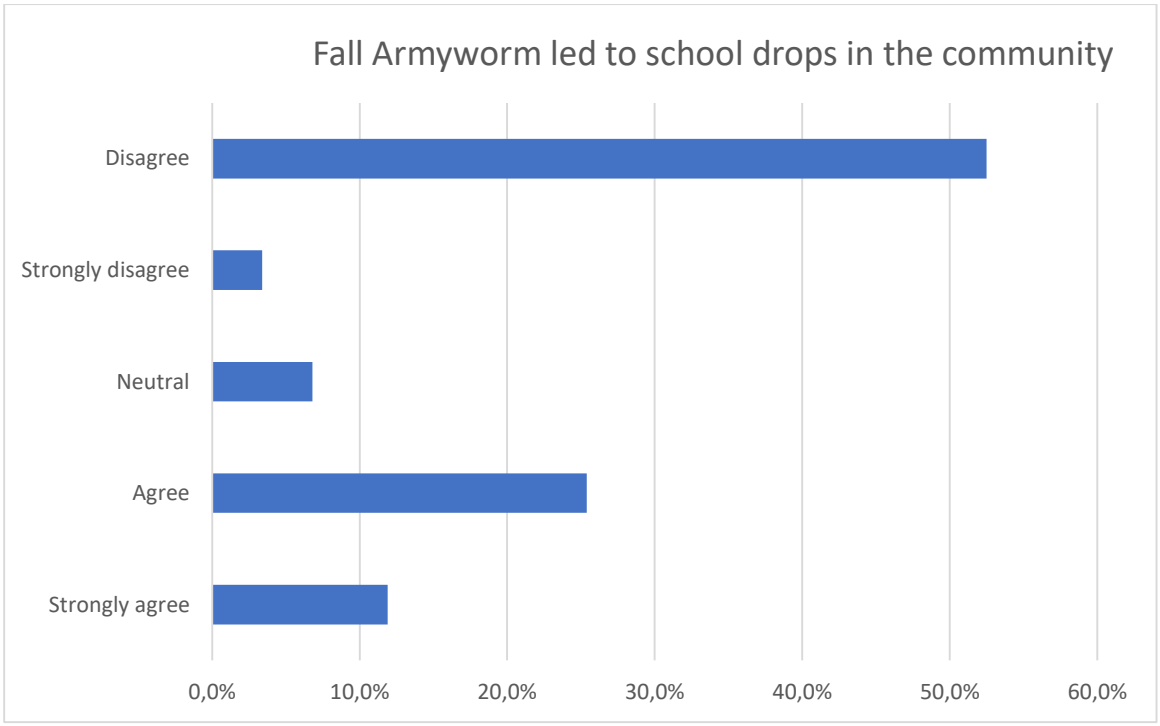

Figure 8: Impact on School drops

4.3.4 Income generation

The findings reveal that 76,3% and 90% of farmers and agriculturists did not make income from maize production or did not have a surplus of maize which they usually sell to generate income hence only 6,8% of farmers thought income generation increased while other participants did not know and thought income stayed the same. Farmers thought that income decreased because the costs of pesticides were too high, the demand for maize decreased, the yield target was not met and there was a lack of control measures for FAW.

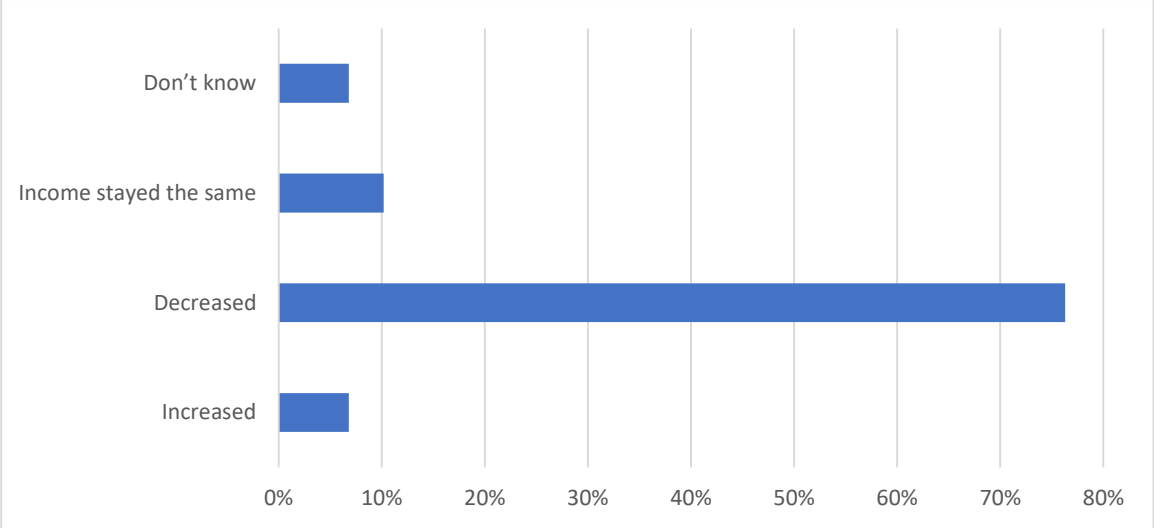

Figure 9: Impact on Income generation

4.3.5 Yield

Farmers indicated that they do not think yield target would be achieved on the following planting season. This illustrates the impact on yield was huge such that farmers expect yield loss even in future (2019/2020 planting season), more vulnerability to food security and income. The findings revealed that 53.3% of farmers do not think they would achieve yield target again, while 46.7% thought they would.

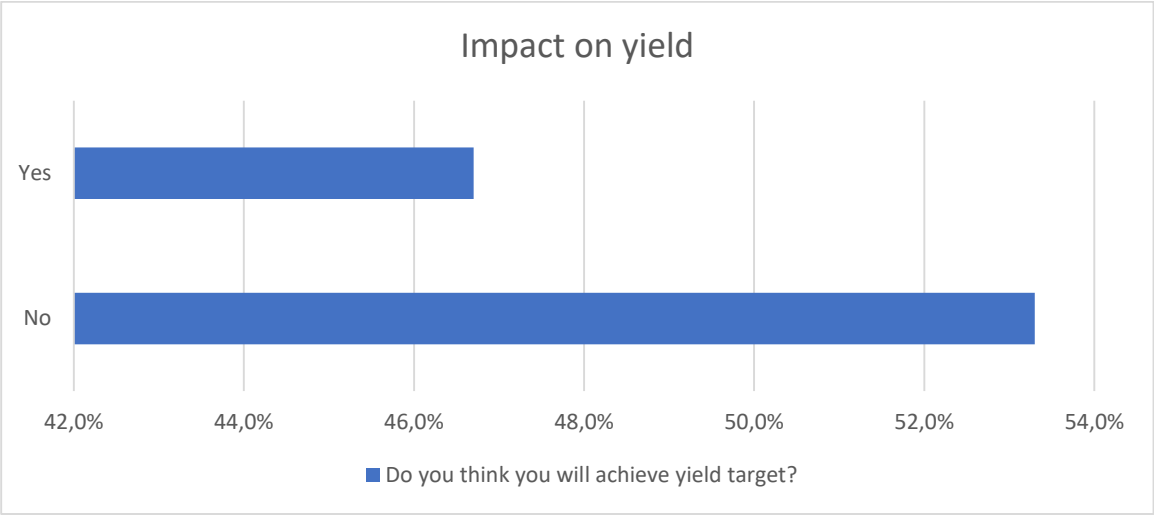

Figure 10: Impact on Yield

4.3.6 Quality of maize

It can be easily assumed that FAW has an impact on the quality of maize as farmers mentioned that it feeds on the leaves, stem and cob. This damage could result in a poor quality of maize harvested as nutrients would not be transported efficiently. The majority of farmers, 48.3% said that maize quality was extremely poor and 21.7% said their maize quality was poor because of FAW, 1.7% others did not know while in contrary to that 5% of the farmers explained that their maize quality was excellent even after FAW infestation. The chart below demonstrates findings.

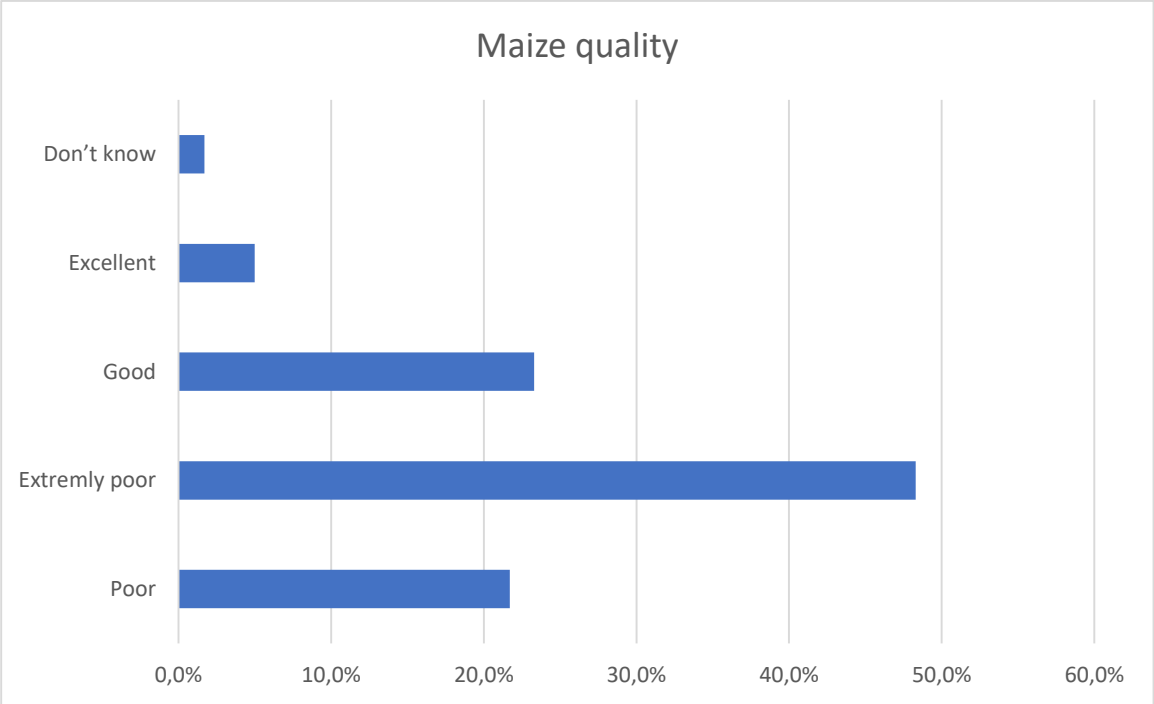

Figure 11: Impact on Quality of Maize

4.4 The coping strategies of Fall Armyworm management

The study reveals that farmers rely on the intervention from the government (department of agriculture) and had not done any experiments on controlling and managing Fall Armyworm. A few farmers were provided with BT Maize varieties which were insect resistant, enough for 1 ha, unfortunately some of the farmers did not receive these varieties and were forced to make means themselves. Only 26.7% farmers received insect resistant maize as an intervention from the department of agriculture.

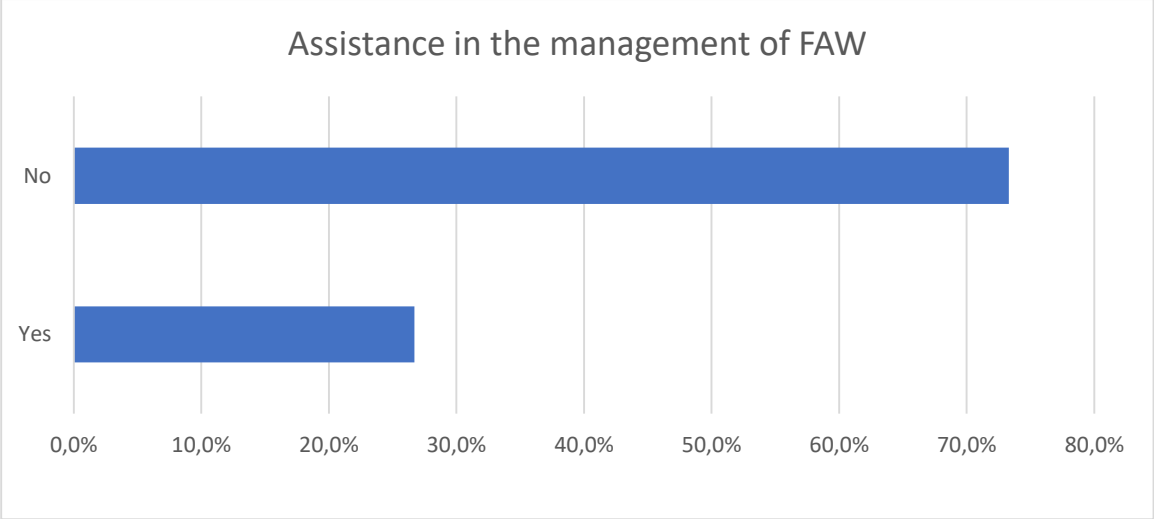

Figure 12: Assistance in the management of FAW

Most participants (53%) mentioned that they were not coping because not all the pesticides they thought would work did not work.

During the observations the researcher noticed that planting at different intervals made a difference. The crops, especially on green mealies farmers which were not planted at the same time had less damage and the crop quality was better than on a typical 1-2 ha of maize planted at the same date.

Other farmers (3.2%) applied irrigation excessively to make the crops wet, in that way Fall Armyworm was unable to crawl and feed on the crop, it eventually disappeared. An equal number of farmers were handpicking Fall Armyworm but discovered that it did not make a difference and mentioned that it is difficult to see Fall Armyworm on the crops except when the crop is opened and examined carefully.

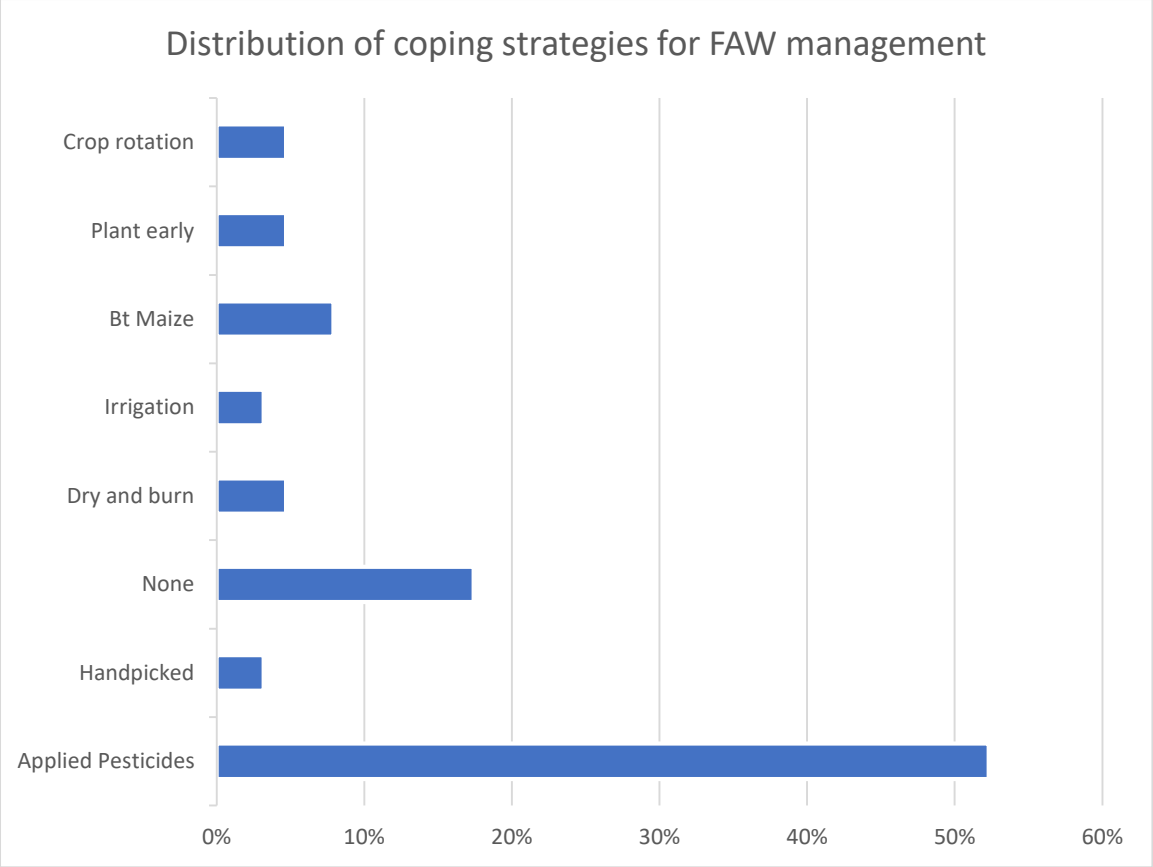

Figure 13: Coping Strategies for FAW management

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

Food security is one of the main concerns in the South African region and is amongst the sustainable development goals aimed at improving livelihoods and ending poverty of the poor. The study sought the socio-economic impact of FAW on maize production, the main crop for food security in the community of Ehlanzeni, South Africa targeting smallholder farmers after the department of agriculture, Mpumalanga confirmed the invasion of FAW on maize in 2017. It became clear that the pest caused destruction in the crops as each and every household experienced it. The perceived network of reasons for FAW invasion are drought, late planting and lack of pesticides. The inability of smallholder farmers to adopt climate smart agriculture systems influenced this mentality. Smallholder farmers are poorly resourced which caused devastation when the outbreak was confirmed. These farmers naturally depend on farming to make a living, by consuming and selling their produce hence a negative socio- impact on smallholder farmers.

5.2 Conclusion

This was study was conducted to determine the distribution of FAW, its socio-economic impacts and coping measures applied to mitigate negative consequences of pest invasion. Finding show that the FAW is widely distributed. The smallholder maize farmers of Ehlanzeni district are vulnerable in terms of socio-economics as demonstrated in the demographics section, modern day farming knowledge mostly because they are uneducated, old, unaware of the trends and challenges of agriculture as well as the need to take action in combating climate change and impacts.

The socio-economic impacts of FAW on smallholder maize revealed by the study are; decreased production costs due to unknown control measures for FAW, increased job opportunities in the management of FAW, decreased income generation caused by shortage of yield, yield target not achieved and poor quality on the maize harvested.

Smallholder farmers also do not know how to manage the pest and have used chemical control as a common method to control the spread of FAW. Chemical control has however not worked, the farmers continue to experience FAW and it is still increasing at a wide range in Ehlanzeni district.

The smallholder maize farmers of Ehlanzeni district do not have coping strategies to manage FAW. These farmers suffered constant worry of being unable to; provide food in the households, buy pesticides, pay labour that was necessary to combat the damage caused by FAW, earn an income from their produce and were financially constrained at the time of the study.

5.3 Recommendations

- Crop diversification: The smallholder farmers need to stop the consistent cultivation of one crop (maize) and diversify. Crop diversification entails cultivation of a variety of crops to ensure food availability, reduces uncertainties of agriculture and provides a more manageable agricultural system (Mango, et al., 2018). Lastly through crop diversification, a smallholder farmer benefits in more food for consumption and marketing.

- Crop rotation. The constant infestation of pests increases the need for pesticide application which may have an effect on the environment and on finances of the farmers. Crop rotation interferes pest life cycles and their habitat. The reduction of pests would improve efficient production and relieve farmers from the constant worry of foreign pest invasions (Rinkesh, 2009).

- Adoption of Climate Smart Agricultural techniques. Changes in climate result in the distribution of insect pests. FAW spreads rapidly on favourable environments leading to implications on food availability. One of the outcomes of CSA is enhanced resilience which promotes resistance to pests, diseases, droughts and other shocks (World Bank Group, 2019). Smallholder farmers should adopt this mechanism.

- Adoption of Integrated Pest Management to both farmers and agriculturists. This encourages the use of agrochemicals and supplements at a manner that does not interfere with the environment or health of the farmer. When these inputs are applied at an optimum quantity the biological processes cannot be interrupted (DAFF, 2017).

5.4 Limitations

Incomplete questionnaires caused by the inability to fully understand the language, to read and write. Lack of literature on Fall Armyworm more especially in the Sub-Saharan Africa.

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Annexure 1: Consent Form

Consent Form
Assessing Socio-economic Impact of Fall Armyworm on Smallholder Maize Farmers in Ehlanzeni District, South Africa

Introduction
You, _____, have been asked to be in this research study, which has been explained to you by Ayabulela Mkosana. This study is being conducted by Ayabulela Mkosana, Master of Sustainable Agriculture in the Centre for Natural and Agricultural Sciences at University of the Free State with funding provided by Maize Trust.

This research is being conducted to fulfill the degree requirements for Master of Sustainable Agriculture at University of the Free State, under the supervision of Mr. David Ekepu.

Purposes of the Study
The purpose of this study is to learn more about Fall armyworm and the socio-economic impacts on smallholder farmers in maize production.

This study is about the invasion and the implications of Fall Armyworm in the Lowveld region and will take approximately twenty minutes for you to complete.

You will be asked to fill out a questionnaire regarding the experiences with maize production. This will take approximately twenty minutes. You do not have to answer all the questions. You will have the opportunity to see the questionnaire before signing this consent form.

Risks and Discomforts
There are no known or expected risks for participating in this study, except for the mild frustration associated with answering the questions. You may decide at any time to quit the study.

Benefits
You may not receive any direct benefit from this study. The knowledge gained from this study may eventually benefit others.

Financial Considerations
No payments will be made for participating in this study.

Confidentiality
Any information about you that is obtained as a result of your participation in this research will be kept as confidential as legally possible. Your research records and test

results, just like hospital records, may be subpoenaed by court order or may be inspected by federal regulatory authorities without your additional consent.

In addition, there are certain instances where the researcher is legally required to give information to appropriate authorities. These would include mandatory reporting of the Fall armyworm status, mandatory reporting of information about the control and management of Fall armyworm that is vital to you or to crops, such as biological control, chemical control, etc.

Audiotapes or videotapes will be kept locked and will be destroyed as soon as possible after the research is finished.

In any publications that result from this research, neither your name nor any information from which you might be identified will be published without your consent.

Voluntary Participation
Participating in this study is voluntary. You are free to withdraw your consent to participate in this study at any time.

Refusal to participate or withdrawal will not affect my academic performance and will involve no penalty to you.

You have been given the opportunity to ask questions about the research, and you have received answers concerning areas you did not understand.

I willingly consent to participate in this research.

_____ Signature of Subject
_____ Printed Name
Date _____ Time_____

_____ Signature of Investigator
_____ Printed Name
Date _____ Time_____

Contact Persons
For more information about this research, you may contact Ayabulela Mkosana at 0728796202. This research has been approved by the Institutional Review Board of the University of the Free State for research with human subjects.

Annexure 2: Questionnaire

FACULTY OF NATURAL AND AGRICULTURAL SCIENCES (UFS)

FAKULTEIT NATUUR- EN LANDBOUWETENSKAPPE (UV)

CENTER FOR SUSTAINABLE AGRICULTURE

SENTRUM VIR VOLHOUBARE LANDBOU

MSA/MLV

QUESTIONNAIRE

ASSESSING SOCIO-ECONOMIC IMPACT OF FALL ARMY WORM ON SMALLHOLDER MAIZEFARMERS IN EHLANZENI DISTRICT, SOUTH AFRICA

Researcher: Ayabulela Mkosana

Tel (work): 013 759 4126

Fax (work): N/A

Mobile: 0728796202

E-mail: ayamkosana@gmail.com

Questionnaire No:	**0**	**1**

ASSESSING SOCIO-ECONOMIC IMPACT OF FALL ARMY WORM ON SMALLHOLDER MAIZE FARMERS IN EHLANZENI DISTRICT, SOUTH AFRICA

SECTION A: DEMOGRAPHIC INFORMATION

Respondent name: _____

Contact number: _____

Date: _____

Name of farm/project: _____

Area/location of farm/project: _____

Instructions: Mark the appropriate block with an X or write your answer in the provided space where applicable.

1. Gender

(a) Male	1	
(b) Female	2	

2. Age

(a) 16-20	1	
(b) 21-25	2	
(c) 26-30	3	
(d) 31-35	4	
(e) 36-40	5	
(f) 41-50	6	
(g) 51-60	7	
(h) 61 or older	8	

3. Racial group

(a) Caucasian/White	1	
(b) African/Black	2	
(c) Indian	3	
(d) Mixed Ancestry/Colored	4	

4. What is your highest level of education?

(a) Never been to school	1	
(b) Grade R to grade 8	2	
(c) Grade 9 to grade 12	3	
(d) Matriculated	4	
(e) National certificate	5	
(f) Tertiary qualification	6	

5. How long have you been farming in this area?

(a) Less than 5 years	1
(b) More than 5 years, but less than 10 years	2
(c) More than 10 years, but less than 20 years	3
(d) More than 20 years	4

6. Do you have any dependents?

(a) Yes	1
(b) No	2

7. If yes to question 6, how many?

SECTION B: DISTRIBUTION OF FALL ARMYWORM IN EHLANZENI DISTRICT, SOUTH AFRICA

8. How many hectares (ha) of maize have been infested with Fall Armyworm?

(a) Less than 1 ha	1
(b) 1-2 ha	2
(c) 2-3 ha	3
(d) 3-4 ha	4
(e) 4-5 ha	5

9. Has the infestation of Fall Armyworm increased or decreased production costs?

Increased	Decreased	Don't know
1	2	3

10. Fall Armyworm infestation has increased job opportunities in the community.

Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

11. Fall army worm infestation has led to school drops in the community in.

Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

12. How has Fall Armyworm infestation affected income generation?

Increased income	Decreased income	Income stayed the same	Don't know
1	2	3	4

13. If your answer is 1 on question 12 why?

(a) The demand for maize increased	1
(b) Yield target was achieved	2
(c) Fall Armyworm was managed well	3
(d) The quality of maize improved	4

14. If your answer is 2 on question 12 why?

(a) The cost of pesticides is too high	1
(b) The demand of maize decreased	2
(c) Yield target was not met	3
(d) Lack of control measures for Fall Armyworm	4

15. Please list the signs and symptoms of FAW

16. Have you ever seen Fall Armyworm in your crops?

(a) Yes	1
(b) No	2

17. What do you think are the reasons for Fall Armyworm invasion?

(a) I planted late	1
(b) There is draught in my area	2
(c) There is no pest management program in the field.	3
(d) The pesticides were unavailable in our community	4
(e) The pesticides were too expensive for me	5

18. When did you first notice the invasion of Fall Armyworm?

19. Did you find any damage on your crops after noticing Fall Armyworm?

(a) Yes	1
(b) No	2

20. If yes to question 17, describe the extent of the damage.

21. At what stage does Fall Armyworm infest the crop?

22. How does it affect your crops?

(a) Feed on leaves	1
(b) Feed on stem	2
(c) Feed on the cob	3
(d) Decrease yield	4
(e) Stunt growth	5

23.Are there ways to prevent infestation of Fall Armyworm?

(c) Yes	1
(d) No	2
(e) Don't Know	3

24. If yes to 21, what are those ways and have you tried them?

_____

_____

25. Which alternative grain crops cannot be affected by Fall Armyworm?

(a) Sorghum	1
(b) Wheat	2
(c) Barley	3
(d) None	4
(e) Don't know	5

26. What do you think should be done to prevent Fall Armyworm?

_____

_____

_____

27. Do you think you will achieve target yield on your maize?

(a)Yes	1
(b) No	2

28. How is the quality of maize from the infected crops?

Poor	Extremely Poor	Good	Excellent	Don't know
1	2	3	4	5

29. Have you received any assistance in the management of Fall armyworm?

(a) Yes	1
(b) No	2

30. If yes to question 27 who is helping you in the management of Fall Armyworm?

31. If no to question 27 what would you like to be assisted with in the management of Fall armyworm?

SECTION D: COPING MEASURES AGAINST FALL ARMYWORM INFESTATION

32. What strategies have you put in place to reduce spread of FAW?

33. How have you managed to cope with the negative impacts of FAW?