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FACULTY OF AGRICULTURAL AND ENVIRONMENTAL SCIENCE

The Effects Of Fall Armyworm On Agricultural Productivity. Case Of Ward 20, Bindura District

BY Gracious Munashe Gede

B190729B

A dissertation submitted in partial fulfillment of the requirements for Bachelor of Science Honours Degree in Agricultural Economics and Management

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Registration Number: B190729B

Degree: Bachelors of Science Honours Degree in Agricultural Economics and Management

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I hereby declare that the research project titled "The effects of fall army worm on agricultural productivity, Case of Ward 20, Bindura District" submitted to Bindura University of Science Education, Department of Agricultural Economics, Education, and Extension is a record of original work done by me under the guidance and supervision of.....and that this work is submitted in partial fulfillment of the requirements for the award of a Bachelor of Agricultural Science. This thesis's findings have not been submitted to any university or institute for the award of a degree or certificate.

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Registration Number: B190729B

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DEDICATION

This study endeavor is dedicated to my parents, Mr. and Mrs. Gede, my little sisters Faith, Shalom, and Shaleen, and my darling daughter Adalia. Thank you for your financial,

spiritual, and moral assistance during my education. This study would not have been possible without your help. God bless you all abundantly.

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ABSTRACT

The research sought to explore the effects of fall army worm on agricultural productivity in Ward 20 of Bindura District. The research's particular objectives were to examine the damaging effects of fall army worm on agricultural yield and to analyze the possible alleviating farmer control methods towards the effect of fall army worm. Use of semistructured questionnaire and observations have been used to collect data from each interview. Descriptive statistics were used in order to assess the casual link of socioeconomic factors with fall army worm effects which posed as a big problem within the study group. Agricultural challenges faced by small maize growers and commercial farmers include; a lack of knowledge about fall army worm, yield quality and amount obtained, and income obtained during production. Farmers, adoption of methods to use in controlling fall army worms are significantly influenced by social economic factors such as gender, education level, extension access, and household head farm experience, while there was a negative correlation between adoption of the latest control methods and family size, age, or income.Extension services need thus to be improved with a view to a better knowledge of farmers about the use of cultural and modern methods for controlling fall army worms, support for the supply of extension services to control fall army worms in Bindura must be worked out between the government and private sector.

KEYWORDS

Fall army worm, yield quality, yield quantity, pest management.

LIST OF ABBREVIATIONS AND ACRONYMS

AGRITEX	Agricultural Technical and Extension Services
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistics
FAW	Fall Army worm
GDP	Gross Domestic Product
MA	Ministry of Agriculture
NGO	Non-Governmental Organization
SSA	Sub-Saharan Africa
SPSS	Statistical Package for Social Sciences
UNDP	United Nations Development Programme

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Agriculture is not just necessary to improve nutrition; it is also the most important source of income for a lot of people. To eradicate hunger, agricultural production must be increased, and the economy and society must improve. Increasing production in agriculture, as well as development of the economy and society are key to ending hunger (Hannah Ritchie et al, 2023). According to the Food and Agriculture Organization, agriculture is crucial to many economies because people continue to rely significantly on it to meet their daily needs and because rural economic activities are becoming more interwoven. The United Nations Development Programme (UNDP) (2012) estimates that 75% of the world's poorest people reside in rural regions and rely largely on agriculture and fisheries. In addition to supplying food, work, and money that keeps people alive, agricultural activity also supplies inputs and raw materials to other sectors of the economy. Countries are able to utilize their human and natural resources well in order to increase farm output.

The strength of rural livelihoods and poverty levels is strongly influenced by the performance of agriculture, as it is the leading source of income for most people around the world, however small-scale and commercial agricultural producers face challenges in their agricultural activities and these include, the outbreak of fall army-worm, low and uneven rain, low and diminishing soil fertility, low investment, recurring food insecurity among others. The fact that there is a lack of essential resources needed for agricultural development in many countries makes it very worrying whether agriculture should be used to generate growth. Zimbabwe’s agricultural sector was considered by several studies to be a major essential of industrialization and economic development. This paper looks at the implications of FAW (Fall Army-worm) on agricultural productivity in Ward 20, Bindura District in Zimbabwe since the invasion of the pest between 2016 and 2017.

Spodoptera frugiperda, often known as the Fall Army Worm (FAW), is one of Africa's most destructive brawny species and a serious danger to the food security and way of life of an increasing number of families. In the beginning of 2016, a pest native to America was reported in West Africa (Goergen et al., 2016). It has now expanded swiftly throughout the rest of Sub-Saharan Africa (SSA), 17 Asian nations, and Australia (CABI, 2020), with a high risk of near-

global invasion (Early et al., 2018). The FAW has been identified as a polymorphous pest, which is able to feed on over three hundred different species of plants and can include important crops like maize, rice, sorghum or wheat in addition to forage grass for livestock (Montezano et al., 2018). It has severely harmed maize, which is a significant food security crop in the region, in SSA. According to estimates from 12 maizeproducing nations in Sub-Saharan Africa (SSA), unless proper measures are adopted, the pest has the potential to inflict maize losses ranging from 4.1 to 17.7 million tonnes per year (about US$1.14.7 billion) (Rwomushana et al., 2018).

FAW has a negative influence on agricultural output in Zimbabwe, endangering food security (Devi, 2018; FAO, 2020). The pest was initially detected in Zimbabwe during the 2016/2017 cropping season, and it has since spread and caused agricultural damage in succeeding seasons (FAO, 2020). Its presence has been established in all ten provinces of the country. In the midst of the FAW outbreak, a few emergency steps were implemented to combat its risks in Zimbabwe and neighboring nations, but the pests continue to cause a major decline in agricultural productivity, affecting the economy's revenue.

The economic perspectives treat an economic agricultural productivity farmer as a profit maximizer, who should commercialize agricultural activities in order to realize better returns for every dollar invested (Sokoni, 2008; Wolter, 2008). This could be attained using costminimizing techniques, apportioning more acreage use of ways to reduce fall army-worm attacks in agricultural productions, and selling huge quantities of high-quality output to lucrative outlets (Sokoni, 2008; Wolter, 2008; Pingali et al.., 2005). Farmers are also anticipated to select cultivars based on market preferences in order to maximize profits (Asrat et al., 2009; Nagarajan et al., 2005).

The purpose of this research is to examine the impact of FAW on agricultural productivity. The study also investigates whether and how control techniques managed to mitigate any reported harmful effects of FAW. Such data can assist policymakers in creating effective solutions to reduce the economic impact of this very destructive bug.

1.2 Statement of the problem

Agricultural production in Zimbabwe has been declining since the year 2000. There is a belief that the decline is due to the invasion of this (Fall Army-worm) persisting pests which have been tormenting maize crops for years and that resulted in a reduced contribution of yield to the national output. Maize production declined from 2002 to 2016 in the year 2016 literature acknowledges that FAW (Fall Army-worm) is a great threat to mainly cereal production mainly maize than diseases and drought in Zimbabwe. The Government has been doing a lot to mitigate the effects of pests on maize production in 10 provinces in Zimbabwe where farming activities are done. In 2016 the Government granted farmers insecticides and pesticides as a measure to reduce the spread of pests, 2020 it assigned Extension services to go and teach farmers some agro-ecological methods that would help farmers to mitigate the effects which were caused by the pests on agricultural productivity. However, despite all these efforts agricultural production mainly maize production is continuously dwindling. It is difficult to get Non-Governmental Organizations (NGOs) participation in this predicament mainly due to a lack of evidence on the effects of these pests on agricultural productivity in Zimbabwe. To get traction from NGOs, this study seeks to investigate the effects of FAW (fall army-worm) on agricultural productivity.

1.4 Objectives are:

The general objective of this study is to investigate the effects of fall army-worms on agricultural productivity in Ward 20, Bindura District. Specifically, the study seeks to:

(i) To examine the damaging effects of fall army-worms on agricultural yield.

(ii) To analyse the possible alleviating farmer control methods towards the effect of fall army worm.

1.5 Research questions

• Does fall army-worm have damaging effects on agricultural productivity?

• What is the extent of yield loss associated with fall army-worm damages?

1.6 Study Hypothesis

The study proposes two alternative hypotheses to examine, both of which are based on the researcher's prior knowledge of the impacts of FAW on agricultural output. The study essentially evaluates two hypotheses at a 5% level of significance, which are as follows:

i. Commercial and small holder farmers in maize farming are not profitable with the current tormenting FAW on agricultural production.

ii. Fall army-worm is negatively affecting productivity in agriculture.

1.7 .0 Justification

The results of this study will greatly advance the field of research since they will provide a fresh angle on the subject and field of inquiry. There have been a lot of studies done on the management, control, and consequences of pests in agricultural output. This study's goal is to learn more about the fall army worm (FAW) and develop ways to help maize growers get rid of the pest issue that has been bothering them for years. It also assesses the impact of the FAW on agricultural production. The advice from this study could be useful to farmers in Zimbabwe and the surrounding nations that grow maize. The following parties would consequently find tremendous value in this study:

1.7.1 The farmers

Farmers will have easy access to information as research expands accessible fall army worm management options. Agricultural farmers in different parts of Bindura have access to a variety of fall army worm management techniques, although adoption of these techniques is very low. Due to the fall army worm's unclear information flow, the majority of small-holder farmers and commercial farmers are exchanged in a structured manner. The findings will put farmers in a better position to make wise judgments, learn more about managing FAW, and increase their level of output.

1.7.2 The Government

The government will find it beneficial to outline the proper fall army worm management actions based on the identified restrictions as this will boost output and profitably contribute to agriculture productivity. This study will be region- and situation-focused rather than relying on sources of information that are outdated and ineffective for farmers.

1.7.3 The Policymakers

Fall army worm policy choices are routinely made without enough information of how they affect agricultural output, merchants, and consumers. Without supporting evidence, such as research results on the causes and contributing factors of the fall army worm, it is challenging to create effective pest management strategies. Farmers face challenges that are sometimes out of their control. To create efficient FAW mitigation efforts, councilors, district administrators, and other important stakeholders and authorities need information. This raises the possibility that farmers in Bindura and those in the neighboring areas will participate more actively in the fight against the fall army worm, which can improve crop quality and productivity as a whole.

1.7.4 Agricultural Extension Department

It will help extension agents advise farmers on the appropriate fall army worm management measures in light of known restrictions since doing so will increase their production and contribute financially to agriculture productivity. This study will be local and context specific, as opposed to farmers employing outdated and irrelevant data sources.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of the relevant literature in the research study. The literature reviewed includes the fall army worm invasion in Africa, agricultural production before fall army worm in Zimbabwe, fall army worm invasion and agricultural production in Zimbabwe, effects of fall army worm.

2.2 Fall army worm invasion in Africa

For the majority of people in Sub-Saharan Africa (SSA), agriculture remains their main source of income (Dercon and Gollin, 2014). Nevertheless, a number of interrelated issues, including biotic and abiotic ones, are limiting agricultural philanthropy to ensuring food security and alleviating poverty. African food security is now in grave risk because of the recent invasion of the fall army wormy (Spodoptera frugiperda JE Smith) (Day et al., 2017). Originating in tropical and subtropical America, the fall army worm (FAW) is an invasive and destructive insect that is currently moving throughout Africa. The pest was found in SSA at a time when the area was having trouble feeding its rapidly expanding population. Since its discovery, the fall army worm has been a persistent issue in West Africa.

Considering more than three hundred million farmers in Sub-Saharan Africa (SSA) depending on maize as their main crop, the FAW pandemic has been a serious setback (Day et al., 2017; Wossen et al., 2017; VIB, 2019). According to estimates from 12 African countries, FAW resulted in a loss of 4.1 to 17.7 million tons of maize annually (Rwomushana et al., 2018). Estimates at the farm level from Ghana and Zambia indicated a yield loss of 22– 67% (Day et al., 2017), 47% (Kumela et al., 2018), and 9.4% (Baudron et al., 2019) due to FAW infestation. If suitable and efficient management measures are not put in place, the pest will continue to destroy maize and worsen the already difficult food security situation. Other FAW-induced economic impacts include decreased income due to decreased maize sales, decreased food consumption due to decreased food availability from both crops and livestock, as crop residues are a major livestock feed source in rural areas, increased medical treatment expenditure for people exposed to insecticides, and environmental damage due to insecticide contamination (Denberg & Jiggins, 2007; Midingoyi et al). Furthermore, FAW infestation has an impact on the performance of other enterprises, such as food processing industries and input providers, such as seeds and fertilizer, along the maize value chain.

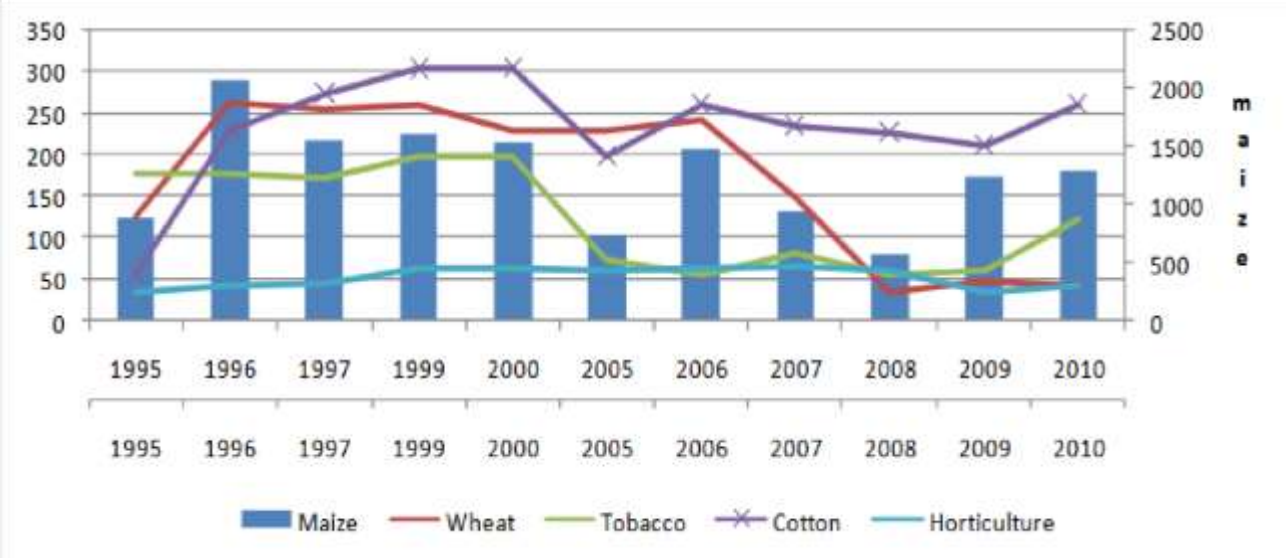
2.3 Agricultural production before Fall Army-worm invasion in Zimbabwe

Agriculture is one of the most significant areas of many African economies, as farming operations provide a living for the vast majority of people. Agriculture is the backbone of the Zimbabwean economy, supporting economic growth, food security, and poverty reduction. Farming activities are carried out on both communal (smallholder) and large-scale commercial farms. According to Ministry of Agriculture statistics, an estimated 70% of the country's population lives in rural areas and is thus directly or indirectly dependent on agriculture for employment and food security. Furthermore, agriculture is a significant source of revenue, with agricultural-related employment accounting for one-third of the official work force (Ministry of Agriculture 2012).

Agriculture is critical to increasing food security in Zimbabwe's urban and rural communities. During the 2008/9 agricultural season, it is expected that 56% of urban households planted maize, Zimbabwe's major crop (Doran 2009). Agriculture, in addition to providing food security, has important links with other sectors of the economy, particularly manufacturing. The agriculture sector provides 60% of the raw materials used by the country's industry and accounts for around 40% of overall export revenues (ZIMSTATS 2017). Agriculture is predicted to account for 15-18% of the country's GDP (Ministry of Lands and Agriculture 2018). The country is endowed with favorable agro- climatic conditions and vast arable land, providing a solid foundation for increased agricultural productivity. Maize, small grains, wheat, groundnuts, and beans are among the principal food crops grown. The main cash crops are tobacco, cotton, sugar cane, soya bean, and horticulture. Beef and dairy cattle, goats, sheep, pigs, and fowl comprise the majority of the livestock sector.

However, Zimbabwe's agricultural performance has deteriorated over time and has failed to fulfill national requirements, particularly for maize and wheat. According to Ndlela and Robinson (2007), there has been a dramatic decrease in agricultural productivity since 2000 as a result of the fast-track land reform program, combined with the effects of macroeconomic mismanagement (including shortages of imported inputs such as fuel, seed, and fertilizer), as well as disruptions in research and extension services, input supplies, and marketing systems. As a result of low productivity, the country has become increasingly reliant on imports to supplement domestic production. Total maize production fell from approximately 2 million tonnes in 1996 to 1.3 million tonnes in 2007.

Figure 1: Key crop production figures in Zimbabwe in "000" tonnes from 1995 to 2010.



Source: Medium Term Plan (MTP) 2011-2015

Zimbabwe's key cash crop production has also been declining. Tobacco output fell from 226 000 tonnes in 1998 to 56 000 tonnes in 2008 before rebounding to 122 000 tonnes in 2010. Cotton output has been declining, while horticulture has fallen from a peak of 82 000 tonnes in 2002 to 35 000 tonnes in 2009 (Figure 1).

As a result, Zimbabwe faces the dual task of increasing agricultural productivity while also boosting the sector's overall competitiveness. Competitiveness goals can be expressed as results like as productivity, marketability, and price received. It is fundamental that Zimbabwe raises agricultural production and productivity, which considerably boosts economic growth and development, if Zimbabwe provides things that the market is eager to buy. Agriculture's competitiveness must be improved if the industry is to perform its role as an anchor for economic development, food security, and employment.

This study aims to offer the finest agricultural productivity practices, which will be utilized to draw lessons for Zimbabwe. Zimbabwe's agricultural performance is evaluated by comparing it to that of high-performing comparator countries, with the goal of adopting long-term sustainable policies to increase agricultural productivity. The study focuses on agricultural productivity as it relates to individual farmers and the state, production costs, revenue, economies of scale, and agricultural research or cultivation methods. However, in order to

achieve all of the aforementioned agricultural goals, this study aims to find effective solutions to lessen the effects of autumn army-worm and boost agricultural productivity in Zimbabwe.

2.4 Fall army-worm invasion and agricultural production in Zimbabwe

Fall army-worm (FAW), Spodoptera frugiperda, has recently become one of Africa's most devastating invasive species, posing a severe danger to food security and livelihoods of many households. The pest, which is native to the Americas, was first discovered in West Africa in early 2016 (Goergen et al., 2016). It has now spread swiftly throughout the rest of SubSaharan Africa (SSA), as well as 17 Asian nations and Australia (CABI, 2020), with the potential for near global invasion (Early et al., 2018). The FAW is a polyphagous pest that can apparently feed on over 300 different plant species, including vital staple crops like maize, rice, sorghum, and wheat, as well as animal pasture grasses (Montezano et al., 2018). It is particularly damaging maize in Sub-Saharan Africa (SSA), which is an important food security crop in the region. According to estimates from 12 maize-producing nations in SSA, unless proper measures are adopted, the pest has the potential to inflict maize losses ranging from 4.1 to 17.7 million tonnes per year (Rwomushana et al., 2018).

FAW has a negative influence on agricultural output in Zimbabwe, endangering food security (Devi, 2018; FAO, 2020). The pest was initially detected in Zimbabwe during the 2016/2017 cropping season, and it has since spread and caused agricultural damage in succeeding seasons (FAO, 2020). Its presence has been established in all ten provinces of the country. Following the FAW epidemic, many emergency measures were implemented in Zimbabwe and neighboring countries to combat the pest.

However, according to the World Bank (2020), Zimbabwe has been characterized by a significant fall in agricultural production and high food costs, which have worsened food insecurity, with close to 50% of the population food insecure in 2019. To encourage agriculture, smart agriculture was adopted in response to climate change, which resulted in the invasion of the most devastating crop pest. Agricultural production has not been profitable due to the fall army-worm, which has destroyed harvests for the past six years, including this year. As a result, the country's economic situation has deteriorated to the point where it can no longer feed itself and must rely on international aid. The Zimbabwean agricultural system has become increasingly vulnerable as a result of the invasive pest crisis. However, it is anticipated that

these negative occurrences will be successfully reversed and transformed for the better, to the advantage of the economy and its people.

2.5 Effects of Fall Army-worm

Fall army worms cause direct agricultural damage, affecting food output and economic returns to farmers and the economy. The fall army-worm causes physical harm to agricultural crop harvests, resulting in yield and income loss when the invasive pests attack ripened grains.

Fall army-worm (FAW) infestations incur additional expenditures due to the usage of insecticides and manpower to eliminate the pest (Kassie M et al 2020). In SSA nations, the principal FAW control approach is the use of pesticides. Furthermore, FAW invasions have an impact on trade, income, and food consumption due to yield supply reductions. FAW invasions also increase health-care costs due to insecticide exposure and have an impact on the success of enterprises along the agricultural productivity value chain, such as crop input suppliers (Jeger. M et al 2017). Unless and until effective control techniques are deployed, the insect will continue to devastate agricultural production of targeted crops and threaten the livelihoods of many Zimbabweans. Implementing such management techniques necessitates updated information on the impact of FAW on the economy and food security.

Furthermore, the breakout of fall army-worms has an impact on the local market, as it raises the price of agricultural seeds such as maize seeds and maize meal. The fall army-worm has an impact on agricultural crop farmers' livelihoods by reducing yields and increasing crop production expenses. According to Day et al. (2017), fall army-worms have an influence on international trade since trade between nations carries the danger of pest introduction into countries where the pest is not present (the risk is on agricultural crop producers and crop producers).

2.6 Empirical Literature

The outbreak of FAW in Zimbabwe drew some scientific attention, notably on the pest's influence on the country's maize crop. Chimweta et al. (2020), for example, found that FAW reduced maize output by 58%, based on estimations from 101 farmers in Zimbabwe's Zambezi Valley (Mashonaland central region). Baudron et al. (2019) observed a maize yield loss of 11.57% using rigorous field scouting

methods in two regions of Manicaland province and concluded that prior yield loss estimates based on farmers' perceptions may have been exaggerated.

In the early months following the pest outbreak (February 2017), the Food and Agriculture Organization (FAO), in collaboration with national governments and stakeholders in Southern Africa, convened an emergency meeting in Zimbabwe to strengthen preparedness and coordinate actions against FAW (Wild, 2017). Similarly, in July 2017, a Zimbabwe FAW working group comprised of representatives from governments, private input companies, non-governmental organizations, research and academic institutions, and donors was formed to develop a strategy to mitigate the pest's impact in the country (CIMMYT, 2017).

Based on household survey data from Ghana and Zambia, as well as agro-ecological parallels, Rwomushana et al. (2018) calculated that the pest has the potential to reduce maize production in Zimbabwe by approximately 264,000 tonnes per year, resulting in a revenue loss of US$ 83 million. Given that maize is Zimbabwe's principal food crop, if the pest is not controlled, it will undermine the country's food security. This paper contributes to the scant evidence base on the economic effects of FAW and its management (Day et al., 2017; Kassie et al., 2020; Rwomushana et al., 2018).

More notably, this is the first study to investigate the effects of FAW on agricultural productivity in Zimbabwe. While assessing the impact of FAW on agricultural output results (as done in the aforementioned studies) is useful. Furthermore, FAW invasion may result in overall household and economic resource reallocation. For example, in order to control FAW, crop protection measures such as pesticides and handpicking may simply divert financial and labor resources away from alternative economic activities, which may not be reflected in outcome indicators such as agricultural productivity yield, sales, or consumption. Using a broader welfare metric, such as economic and household revenue and income, will allow us to capture the potential resource reallocation.

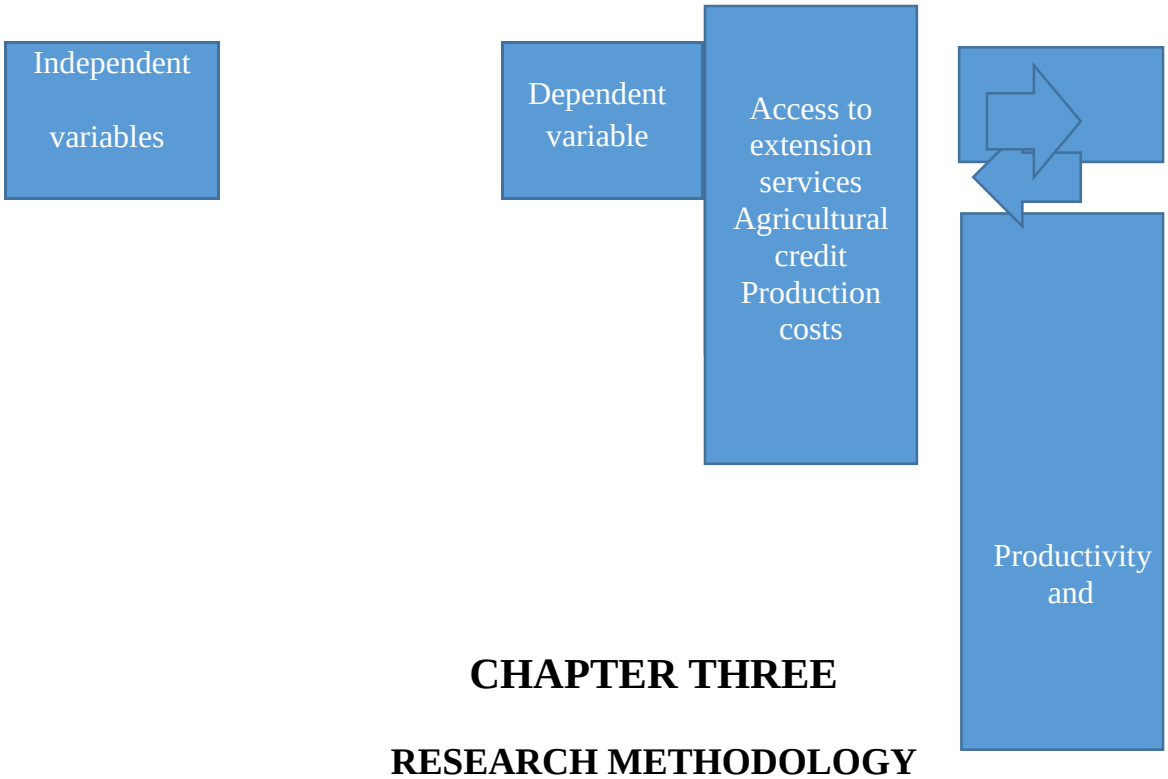
The current study intends to examine the impact of FAW on agricultural productivity metrics such as revenue, profitability, production costs, and food security. The study also investigates whether and how control techniques managed to mitigate any reported harmful effects of FAW. Such data can assist policymakers in creating effective solutions to reduce the economic impact of this very destructive bug.

2.7 Conceptual framework

In research, a conceptual framework for the topic is essential. It is, by definition, a tool for making conceptual distinctions and organizing ideas. The conceptual framework in this study depicts the links between study variables and explains the arrangement of the entire proposal in a diagram. The purpose of this study is to examine the factors influencing agricultural production, productivity, and profitability as a result of the invasion and spread of the fall army worm.

Agricultural productivity and FAW are the two dependent variables, whereas a variety of social, economic, cultural, institutional, and environmental factors are the covariates that explain variance in agricultural output profitability in Zimbabwe. The key independent variables that affect agricultural production include marketing issues, access to inputs, agricultural loans, and extension. Other moderating elements that effect agricultural productivity include high chemical expenses, high production costs, and significant crop losses.

Figure 2: Conceptual framework



CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter outlines the methods and steps taken to conduct the research inquiry. The study area is described, the research design is stated and discussed, the data sources used in the analyses are stated and discussed, the sampling strategy and data collection techniques are discussed, along with the types of data that were collected, how they were collected, and the types of analyses that were carried out to produce the findings that have provided answers to the study's research questions. A research methodology is a methodical strategy for dealing with a research problem. It is a science that investigates the methods of conducting research.

3.2. Description of the study area.

The research project was conducted in Zimbabwe's Mashonaland Central Province's Ward 20 in the Bindura District. The district was chosen by smallholder and large-scale farmers because it is one of Zimbabwe's most productive agricultural areas. The area is located 87 kilometers from Harare. The district is situated in agro-ecological region 2, which has 750 to 1000 mm of annual rainfall on average. It generally occurs between November and March or April. Among the crops that do well in the area are maize, flue-cured tobacco, cotton, wheat, soybeans, sorghum, groundnuts, seed maize, and barley. White and brown loom soils that are suitable for agriculture are found in the Bindura District. Clay and sand are the two main soil types in the district.

Figure 1 Bindura Map

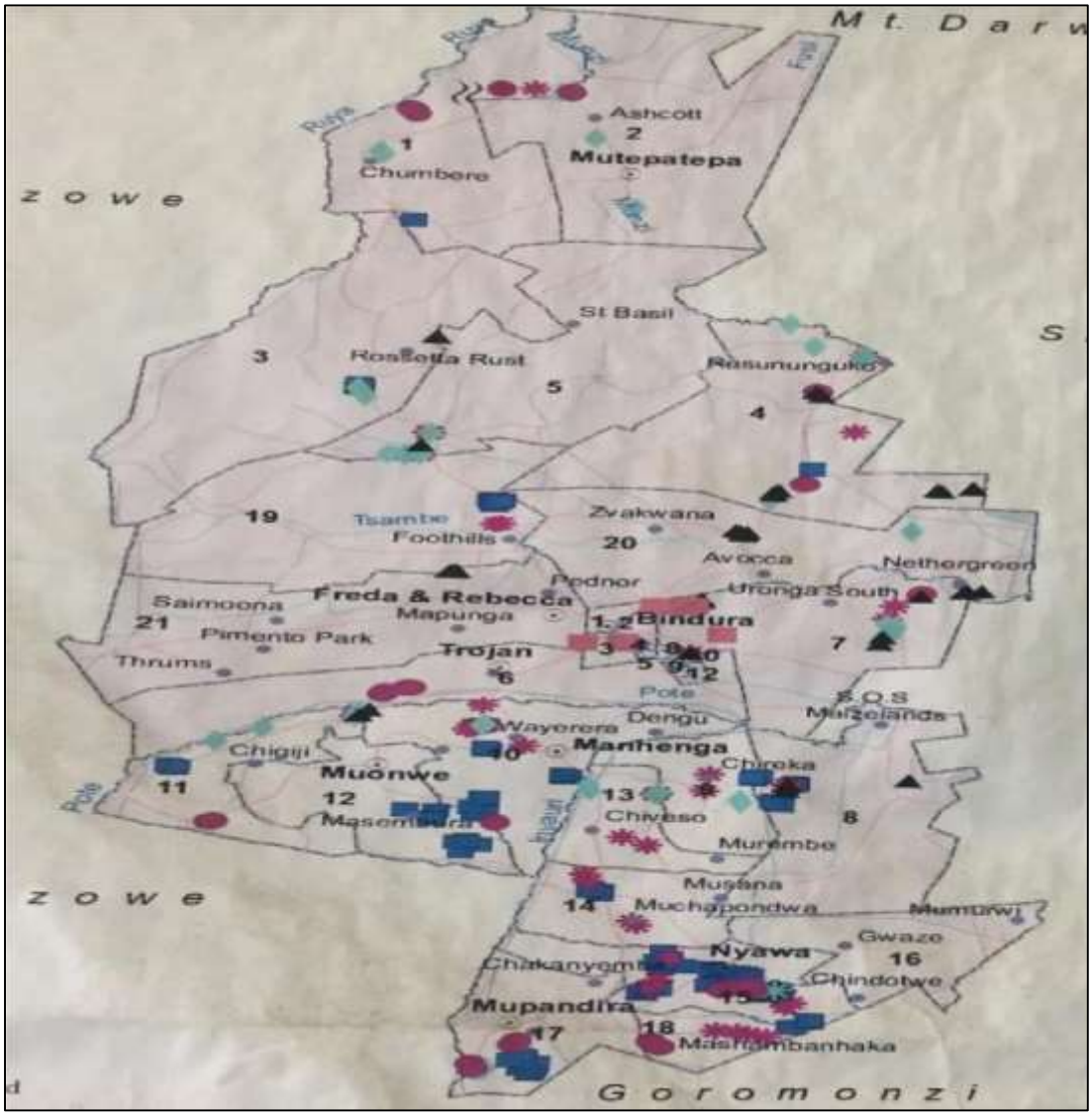


Figure 3.1: Map of Bindura District

3.3 Sampling Methods

The District Extension Officer for Bindura District, Ward 20, provided a list of farmers who were actively engaged in the cultivation of maize in the chosen ward, and 35 out of 120 farmers were chosen at random for an interview. The Slovian formula below was used to get the sample size;

$$n=\frac{N}{1+N(e)^2}$$ where

n stands for sample size.

N is the population size, and e denotes the allowed margin of error.

3.4 Research Design

The study applied a case study mixed methodology approach, and qualitative as well as quantitative research in Bindura District's Ward 20 was undertaken. The data was obtained from growers producing maize crops. To gather information for the study endeavor, survey questionnaires and the observation technique were both used. The approach intends to address research questions about the effects of the fall army worm on agricultural output.

3.5 Data Collection Methods

The researcher utilized both primary and secondary sources to acquire data.

3.5.1 Secondary data methods

Secondary figures were given by the Bindura Rural District Council and the AGRITEX maize production division. In order to profile and understand the research location, secondary data were used. Depending on the department's mandate, several types of data are collected from stakeholders. The AGRITEX department provided details on the fall army worm, the areas with the highest concentration of affected households, maize production, and its management collection in the region. This information helped farmers manage FAW and allowed for the comparison of maize producers. From library journals, further details regarding fall army worm damage and its effect on maize output were obtained.

3.5.2 Primary data collection methods

The study's primary data collection methods included the use of structured questionnaires, key informant interviews, and observations.

3.5.3 Questionnaires

The primary data from the designated maize crop farmers was gathered through a formal survey in which a questionnaire was distributed in the field. To gather information from the chosen respondents, a structured questionnaire was developed in a methodical manner. The questionnaire survey was altered in advance of the field survey's real deployment to guarantee its dependability in gathering the necessary data. The

information gathered included the effects of FAW cereal crop producers such as maize, the level of maize crop productivity in the area, yield quality obtained by maize crop farmers each season, and profitability and costs associated with producing maize crops as well as maintaining fall army worm.

3.5.4 Key informant interview

A total of 6 key informants were interviewed in their offices in Bindura District individually. The key informant who were interviewed included two AGRITEX officers, crop production officers and councilors. The key informant were asked related questions to the damages caused by fall army-worm on maize in the villages they operated in. The questions were related to the ways that were ever implemented in trying to control the persistent pest (fall army wormy), the rate of yield loss in relation to the spread of FAW. Key informant interviews have an advantage that the targeted respondents are better informed about the subject are like extension workers will supply more relevant information.

3.5.5 Observations

Observations were carried out to observe condition of maize yields that was attacked by fall army-worm and those that were not attacked. Observations were used since it provided the researcher with information on the quality of maize yields, the level of productivity of maize that was produced and the rate of damage that was caused by Fall Army-worm. Also observations were used since it provided the researcher with ways to check for non-verbal feelings expressions, determine who to interact with and grasp how participants communicate with each other.

3.6 Analytical tools

To achieve the objectives of the study, the following data analysis approaches, including descriptive statistics, were used. The data were analyzed using SPSS (Statistical Package for Social Sciences) version 20 and Microsoft Excel. The fact that SPSS is a storage facility with effective and user-friendly analysis capabilities is a benefit. Data quality, such as data input, and data consistency were checked as part of the cleaning process

Table 1: Analytical tools

Objective	Tools	Data
To investigate the effects of FAW on agricultural productivity	Linear regression	Income Costs Input cost
To examine the damaging effects of FAW on agricultural yield	Descriptive statistics	Yield quality Yield quantity Maize grade
To analyze the possible alleviating farmer control methods towards the effect of fall army worm	Descriptive statistics	Income Pesticides Price output of maize

Table 3.1: analytical tools

3.6.1 Descriptive statistics

A summary statistic known as a descriptive statistic quantifies the properties of a collection of data. In other words, using and analyzing data is what descriptive statistics is all about. Among the variables used to characterize a data collection were measurements of central tendency and measurements of variability. While the standard deviation (or variance), the minimum and maximum values of the variables, kurtosis, and skewness are measures of variability, the mean, median, and mode are metrics of central tendency.

3.6.2 Regression analysis

The impact of the fall army worm on agricultural production in relation to socioeconomic factors was investigated using a linear regression model. Analysis of regression using a large number of predictors. The model search component, which entails looking through a list of candidate descriptive variables for a subset that accurately characterizes the response. The following is the basic model for multiple regression analysis:

$$y= \beta_0+\beta_1 x_1+\ldots\ldots + \beta_i x_i +\varepsilon$$

In this case, X_1,..., Xi are the explanatory variables and the parameters β_1,...,β_i can be evaluated using the measurement of least squares approach (Dalgaard,2002).

3.6.1 Explanatory Variables

Table 2 explanatory variables

Variable	Description
Fall army-worm	Household experienced fall army-worm attacks on maize crops
Age	Age of the household head (years)
Gender	Gender of household (1= male, 0= female)
Education	Household has secondary education
Marital status	Household marital status
Household size	Number of household members
Farm size	Total area planted with maize crops (hectares)
Income	Household income from maize production
Access to extension services	Household has access to extension services

Table 3.2: Descriptive variables

CHAPTER FOUR RESULTS AND DISCUSSION

4.1 Introduction

The findings and outcomes of the study are presented in this chapter, along with a discussion of them. It presents the findings of the study's goals, and research questions, the impact of the fall army worm on agricultural output in Ward 20 of Bindura District. The chapter goes on to discuss socioeconomic difficulties affecting maize growers as well as other production-related issues that small-scale and commercial farmers in the study region must deal with.

4.2 Fall army worm effects on socio-economic factors

A detailed summary of the output and input variables in determining the effects of fall army worm on agricultural productivity in Bindura District Ward 20 farms. Table 3 provides a summary of the sample mean, standard deviations, and variable definitions used in the study. The outcome evaluated in terms of the rate of effect of fall army worm on each farmer in each maize farming season is the dependent variable for the socio-economic variables, and these variables are classified as independent socioeconomic variables.

Table 3: Definitions and Summary Statistics

VARIABLES	DESCRIPTION	MEASUREMENT	MEAN	SD
FAW	Household experienced fall army worm attack on crops	1=if yes 0= otherwise	0.6571	0.48159
AGE	Age of household head	Number of years	41	7.69262
GENDER	Gender of household head	1=male 0=female	0.5429	0.50543
HOUSEHOLD SIZE	Number of household members	Number of household members	6.6	1.76901
EDUCATION	Years of education of household head	Total number of years in formal education	1.6857	0.96319
MARITAL STATUS	MARRIED,SNGLE,DIVORCED ,WINDOWED	MARRIED,SNGLE,DIVORCED ,WINDOWED	2.2	0.86772
FARM SIZE	Farm area or size	HA	12.4571	19.31373
FARM INCOME	Household total farm income	ZWDRTGS	250	144.8732
EXTENSION	Access to extension services	1=if yes 0= otherwise	0.3429	0.48159
FARM GROUPS	Social group members	1=if yes 0= otherwise	0.4	0.49705

4.2.1 Age

Age was captured according to the age group that is more active and energetic in production in terms of farming. The mean of the active people in agriculture was 41 and the standard deviation of the age group also was 7.69262 of the most active people in Ward 20. This affirms that young people are more active in agriculture as they will be strong and energetic, thus their involvement in farming will be high and the active people age ranges from 25 to 60 years.

4.2.2 Gender

Gender was recorded as a dummy variable describing the respondent's sex, with 0 representing the female and 1 representing the male. With a standard deviation of

0.50543, the total mean of gender was 0.5429, implying that the typical sex of the respondents was male. The results show that males were more dominant in agricultural activities and in research than females. More males are dominating since most of the population is characterized by men. This is because, in Ward 20, most of the respondents were males who work on farms and also were household heads.

4.2.3 Household size

Household size was captured according to a normal household size which is regarded as a normal family size of 6 people per household. From the findings of the household research, the mean variation from the statistics was 6.6 and the standard deviation was 1.76901. As a result, larger household sizes indicate the availability of farm labor; nevertheless, the quantity of labor capable of performing farm work varies with age. The majority of big households are compelled to seek out alternative cash streams, including maize production and other avenues of income.

4.2.4 Education level

Table 3 above displays the average level of literacy in the examined area. . With a mean of 1.6857 and a standard deviation of 0.96319, it was determined that the majority of respondents who were involved in maize farming had finished their primary education. Because most agricultural technologies can be supplied in a foreign language, literacy is particularly important for small-scale and commercial farmers to understand, utilize, and embrace new relevant agricultural technology introduced. However, due to the farmers' low literacy level in Ward 20, the results suggest that they are unable to recognize the fall army worm, or even learn about it, resulting in a high rate of fall army worm attacks, which affects yield output.

4.2.5 Marital status

During the survey, respondents were asked to state whether or not they were married. The results of this study indicate that marital status is an important factor in domestic affairs. According to statistics, marital status had an average of 2.2 and a standard deviation of 0.86772. Due to labor availability and the opportunity to share farm tasks in agricultural production or non-farm activities, the data suggested that married couples are more likely than single people to be productive.

4.2.6 Farm size

Farm size was captured according to the types of farmers who were more dominant in the study area and in this case A2 farmers were more dominant in this case. The results statistics states the mean as 12.4571 and the standard deviation as 19.3137 of farmers owning above 10 hectares of farms.

4.2.7 Farm income

Farm income was obtained according to the revenue farmers were obtaining from their yields after controlling fall army worm on their maize crops. Hence, the mean from the statistics was 250, with the standard deviation as 144.8732, this implied that most farmers were obtaining more income from maize production after controlling fall army worm.

4.2.8 Extension services

Extension services were captured according to if the farmers were receiving extension services on the issues of fall army worm. This variable was denoted into categories, where extension services were captured as a dummy variable describing if farmers were obtaining help from extension agents pertaining fall army worm effects, in this case, 0 represented farmers who did not receive extension services and 1 represented farmers who received extension services. However, the statistics showed that many farmers were not receiving the services due to variations in the mean of 0.3429 and standard deviation of 0.48159.

4.2.9 Farm groups

Farm groups were captured according to if the farmers were doing discussions or helping each other among themselves on the issues of fall army worm. This variable was denoted into categories, were farm groups was captured as a dummy variable describing if farmers were helping each other pertaining fall army worm effects, in this case 0 represented farmers who did not have groups and 1 represented farmers who had farm groups. However, the statistics showed that many farmers had no farm groups due to variations in the mean of 0.4 and standard deviation of 0.49705.

4.3 Damaging effects of fall army worm on agricultural yield

To determine the damages caused by fall army worm on agricultural yield of Ward 20 farmers, table 4 below identified the statistics of farmers who were affected by FAW and those that were not affected. The effects variables used in the study included age, gender, household size, education level, income, farm size, extension services and farm groups.

Table 4 linear regression

VARIABLES	AFFECTED		NOT AFFECTED		
	Mean	Std. Deviation	Mean	Std.Deviation	MEAN DIFF
AGE	40	7.19299	43.1818	8.63502	-3.1818
GENDER	0.6	0.50262	0.6	0.50709	0
HOUSEHOLD SIZE	6.1429	1.68184	7.2857	1.72888	-1.1428
EDUCATION	1.1364	0.35125	2.6154	0.96077	-1.479
MARITAL STATUS	1.75	0.44426	2.8	0.94112	-1.05
FARM SIZE	15.3182	23.89339	7.6154	4.1741	7.7028
FARM INCOME	238.3333	129.53652	275.4545	178.12151	-37.1212
EXTENSION	0.2174	0.42174	0.5833	0.51493	-0.3659
FARM GROUPS	0.24	0.43589	0.9	0.31623	-0.66

4.3.1 Age

Age have a great impact in agriculture as it determines the age group of people who are energetic, who are more knowledgeable, and who have more experience. As a result, based on the number of farmers impacted by the fall army worm and those that were not affected, the results denotes that, affected farmers had an average of 40,with a variation 7.19299, whereas farmers who were not affected by FAW had an average rate of 43.818 with a variation of 8.63502. However, this shows that the average age of farmers that

were affected by fall army worm is the age of young farmers who have no or less experience in controlling fall army worm, in contrast to farmers who were not harmed by the fall army worm had experience in farming as well as in controlling FAW and they also knew various methods of fall army worm control from cultural methods to the use of pesticides.

4.3.2 Household size

The results indicated that on average, the household size that was affected by fall army worm was 6.1429 with a variation of 1.68184 and the household size that was not affected by fall army worm had an average rate of 7.2857 with a standard deviation of 1.72888. Therefore, the results denotes that households that had a small number of people faced division of labor challenges as there was a limited number of people who would go into the fields to check on the invasive pests and also to do the manual job of hand picking as a method of fall army worm control. Households that were not affected by fall army worm had an advantage of a division of labor because their household size was large enough to assign each member to supervise a certain area of the farm as a way to mitigate the problem of fall army worm. Large household sizes ranged from 10 to 15 people unlike small households who had between 4 to 6 people a normal family size.

4.3.3 Education level

Table 4 shows the average literacy level in Bindura District's Ward 20. It was discovered that the majority of respondents affected by the fall army worm are illiterate, with an average of 1.1364 and a standard deviation of 2.6154 literacy level. Given that the majority of agricultural technologies are available in foreign languages, this literacy level is particularly helpful for small-scale and commercial farmers to study, apply, and accept new agricultural technologies that have been developed.

However, because the farmers in Ward 20 have a low reading level, they are unable to recognize the fall army worm or even learn about it, resulting in a high rate of fall army worm attacks, which reduces yield output.

4.3.4 Farm size

Fall army worm damages was determined by farm size, in the sense that farmers impacted by the fall army with an average hectares of 15.3182 had large sizes of land which ranges between 15 ha to 20 ha, and those households had a small number of

people to cater for labor in the fields which would have helped them to be able to manage fall army worm on their yields. Non- affected areas had normal sizes of land at an average of 7 ha which met the number of household size which helped them to divide labor within the farm evenly.

4.3.5 Income

Income is essential in agriculture as it portrays the revenue a farmer obtains from his hard work. Therefore, on the basis of fall army worm damages on yield, the affected households had an average income of ZWD $ 449 673.3 (US$ 238.33) at inter-bank rate of yield they obtained after the fall army worm invasion on their crops. . Farmers who were not afflicted by the fall army worm earned an average income of ZWD$ 520 049.6. on this scenario income for these two categories showed that, the ones who were affected by FAW received less income than those who were not affected because, those that were affected could not control the persistent pests so as to obtain the quality of yield that was needed in the market, thus the farmers faced huge damages on their vast land sizes as they failed to maintain and control the pests due to labor shortages.

4.3.6 Extension services

Extension services are important in agriculture, because farmers will be able to be updated with information of the activities that will be currently occurring in farming. Extension boost knowledge and expertise of farmers by imparting them with knowledge and skills in farming. According to the results of the effects of FAW on yield, two categories of farmers were found, with an average of 0.217 being the affected farmers by fall army worm because they had no knowledge about the pest, since they were not receiving fall army worm guidelines from extension and 0.5833 which represented the farmers who were not affected by fall army worm because they received extension services.

4.3.7 Farm groups

Farm groups was captured according to if the farmers were doing discussions or helping each other among themselves on the issues of fall army worm. This variable was denoted into categories, were farm groups was captured as a dummy variable describing if farmers were helping each other pertaining fall army worm effects, in this case 0 represented farmers who did not have groups and 1 represented farmers who had farm

groups. However, the statistics showed that many farmers had no farm groups due to variations in the mean of 0.4 and standard deviation of 0.49705.

4.4 Control measures of fall army worm

Graph 4 shows whether households affected by the fall army worm were able to apply fall army worm management methods to lessen the detrimental effect on crop production. The graph below depicts the fall army worm mitigation techniques employed by affected and non-affected households. It depicts the percentage of fall army worm management measures used by the study group. Control tactics included the use of detergents, the use of ash and sand in maize whorls, the application of pesticides, and the burning of afflicted plants.

4.4.1 Use of detergents

According to the graph below, only 3% out of 35 farmers could use detergents as a way to mitigate the effects of fall army worm. However, such a small percentage of detergent used was because detergents are expensive to purchase as a result many farmers cannot afford to purchase these products in a way to control the invasive pest (fall army worm). On the same note, regarding the size of the farms that were infested by the pest, the farmers in Ward 20 were mostly A2 farmers who owned large pieces of land and this made it difficult to use detergents as they needed multiple packages of them as they did not have actual measurements required on each hectare of land owned.

4.4.2 Application of ash and sand

In the sample of 35 farmers, ash and sand were applied by 11% of the farmers. This method of fall army worm control is a cultural method known mostly by the elderly farmers. Therefore, in this case only elderly farmers implemented the control method on the effects of fall army worm as they had the knowledge and the skills on how to apply the ash and sand unlike young farmers who only knew about pesticides.

4.4.4 Synthetic pesticides use

Synthetic pesticides were the most commonly utilized control measure by farmers in Bindura District's Ward 20. Synthetic insecticides are inexpensive to purchase and

widely available, making them easier to obtain while combating FAW. According to the statistics 31% of the farmers used these synthetic pesticides on mitigating fall army worm effects. However, these pesticides are harmful to health of people and animals and hazardous to the environment.

4.4.5 Hand picking of eggs and caterpillars

The statistics from the below graph shows that 26 % of farmers from the sample size used hand picking method as a way of mitigating the effects of FAW on their agricultural yield. Even though hand picking method was labor conducive and time consuming, farmers preferred it as a simple method to protect their yields. Hand picking method had an advantage that the caterpillar or its larvae would be destroyed as soon as it was observed, rather than allowing the pest to spread whilst trying to access pesticides for the control.

4.4.6 Destruction of infested plants

According to the results from the graph below, 6% of farmers used destruction of infested plant method as a way of mitigating the effects of fall army worm on their yields. However, this method was not effective because, when the pest attack a plant it leaves its eggs and move to the next plant within a small space of time, which then resulted in farmers destroying all infested crops without controlling or destroying the pest. Thus resulted in continuous spreading of the FAW as farmers only focused on the infested plants instead of protecting the unaffected plants.

Figure 3 use of control measures

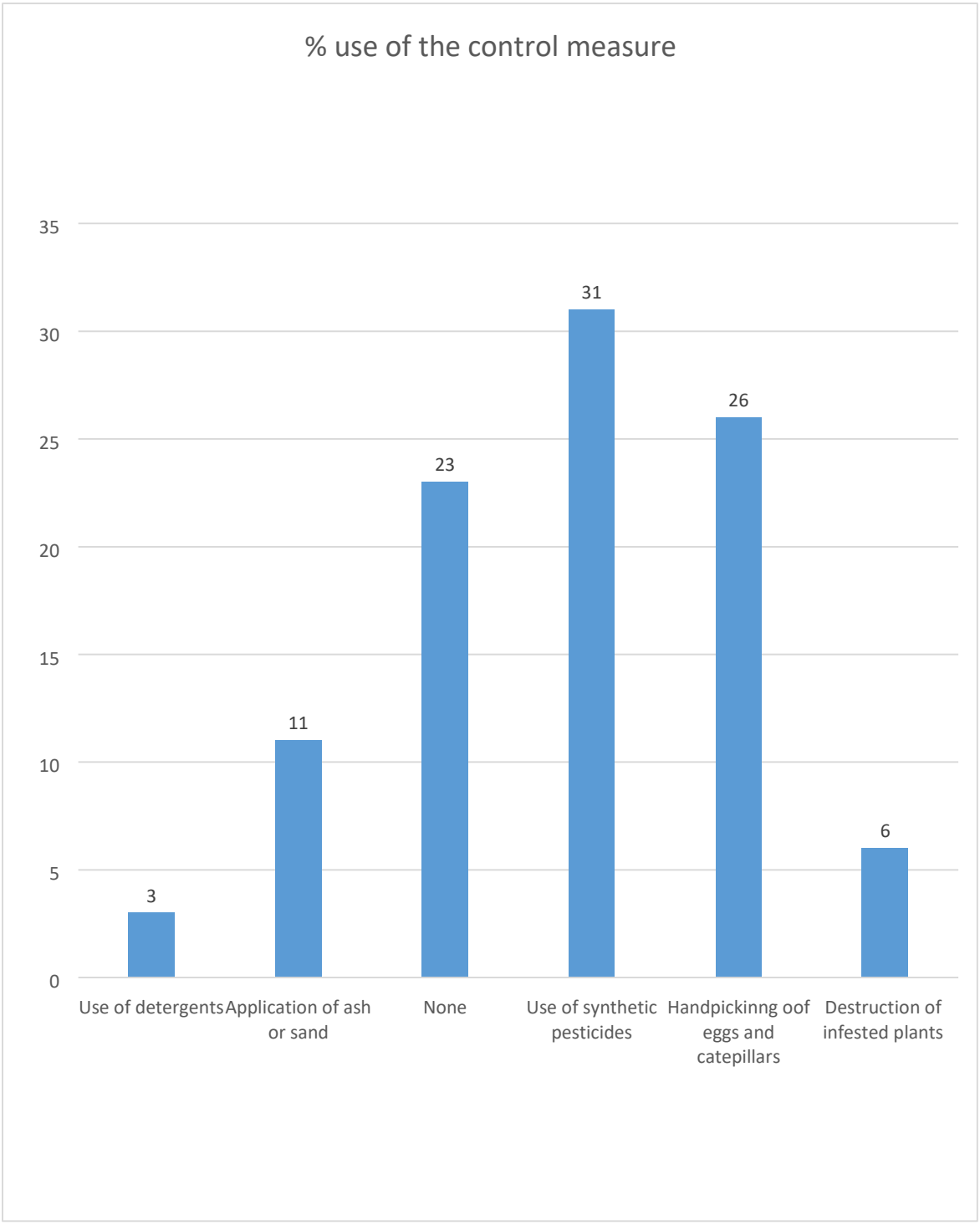


Figure 2 use of the control measures

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter provides the research's conclusions and recommendations based on the findings and interpretation of the study results. The conclusions present the main findings of the investigation, whilst the recommendations present potential solutions and techniques for dealing with the difficulties highlighted in the research. The initial goal of this study was to look at the effects of fall army worm on agricultural productivity in Ward 20 in Bindura District. The study was targeted at investigating the detrimental impacts of fall army worm on agricultural yield, as well as analyzing feasible mitigating farmer control strategies against the influence of fall army worm.

5.1 Conclusion

The results show that crop production is a significant means of support for the farmers in Ward 20 of Bindura District; however, crop producers encountered numerous challenges as a result of the fall army worm. Some problems that have been noted from the study which indicated some inefficiency in the entire production system need to be addressed. The study findings show that farmers were more dominant in using pesticides and cultural method of hand picking of the pest. These kind of methods used were time conducive, which required high division of labor.

5.2 Recommendations

The study identified the causes and effects of fall army worm in Ward 20 of Bindura District. Recommendations were made in light of the findings that were examined and the judgments that were drawn. Fall army worm constraints were the main setbacks as mentioned by farmers' especially poor yield they obtained, decrease in productivity, and lack of knowledge on the invasive pest. This study therefore recommends that these problems should be addressed in order to improve performance of crop production in Bindura District and other regions of Zimbabwe. As a result, the following recommendations are made to farmers, policymakers, extension agencies, and the government:

5.2.1 Farmers

Farmers are advised to employ new or superior fall army worm control measures first and foremost. This will increase the quality of agricultural crops that are susceptible to fall army worm assaults, boosting their chances of obtaining higher market prices. High-quality crops allow farmers to enter higher-order channels of the market, where they can earn more money, such as contracts, retailers, and wholesalers. Second, farmers who grow crops susceptible to fall army worm assaults should join stronger and more functioning farmer or commodity groups that assist the dissemination of knowledge about the invasive species, allowing farmers to remain aware of such pests while sustaining yields. Farmers can mobilize funds and credit facilities through these associations, which can help those in need.

5.2.2 Government

It will be useful for the government to set out the appropriate control measures on fall army worm on identified constraints that are disturbing agricultural production in various areas, setting out measures will cause an increase in the production and profitably participate in agriculture productivity. Rather than farmers relying on old and inappropriate data sources, the government should send out extension agents to go and teach farmers on current information about the fall army worm and also the current measures they can use in maintaining their yields as well as improving them.

5.2.3 Policymakers

Policymakers should develop a policy on the consequences of fall army worms on agriculture that ensures farmers are aware of the pest. Policymakers should focus on increasing yields through fall army worm control so that farmers may produce without the worry of incurring enormous costs due to the fall army worm. The cost of inputs such as pesticides used to manage FAW in agricultural output accounts for a significant portion of total production costs. As a result, policymakers should aim to implement cost-cutting strategies for pesticides and other inputs in order to assist farmers in lowering production costs. Furthermore, policymakers should promote research and development in crop production sub-sector policymakers through FAW financing management programs.

5.2.4 Agricultural Extension Department

Extension departments should develop appropriate fall army worm management techniques in light of identified limits in order to boost production and financially engage in agricultural productivity. Instead of providing farmers with obsolete and useless data, extension departments should educate and empower farmers about the fall army worm so that farmers do not experience additional production issues as a result of the pest.

5.3 Area for Further Research

In order to create effective methods of getting rid of the persistent pest and improving yield quality and quantity to satisfy the demands of the population for food security, it is recommended by this study that additional research be done on the management of fall army worms on agricultural productivity.

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APPENDIX 1: Survey questionnaire

THE EFFECTS OF FALL ARMYWORM ON AGRICULTURAL PRODUCTIVITY.CASE OF WARD 20, BINDURA DISTRICT.

QUESTIONNAIRE

Questionnaire serial number

My name is Gracious M Gede ; I am an undergraduate student within the Department of Agriculture Economics at Bindura University of Science and Education. As part of the degree program, students are supposed to be involved in a field research and produce a dissertation covering their areas of interests. Therefore I am conducting a research on the effects of fall army-worm on agricultural productivity, case of Bindura District.

I assure that the data collected in this exercise will be firmly for academic use only and the privacy of respondents will be respected. I would like to appeal for your contribution in this exercise. One is free to decide not to answer any questions that seem uncomfortable or to withdraw from the interview if you wish to.

Thank you in advance.

SECTION A: HOUSEHOLD DEMOGRAPHICS INFORMATION

Tick the appropriate response or fill in the space provided.

1. Ward [ ]
2. Farm name ……
3. Gender …… (i) Male [ ] (ii) Female [ ]
4. Age…… below 18years [ ] 19-35years [ ] 36-59years [ ] Above 60 years [ ]

5. Marital status…… i)Single [ ] ii) Married [ ] iii) Divorced [ ] iv) Windowed [ ]
6. Household size

GENDER	Number of people below 18years	Number of people aged 19-35years	Number of people aged 36-59years	Number of people above 60 years
Male				
Female				

7. Level of education attained (i) Primary [ ] (ii) Secondary [ ] (iii) Tertiary [ ]
8. Are you a full-time farmer (i) Yes [ ] (ii) No [ ]
9. Farm size owned [ ] Below 1 ha 1 ha to 2 ha [ ] 2.1 ha to 3 ha [ ]
10. Farming experience (No of years)….....

SECTION B PROBLEMS: To investigate effects of fall army worm on agricultural productivity.*Tick the appropriate response or fill in the space provided.*

- Have you heard about fall army worm? (1)Yes (2)No
- If yes, where have you heard the term 'fall army worm'? (1.)TV and Radio (2.) Extension officer (3.)Family-members (4)NGOs (5)Newspaper (6) other, if other where……..
- Does fall army worm have a damaging effect on agricultural productivity? (1.) Yes (2.) No
- If yes what are the damaging effects of FAW on your agricultural production? ……
  ……
  ……
  ……
- Is financial instability a problem you are facing in controlling fall army worm? (1)Yes (2)No
- As farmers facing fall army worm problems do you have adequate herbicides and pesticides ? .(1) Yes 2) No`

- If yes what types of herbicides or pesticides you are using in controlling the pest?……
  ……
  ……

- Do you consider lack of training as a barrier to accessing fall army worm information or having the knowledge on fall army worm? (1)Yes (2)No

- Before fall army worm invasion or existence were you having good returns from agricultural production,(maize in particular). (1.) Yes (2.) No

- Is fall army worm invasion causing an increasing in production costs in agricultural productivity. (1.) Yes (2.) No

- As a farmer growing maize or any other crop that is being affected by fall army worm, are you obtaining any income from your production? (1.) Yes (2.) No

- If yes what amount of income are you obtaining?……

  ……
  ……

Section B: To examine the damaging effects of fall army worm on agricultural yield. ***Agree (A)=1;Disagree D=2; Tick the appropriate response or fill in the space provided.***

- Fall army-worm outbreak is a step back to farming of the past. 1 [ ] 2 [ ]

- Are herbicides and pesticides shortage a factor affecting the yield of crops obtained by farmers experiencing fall army-worm attacks on crops especially maize? 1 [ ] 2 [ ]

- Hand picking of the pest is too labour intensive 1 [ ] 2 [ ]

- Governmental support to fall army-worm is important 1 [ ] 2 [ ]

- Does technical training constitutes to some of the factors which affect maize yield?

1 [ ] 2 [ ]

- Is fall army-worm outbreak a factor which affects the maize yield in Bindura District? 1 [ ] 2 [ ]
- Is yield quality a problem you are facing due to fall army worm damages? 1 [ ] 2 [ ]

- Due to fall army worm effects, are you obtaining the required maize grade needed in the market? 1 [ ] 2 [ ]

Section C:To analyse the degree of agricultural profitability in relation to fall army worm damages in agricultural production.*Tick the appropriate response or fill in the space provided.*

- Do you control fall army-worm? (1)Yes (2)No

- What methods of control are you using?
  ……
  ……
  ……
  ……
  ….

- Do you farmers practicing fall army-worm control methods facing huge costs? (1)Yes (2)No

- As farmers controlling fall army-worm are you gaining more total revenue from the output you produce? (1)Yes (2)No

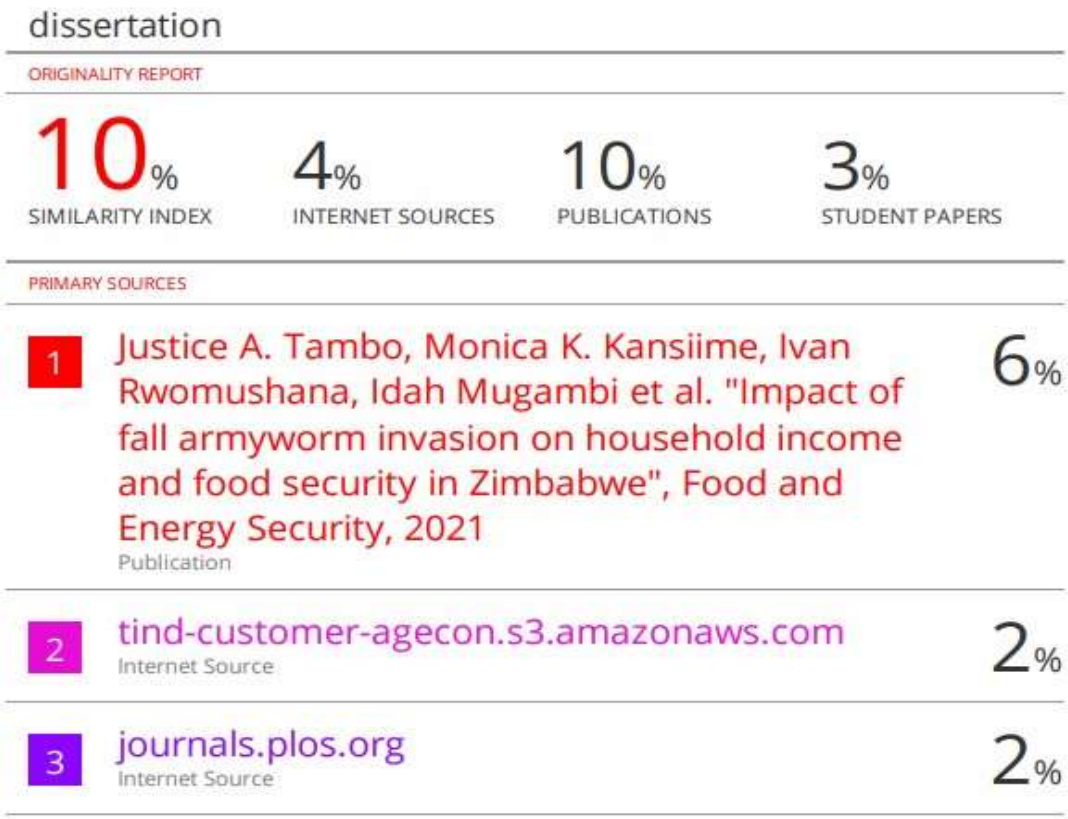
- As farmers practising fall army worm control methods are you enjoying economies of scale in Ward 20? (1)Yes (2) No

- Do farmers gaining profit out of maize production? (1.) Yes (2.) No

- Do you obtain or receive extension services on the fall army-worm outbreak? (1)Yes (2)No

- Was maize production more profitable before the existence of fall army worm? (1.) Yes (2.) No

THANK YOU



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