Factors affecting the adoption of Integrated Pest Management on food access: A case of Masembura communal lands, Bindura district

A dissertation submitted in partial fulfilment of the requirements for the Master of Science Degree in Food Security and Sustainable Agriculture (Policy)

Bindura University of Science Education

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DECLARATION

I hereby declare that the research project entitled "**Factors affecting the adoption of Integrated Pest Management on food access: A case of Masembura communal lands, Bindura district"** submitted to Bindura University of Science Education, Faculty of Agriculture and Environmental Science, Department of Agricultural Economics, Education and Extension is a record of an original work done by me under the guidance and supervision of Prof. Karavina and this work is submitted in partial fulfillment of the requirements for the award of a Master of Science Degree in Food Security and Sustainable Agriculture. The results embodied in this thesis have not been submitted to any University or Institute for the award of any degree of diploma.

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DEDICATION

I dedicate this work to my parents, my wife Linda and my daughter Tahlia

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ABSTRACT

Food security is under great threat globally with food demand increasing exponentially propelled by the growth in population which is expected to hit the 9.5 billion mark by the year 2050 (FAO, 2019). There is great need to sustainably manage food production and one way to do that is through pest management. IPM is one of the ways which is sustainable as efficient in controlling pests. The thesis looks into the factors affecting IPM adoption and its contribution to food security. The other objective of the study is to determine the characteristics of the adopters and the non-adopters of IPM, to analyse the effects of IPM on food access, to ascertain the challenges affecting adoption of IPM and to analyse the factors affecting adoption of IPM amongst the smallholder farmers in Masembura communal area in Bindura. The study employed a cross sectional survey design, collecting data mainly using the research questionnaire. Data was analysed using descriptive statistics and Binary Logistic Regression. The results from the first objective indicates that there are more male than female participants in agriculture. Independent T-test was used to test for the significance difference between adopters and non-adopters in terms of income, household size, farming experience and land size. The results from the Independent T-test indicated that at 5% significant level there was difference in terms of income (p=0.006), household size (p=0.030) and land size (p=0.00002). The study also shows that they were more males in the study (58.1%) and 54% in the 28-35 years age group as well as 69% who attained secondary education. The majority of farmers indicated that the cost of implementation of IPM and climate change were the greatest external challenge affecting adoption of IPM. It was concluded from the study that adoption was stalled because of these challenges. The results from the study also indicated that they were more food secure respondents (56.2%) under the adopters compared to (34.9%) under the non-adopters. There was significant difference in HFIAS between the adopters of IPM and the non-adopters of IPM ($t_{122.90}$*=7.61,p<0.01. From the results, household size, land size, sex, farming experience and income were found to be statistically significant at 0.05 significance level. It was recommended from the stud the government look into policy that supports adoption of agriculture technology as well as providing research that makes use of local and available material for IPM as well as methods of propagating and multiplying them.*

Key Words IPM adoption Challenges Food Access Binary Logistic

LIST OF ACRONYMS AND ABBREVIATIONS

IPM	Integrated Pest Management
FAO	Food and Agricultural Organisation
EU	European Union
FFS	Farmer Field School
AGRITEX	Agricultural Technical and Extension Services
WHO	World Health Organisation
WB	World Bank
CIMMYT	Centro Internacional de Mejoramiento de Maizy Trigo (Spanish for International Maize and Wheat Improvement Centre)
NGO	Non-Governmental Organisations

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CHAPTER 1

INTRODUCTION

1.1 Background of the study

Food security is under great threat globally with food demand increasing exponentially propelled by the growth in population which is expected to hit the 9.5 billion mark by the year 2050 (FAO, 2019). An increase of around 60 to 70 percent of food production will be required to match this growth. By 2060, the population of SSA alone could grow to 2.7 billion people from the present 1 billion (World Bank, 2020). In SSA, around 330 million young people are expected to join the labour market between 2010 and 2025, around 40 percent of them initially located in rural areas (Kogan & Bajwa, 1999). Moreover, the pattern of food consumption is changing due to urbanization and a shift in dietary patterns towards increased fruit and vegetable consumption. Intensification of agriculture production globally and in the SSA has been prioritised with limited attention on the pesticide management. This is one of the most critical factors in the success of food production and has been the greatest drive in the manufacture and use of chemicals which have ecological and biological implications (Muriithi et al., 2020).

Worldwide, chemical pesticides have played a vital role in providing an abundant and inexpensive food source (US-EPA, 2015). Despite an increase in food production, however, the persistent overuse of chemicals has resulted in a number of adverse environmental impacts such as, outbreak of secondary pests, decreasing of beneficial insects and the accumulation of toxins in the food webs (Orr, 2003). The Food and Agriculture Organization (FAO)[5] estimates that demand for food will more than double by the year 2050. To meet this demand, cereal-crop production in developing countries must increase by 40% (Parsa et al., 2014). According to the latest estimates of the Food and Agriculture Organization of the United Nations (FAO), 2018 up to 40% of food crops worldwide are lost every year due to pests and plant diseases.
International Centre for Agricultural Research in the Dry Areas (ICARDA) and various National Agricultural Research Institutions and Universities in Central Asia are implementing a regional Integrated Pest Management (IPM) Program. This program was designed based on

the priorities and the needs identified by stakeholders through a regional IPM forum organized in Tashkent, Uzbekistan in May 2005 (Dara, 2019).

While the reporting of pesticide use and market data is patchy and irregular, it is generally clear that the use of synthetic pesticides in agriculture has grown steadily, and now amounts to 3.5 billion kg of active ingredient per year. The highest world market growth rates occurred in the 1960s, at 12% per year, later falling back to 2% and below during the 1980s–1990s, then rising to 3% per year to 2014 (Hristovska et al., 2009). The value of the global market is now US $45 billion per year. Herbicides account for 42% of sales, insecticides 27%, fungicides 22%, and disinfectants and other agrochemicals 9%. The largest markets are in Europe and Asia (US$12 billion each), Latin America ($10 billion) and North America ($9 billion); the market in the Middle East and Africa is $1.5 bn (Shankar & Abrol, 2012). Synthetic pesticides entail huge cost; it has been estimated that the costs to bring a single active ingredient to market are $250 million, having synthesised 140,000 compounds to find each success(Hristovska et al., 2009).

The rapid increase of pesticide use has led to the growth of Integrated Pest Management as a strategy to foster ecological sustainability, food safety and also protect the health of the farmers and the end consumers. Globally, an average of 35 percent of crop production is lost to pre- and post-harvest pests (Kogan, 1998), underscoring the importance of improved pest management. There is a lot of evidence pointing out to the adoption of IPM globally though there is limited data on the actual impact in terms of reduction in chemical pesticide use with the exception of Vietnam and Denmark. In addition policy changes in Indonesia and the adoption of IPM and Farmer Field Schools (FFS) might have changed aggregate pesticide use in the early years but national level data have not been collected on it effect on chemical use reduction and its benefits on the increase of food production (Kiplang'at, 2016). IPM has also been employed in agricultural lands in UK, France, Italy and Japan with the aim to align production to global food safety standards. However there is evidence showing that the main reason behind reduction of pesticide use has been more economic that the implementation of IPM as the farmers try to become cost effective.

In Sub- Saharan Africa, IPM was done from the ancient days before the introduction of the Green Revolution with the early inhabitants practicing crop rotations, early planting and the use of other plants and ash to control pests (Bueno et al., 2021). FFSs have been on the fore front of diffusing IPM messaging and demonstrating its effectiveness in sustainably controlling pests. In Zimbabwe, agriculture is the backbone of the economy employing over 70% of the population. Pre and post-harvest pests have been a great hinderance to production especially in the horticulture section. Over the last few decades, developments along IPM in the country have been undertaken to reduce chemical input into agriculture, and new data, public policies, technologies and strategies have emerged to improve or reduce pesticide usage and to develop alternative strategies to manage pests in a more environmentally responsible manner (Zinyemba et al., 2018).

Agriculture dominates Bindura district as well as Masembura area. Besides staple food production, horticulture production dominates. Masembura communal lands is an area that is predominantly an agriculturally based economy that sustains its population through agricultural activities mostly horticulture and cereal production. The area has three irrigation schemes and surrounded by perennial water sources making it viable for production throughout the year. The main challenge the community has is pest management on and off the field as it is the predominant threat to their source of livelihood. Thus it translates to over 50% loss of potential revenues and in some cases total loss of income.

1.2 Statement of the problem

Public concern about the potential adverse effects of chemical pesticides on human health, the environment and biodiversity is on the rise and the negative factors cannot disappear altogether. However, their intensity can be reduced through the development, dissemination and promotion of alternative technologies such as the use of bio-pesticides and bio-agents, not limited to activities like good agronomic practices, rather than solely on chemical pesticides. Communal areas are most affected by reduced crop yields and post-harvest losses. There has been less attention from studies into the adoption as well as the contribution to food security of IPM. There is a huge knowledge and information gap on the advantages of IPM which relates beyond more than just cost saving to its contribution to livelihood improvement through reduction of pesticide residues in food which have been on the rise in the majority of food crops.

Failure to control pests in the field leads to substantial losses in the produce which comes from losses in quantity and quality. This has a huge implication when it comes to processing, storage, packaging and marketing of the crop. Horticulture crops for example tomatoes have been prone to Tuta Absoluta which affects the crops quality at the market fetching a very low price. This is detrimental to the farmer, who would have put in all her hard labour in the field only to realise very low proceeds which cannot even reach the breakeven price.

There is also a growing worry into pest resistance which is caused by the application of one method (usually chemical) in dealing with pests in the field. The continued use of pesticides leads to mutation of some of the common species of pests into new species with defensive mechanisms making it difficult to control them with known methods of control. This becomes expensive to the farmer as well as the farmers in the areas around since the mutated specie might become invasive as well.

The biggest takeaway in the Masembura area in Bindura is the issue of culture and resistance to change. The farmers do prefer their usual methods of doing their production and some possess resistance to change. Majority of farmers prefer use of solely chemical methods of controlling pests due to the fact that it has become their culture. Adopting other methods of pest control is very difficult. This is one of the key reason for the issues raised above.

With these issues clearly spelt out, the researcher decided to study the factors affecting IPM, its challenges as well as its contribution to food security in Masembura communal area in Bindura.

1.3 Objectives of the study

1.3.1 Main Objective

The main objective of the study is to ascertain the factors and challenges affecting the adoption of IPM amongst smallholder farmers in Bindura District

1.3.2 Specific Study Objectives

The specific objectives of this study are:

1. To characterise the adopters and the non-adopters of IPM in Masembura communal area in Bindura District

2. To determine the effect of IPM on food access in Masembura communal area in Bindura.

3. To ascertain the challenges affecting the adoption of IPM in Masembura communal area in Bindura District

4. To analyse the factors affecting the adoption of IPM in Masembura communal area in Bindura.

1.4 Research questions

1. What are the socio-economic characteristics of adopters and non-adopters of IPM amongst the smallholder farmers?

2. Is there any effect of IPM on food access amongst smallholder farmers in Masembura communal area in Bindura

3. What are the challenges affecting the adoption of IPM amongst the smallholder farmers in Masembura communal area in Bindura?

4. What are the socio-economic factors affecting adoption of IPM amongst the smallholder farmers in Masembura communal area in Bindura?

Table 1

Objective	Research Question	Analytic tools
i) To characterise the adopters and the non-adopters of IPM in Masembura communal area in Bindura District	What are the socio-economic characteristics of adopters and non-adopters of IPM amongst the smallholder farmers?	Descriptive Statistics
ii) To determine the effect of IPM on food access in Masembura communal area in Bindura.	Is there any effect of IPM on food access amongst smallholder farmers in Masembura communal area in Bindura	HFIAS, HDDS, individual's dietary intake, Descriptive statistics

iii)	To ascertain the challenges affecting the adoption of IPM in Masembura communal area in Bindura District	What are the challenges affecting the adoption of IPM in Masembura?	Tables
iv)	To analyse the factors affecting the adoption of IPM in Masembura communal area in Bindura.	What are the socio-economic factors affecting adoption of IPM amongst the smallholder farmers in Masembura communal area in Bindura?	Descriptive Analysis Table Binary regression analysis

1.5 Justification

Households that are either positively or negatively impacted by losses resulting from poor pest management particularly those that do not adopt IPM strategies. However, stakeholders to promote an inclusive approach to IPM that addresses the needs of farmers by promoting self-sufficiency through income derived.

The study will specify the extent to which IPM has been conducted and limitations of the contribution of locals to the attainment of good yields and reliable storage that affects their food security. This research project emphasizes the importance of sustainable production through use of IPM tools efficiently maximizing on yields and minimizing on post-harvest losses. It provides strategic information for livelihoods and sustainable crop development in the process contributing to the national bread basket.

1.6 Scope / Delimitations and Limitation of the study

The study focus on smallholder farmers in villages in Masembura communal lands in Bindura district who derive their livelihoods from agricultural activities that are under threat from poor pest management and new pests. Monetary and time challenges were the major limitations to research coverage.

1.7 Outline of thesis

This research has a total of six chapters.

Chapter one presents the introductory part of the study which comprises of the background information, problem statement, objectives, justification and scope of the study.

The second chapter reviews related literature covering the problem under study. Multiple articles having diverging and converging ideologies in different school of thought as well as empirical findings by other researchers that are pertinent to the problem were critically read and presented. The conceptual framework of the study is also presented.

The third chapter denotes research methodology with it carries the description of study sites, research design, sampling procedure, data collection procedure, data analysis procedure and the ethical considerations.

Chapter four consists the presentation of results on the first three objectives, namely the characterisation of the smallholder farmers, the analysis of the effect of IPM on food access and the challenges encountered in the adoption of IPM.

Chapter five, six and seven consists of the presentation and the analysis of data on the analysis of the factors affecting the adoption of IPM amongst the smallholder farmers in Masembura communal area in Bindura.

Chapter eight consists of the research summary, conclusions, policy implementation and recommendations

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This literature related to effects of pests in this chapter, the role of IPM and infield/post-harvest losses on food security. Various scholarly articles of diverging and converging ideas as well as empirical findings by other researchers that are viable to the problem are presented. Adoption of IPM is critical in sustainable agriculture since it is both profitable and beneficial to the farmer’s health as well as environment health. There is also need to dissect the benefit of IPM in contributing to food and nutrition security.

2.1.1 Contextualization of Food security

There are a lot of definitions around food security and nutrition that has been postulated by a number of authors (Kiaya, 2014; Munongo & Shallone, 2010; Raleting & Obi, 2015; Shee et al., 2019). Food insecurity is one of the visible dimensions of poverty and squalor and is one of the clearest signs of destitution (Béné & Heck, 2005). FAO, (2017) defines food security as “a condition when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”, concerns not only food production and distribution but also has social, economic and institutional dimensions. Food security is one key issue which is at the core of programming of many nations as well as policy makers and the attainment of food security especially amongst all people is the chief goal for many governments.

2.1.2 Contextualisation of Integrated Pest Management

The FAO have defined IPM as the “careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment.” The most important thing to remember with IPM is that it is a flexible approach; one that makes use of all available technologies and is adapted to local needs. This is not a blanket approach but an evolving one tailored to the specific needs of every farmer. A recent Scientific Foresight Study, published by the European Parliament, underlines that thanks to precision agriculture techniques applied in orchards and vineyards we see a reduction in pesticide use of up to 20-30% and a reduction of sprayed area between 50-80%.

In order to have a clear analysis of the situation at hand there is need to have a clear demarcation in terms of definitions of what IPM is. Generally IPM involves numerous pest control strategies that can be location oriented or extend to become crop specific. There is no stringent demarcation line as to which pest management practices are part of IPM but they are broad classification which includes, mechanical, physical, biological, cultural and chemical (Rahman & Norton, 2019). Dara, (2019) classifies IPM as input and output oriented, with the later focusing on the desired outcomes such as profitability and the former focusing on the practices. Unlike single item innovations such as high yielding varieties, IPM relies on multiple pest management strategies used singly or in combination as a package to keep pest population at low levels as well as minimize pesticides use (Kiplang'at, 2016).

2.2 Characteristics of Adopters and Non-adopters of IPM

They are many characteristics that affect adoption which can be economical, social as well as cultural. Many studies (Berg, 2013; Hoidal & Koch, 2021; Hristovska et al., 2009; Rahman & Norton, 2019; Talukder et al., 2017; Wangithi & Muriithi, 2021) reviews the various factors that separate the adopters and the non-adopters of IPM supporting the assertion that farmer characteristic has a huge tour on adoption and non-adoption.

Gender: A study done by (Wangithi & Muriithi, 2021) in Kenya, indicated that 99% of the farmers possessed knowledge of the threat of pests as well as the excessive use of pesticides to control fruit flies in their production. The study indicated that IPM adoption however was relatively low despite farmers possessing that knowledge. Findings from the study also indicated that gender was critical in adoption of IPM as a method of pest control. 88% of the male headed households in the study were adopters of IPM this is because they were dominant in crop management. (Ochilo et al., 2018) also concurs with the findings and explains that men usually take the upper hand in production as well as crop management, and indicates that agriculture is drudgery and is mainly done by men.

Age: is one of the characteristics of farmers that distinguish significantly the adopters and the non-adopters. There are varying age groups in Masembura with a youthful population dominating the elderly in the area. The majority of the farmers are with the age groups 18-35. In previous studies done in Kenya, 59% of the respondents where in 18-35 years category whilst the 36-50 and the 50 plus age groups both had 41% in total (Wangithi & Muriithi, 2021). In a study carried out in Bangladesh, 66.5% of the respondents were below the age of 40 whereas those above 40 constituted 34.5% of the respondents in the study. This is mainly because the younger age still has got energy to participate in agriculture production.

Knowledge: A study by **(**Samiee et al., (2014) indicates that knowledge is of that characteristic that significantly distinguished adopters and non-adopters. The findings from the study done in Iran indicates that knowledge controlled around 60% of the variation in adoption and non-adoption of IPM in wheat production. Several studies indicate that farmers who are literate and have more education as contact with extension, are found on the adopter's side of IPM compared to farmers without this (Kiplang'at, 2016; Li et al., 2011; Maumbe & Swinton, 1999; Muzari, 2017; Norton, 2017) this is because those with knowledge have adequate information on the harmful effects of pesticides on human beings and on the environment.

Farm size: Masembura has a communal holding setup with farm size varying between 1 acre to 5 ha. Farm size according to (Bueno et al., 2021) has a huge effect on the adoption of agriculture technology since those with large pieces of land are likely to have extra land to try out technologies compared to those without. However, a number of authors found out that land holding size does not have anything to do with adoption of IPM since it can also be practiced on any crop and on any land holding unlike other technologies (Alwang et al., 2019; Kabir et al., 2017; Kiplang'at, 2016; Muzari, 2017).

Farming experience: A number of studies globally have highlighted farming experience as one of the key characteristics of farmers in adoption and non-adoption of IPM (Hristovska et al., 2009; Li et al., 2011; Norton, 2017; Samiee et al., 2014; Wangithi & Muriithi, 2021). In a study carried out in Bangladesh, the farmers with more years of experience were dominant adopters of IPM whereas those without experience dominated in the non-adopters' side. (Talukder et al., 2017). Those with farming experience have experience and knowledge and can make informed decisions on adopting or not adopting technologies.

2.3 Effects of IPM on Food Security

Food security is anchored on our key pillars which include food access, food availability, food utilization and food availability. These are critical and it is the mandate of all agriculture innovations and technologies to make sure that these pillars are guaranteed. IPM as an innovation has impact on each of these pillars as will be explained and illustrated in the sections below.

a) Effect on Food Access

Pests are one of the main limitations to attainment of sustainable yields and returns in agriculture production. Elimination of pests is critical in attainment of optimum yields in all crop enterprises. There is some evidence indicating that these losses are rising, despite the increasing use of chemical pesticides. At the same time, there is rising public concern about the potential adverse effects of chemical pesticides on human health, the environment and biodiversity. Increased use of pesticides leads to pest mutation causing a growth in menace and chemical resistant which leads to devastating yield losses. Food access includes access to adequate resources for acquiring appropriate foods for a nutritious diet. IPM lead to sustainable management of pests leading to substantial increase in yield which leads to increased food access.

b) Effect on Food affordability

Management of pests is very expensive and takes a substantial proportion of agricultural costs. In addition, the cost and burden on the farmer is more when, the pests would have exceeded the allowable threshold and also in the event of chemical resistant pests. In horticulture around 20% of the total costs is taken up by pest control which is mandatory since there are a big risk in the enterprise. The cost of production is reflected on the cost of the final produce and is passed on to the consumer. Hence the more the money that is dedicated to pest control as well as the control of the harmful and incorrect usage pf pesticides, the higher the price of the final produce making food very unaffordable for the rest of the consumers.

IPM contributes to efficient management of pest in a less costly manner and also helping the farmer to prevent other additional costs associating in correcting the effects of excessive pesticide use. Parsa et al., (2014) indicates that successful implementation of IPM can lead to reduction of overall production cost by 15% which means that it can contribute to the increase in the affordability of food produce by that same percentage. Therefore, the removal of the extra burden and cost of pesticides associate with IPM leads to a reduction in the overall price of food produce making it more affordable.

c) Effect on Utilization

Food utilization is the proper biological use of food, requiring a diet providing sufficient energy and essential nutrients, potable water, and adequate sanitation (FAO et al., 2020). Effective food utilization depends in large measure on knowledge within the household of food storage and processing techniques, basic principles of nutrition and proper childcare. Food utilisation requires that the food be safe as well as containing the required nutrition value as well as adequate sanitation. Improper pest control in agriculture production reduces food quality through pests infestations. These reduces also the quantity of food available as well as its nutritional status. Excessive use of chemicals is also harmful to health hence a risk to attainment of proper food utilisation.

One of the key issues with pesticide use is the issues of food safety since a lot of pesticide residues some which are carcinogenic are found in the food that is consumed at the end of the chain. This is dangerous to health of the consumer as well as the general assimilation of nutrients in the body. IPM focuses on sustainable and effective control of pesticides as well as usage of chemicals is replaced using other modes of control such as biological and physical (Alabi et al., 2020). This eliminates harmful residues of chemicals in the agriculture produce as well as maintaining a safe environment which is healthy for the producer and the consumers.

d) Effect on Food availability

Pests are detrimental to agriculture production. Globally, approximately half of the food and fibre produced is lost to fi eld and storage pests (insects, pathogens, weeds, nematodes and vertebrate pests) (Pretty & Bharucha, 2015). It has been estimated that 5–40% of crop losses each year are due to pests (Shankar & Abrol, 2012). Pests damage crops at different stages of growth in the fi eld, at harvest, during transportation and in storage. This leads to significant crop losses yearly and has a serious effect on food security for the ever-increasing population. The management of pests in crops to obtain a better yield is paramount for food security. Resource-poor farmers who produce a large percentage of their crop for consumption cannot afford expensive management of pests to meet the yearly target consumption levels for their country. IPM is important in bringing out sustainability of pest control which are successful in controlling pests which have a negative effect on the availability of food which an important pillar of food security.

2.4 Challenges of IPM Adoption

Despite its theoretical prominence and sound principles, integrated pest management (IPM) continues to suffer from anaemic adoption rates in developing countries. (European Union, (2021) indicates in a report that there are a lot of challenges that are faced in the mandatory implementation of the principles of IPM as called by Directive 2009/128/EC on the sustainable use of pesticides. IPM is facing both external and internal challenges. External challenges include.

2.4.1 External Challenges

There are a number of external challenges that affect the effective implementation of IPM in the communities and these external factors are listed below.

1. Climate change

Climate change affects the growth and multiplication as well as rise in mutated species of pests which are difficult to control. Climate change can affect the population size, survival rate and geographical distribution of pests; and the intensity, development and geographical distribution of diseases. Temperature and rainfall are the big drivers of shifts in how and where pests and diseases spread, according to experts (Kogan, 1998). In general, an increase in temperature and precipitation levels favours the growth and distribution of most pest species by providing a warm and humid environment and providing necessary moisture for their growth (Laegreid & Agroecology, 2018). There is a growth of Tuta Absoluta and Fall Army Worm which have devastating effects on horticulture and staple food production in Zimbabwe respectively. The growth of these pests is linked through evidence with climate change (Pretty & Bharucha, 2015). Implementation of IPM is sustainable

2. Pesticide Resistance and evolution

Pesticide resistance is not only a textbook example of rapid adaptive evolution in response to human activities in organisms with short generation times, but it also has practical consequences, in that the evolution of resistance and its spread in pest populations can disrupt pest control, thereby threatening food security. This risk has been exacerbated by more stringent pesticide regulations, a direct consequence of rising public concern about the detrimental effects of pesticides on human health and ecosystems. Both the development of resistance and the tightening of regulations have reduced the diversity of pesticide molecules and modes of action available for each crop, in turn increasing the risk of selection for resistance. The rise of resistant pests makes it difficult to implement IPM as well as bring out its effectiveness

3. Pesticide Companies

Another huge problem in the implementation of IPM is the messaging from chemical companies who have a profit motive and who in turn lose in the light of the implementation of the IPM. These organizations in turn advertise the effectiveness of their pesticides in controlling some pests which in turn leads to the rise of resistant pests. Pesticide industry has been blooming ever since the coming in of the Green Revolution and to reduce their capacity in the run to promote IPM is a very difficult stance.

2.4.2 Internal Factors

a) Limited Research on IPM

In addition there is a big gap in research into the economic incentives such as cost reduction and economic contribution of adoption of IPM which makes it unattractive for farmers to adopt. The messaging hinges on the harmful effects of pesticides without focus on the benefits especially economic since agriculture is profit oriented as well as production efficiency oriented. They are weak research institutions in the developing countries with very little budgetary consideration for agriculture research which limits the knowledge available on IPM therefore limiting its repeatability as well as its adoption.

b) Limited Training and Knowledge

PM presents an educational challenge for farmers, research and extension personnel in developing countries (Talukder et al., 2017; Wangithi & Muriithi, 2021). Pellegrini, (2013) singled out lack of IPM training and knowledge as major constraints to the implementation of IPM in Africa within the subsistence and emerging agricultural systems. Other limitations are specific crop and pest management information as well as access to information on alternative pest control practices. Muzari, (2017) in discussing pest management in Africa observed that farmers lacked biological and ecological information needed for exploratory approaches to pest management.

Norton, (2017) pointed out, little may be attained through developing and evaluating IPM practices without complimentary efforts in extension and training. When extension agents do not have information on IPM practices, they are likely to be sceptical about their role towards sustainable agricultural practices. Extension agents are, however, important in facilitating adoption of new agricultural technologies. Overcoming the barriers in knowledge and training that extension agents face is one way of enhancing their role in adoption of IPM (Afolabi, 2020). The knowledge and management-intensive nature of IPM, therefore, requires means to ensure in-depth learning on the ecology of pests in the diverse agricultural systems of developing countries. Overcoming training and educational constraints in IPM programs for both farmers and extension agents is still a major challenge in many developing countries (Hristovska et al., 2009).

c) Weakness in Extension and outreach

In order for IPM to be diffuses in a sustainable way. There is need for effective extension for the effective adoption of IPM. Extension is needed to explain and pass on knowledge on the benefits of IPM and its advantage over excessive reliance on chemical pesticides. There are limited resources for extension in Zimbabwe to incentivize and support the public extension to carry out sensitization and support the necessary diffusion of IPM and also monitor and supports its adoption. In Asia and Europe IPM has been supported through capacitation of the public extension to establish IPM-FFS which are critical learning centres for sustainable IPM uptake. In the African continent because of the economic woes, IPM sensitization and diffusion has been supported by private extension and Non- Governmental Organizations who come in with funding complementing the public extension.

A reciprocal, horizontal, inclusive relationship between extension agents and farmers as opposed to vertical (top-down) extension approaches is needed to increase success of sustainable practices such as IPM. It is more important than ever to appreciate the role of the farmer as a researcher, in testing and refining of sustainable technologies

d) Weakness of the delivery system

The success of IPM programs depends on the delivery system, which to a great extent determines the farmer's response (Hoidal & Koch, 2021). The problem of transfer of IPM practices is regarded as a major barrier limiting progress of IPM worldwide (Dara, 2019). In developing countries, the Transfer of Technology (TOT) model for extension has been predominant. In TOT, research/scientists and extension develop new techniques, which are then transferred to farmers. The TOT model however is regarded as inappropriate in implementing IPM practices. IPM practices are not fixed prescriptions, but depend on the farmer's ability to experiment and make decisions relative to prevailing location-specific Agro-ecological conditions.

e) Phycological factors barrier

Overcoming psychological barriers occurs in any change process and IPM is no exception. (Kiplang'at, 2016) observed that decisions on practices associated with sustainability are value-laden and would therefore require reflection on the impact of personal preferences. IPM practices may promise ecological sustainability, environmental conservation and even better health for the society but they must undergo social acceptance by farmers (Li et al., 2011). Until IPM practices are observed in farmers' fields, then their potential in pest management will remain elusive. Farmers in developing countries are constrained by limited resources and depend on very small farms (usually less than 2.0 hectares) for income generation and food. According to (Pellegrini, 2013), farmers had a distancing perception towards the problems associated with dependence on agricultural chemicals. Farmers recognize that agricultural production depends too much on agricultural chemicals but generalize the concern, and fail to acknowledge the contributions of their individual farm operations to the problem. Implementing IPM practices will require overcoming personal attitudes and misconceptions. Education and efforts to increase farmers' awareness of environmental problems arising through pesticides is also needed to overcome the personal related barriers to adoption of integrative pest management practices

2.5 Factors affecting Adoption of IPM

There are a number of factors that affect adoption of IPM. The characteristics can be divided into social, economic as well as institutional. Under social there is sex, age, education, marital status and household size which are the key drivers of IPM adoption and under economy there is farm size and average income which are also key drivers of adoption of IPM. Under institutional factors there is contact with extension.

2.5.1 Social Factors

Sex is one of the major determinants of adoption of agriculture technologies (Wawire et al., 2017). Agriculture is drudgery and hence requires a lot of hard labour for its efficiency if there is no mechanization. In a study carried out in Bangladesh, (Rahman & Norton, (2019) highlighted that more male (67%) participants were available as respondents compared to women and also indicated that they were more male adopters than females. This was also supported by (Li et al., 2011). This is mainly because in the majority of developing communities' men are the decision makers and also have access and ownership of factors of production (Hoidal & Koch, 2021).

Age is another key factor in adoption as postulated by a number of authors (Bueno et al., 2021; Muriithi et al., 2020; Parsa et al., 2014). There is a mixture of input from various authors on age and adoption of technology, with some authors such as (Berg, 2013) indicating that age has an inverse effect on the adoption. This is contradicted by (Muzari, 2017) who indicates that there is a positive relation between age and adoption of technologies since age is intertwined with experience in production and decision making as well. Usually, older farmers are less likely to explore new sources of information and thus less likely to depend on multiple sources. It is hypothesized that the increase in age would have influence on access to different sources of information (Li et al., 2011). In addition, age can also be interpreted as experience in farming which improves farmers' skills in production and low level of uncertainty regarding innovations performance and can assess the advantages of new technology.

Education. (Alwang et al., (2019) postulates lack of education and illiteracy as one huge barrier to adoption of IPM and indicates sub-Saharan Africa as the area most affected by this. Education increases information handling capacity as well as decision making as well as boosting knowledge especially on the harmful effects of pesticides. This then means that informed decisions can be made by someone who is educated compared to one who is not (Rahman & Norton, 2019). Education is one of the important factors that influence farmer's decision to bear the risks associated with new technologies and modern information sources. Farmers with better education are earlier adopters of modern technologies and apply modern inputs more efficiently throughout the adoption process (Mittal & Mehar, 2015).

Household size is also a key social factor in the adoption of IPM and depicts the number of people who reside and get their food from a particular household. A bigger household size has adequate labour for the adoption and implementation of IPM and other agriculture technologies (Uwagboe et al., 2012). This also concurs with (State et al., (2020) who also highlighted that large households are quicker to adopt different agriculture technologies because they have representatives even during trainings and meetings compared to those households with very few members.

Farming Experience. (Parsa et al., (2014) pointed out farming experience as one of the factors that can make farmers weak or strong adopters of IPM in the developing countries. In a study in Kenya, (Wangithi & Muriithi, (2021) indicated that experience in farming improved farmers' skills in production and low level of uncertainty regarding innovations performance as well as assessment capabilities of innovative technology. In addition, experienced farmers have more experience in pest management and therefore are likely to be more aware of the benefits of IPM. Farming experience may also come with the required resources required to invest in sustainable pest management (Dijkxhoorn et al., 2013).

2.5.2 Economic

Income. Income is an important factor which shoes the farmer's economic status. A study carried out to ascertain issue affecting IPM in Asia and Africa pointed out that most farmers who adopt IPM do so in order to save costs and improve their farm income (Pretty & Bharucha, 2015). Income has a huge effect on adoption of agriculture technologies. If the implementation of the technology requires extra cost, then those with a lot of income can afford adopting as well as implementation of these technologies (Pretty & Bharucha, 2015).

Farm size. This is proxy for farmer's economic status. It is measured in acres. It is expected to be positively associated with probability of using modern information sources. The sample has a greater number of small and marginal farm holders and this matches the operational land holding statistics of agricultural census data by the government of Zimbabwe (Mutasa, 2010).

Cost of technology. Farmer wealth endowment is a major determinant of affordability as the higher the cost of implementing the greater the wealth and income the farmer has to have. The lower the cost of technology results in more wide spread adoption rate amongst farmers of diverging income groups

Expected Benefits from technology. The rate of adoption of an innovation is affected by 8 factors. These are farmers' ability to pay, their vulnerability, scale of production by farmers, the adaptability of the innovation to local condition, the perceived long-term considerations, suspicions towards new technology, endorsement by opinion leaders and farmers' access to information. Rogers (2003)

Off farm activities. Alternative sources of income other than from agriculture such as remittances from family, rentals from properties and other business operations. Off farm activities bring in income increasing the income base of the farmer. Some of the technologies come with cost of implementation of which the farmers with many streams of income can easily accept the innovation since the cost burden of technology can be a huge barrier in adoption.

2.5.3 Institutional

Contact with Extension services. Extension services play a critical role in the diffusion of information on the IPM as well as other innovative agriculture technologies (Bueno et al., 2021) Extension and Advisory Services is the conscious and unconscious involvement of the public, private, NGOs as well as farmer organisations in influencing knowledge generation and dissemination in agriculture (FAO, 2017).

Private sector organizations Involvement. Private sector organizations have a huge role diffusion of information, innovations, good stewardship of products and out-grower policies that foster adoption of IPM technologies. The world extension service provision is done 80% of it by public sector while NGOs contribute about 12% and private sector only 5%. The world has over 800 000 formal extension service providers of which 90% are in developing world (Fanzo, 2015). Maseru (2015), identified an impeding environment against public extension delivery in Zimbabwe. He wrote about a sector that is inadequately funded and remunerated leading to brain drain of experienced staff to greener pastures leaving new and inexperienced staff behind which is not conversant with some of the technologies they should propel. This leads to low and poor adoption of some otherwise good innovations (Mngumi, 2010, cited by Masere, 2015).

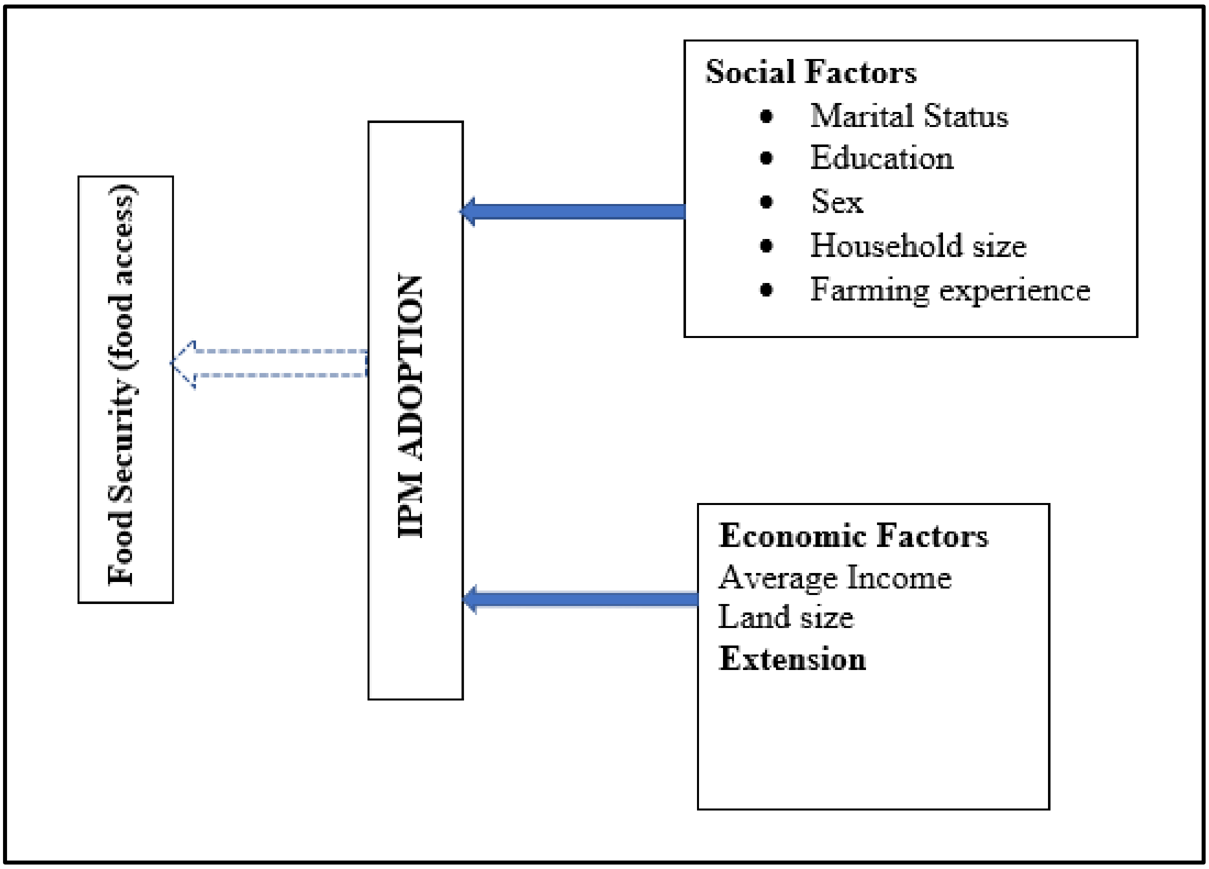
Government Support. In Europe residue testing has necessitates mandatory IPM adoption if you are to serve the EU markets for fresh produce as well as standards associations that conform to set practices. The support of government and its weight on and innovation leads to quick diffusion of the innovation. The government in Zimbabwe put its weight on the Pfumvudza concept which has the element of IPM in it through mulching and encouragement of scouting and crop rotation. The government also supported the initiative with incentives of inputs leading to its adoption on many communities by many people. Government support is therefore necessary and critical.

Access to information. The internet, farmer organizations and magazines are a good source of information. Kachelriess *et al*. (2016) emphasises the role extension plays through information dissemination on technology adoption. Farmers would adopt a technology when then extension agents and other opinion leaders have information about it especially in farmer groupings. Information structures are key in driving knowledge to the communities. Knowledge is key in the quick adoption of innovative technologies. If there are excellent communication structure and also effective information communication and technology facilities such as network boosters and radio technologies it also has an effect of movement of knowledge.

2.6 The study conceptual framework

The conceptual framework used in this study illustrates the relationship first between adoption and the various social economic characteristics of the communal farmers in Masembura Bindura. It then also gives the connection between the adoption of IPM and food security. The illustration in fig 1 below conceptualise IPM adoption as affected by the socio-economic characteristics of the respondents and food security as also affected by adoption of IPM. It is also conceptualised that these factors affect adoption and use at ceteris paribus without taking into effect how other factors outside the side-affect these independent factors.

Figure 1 Conceptual framework of the study



2.7 Summary of literature review

The chapter dealt with consequences of poor pest management both infield and post-harvest using various authors and case studies to illustrate the impact and various dangers on food security and sustainable livelihoods. The chapter discussed livelihood strategies that have been transformed as a direct result of proper implementation of IPM strategies and success stories that followed.

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CHAPTER 3
METHODOLOGY

3.1 Introduction

This third chapter represents all tools and methods used in this study. The research design and empirical methods for the general approach, and specific techniques to address the objectives for this research. The description of data collection procedure, study sites, sampling procedure, data analysis procedure and the ethical considerations.

3.2 Description of study sites

The study focused on Masembura communal lands in Bindura district, Mashonaland Central Province in, Northern Zimbabwe. The rainfall in the area is fairly reliable and ranges from 750 to 1 000 mm/year falling from around November to end March and sometimes into April. Because of the reliable rainfall and generally good soils, NR II is suitable for intensive cropping and livestock production. It accounts for 75-80 percent of the area planted to crops in Zimbabwe. The cropping systems are based on horticulture, flue-cured tobacco, maize, cotton, wheat, soybeans, sorghum, groundnuts, seed maize and burley tobacco grown under dryland production as well as with supplementary irrigation in the wet months.

Irrigated crops include wheat and barley grown in the colder and drier months (May-September). NR II is suitable for intensive livestock production based on pastures and pen-fattening utilizing crop residues and grain. The main livestock production systems include beef, dairy, pig and poultry. Prior to 2000, the region was dominated by the communal farming subsector characterized by less mechanised villages ranging from 2-5ha under freehold title and owner-operated. Following the agrarian and land reform programs initiated in 1999/2000, a large proportion of the farms were subdivided into smaller units and allocated to new farmers under the A1 and A2 small-scale farming system.

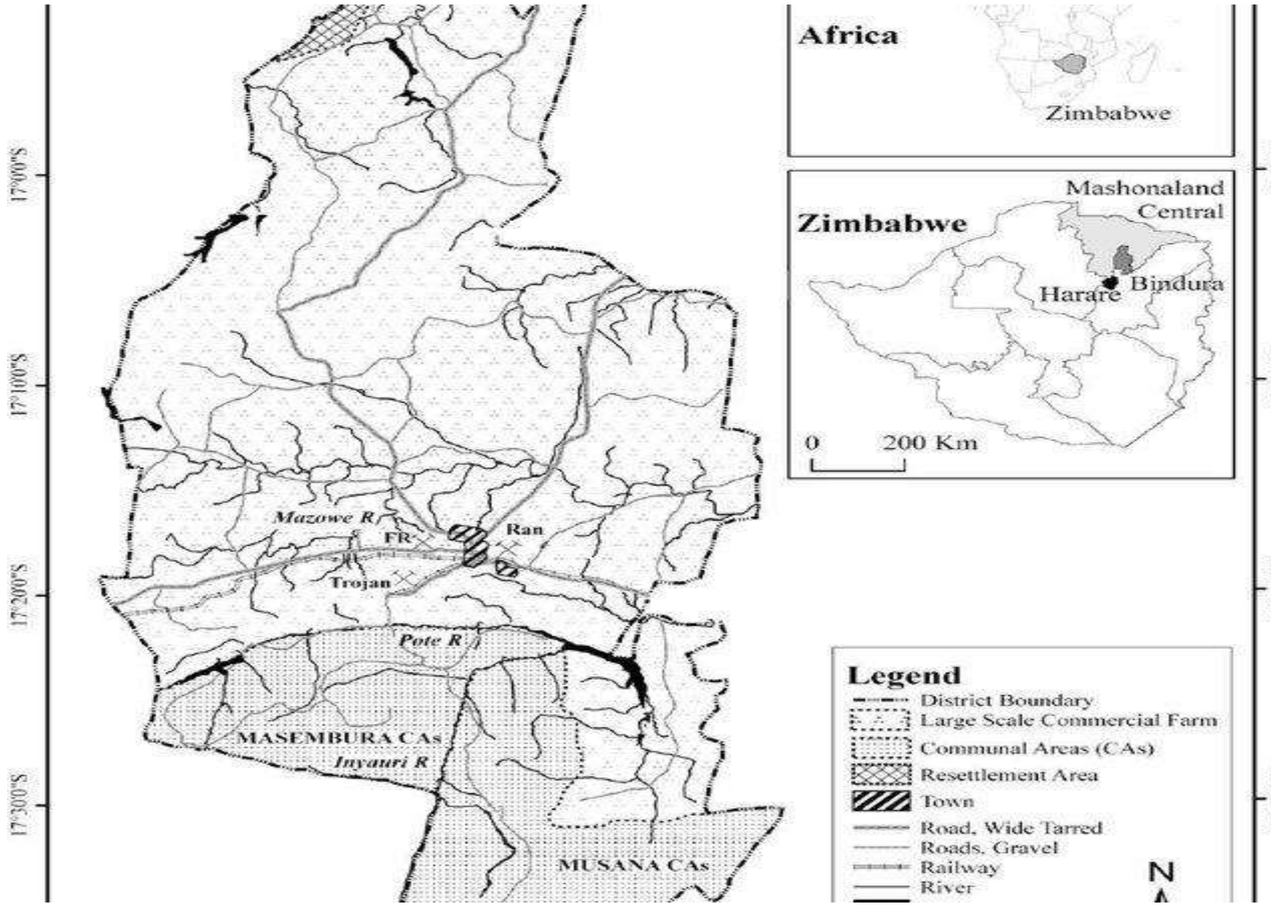

Figure 1 Area of study

3.3 Research design

This study adopted qualitative and quantitative methods of data collection were used. Qualitative data was collected through interviews with selected key informants who include local community leaders and line ministries in the process managed to collect secondary information from them. Household demographic and socio-economic characteristic data was collected using questionnaires with selected households in Masembura communal lands.

The effects of IPM strategies, household livelihood strategies data was gathered for periods before and after the cropping cycles of summer cropping season and horticultural crops grown throughout the year. Household food security status was determined using data collected using the Household Food Insecurity Access Scale for households in the area. Data was analyzed as per each given objective.

3.4 Sampling procedure

The study was done in Masembura communal area ward 12 and ward 13. The researcher used the list from the ward councilor and purposively sampled two villages in each of the 2 wards to make it a total of 4 villages with a total of 620 households which was used as the population of the study. The wards were selected because they had fully received their presidential input scheme packages at the onset of the study hence, they would give relevant information.

The formula below was used to determine the sample size for the study and a total of 150 respondents

Equation 1: Slovin's Formula for sample size determination

$$n = \frac{N}{1 + Ne^2}$$

n= sample size

N= population size

e= confidence level (0.1)

Purposive sampling method was used to select the sample. Those deemed relevant in contributing to the matter under investigation will be chosen through the researcher’s choice. This form of sampling is judgmental in its nature. After the purposive technique was employed, the convenience sampling technique was also be used to select the respondents. I select the respondents based on their knowledge and involvement in the agriculture field. The advantage of purposive sampling is that there is a great possibility of selecting those with very relevant data to the matter under study. The disadvantage is that there is researcher biasness in the selection of the respondents.

3.5 Data collection procedure

For the purpose of this study, both primary and secondary data was used. Primary data collection included a structured household survey questionnaire and key informant face to face interviews. Some processes were followed to get approval to undertake the proposed research from relevant local authorities such as village heads, chief and agricultural extension officers that preside over the area. The first step involved application for approval to local government national office followed by stakeholder mapping to identify key stakeholders at regional and district levels. They were then notified of the intended study.

Secondary data supplemented findings by primary data. Review of relevant literature was done to obtain secondary data on objectives under study. Published data was collected from ZIMVAC reports and data from other studies conducted in the area were from NGOs and government department reports.

3.5.1 Validity of Research Instruments

The validity of an instrument is in measuring what it is meant to measure and bring out the true effect of the phenomenon of the study at hand, after collection, data obtained should be a true reflection of the variables under study. Validity is the extent to which the results obtained from the analysis of data actually represent the phenomena under study (Mugenda and Mugenda, 2003). The research ascertained the validity of the research instrument by comparing the results from the pilot study with the expected responses and outcomes. Content validity was used to verify whether the questions in the questionnaire answers to the objectives of the study. In order to achieve discrepancy, adjusting, correcting and rephrasing statements on the questionnaire was done. The questionnaire was designed to include all the element under the study.

3.5.2 Reliability of Research Instruments

The research instruments were tested for their reliability which was meant to find out if they were capable of bringing out the required information. Mugenda and Mugenda (2003) define reliability as a measure of the degree to which an instrument yields consistent results or data after repeated trails. Piloting enabled the researcher to test for the reliability of the research instruments. It involved testing the questionnaire to one group selected randomly as stated and then after some time the test was administered to the same group a technique called re-test.

3.6 Data analysis procedure

Data from questionnaires and secondary sources were compiled, sorted, cleaned and coded into a coding sheet and was subjected to a computerized statistical package SPSS 23. Data was analyzed as per each given objective. Household demographic and socio-economic characteristics data was analyzed using descriptive statistics to describe and summarize gathered data.

3.6.1 Analysis of the characterization of the adopters and the non-adopters of IPM

Data under this objective was analyzed using qualitative descriptive statistics such as tables, bar graphs, percentages, means and mode that is for qualitative data under this section (marital status, education level, adoption/ non-adoption, sex, exposure to extension. Quantitative data was analyzed using t-tests, standard deviation, means to find if there are statistical differences in these variables between the adopters and the non-adopters.

3.6.2 Analysis of the food security access of the adopters and the non-adopters of IPM

Data under this objective was analyzed using qualitative descriptive statistics such as tables, bar graphs, percentages, means and mode that is for qualitative data under this section (marital status, education level, adoption/ non-adoption, sex, exposure to extension.

3.6.2.1 Food access.

Household Food Insecurity Access Scale (HFIAS) was used to measure food access of the respondents. Food security status of respondent households was estimated using the Household Food Insecurity Access scale (HFIAS) for measurement of food access. The HFIAS is an adaptation of the approach used to estimate the prevalence of food. The method is based on the idea that the experience of food insecurity (access) causes predictable reactions and responses that can be captured and quantified through a survey and summarized in a scale. The results from the HFIAS were categorized in terms of adoption and non-adoption and were tested for significant difference in order to ascertain whether there is significant difference between the adopters and the non-adopters.

3.6.2.2 Food stability.

After years of increasing global food security world hunger is rising again. This rise is concentrated mainly in countries affected by conflict and fragility where violent conflict can destroy crops, assets and displace people. As a result of prolonged instability borders can be closed, (safe) access to markets can be limited, and farm inputs can become scarcely available. To deal with such a precarious environment farmers and actors along the food chain employ various coping mechanisms that are at best detrimental to food availability, and at worst can contribute to further instability. Conversely through the importance of agriculture in the economies of these countries the development of the sector can contribute to an enabling environment for increased stability. The promotion of resilience of rural food systems can serve to increase household and community food security in the face of instability. The data collected using a coded questionnaire. The data will be entered, cleaned and run in Statistical Package for Social Sciences (SPSS Version 23) software for analysis. The researcher will compute percentages and frequencies in the form of descriptive statistics to analyse the categorical qualitative data. The researcher is choosing to adopt percentages and frequencies because the characteristics such as age, marital status, education, experience and access to starter pack is measured using qualitative scales such as ordinal scale. The ordinal scales will be based on a 5-point Liker scales to measure the extent to which characteristics of IPM adoption are affected by food stability.

3.6.2.3 Food utilization.

Household food utilization will be evaluated by using the Household Dietary Diversity Score (HDDS) established by USAID, FANTA and IFPRI in 2006. For computing, household dietary diversity score data will be attained through a set of the questionnaire which will contain questions of food consumption within one week seven days recall period.

In the set of questionnaire nine food groups' A= cereals and grains, B= pulses and legumes, C= vegetables, D= fruits, E= meat, F= milk and dairy products, G= oil and fats, H= sugar and sweets, I= condiments and spices included according to the international rules of constructing household dietary diversity score. Food consumption groups included in questionnaire will be assigned two values yes positive answer (consumed) =1 and no negative answer (Not consumed) =0. Household dietary diversity score included the food groups prepared and consumed by household members within the home. Household dietary diversity score calculation is very unpretentious; it will be the sum of responses by respondents about consuming each food group. HDDS=Sum (A+B+C+D+E+F+G+H+I). Average HDDS=Sum (HDDS)/Total number of households surveyed. Household dietary diversity score has nine food groups so score will be spotted between 0 and 9.

3.6.2.4 Food availability

It is measured by assessing individual's dietary intake. The individual's dietary intake can be measured through different methods including: i) 24-hour recall; ii) food frequency questionnaires; iii) food records kept by individuals or by an observer. All dietary intake methods need to make use of a reference time frame. Whereas some of the methods rely on the memory of participants (24-hour recall, food frequency questionnaire), others rely on the recording of foods, as they are consumed, by the study participant, a proxy or an observer. Portion size estimations can rely on assisted memory for example, using food models or foods can actually be weighted before and right after consumption. These portion size estimations are needed to estimate food group counts as well as nutrient intakes, the latter provided that culturally appropriate and valid food composition data bases are available. Lastly, to interpret the nutrient intake findings it is important to have cut-off points for determining the proportion of the sample or population at risk of deficiencies for different nutrients.

3.6.3 Analysis of the challenges affecting adoption of IPM amongst smallholder farmers

The input from the questionnaire section on challenges affecting adoption were analyzed using the 5-liker scale. The challenges were ranked according to percentage respondents selecting them and their ranking to ascertain the most substantial challenge in the adoption of the IPM.

3.6.4 Analysis of the factors affecting adoption of IPM amongst smallholder farmers

Descriptive analysis table detailing internal versus external factors affecting adoption of IPM in Masembura communal lands. Binary Logistic regression was used to analyse the factors affecting adoption of IPM amongst the smallholder farmers in Bindura District.

The Analytic Model

We explored the effects of socio-economic variables to adoption of IPM. The farmers either adopted or did not adopt the use of the IPM methods. The Binary logistic regression method was used to analyse the effects of socio-economic variables on IPM adoption. Since the adoption is a binary (1 for ‘adopted’ 0 for “not adopted”) therefore Y=0 will denote, not adopted and Y=1 will represent adopted. X denotes the vector for independent variables which include, age, gender, education level, land size, household size, income, extension education. The binary logistic is stated in the probability that Y=1 given X:

$$P(Y=1|X)=\frac{1}{1+Exp(-\beta X)}$$

$Z=\beta X$ is called the linear predictor and stands for $\beta_o+\beta_1 X_1+\cdots\ldots\ldots\ldots\ldots\ldots..+\beta_P X_P$

By solving Y the form for the binary logistic regression model is obtained:

In $\frac{P(Y=1|X)}{P(Y=0|X)}$=logit ($Y$)= βX (Kosemely and Vadnal, 2003)

The recommended sample size for this kind of research is calculated by taking into consideration the minimum ratio of sample size to independent variables of 10 to 1 with a sample size of 100 to 50 plus a variable number which that is a function of the predictor (Peng, Lee & Ingersoll, 2002). This was satisfied in the research

Table 3.1 measurable variables

Variable	Coding	Type of Measure	Prior Expectation
DEPENDENT VARIABLE			
IPM Adoption	ADPTN	0, Did not adopt 1= Adopted	+/-
INDEPENDENT VARIABLES			
Age	AGE	Continuous	-
Gender	GENDER	0 for females, 1 for males	-/+
Household size	AGE	Continuous	+/-
Education	EDU	Continuous-denoting number of years of formal education	+

Farming experience	FARMEXP	Continuous	+
Income	INCOME	Continuous	+
Land size	LANDSIZE	Continuous	+
Extension	EXTEN	Dummy 0 for no, 1 for Yes	+

3.7 Ethical considerations

The researcher considered the following ethical principles; honesty, objectivity, integrity, carefulness, respect for intellectual property, confidentiality and legality in carrying out his work. Participants in the study were fully informed and had a full consent before taking part in the study. The researcher was honest hence no fabrication, falsifying or misrepresentation of data was done. Professionalism was consistent throughout analysis and data interpretation as the researcher had no financial or hidden interests that may affect the study. Keeping all promises and agreements the researcher strived for consistency throughout the project. No research documents were lost, destroyed or altered. Proper acknowledgement or credit of any contributions to this research has been done. Respondent information confidentiality was protected throughout the research. All relevant laws, institutional and government policies were followed in carrying out this research work.

3.8 Summary

This chapter has provided an outline and description of the research methodology undertaken in the research project. The description of the study area, the research design, the sampling methods, the data collection methods and the data analysis methods are all included in this study.

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CHAPTER FOUR

CHARATERISTICS OF ADOPTERS AND NON-ADOPTERS OF IPM

Abstract

This chapter looks at the presentation and the analysis of the findings of this research project. It looks at both the descriptive and econometric analysis. Descriptive data was analysed in the form of tables, mean, percentages, standard deviation and frequency distribution. Independent T-test was used to test for the significance difference between adopters and non-adopters in terms of income, household size, farming experience and land size. The results from the Independent T-test indicated that at 5% significant level there was difference in terms of income (p=0.006), household size (p=0.030) and land size (p=0.00002). The study also shows that they were more males in the study (58.1%) and 54% in the 28-35 years age group as well as 69% who attained secondary education. It was recommended that there is great need to boost the income generating capacity of farmers through facilitating diversification of enterprise and other off farming activities.

Key words: challenges, socio-economic characteristics, adoption, non-adoption, Independent T-test

4.1 Introduction

The chapter looks into the presentation, analysis and discussion of results for the objective, characterisation of the adopters and the non-adopters of IPM. This section also contains the results of the independent t-tests that were done to ascertain the statistical difference between quantitative characteristics of the adopters and the non-adopters of IPM.

4.2 Socio-economic Characteristics of Small-holder farmers in Masembura

The following section gives summary of socio-economic factors of the respondents in the study.

According to the table below, the 28-43 age group constituted the highest proportion (25.3%) and the 61-90 years category had the least number of respondents (5.3 %). This shows that agriculture is manned by the economically active population which compared to the elderly in order to ensure productivity on the farmer. The study had more male participants (93) than females (67). This gives an indication that they are more male participants in agriculture production than females. This is because agriculture is a drudgery economic activity which requires a lot of intensive hard labour which women cannot endure especially tobacco production which requires curing and other hard activities. The majority of the respondents in this study had attained secondary level education (46%) whereas only 6.7% had attained tertiary education according to table below. This shows a high literacy rate in Zimbabwe with the majority of the respondents and the farmers being able to read and write. The majority of the respondents are married (63.3%) compared to the least of the respondents who are divorced (8%).

Table 4.1: Socio-Economic Characteristics of Smallholder Farmers

Variable	Frequency/ N=150	Percentage
Age		
18-27	38	25.3
28-43	54	36
44-60	50	33.3
61-90	8	5.3
Sex		
Male	93	58.1
Female	67	41.9
Education Level		
Illiterate	21	14
Primary	50	33.3
Secondary	69	46
Tertiary	10	6.7
Marital Status		
Married	95	63.3
Single	95	28.7
Divorced	12	8

4.2.1 Comparisons between adopters and non-adopter of IPM amongst smallholder farmers

The table below shows the independent T-test results carried from the results of the study. Income, household size and Size of land had significant mean differences whereas farmer experience was not statistically significant at 5% significant level. From the results in the table we can pick that those who adopted IPM had a statistically higher income level of $2082.81

than those who didn't adopt who had an average income of $1737.21. This implies that income affects adoption of IPM. Income is a big proxy of economic status and this signifies the farmers ability to buy and explore IPM compared to those farmers who have lower income spreads.

Those with a statistically significant lower household size of 4.60 adopted IPM for agriculture use compared to those who had higher statistically significant household 6.41. A larger house implies pressure on economic resources hence there is little to spend on the establishment IPM (Uwagboe et al., 2012). Furthermore, land size was also statistically significant in the independent T-test according to the table below. It shows that those who had statistically high hectarage 5.84 ha adopted IPM compared to those with less hectarage (2.63).

Land size is a proxy for economic status since it reflects also the output from land, hence those with larger pieces of land are likely to explore avenues on risk management as well as they are faced with the need to look for markets and marketing information, therefore they adopt compared with those with less land (Colmenárez et al., 2016).

Table 4.2: Comparisons of quantitative characteristics between non-adopters and adopters

Variable	Default/Non-default	N	Mean	Independent t-test sig.
Income	Adopter	64	2082.81	
	Non-adopter	86	1737.21	0.006
household size	Adopter	64	4.60	
	Non-adopter	86	6.41	0.030
Experience	Adopter	64	6.80	
	Non-adopter	86	5.66	0.260
Size of Land	Adopter	64	5.84	
	Non-adopter	86	2.63	0.006

The table below shows the groupings and comparisons of socio-economic factors according to adoption of the IPM. Under those respondents who adopted, the 18-27 years age group had the highest percentage of adopters with the 61-90 years age group having the least percentage of adopters (7). From the observations it is noted that adoption decreases with increase in age. The 44-60 age group had the highest number of non-adopters according to the table below (41.6%) with the least percentage of non-adopters found in the 61-90 age group (2%). This is consistent with several studies (Alabi et al., 2020; Orr, 2003; Parsa et al., 2014) which indicates that younger generation have exposure to information that makes decision making on adoption very easy and quick thereby leading to adoption. It can be observed from the data that non-adoption of IPM increases with age. However this contradicts the findings of (Kiplang'at, 2016) who identified a correlation between age and farming experience as well as capacity to invest in technologies as well as income which guarantees adoption.

Education level also has an important effect on the adoption of IPM since it is a proxy which determines complexity and tribality of the innovation. There were more adopters who attained secondary education (57%) compared to those who did not adopt or use any IPM for agriculture purposes (31.2%). This is consistent with the findings of Muzari, (2017) and Afolabi, (2020) who also had findings indicating that education was a key determinant of adoption with those with more years in education dominating the adoption category compares to the non-adopters category. Everyone who attained tertiary education adopted the use of IPM as shown by the table below. There were more respondents in the non-adoption category compared to those respondents who adopted the use of either on of IPM (Berg, 2013). This indicates that as one advances in the stages of education, there are more likely to adopt IPM.

Marital status is one of the variables included in the study. The majority of those who adopted either one of the IPM were married (56%) and the divorced (2 respondents) were the least of the adopters. There were more singles (30%) who adopted more 3 and above of the IPM components compared to the singles (29%) who 2 or and below of the listed 5 IPM components. The difference under the singles category is very negligible. The majority of the farmers are at mid age which is the economic able age group and therefore majority of them are married as per cultural and legislation which permits marriage after 18 years.

Sex was also included as a social variable that is important in determining adoption of IPM. From the data in the table they were more males (59 respondents) who adopted either one of the IPM compared to the same gender in the non-adoption section (36 respondents). These results are opposite in the female sex, with less females being found in the non-adoption section compared to those who adopted. Generally this shows that adoption is affected by gender with males adopting IPM more than women (Heh, 2014).

Table 4.3 Comparison of descriptive characteristics of non-adopters and adopters

Adopter/Non-Adopter	Variable	Frequency	Percentage	Cumulative Percentage
		Age		

Adopter	18-27	18	39.5	20.9
	28-43	28	32.6	53.5
	44-60	34	.9	93
	61-90	6	7	100
Non-Adopter	18-27	20	25	31.3
	28-43	26	33.3	71.9
	44-60	16	41.6	96.9
	61-90	2	3.1	100
		Educational Level		
Adopter	Illiterate	5	5.8	5.8
	Primary	22	25.6	31.4
	Secondary	49	57	88.4
	Tertiary	10	11.6	100
Non-Adopter	Illiterate	16	25	25
	Primary	28	43.8	68.8
	Secondary	20	31.2	100
		Marital Status		
Adopter	Single	25	30	30
	Married	59	68	98
	Divorced	2	2	100
Non-Adopter	Single	18	29	29
	Married	36	56	85
	Divorced	10	15	15
		Sex		
Adopter	male	59	67.0	67
	female	27	33.0	100
Non- Adopter	male	36	56.3	56.3
	female	37	43.	100.0

4.3 Conclusion

From the results above it can be concluded that agriculture is still dominated by the male and also income in critical in agriculture production since it gives the capacity to invest and hence is critical in adoption of IPM and other agriculture technologies. Household size is also critical thought it has been over looked by many other authors as a determinant of adoption of IPM and other agriculture as well as farming experience.

4.4 Recommendations

From the results it can be ascertained that there are still more male participants in agriculture compare to female therefore there is great need for the government and other stakeholders to come up with gender sensitive and gender inclusive programs that encourage women participation. In addition there is need for farmers to diversify and have a number of income generating projects that boost their income since income was difference was significant between adopters and non-adopters. There is need for stakeholder

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CHAPTER FIVE

CHALLENGES AFFECTING ADOPTION OF IPM

Abstract

Since the onset of IPM diffusion, there has been alarming increase in the usage of pesticides instead of their intended decrease. The study also focused on determining the challenges that affects the adoption of IPM amongst the smallholder farmers. A survey questionnaires was used to probe farmers on the challenges that affected their adoption. The challenges were categorised as cost, culture, lack of knowledge, lack of substantial economic incentives and weakness in extension. The majority of farmers indicated that the cost of implementation of IPM and its components which included looking for and multiplying biological agents was the greatest challenge. Climate change was also brought out from the respondents as the greatest external challenge affecting adoption of IPM. It was concluded from the study that adoption was stalled because of these challenges and it was also recommended that there is collaboration of stakeholders to deepen research and to come up with solutions that are not costly to the farmer as well as strategies to be put in place to allow effective extension and smooth flow of knowledge.

Key words: IPM adopter non-adopter challenges smallholder

5.1 Introduction

This chapter includes the presentation, analysis and discussion of the objective on the challenges affecting the adoption of IPM. The results were analysed using a 5 point Likert scale on both the external and the internal challenges. The chapter also has the recommendation from the findings as well as the conclusion.

5.2 Overall Challenges faced by farmers in adopting IPM

The are many challenges faced by farmers in adopting IPM. The table below gives the main challenges recorded from the respondents. From the results from table 5, the majority of the respondents (44%) indicated that cost of establishment of IPM was a very big challenge whereas the majority of the respondents (32.6%) indicated that weakness in IPM delivery system was not a challenge in the adoption of IPM. This is consistent with the findings of Mulimbi et al., (2019) who found cost of implementation as one of the key barriers to the adoption of IPM. Cost affect the affordability of IPM components such as bioagents hence many farmers are not capable to procure these since they are smallholder in nature.

Infrastructure for multiplication of bio agents is also indicated as one of the challenges faced by smallholder farmers which also affected use and adoption of IPM (Samiee et al., 2014). They are may issues in infrastructure development in Africa which are borne by bad developmental policies and poor governance.

Table 1.1: Internal challenges faced by farmers in adopting IPM

INTERNAL FACTORS	Is not a challenge		Is a minor challenge		Is a challenge		Is a big challenge		Is a very big challenge	
	N	%	N	%	N	%	N	%	N	%
Limited research on IPM	13	8.7	25	16.7	26	17.3	35	23.3	51	34
Cost of establishment	2	1.3	10	6.7	31	20.7	41	27.3	66	44
Limited knowledge	5	3.3	14	9	54	36	45	30	32	21
Weakness in extension and outreach	12	8	19	12.7	24	16	52	28	53	35.3
Weakness in delivery system	49	32.6	37	24.7	28	18.7	21	14	15	10
Psychological factors barrier	37	24.7	31	20.6	27	18	22	14.7	33	22

Table 5.2 below shows the external challenges that are obstacles in the adoption of IPM. From the results 45.3% of the respondents indicated that their biggest external challenge in the adoption of IPM was climate change whereas 35.3% of the respondents indicated that evolution of pesticide resistance was not a challenge. Climate change has a huge bearing on the multiplication of bio agents such as Napier and Desimodium which are needed for push and pull in Fall army worm (Pellegrini, 2013). Parsa et al., (2014) concurs with the findings when he indicates that climate change also leads to abnormal multiplication of pest as well as mutations which are difficult to deal with which make implementation and the effectiveness of IPM difficult to bring out results.

Psychological factors are also a major challenge affecting the adoption of IPM . There are a lot of people who are used to the culture of using pesticides as an effective method of pest control (Mwangi & Kariuki, 2015). Some of the farmers actually believe that a higher rate of application is effective for control of pest not knowing that it is a chief contributor to residues in the final product as well as harmful to the environment and the health of the farmer as well (Colmenárez et al., 2016). These people are adamant when it comes to adoption of IPM and they rely upon other farmers for information on markets and agriculture production.

Table 5.2: Challenges faced by farmers in adopting IPM

EXTERNAL FACTORS	Is not a challenge		Is a minor challenge		Is a challenge		Is a big challenge		Is a very big challenge	
	N	%	N	%	N	%	N	%	N	%
Increasing needs to manage pests (pathogens, animal pests and weeds)	12	8	19	12.7	24	16	53	35.3	42	28
Climate change	6	4	13	8.7	21	14	42	28	68	45.3
Evolution of pesticide resistance	53	35.3	31	20.7	42	28	19	12.7	5	3.3
Complexity of effective pest management strategies	2	1.3	10	6.7	31	20.7	41	27.3	66	44
Increased influence from Chemical Companies	12	8	19	12.7	24	16	42	28	53	35.3

5.3 Conclusion

It can be concluded that amongst the other challenges cost is the biggest one in terms of adoption. It can also be concluded from the results from the study that extension weaknesses and research limitation are a huge impediment in the adoption of IPM

5.4 Recommendations

From the results presented and discussed above it can be recommended to the government that they cement their extension service so that they are well capacitated to disseminate information about technologies since knowledge is one of the key issues in adoption. In addition research should come up with relevant researches on how farmers can effectively harness IPM on their own in their farms regardless of scale. It should also come up with species that best suits the environment and which can be easily propagated for biological control. Farmers should look for cost effective local resources such as local species of trees and roots that can be used to control pests, hence there is need for a deep evaluation of indigenous technical knowledge systems.

5.5 References

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CHAPTER SIX

EFFECTS OF IPM ON FOOD ACCESS OF SMALLHOLDER FARMERS

Abstract

Food security is topical globally with the challenge mainly emanating from the stagnant food production which is being chased by the growing population. Pest control is critical for optimum yield attainment and one of the most sustainable way of attaining successful pest control is through IPM. This section looks at the effects of IPM on food access of the smallholder farmers in Masembura. The researcher used a cross-sectional survey design and research questionnaires to collect data on this objective. Data was analysed using independent t-tests as well as descriptive statistics such as means and percentages. Food access was determined using HFIAS and the scores were analysed between those who adopted IPM and those who did not. The results from the study indicated that they were more food secure respondents (56.2%) under the adopters compared to 34.9% under the non-adopters. From the results, the non-adopters have a higher HFIAS mean of 5.3152 compared to non-adopters who have a mean of 2.1628. There was significant difference in HFIAS between the adopters of IPM and the non-adopters of IPM ($t_{122.90}$=7.61,p<0.01).It can be concluded from the study that IPM affects food security looking at the results. It can therefore be recommended that there be collaboration between all of the stakeholders to facilitate adoption of IPM and other sustainable agriculture technologies since they also have spill overs in the attainment of food security.

Key Words; IPM adopter non-adopter HFIAS independent t-test

6.1 Introduction

This chapter contains the presentation, analysis and the discussion of the objective on the effect of IPM on food access. Th chapter has the food access classification of the adopters and the non-adopters in the study. The study also contains the independent t-test results for the HFIAS scores of the non-adopters and the adopters of IPM which was done to ascertain if there is a significant difference in terms of food access between adopters and non-adopters.

6.2 Results of the effects of IPM on Food Access

The section below looks into the food access status and their categorisation of the adopters and the non-adopters of IPM in Masembura communal area in Bindura.

6.2.1 Food Access status of the respondents

The table below shows the categories of food access under the adopters and the non-adopters of IPM. From the results in the table, the majority of the non-adopters (36%) were severely food insecure whereas the least of the non-adopters were moderately food secure. Under the adopters, 56.2% of the respondents were food secure whereas 17.2% of the respondents were severely food insecure. From the analysis of this table a total of 56.2% of the respondents are food secure under those who adopted IPM compared to 34.9% under the non-adopters.

ADOPTION		**Frequency**	**Percent**
non-adopter	Severe Food Insecure	31	36.0
	Mild Food insecure	25	29.1
	Food Secure	30	34.9
	Total	**86**	**100.0**
Adopter	Severe Food Insecure	11	17.2
	Mild Food insecure	17	26.6
	Food Secure	36	56.2
	Total	**64**	**100.0**

Table 6.1 food access of adopters and non-adopters

6.2.2 Independent t-test results for IPM

The tables below indicate the results of the mean comparisons of HFIAS between adopters and non-adopters of IPM. From the results in the table, the non-adopters have a higher HFIAS mean of 5.3152 compared to non-adopters who have a mean of 2.1628. This means that the non-adopters had more positive responses to food insecurity questions compared to the adopters who answered positively on average 2 out of 8 questions.

Table 6.2 t-test results

Adopter or non-adopter		N	Mean	Std. Deviation	Std. Error Mean
HFIES	Non-adopters	64	5.3125	2.66592	.33324
	Adopter	86	2.1628	2.27446	.24526

The table below shows the results from the independent t-test done to ascertain if there is significance difference in food access between the adopters of IPM and the non-adopters of IPM. Results from the table indicate that, there was significant difference in HFIAS between the adopters of IPM and the non-adopters of IPM ($t_{122.90}$=7.61,$p<0.01$).

Table 6.3 Levene's Test for Equality of Variances

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
HFIAS	Equal variances assumed	4.076	.045	7.791	148	.000
	Equal variances not assumed			7.612	122.990	.000

The results indicate that those who adopted IPM had a lower HFIAS score compared to those who did not adopt IPM indicating that there had more food access compared to the non-adopters. These results are supported by the findings of (Shankar & Abrol, 2012) who indicated that, IPM contributes greatly to effectiveness of pest control which also contributes to the attainment of the overall yield. (European Union, 2021) indicates that, adoption is behavioural and also those who adopt IPM-FFS are also exposed to other beneficial technologies which boost their production capabilities thereby increasing their capacities to produce food sufficient for their households as well as for the market.

Kiplang'at, (2016) indicates that IPM is more cost effective than the heavy reliance on pesticides for pest control which are costly. The difference is then used to purchase other foods therefore increasing the household food access. IPM is also sustainable in managing pests hence reducing the damage caused by pests. This means that it contributes to the attainment of high optimum yields. This is supported by Pellegrini, (2013) who highlighted that those who use IPM have better yields overally compared to those who do not because of their efficiency in managing losses attributed to pest damage. This ultimately contributes to more food access since more is coming out from the field. Rahman & Norton, (2019) however, contradicts when they postulate that IPM has a lot of weaknesses when it comes to contribution economically as well as food security wise. They further indicate that they is no substantial differences between IPM and reliance on pesticides which is the norm for the commercialised production in terms of economics.

The results indicate that IPM holding all other factors constant has an effect on food access. These results are supported by (Colmenárez et al., 2016) who indicated that the majority of the farmers in the communal areas are food insecure because of a myriad of factors which include, climate change, poor infrastructure and pests and diseases. The same author went on to say that proper management of pests leads to optimum yields in the field thereby leading to more food secure communities. This is because the implementation of IPM leads to sustainable management of pests, which leads to the reduction of the infield losses caused by pests (Mwangi & Kariuki, 2015).

Globally, approximately half of the food and fibre produced is lost to field and storage pests (insects, pathogens, weeds, nematodes and vertebrate pests) (Afolabi, 2020). These losses threaten global food security and are a serious economic and nutritional burden to farmers and consumer around the world. FAO, (2020) highlights in its briefing note that sustainable food production which leads to food security is a proxy of proper agriculture activity management which includes pest management and further elaborates the impact of IPM in fostering the above benefits if properly implemented and adopted. Mujati, (2011) further postulate that IPM is a cost effective and sustainable method of pest control and hence the cost reduced in controlling pests and also avoidance of poisoning from residues as well as the cost of pesticides and chemicals to the environment is used in attainment of other basic life needs and on top is food, hence the cost saved is used to increase food access.

6.3 Conclusion

It can be concluded from the study that the majority of the non-adopters are food insecure compared to the adopter. It can also be noted that the majority of the respondents are found in the severely food insecure and the mild food insecure. It can also be concluded that there is significant difference at 0.05 significance level in terms of food access between the non-adopters and the adopters of IPM with the adopters of IPM being more food secure compared to the non-adopters of IPM.

6.4 Recommendations

From the results from the study it is recommended to the government first that they go on the fore front of implementing supportive policies and legislations as well as broker their support in the development of agriculture in particular the adoption of IPM. Farmers should also move in to use local resource which are found in their environment in order to reduce costs which can be used to buy food and for other livelihood basic needs. The various development agents and the relevant stakeholders should look into sustainable ways to make sure the people in the rural areas are food secure through food aids and other resilient building development initiatives since the majority of the people in the communal areas are food insecure.

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CHAPTER SEVEN

ANALYSIS OF FACTORS AFFECTING THE ADOPTION OF IPM

Abstract

Food security is under great threat globally with food demand increasing exponentially propelled by the growth in population which is expected to hit the 9.5 billion mark by the year 2050. An increase of around 60 to 70 percent of food production will be required to match this growth. By 2060, the population of SSA alone could grow to 2.7 billion people from the present 1 billion (World Bank, 2020). There is great need for effective and sustainable innovations like IPM which can be adopted and can be very useful in cutting field losses caused by pest in the field. The objective of this chapter is to give an in-depth presentation, analysis and discussion on the factors affecting the adoption of IPM. Binary logistic regression was used to analyse the socio economic factors. From the results, household size, land size, sex, farming experience and income were found to be statistically significant at 0.05 significance level. From the results it was recommended that there is great need to concentrate on policies that boost farmers income and land size as well as adding experience in farming since according to the study these are crucial in facilitating adoption of IPM

Key words: Binary logistic Regression Adoption IPM

7.1 Introduction

This chapter looks at the presentation, analysis and discussion of the factors affecting the adoption of IPM. The chapter contains the analysis of the socio-economic and institutional factors that were analysed using Binary Logistic Regression to ascertain the significant factors that have a meaning statistical effect on the adoption of IPM. The chapter also contains the recommendations and the conclusion of this chapter

7.2 Socio-economic factors affecting adoption of IPM

Binary logistic regression was carried out to find out the effects of socio-economic factors on IPM adoption, age, marital status, education, sex, income, household size, land size, years of experience were the valuable analysed to ascertain whether from the study they influenced the likelihood of one to adopt IPM. According to the Nagelkerke R^2 , the model explained 66.5% of the variance in adoption and correctly classified 84.7% of the adoption scenario as shown by the table in Annex 2. Furthermore according to the table in Annex 2, the model is statistically significant.

The table below shows 2significantly the likelihood of a respondent adoption of IPM.

According to the binomial logistic regression output, Males are 0.91 times more likely to adopt and use modern IPM compared to women. This is mainly because of the patriarch nature of most smallholder farmers societies where man are decision makers having more exposure to the technologies than women. Also agriculture is drudgery in nature hence there are more men than women in the industry.

Table 7.1 Variables in the equation

Variables in the Equation	B	S.E.	Wald	Exp(B)	Sig.
Age1			7.736		.052
Age1(1)	3.028	1.471	4.235	20.650	.070
Age1(2)	1.086	1.317	.681	2.964	.409
Age1(3)	.750	1.245	.363	2.118	.547
sex(1)	-.093	.521	.032	.911	.004*
Education			2.543		.092
education(1)	2.320	1.256	3.325	1.298	.350
education(2)	2.325	1.176	.651	6.026	.075
education(3)	0.000	0.152	.544	3.766	.053
Maritalstatus			0.660		.580
maritalstatus(1)	-2.546	1.182	4.641	0.780	.331
maritalstatus(2)	-2.480	1.050	5.578	0.840	.058
Income	2.63	.000	.702	1.000	.041*
Householdsize	-.750	.194	15.029	2.110	.000*
yearsofexperience	.395	.120	10.943	1.485	.001*
Sizeofland	.323	.112	8.280	0.720	.004*
Memberoforganisation	.423	.232	5.689	0.789	.589
Constant	-24.899	10671.957	.000	.000	.998

a. Variable(s) entered on step 1: Age1, sex, education, maritalstatus, income, householdsize, yearsofexperience, sizeofland.
*significant at 0.05 significance level

Household size was also found to be statistically significant. Decrease in household size by 0.75 members which is rounded off to 1 increases the likelihood of adoption by 2.11 times. This shows that there is a negative relationship between adoption of IPM and household size. This concurs with the findings of Uwagboe et al., (2012) who identified that bigger households of over 7 people dominated the non-adoption category. The more the members of the household, the more the demand on the family disposable income, hence and the more the financial burden (Berg, 2013). Therefore since IPM adoption requires some expenditure and is required by some as a want, such households will be less likely to spend on IPM like mobile phones and radios.

From the table above, increase in income is associate with an increase in likelihood of adoption of IPM. An increase in $USD2.65 increases the likelihood of adoption of IPM by 1.0005 times. This entails that the higher the income the more freedom of choices one has when it comes to expenditure hance one can investing in the required labour for scouting as well as planting of napier for push and pull.. Berg, (2013) also highlighted in contradiction that, income may contribute to low adoption rates of technologies that result in increased complexity of farming systems and that are perceived to add to labour requirements.

An increase in the size of land is associated with an increase in the likelihood to adopt IPM. There is correlation between land size and output in terms of production. The results are similar to those of Mwangi & Kariuki, (2015) who found land to be a significant factor in the adoption of agricultural technologies. Smaller land pieces are associated with less use of efficient mechanisms like machinery, thus there is more productivity on larger land pieces and the urge to look for agriculture information for management (Nguthi, 2017). The large production means that there are large sums of income coming in from the investments on field compared to smaller land sizes (Kebeto, 2017).

According to the Binomial logistic regression output, an increase in years of farming experience is positively associated with an increase in the likelihood to adopt IPM such as biological, cultural and mechanical. An increase in 0.365 years on experience increases the likelihood of adoption of IPM by 1.456 times. This results concur with the results of Muzari, ((2017) who found out years of experience to be a significant factor that affects adoption of IPM. Muriithi et al., (2020) highlighted that experience is linked with good agriculture practices and the need for improvement from the traditional methods and with yield success and increased income to spend on IPM. It also comes with reduced negative perceptions which facilitates increase adoption.

7.3 Conclusion

In conclusion income, land size, household size and farming experience according to the study significantly affect adoption of IPM.

7.4 Recommendation

There is great need to concentrate on policies that boost farmers income and land size as well as adding experience in farming since according to the study these are crucial in facilitating adoption of IPM

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CHAPTER EIGHT

SUMMARY OF FINDINGS, CONLUSION AND RECOMMENDATIONS

8.1 Introduction

This Chapter summarises the research proceedings and findings from Masembura communal area in Bindura District, Mashonaland Central Province, Zimbabwe. The broad objective of the study was to ascertain the factors and challenges affecting the adoption of IPM amongst smallholder farmers in Bindura District as enunciated in the introductory chapter of the study. Descriptive statistics, 5-point Likert scale, binary regression analysis were approaches used to analyses the specific objectives of the study. The results from a sample of 150 farmers who were interviewed using a pre-tested structured questionnaire are explained as stated in Chapter 4, 5, 6 and 7. The same results chapters also gives a discussion of the results and conclusions of the study. Finally, this chapter summarises, concludes, makes policy recommendations and looks at areas for further research.

8.2 Research summary

The first chapter of the study was introduction, problem statement, objectives, research questions, justification and outline of the thesis. Second chapter of the study was on literature review synthesis. Third chapter of the study was on methodology which covered study site, research design, sampling procedure, data collection procedure, data analysis produce, ethical considerations and finally the summary of the methodology chapter.

Chapter four, five, six and seven were results chapters for each objective respectively. Chapter four was to characterize the adopters and the non-adopters of IPM in Masembura communal area in Bindura District. This was achieved through use of Descriptive data was analyzed in the form of tables, mean, percentages, standard deviation and frequency distribution. Independent T-test was used to test for the significance difference between adopters and non-adopters in terms of income, household size, farming experience and land size. The results show that the Independent T-test indicated that at 5% significant level there was difference in terms of income (p=0.006), household size (p=0.030) and land size (p=0.00002). The study also shows that they were more males in the study (58.1%) and 54% in the 28-35 years age group as well as 69% who attained secondary education.

After having to characterize the adopters and the non-adopters of IPM in Masembura communal area in Bindura District factors and challenges affecting the adoption of IPM amongst smallholder farmers in Bindura District, the study proceed in Chapter five to determine the effect of IPM on food access in Masembura communal area in Bindura. One hundred and fifty communal farmers were randomly selected from the wards lists for cross-sectional household survey. A survey questionnaire was used to probe farmers on the challenges that affected their adoption. The challenges were categorized as cost, culture, lack of knowledge, lack of substantial economic incentives and weakness in extension. The majority of farmers indicated that the cost of implementation of IPM and its components which included looking for and multiplying biological agents was the greatest challenge. Climate change was also brought out from the respondents as the greatest external challenge affecting adoption of IPM. It was concluded from the study that adoption was stalled because of these challenges and it was also recommended that there is collaboration of stakeholders to deepen research and to come up with solutions that are not costly to the farmer as well as strategies to be put in place to allow effective extension and smooth flow of knowledge.

Chapter six presents results of the challenges affecting the adoption of IPM in Masembura communal area in Bindura District socio-economic, cultural and institutional. One hundred and fifty respondents were randomly selected from the wards lists for cross-sectional household survey. Data was analysed using a cross-sectional survey design and research questionnaires to collect data on this objective. Data was analyzed using independent t-tests as well as descriptive statistics such as means and percentages. Food access was determined using HFIAS and the scores were analyzed between those who adopted IPM and those who did not. The results from the study indicated that they were more food secure respondents (56.2%) under the adopters compared to 34.9% under the non-adopters. From the results, the non-adopters have a higher HFIAS mean of 5.3152 compared to non-adopters who have a mean of 2.1628. There was significant difference in HFIAS between the adopters of IPM and the non-adopters of IPM ($t_{122.90}$=7.61, $p<0.01$).

In addition one hundred and fifty respondents were randomly selected from the wards lists for cross-sectional household survey. Data was analysed using Binary logistic regression to analyses the socio economic factors. From the results, household size, land size, sex, farming experience and income were found to be statistically significant at 0.05 significance level. From the results it was recommended that there is great need to concentrate on policies that boost farmers' income and land size as well as adding experience in farming since according to the study these are crucial in facilitating adoption of IPM.

8.3 Conclusions

From the results from the study, it can be concluded that, household size, years of experience, farm size and sex all significantly affect the adoption of IPM. In addition the it can also be concluded that cost of implementation of IPM is the greatest challenge in the adoption of IPM amongst the smallholder farmers in Masembura. Other challenges that affect IPM challenges include, research weakness, limitations of trainings, weaknesses in extension and outreach as well as climate change and mode of IPM delivery. It can also be concluded that the majority of the respondents in the study rare severely food insecure according the HFAS results attained in the study. In addition, IPM affects the food security status of the respondents since it leads to effective and sustainable control of pests are very vicious in the reduction of yields.

8.4 Policy implication and recommendations

Government should promote increased uptake of IPM technology as sustainable agricultural practice that increases food security by increasing food access in order to reduce in field and postharvest storage losses leading to improved household food security by farmers.

8.4.1 On challenges.

Intensively recruiting and training more agricultural extension officers in all districts of the country in order to increase the availability of knowledge and information base in all wards of the district. This will spearhead wide spread of adoption of IPM and reduce in field and postharvest storage losses .

Tailoring IPM technologies in the context of women and address women's challenges for optimal uptake and increase the food security status.

8.4.2 On perceptions.

To increase extension trainings mainly on rural women, awareness and IPM technological demonstrations to enhance technical knowhow in women farmers in the district.

AGRITEX department in collaboration with NGOs operating in Bindura District should encourage extension officers to produce and print literature material like leaflets and facts sheets on metal silo utilisation written in local languages. These literature material written in local language should be distributed in all farmer gatherings.

Field visits, exchange visits and farmer gathering should be promoted to share IPM technology experiences among farmers utilising the technology.

8.4.3 On socio-economic, cultural and institutional factors.

Societal cultural or traditional beliefs to be orientated in such a way that it promote equitable household division of labour during IPM activities.

Promote diversity of household agricultural income generating enterprises in order to boost household income leading to gender roles equality and equity in the IPM technologies adoption.

Encourage households with smaller household size to practice/share IPM activities by working in family groups or in syndicates. Promote group formation of farmers in the communities in order to boost household labour forces availability

Farmer field schools should be introduced to teach men and women IPM technologies. Male and female farmers should be trained on the advantages of collaboration and sharing IPM tasks to enhance equality and equity.

8.5 Areas for further research

A study to evaluate IPM challenges in the adoption in other districts where IPM technology was introduced as pilot project for farmers to adopt IPM could produce different challenges.

A study to determine factors affecting adoption IPM in the context of Zimbabwean smallholder farmers could produce clear factors might contribution to poor uptake

Appendix 1

Bindura University of Science Education

Faculty of Agriculture and Environmental Science

Department of Agricultural Economics, Education and Extension

The principal objective of this questionnaire is to investigate the impact of integrated pest management as a strategy to enhance communal food security status: A case of Masembura communal lands, Bindura district. The study is meant for academic purpose hence the information provided by respondents is confidential and cannot be identified with the people who provide it.

I. Identification

Name of enumerator ____

Date of interview ________________________

Ward number ________________________

Name of settlement ________________________

Name of village ________________________

SECTION I: CHARACTERISATION OF ADOPTERS AND ADOPTERS OF IPM IN MASEMBURA

A. Household demographic characteristics

1. Age of household

……………………………………………………………… Years

2. Sex of household head

Male	
Female	

3. Marital status of household head:

Married living together	
Married living apart	
Divorced/separated	
Widow/Widower	
Never married	

4. Household size ________

5. Household labour size

Below 2 people	
3 to 5 people	
Above 5 people	

B. Household socio-economic characteristics

1. Literacy status of respondent

Primary	
Secondary	
Tertiary	

2. What is the size of your arable land __________ (ha)

3. Do you own a permanent crop land

Yes	
No	

4. Do you know what integrated pest management is?

Yes	
No	

5. Has farmer received any crop protection stewardship training

Yes	
No	

6. What is the main source of agricultural information to the farmer?

agriculture extension officer	
agro-companies	
internet	
magazines	

7. How are households dealing with new pests

traditional methods	
spraying	
nothing	

8. What pest control measures do you use in your field.

Chemical	
biological	
cultural	
IPM	
mechanical	
None	

9. Is your household a member to farmer and micro-finance groups

Commodity association	
Irrigation scheme	
Agriculture extension group	
none	

10. How does your household get agricultural inputs

Government	
Purchase	
Retained	
Remittances	
NGOs	
Private contractors	

11. Where do you sell you produce?

Other households in the area	
Private traders	
GMB	
local markets	
local millers	
Distant markets	
Contracting companies	
Local shops	

Other (Specify) ______________________________

12. Do your household access small grants for income generating projects (IGPs)

Yes	
No	

SECTION II: EFFECTS OF IPM ON FOOD ACCESS IN MASEMBURA COMMUNAL AREA IN BINDURA

Household food security status

Nº	**Question**	**Response option**	**code**
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No 1 = Yes	________
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	________
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q2) 1 = Yes	________
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	________
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q2) 1 = Yes	________

3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	______
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q2) 1 = Yes	______
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	______
5.	In the past four weeks, did you or any house hold member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q2) 1 = Yes	______
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	______

6.	In the past four weeks, did you or any house hold member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q2) 1 = Yes	______
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	______
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q2) 1 = Yes	______
7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	______
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q2) 1 = Yes	______
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	______

9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (skip to Q2) 1 = Yes	________
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	________

SECTION 3: CHALLENGES AFFECTING ADOPTION OF IPM

A1. Internal Challenges

Kindly indicate is the following factors are huge challenges affecting the adoption of IPM

INTERNAL FACTORS	Is not a challenge	Is a minor challenge	Is a challenge	Is a big challenge	Is a very big challenge
Limited research on IPM					
Limited training					
Limited knowledge					
Weakness in extension and outreach					
Weakness in delivery system					
Psychological factors barrier					

B1. External Factors

Kindly indicate is the following factors are huge challenges affecting the adoption of IPM

EXTERNAL FACTORS	Is not a challenge	Is a minor challenge	Is a challenge	Is a big challenge	Is a very big challenge
increasing needs to manage pests (pathogens, animal pests and weeds)					
climate change					
evolution of pesticide resistance					
complexity of effective pest management strategies					
reduction of pesticide availability					

SECTION 4: FACTORS AFFECTING THE ADOPTION OF IPM IN MASEMBURA COMMUNAL AREA IN BINDURA.

Kindly select YES/NO under the following questions.

Variable	**Yes**	**No**
Does Age affect the adoption of IPM by the smallholder farmers in Masembura communal Area?		
Does sex affect determine the adoption of IPM by the smallholder farmers in Masembura communal Area?		
Does household size affect the adoption of IPM by the smallholder farmers in Masembura communal Area?		
Does education affect adoption of IPM by the smallholder farmers in Masembura communal Area?		
Does farming experience affect the adoption of IPM by the smallholder farmers in Masembura communal Area?		
Does Income affect the adoption of IPM by the smallholder farmers in Masembura communal Area?		

Does land size affect the adoption of IPM by the smallholder farmers in Masembura communal Area?		
Does extension affect the adoption of IPM by the smallholder farmers in Masembura communal Area?		
Does marital status affect the adoption of IPM by the smallholder farmers in Masembura communal Area?		
Does membership of farming organization affect the adoption of IPM by the smallholder farmers in Masembura communal Area?		

Objective		Research Question	Analytic tools
i)	To characterise the adopters and the non-adopters of IPM in Masembura communal area in Bindura District	What are the socio-economic characteristics of adopters and non-adopters of IPM amongst the smallholder farmers?	Descriptive Statistics
ii)	To determine the effect of IPM on food access in Masembura communal area in Bindura.	Is there any effect of IPM on food access amongst smallholder farmers in Masembura communal area in Bindura	HFIAS, HDDS, individual's dietary intake, Descriptive statistics
iii)	To ascertain the challenges affecting the adoption of IPM in Masembura communal area in Bindura District	What are the challenges affecting the adoption of IPM in Masembura?	Tables
iv)	To analyse the factors affecting the adoption of IPM in Masembura communal area in Bindura.	What are the socio-economic factors affecting adoption of IPM amongst the smallholder farmers in Masembura communal area in Bindura?	Descriptive Analysis Table Binary regression analysis

Variable	Coding	Type of Measure	Prior Expectation
DEPENDENT VARIABLE			
IPM Adoption	ADPTN	0, Did not adopt 1= Adopted	+/-
INDEPENDENT VARIABLES			
Age	AGE	Continuous	-
Gender	GENDER	0 for females, 1 for males	-/+
Household size	AGE	Continuous	+/-
Education	EDU	Continuous- denoting number of years of formal education	+
Farming experience	FARMEXP	Continuous	+
Income	INCOME	Continuous	+
Land size	LANDSIZE	Continuous	+
Extension	EXTEN	Dummy 0 for no, 1 for Yes	+

Variable	Frequency/ N=150	Percentage
Age		
18-27	38	25.3
28-43	54	36
44-60	50	33.3
61-90	8	5.3
Sex		
Male	93	58.1
Female	67	41.9
Education Level		
Illiterate	21	14
Primary	50	33.3
Secondary	69	46
Tertiary	10	6.7
Marital Status		
Married	95	63.3
Single	95	28.7
Divorced	12	8

Variable	**Default/Non-default**	**N**	**Mean**	**Independent t-test sig.**
Income	Adopter	64	2082.81	
	Non-adopter	86	1737.21	0.006
household size	Adopter	64	4.60	
	Non-adopter	86	6.41	0.030
Experience	Adopter	64	6.80	
	Non-adopter	86	5.66	0.260
Size of Land	Adopter	64	5.84	
	Non-adopter	86	2.63	0.006

INTERNAL FACTORS	Is not a challenge		Is a minor challenge		Is a challenge		Is a big challenge		Is a very big challenge	
	N	%	N	%	N	%	N	%	N	%
Limited research on IPM	13	8.7	25	16.7	26	17.3	35	23.3	51	34
Cost of establishment	2	1.3	10	6.7	31	20.7	41	27.3	66	44
Limited knowledge	5	3.3	14	9	54	36	45	30	32	21
Weakness in extension and outreach	12	8	19	12.7	24	16	52	28	53	35.3
Weakness in delivery system	49	32.6	37	24.7	28	18.7	21	14	15	10
Psychological factors barrier	37	24.7	31	20.6	27	18	22	14.7	33	22

EXTERNAL FACTORS	Is not a challenge		Is a minor challenge		Is a challenge		Is a big challenge		Is a very big challenge	
	N	%	N	%	N	%	N	%	N	%
Increasing needs to manage pests (pathogens, animal pests and weeds)	12	8	19	12.7	24	16	53	35.3	42	28
Climate change	6	4	13	8.7	21	14	42	28	68	45.3
Evolution of pesticide resistance	53	35.3	31	20.7	42	28	19	12.7	5	3.3
Complexity of effective pest management strategies	2	1.3	10	6.7	31	20.7	41	27.3	66	44
Increased influence from Chemical Companies	12	8	19	12.7	24	16	42	28	53	35.3

ADOPTION		**Frequency**	**Percent**
non-adopter	Severe Food Insecure	31	36.0
	Mild Food insecure	25	29.1
	Food Secure	30	34.9
	Total	**86**	**100.0**
Adopter	Severe Food Insecure	11	17.2
	Mild Food insecure	17	26.6

Food Secure	36	56.2
Total	**64**	**100.0**

Adopter or non-adopter		N	Mean	Std. Deviation	Std. Error Mean
HFIES	Non-adopters	64	5.3125	2.66592	.33324
	Adopter	86	2.1628	2.27446	.24526

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	Df	Sig. (2-tailed)
HFIAS	Equal variances assumed	4.076	.045	7.791	148	.000
	Equal variances not assumed			7.612	122.990	.000

Variables in the Equation	B	S.E.	Wald	Exp(B)	Sig.
Age1			7.736		.052
Age1(1)	3.028	1.471	4.235	20.650	.070
Age1(2)	1.086	1.317	.681	2.964	.409
Age1(3)	.750	1.245	.363	2.118	.547
sex(1)	-.093	.521	.032	.911	.004*
Education			2.543		.092
education(1)	2.320	1.256	3.325	1.298	.350
education(2)	2.325	1.176	.651	6.026	.075
education(3)	0.000	0.152	.544	3.766	.053

Maritalstatus			0.660		.580
maritalstatus(1)	-2.546	1.182	4.641	0.780	.331
maritalstatus(2)	-2.480	1.050	5.578	0.840	.058
Income	2.63	.000	.702	1.000	.041*
Householdsize	-.750	.194	15.029	2.110	.000*
yearsofexperience	.395	.120	10.943	1.485	.001*
Sizeofland	.323	.112	8.280	0.720	.004*
Memberoforganisation	.423	.232	5.689	0.789	.589
Constant	-24.899	10671.957	.000	.000	.998

a. Variable(s) entered on step 1: Age1, sex, education, maritalstatus, income, householdsize, yearsofexperience, sizeofland.
*significant at 0.05 significance level