UNIVERSITY OF CAPE COAST

EFFECT OF INTEGRATED SOIL FERTILITY MANAGEMENT TECHNOLOGIES ON THE PRODUCTIVITY AND LIVELIHOOD OUTCOMES AMONG MAIZE FARMERS IN THE HOHOE MUNICIPALITY, VOLTA REGION, GHANA

ANGELINA ADDAI

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BY

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Thesis Submitted to the Department of Agricultural Economics and Extension, School of Agriculture, University of Cape Coast, in Partial Fulfillment of the Requirement for the Award of the Master of Philosophy Degree in Agricultural Extension

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere.

Candidate's Signature: ……………………………. Date……………………

Name: Angelina Addai

Supervisor's Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Supervisor's Signature…………………………..…. Date……………………

Name: Dr. Albert Obeng Mensah

ABSTRACT

MoFA in collaboration with AFRICARE trained smallholder maize farmers in the Hohoe Municipal Assembly in the Volta region in Integrated Soil Fertility Management technologies. The programme aimed to enhance productivity and livelihood outcomes of the farmers. Although anecdotal evidence suggests the programme was effective in meeting its objective, empirical evidence is scant in the literature. This research determined the impact of the ISFM technology training programme on smallholder maize farmers' productivity and livelihood. A structured interview schedule that had been validated was employed to gather data from 278 randomly chosen farmers. Cross-sectional survey design and quantitative methodology were used to conduct the research. Frequencies, percentages, means, standard deviations, binary logistic regression, chi-square and the dependent sample t-test were used to analyze the data. The programme significantly improved farmers' knowledge, attitude skills, and aspirations on the application of ISFM technologies. Inorganic/ chemical fertilizers, slash- no burn, good farm sanitation, zero tillage and ploughing were practiced by the majority of the farmers and the perceived technology characteristics that influenced the adoption of the ISFM technologies are observability, "Others", compatibility and relative advantage. The ISFM technology training programme significantly increased the farmers' productivity and improved their livelihood. MoFA and other stakeholders should encourage the farmers to sustain the practice of the ISFM technologies and the implementation of more such programmes to improve farmers' livelihoods.

KEY WORDS

Impact

Livelihood

ISFM technologies

Farmers

Productivity

Soil fertility

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DEDICATION

To my dear husband, Mr Ammishaddai Quartey, and my lovely children: David, Ammishaddai Jnr, Gerald and Adriana.

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AE:	Agronomic Efficiency
AGRA:	Alliance for a Green Revolution in Africa
CFSVA:	Comprehensive Food Security and Vulnerability Analysis
CSA:	Climate-Smart Agriculture
CSIR:	Council for Scientific and Industrial Research
DOI:	Diffusion of Innovation
FAO:	Food and Agriculture Organisation
FBO:	Farmer-Based Organisation
GEM:	Genotype, Environment and Management
GPD:	Gross Domestic Product
GSGDA:	Ghana Shared Growth and Development Agenda
GSS:	Ghana Statistical Service
IFPRI:	International Food Policy Research Institute
ISFM:	Integrated Soil Fertility Management
KASA:	Knowledge, Attitude, Skills, Aspiration
MFP:	Multifactor Productivity
MoFA:	Ministry of Food and Agriculture
NGO:	Non-Governmental Organisation
NPK:	Nitrogen Phosphorus Potassium
OECD:	Organisation of Economic Co-operation and Development
QPM:	Quality Protein Maize

SD:	Standard Deviation
SOM:	Soil Organic Matter
SSA:	Sub-Saharan Africa
TFP:	Total Factor Productivity
USDA:	United States Department of Agriculture
WFP:	World Food Programme

CHAPTER ONE

INTRODUCTION

This chapter describes the background of the study, the problem statement, the general objective, the specific objectives, the research questions, the hypothesis, the study's variables, significance, delimitations, limitations, definition of terms, and the way the study was structured.

Background to the Study

Over the previous 18 years, the African continent has been experiencing persistent food insecurity in terms of food availability and access (OECD-FAO, 2019). This phenomenon is rising in almost all African subregions. This makes the continent one with the highest food insecurity worldwide (FAO, 2019). The 2020 report of the Food and Agricultural Organization's states that there is a wide disparity in the degrees and patterns of food insecurity across Africa's subregions, with Eastern and Central Africa experiencing the highest degrees of food insecurity. However, between 2014 and 2018, the incidence of food insecurity increased the most in Western and Central Africa (FAO, 2020). An additional 399 million people were discovered to lack regular access to healthy and adequate food, even though they were not necessarily hungry. Eighty-seven percent of these people live in Sub-Saharan Africa (FAO, 2017). Food insecurity affects 256 million Africans, or 20% of the citizenry. Sub-Saharan Africa has 239 million people, while Northern Africa has 17 million. Based on the Comprehensive Food Security and Vulnerability Analysis (CFSVA) survey conducted in 2020, approximately 3.6 million Ghanaians, or 12% of the citizenry, are food insecure. Most of the insecure (2.8 million) live in cities, while the remaining 0.8 million live in rural areas (Asare & Lagba, 2021).

While factors such as conflict, diseases and economic downturn among others are noted to fuel food insecurity in Africa, many studies show that food insecurity largely results from soil degradation causing a short fall in agricultural productivity (FAO, 2020; McGuire, 2015). Soil degradation is an alteration in soil quality that reduces the environment's ability supply goods and services to its recipients. According to McGuire (2015), deteriorated soils have a health status that prevents them from ensuring healthy growth of crops, resulting in low productivity and food availability.

Agriculture, which provides a living for most residents in sub-Saharan Africa (Antle & Diagana, 2003) has been unsteady and decreasing in productivity (Nkonya et al., 2016). Soil degradation is identified as the major problem that affects agricultural production in sub-Saharan Africa (SSA), including Ghana. Due to this, increase in agricultural production in the majority of SSA countries remains almost a standstill since past 30years with an annual average growth less than 2% (McGuire, 2015). Gomiero (2016) reveals that soil erosion is projected to decrease production on approximately sixteen percent of farmland, particularly cropland in Africa. Furthermore, extreme events can exacerbate erosion, particularly if the soil is already susceptible to erosion, and can create landscape characteristics that are both dramatic, resistant to atmospheric pressure and longlasting (Gomiero, 2016).

In the past, soil fertility management practices in SSA mainly incorporated natural fallowing, shifting cultivation and zero tillage. Over the last half century, large populace per area have cause these activities to lose sustainability, necessitating the implementation of sustainable agricultural approaches like the Integrated Soil Fertility Management (ISFM) (Vanlauwe et al., 2015a). McGuire (2015) has called for immediate action to mitigate food insecurity problems through intervention programmes to ensure food security, and one such programme is the ISFM technology.

The ISFM is an assuring tool which aims to eliminate the challenges of soil fertility and food insecurity. This comes to play because fertile soils support plant growth to enhance food production, availability and supply. Fertility constitutes the quality of producing in abundance. Soil fertility contributes to soil productivity--the capacity of a chosen area to produce abundantly, ensuring soil fertility and food security—food availability and supply consistency, which are prerequisites for food security (Yemefack, 2014). ISFM, as defined by Mugwe et al. (2019), is soil fertility management package comprising the application of fertilizer, organic inputs, and enhanced germplasm, as well as other cultural practices.

Agriculture constitutes an economic activity mainstaying Ghana presently. It contributes more than 33% to Ghana's Gross Domestic Product (GDP). Furthermore, it is essential to the economic growth of the Volta Region. The Region's economy is primarily rural, with agriculture employing approximately 74 percent of the active population. The Hohoe Municipality especially, is one of the region's major food baskets. Cassava, maize, and legumes are among the most important food crops produced in the region (MoFA, 2017).

With the increasing exploitation by growing human and animal populations in the Volta Region, there is an unending crop cultivation on the same given land. Farming practices like slash and burn, bush burning and deep ploughing have resulted in soils that are weathered, fragile, and of low inherent fertility and ultimately have resulted in a drastic decline in crop yields and hence food insecurity in the Region. To respond to significant challenges in food production and soil fertility management facing rural communities in Ghana, particularly in the Volta Region, the concept of ISFM is being upheld and practised by farmers in the Region to reduce land degradation and increase crop productivity (MoFA, 2017).

Despite having benefited from improved seeds, subsidized fertilizer, and free extension services delivery from MoFA, low yields typify agricultural output in the Volta region. Drought and dry spells during the planting period, infertile soils, low factors of production, poor infrastructure, and low labour productivity are all blamed for the low yields. These result in a wide spread of poverty among the rural population whose primary occupation is farming, and ultimately results in food security problems in Ghana (MOFA, 2017; Lemoalle & de Condappa, 2010). The traditional system of crop production is practiced in the region. This production system mainly depends on inherent fertility in the soil which makes crop productivity low. Nonetheless, this system of production allows for sustained production of crops in low quantities for the consumption of the region's growing population in a minimal supply (MOFA, 2017). This implies that farmers must increase crop productivity through the use of improved soil enhancing technologies. Owing to this, in 2017, AFRICARE, in collaboration with the government of Ghana through MoFA, implemented an intervention programme to train smallholder farmers in the Volta Region's Hohoe municipality on the use of ISFM technologies. Farmers were educated on the use of improved seeds, inorganic fertilizers, organic inputs including compost and farm manure, and the incorporation of leguminous plants into the soil to improve its fertility as part of the programme's activities. There is the need for determining the effect of the programme, especially on the beneficiary farmers, to reveal the effectiveness of the programme inform policy and advise on future such programmes. This study, therefore, aims to provide empirical information on the impact of the ISFM technologies training programme in the Hohoe municipality.

Statement of the Problem

The Hohoe municipality is largely reliant on farming for a living. Agriculture employed more than half of all households (57.4%). Six out of ten homes (65.3 percent) are agricultural homes in rural communities, while 34.7 % of households in urban areas are agricultural. Crop farming is practiced by the majority of households in the municipality (91.1percent). The Municipality's farmers are mostly smallholders, with an average land holding of about 0.5 ha. The municipality's main food crops are maize, cassava, rice, and plantain, with maize dominating (GSS, 2014).

Despite the municipality's heavy reliance on agriculture for economic development, agricultural production in Hohoe is marked by low productivity due to reduced soil fertility (Ghana Shared Growth and Development Agenda (GSGDA), 2010). A report by Soil Research Institute, Kumasi indicates that the organic matter contents of soils in the Volta region are very poor, ranging from 0.00 to 5.63 per cent (CSIR(Soil Research Institute), 2018). This suggests that crop output volume and quality in the region in hampered, which connotes a negative effect on the Municipality's food security. Evidence from MoFA indicates that the average maize yield productivity for the past three years of the Hohoe Municipality is 2.79 metric tonnes, which is regarded as very low, and below the expected achievable level of 5.9 metric tonnes (MoFA, 2019).

To boost crop production, particularly maize, and to enhance food security in the municipality, the government of Ghana through MoFA, partnered with AFRICARE to implement the ISFM programme in Hohoe Municipality. Farmers were trained on the use of improved seeds, inorganic fertilizers, organic inputs like compost and farm manure, and the incorporation of leguminous plants into the soil to improve soil fertility as part of the programme's activities.

Although anecdotal evidence suggests that the project was successful and farmers adopted the technologies, empirical evidence to support this is limited. The few empirical studies, such as Kwadzo and Quayson (2021), have concentrated on determining farmers' adoption or practice of only four of the nine ISFM technologies introduced to farmers in the region. The research also did not determine the impact of technology practice on maize productivity and the farmers' livelihood. As a result, there is no adequate scientific evidence of the extent to which all ISFM technologies are practiced and their perceived impact on maize productivity and livelihood. This creates an information gap that must be filled to inform policymakers and programme implementers about the impact of such important interventions on the beneficiaries' livelihoods. It is also worthwhile to encourage all or most of the farmers to practice other such technologies and direct responsive extension delivery strategies. As a result, the purpose of this research is to fill that void.

General Objective of the Study

The research's overarching aim is to determine the practice of ISFM technologies and their effects on productivity and livelihood outcomes among smallholder farmers in Ghana's Hohoe Municipality in the Volta Region.

Specific Objectives of the Study

The research specifically aimed to

1. Determine the knowledge, attitude, skills and aspiration levels of the beneficiary smallholder farmers before and after the ISFM training technologies programme.
2. Determine the adoption of the ISFM technology by the smallholder farmers.
3. Analyze the factors influencing the practice of the ISFM technologies among the farmers.
4. Determine the farmers' perceived characteristics of the ISFM technologies that influenced their decision to practice the ISFM technologies
5. Determine the productivity of farmers before and after practising the ISFM technologies.
6. Examine the livelihood outcomes (income and well-being) of farmers involved in the ISFM technologies training.

Research Questions

1. What is the knowledge, attitude, skills and aspiration levels of the beneficiary farmers of the ISFM project?
2. What is the adoption of ISFM technology by smallholder farmers?
3. What factors influence the practice of ISFM technology among the farmers?
4. What perceived characteristics of the ISFM technologies influenced the farmers' decision to practice (intensity of practice) the ISFM technologies?
5. What is the productivity of farmers before and after practising the ISFM technologies?
6. What are the livelihood outcomes of farmers involved in the ISFM technologies training in terms of their income and well-being?

Hypotheses of the Study

1. H_0: No statistically significant difference exists between the farmers' perceived level of knowledge, attitude, skills and aspiration about the ISFM technologies before and after the ISFM technologies training programme.

   H_1: Statistically significant difference exists between the farmers' level of knowledge, attitude, skills and aspiration about the ISFM technologies before and after the ISFM technologies training programme.

2. H_0: No statistically significant difference exists in the maize productivity of ISFM project beneficiaries before and after practising the ISFM technologies.

   H_1: A statistically significant difference exists in maize productivity levels of ISFM project beneficiaries after practising the ISFM technologies.

3. H_0: No statistically significant difference exists in the livelihood outcomes of ISFM project beneficiaries before and after the ISFM technologies training programme.

   H_1: There is a statistically significant difference in the livelihood outcomes of ISFM project beneficiaries after the ISFM technologies training programme.

4. H_0: No statistically significant association exists between farmers' adoption of the ISFM technologies and perceived characteristics of the ISFM technologies.

   H_1: There is a statistically significant association between farmers' adoption of the ISFM technologies and perceived characteristics of the ISFM technologies.

5. H_0: Sociodemographic and socioeconomic characteristics of farmers do not have a statistically significant effect on the adoption of ISFM technologies.

   H_1: Sociodemographic and socioeconomic characteristics of farmers have a statistically significant influence on the adoption of the ISFM technologies.

Significance of the Study

To begin with, the research's results add up to the existing literature on the factors that influence the ISFM practice in Ghana. Again, the research reveals the factors that influence the success or failure of ISFM intervention in terms of improvement in soil fertility, high or low output per unit size of land, and whether these factors have any significant impact on farmers' income. These findings will inform the programme implementors to revise the programme package and implementation strategies to increase effectiveness.

Furthermore, knowing the factors that influence the practice of ISFM technologies by smallholder maize farmers will allow agricultural extension agents to scale up the ISFM intervention program in the municipality. The finding will enable MoFA to plan, and implement similar programmes to help reduce soil degradation and nutrient depletion and to promote a maize productivity approach that can be used to intensify the practice of ISFM to increase yield and increase farmers' income which will also inform stakeholders in the agricultural sector of Ghana on why some farmers are finding it difficult to practice the ISFM and some remedial measures that are deemed appropriate.

Delimitation

The study is confined to smallholder maize farmers in the Volta Region's Hohoe Municipal. The study also focused on the research topic.

Limitations

The researcher relied on the farmers' memory recall to calculate some variables, such as maize yield and average income. This type of memory recall may provide inaccurate information.

Definition of Key Terms

ISFM technologies: These are the nine ISFM technologies communicated to the farmers in the study area. They include mulching, manuring, zero tillage, slash-no-burn, intercropping with maize, chemical fertilizer application, and ploughing, among others.

Adoption: the number of ISFM technologies that are used by the farmers at a point in time.

Perceived technology characteristics: These are the technology characteristics revealed by Rogers (1983) to influence the practice of agricultural technologies. They include observability, compatibility, ease of use, trialability and relative advantage.

Organization of the Study

The research is divided into five chapters. Chapter One defines the research background, the problem statement, states the general and the specific objectives, the research questions, the significance of the research, the delimitation and limitations of the research. The second chapter discusses the research's theory, the existing body of knowledge on the research topic, and the conceptual framework guiding the research. The methodology of the research is covered in Chapter Three, which includes the study area, population, research design, sample size and sampling technique, measuring instruments, data gathering process, and analysis of the data. The fourth chapter contains a presentation and discussion of the research results. The final chapter encompasses the highlights of the research findings, conclusions, and recommendations based on the research results.

CHAPTER TWO

LITERATURE REVIEW

The chapter provides a thorough examination of the theory underlying the research, the concepts employed in the research, and the conceptual framework devised by the researcher to describe the association between the variables examined in the research.

The Diffusion of Innovation (DOI) Theory

Diffusion is the process by which technology is communicated over time between many persons found in a social system via specific channels, and the adoption rate is the rate at which such people practice a new technology (Rogers, 1983). The theory concentrates on the five (5) key factors that affect the rate of adoption, including (a) perceived characteristics of the technology, (b) the type of technology, (c) the type of communication channels used to disseminate the technology at different levels in the technology-decision process, (d) the characteristics of the given society in which the technology is disseminating, and (e) the degree to which change leaders promoted the technology during its spread (Rogers, 1983).

However, Rogers (1983) acknowledged that since most adoption research has demonstrated that "Perceived attributes or characteristics of the technology" explain approximately 49 and 87 % of the variance in the rate of the practice of technologies, the other four (4) aforementioned variables have received little consideration among most adoption scholars. As a result, the DOI theory has emphasized the perceived characteristics of technology (specifically, relative advantage, compatibility, complexity, trialability, and observability) to illustrate the variation in adoption. Adoption decisions or intentions are thus influenced by the five characteristics of technology previously discussed.

The use of the DOI theory in this research is justified by the fact that maize farmers' perceptions of the characteristics of ISFM technologies will decide whether or not they adopt the technology. Adoption decisions over time will lead to adoption intensity, which is the number of technologies maintained at any given time (Rogers, 1983). As a result, this theory aids in measuring farmers' perceived characteristics of the ISFM technologies, which are used to comprehend their decision to adopt a number of the technologies at the time of this research.

The choice to adopt agricultural innovation is regarded as a complicated procedure which begins with assessing if or not a farmer is practising as well as. Gunawan (1998) and Rogers (1995), referenced in Mwaura et al. (2021), presented a theoretical basis that proved that farmers get to be acquainted with new technology, which represents the first phase in the decision to practice a technology, known as innovation-diffusion. Farmers form an attitude toward innovation during the innovation-diffusion phase before deciding whether or not to practice it (Mwaura et al., 2021). Inquiring about the important considerations farmers make in their adoption decision and helps comprehend the farmer's decision-making process on the adoption of an innovation. However, the rate of adoption of the innovation varies (Mwaura et al., 2021).

In the context of agricultural technologies with multiple components, such as ISFM training, the adoption is measured rather than the rate of adoption. This is because the adoption determines the number of technologies being practised by farmers in a period, which helps to realistically quantify the amount of the technology in use. Age, gender, education, membership in a farmer-based organization, land ownership, credit, and extension services are all variables that directly impact the adoption of the ISFM technologies, according to the literature (Kolady et al., 2021).

It has been found that aged farmers have acquired more knowledge of production techniques and have gathered more physical assets. Notwithstanding, older farmers are more conservative and more vulnerable to physical energy decrease. As a result, the impact of age on the practice of innovation is unclear (Kassie et al., 2015).

A smallholder producer might opt to practice ISFM innovations irrespective of being male or female since other production assets, like farmland ownership, may impact their choice to practice such innovations. As a result, the nature of the association between gender and the possibility of adopting new technologies is uncertain (Kwadzo & Quayson, 2021).

Formal education helps people become more capable of learning and applying new information. This connotes that farmers with more formal education have a high probability to practice cutting-edge techniques.

It has been discovered that a farmer's intention to commit to agricultural innovations like ISFM is influenced by how much land he or she owns (Kamau et al., 2014). Personal land ownership will promote the use of such innovations because financing some agricultural technologies may take a while to recognize their advantages. When a participant has the farmland, their land ownership was coded as 1, otherwise, it was coded as 0.

Farmers' financial means, in addition, affect their capacity to buy farm inputs like mineral fertilizers or quality seeds. As a result, producers who can easily obtain loans are more likely to practice ISFM innovations. A farmer who has acquired credit is coded 1, otherwise, it is coded 0.

Extension services are a non-formal education system that assists farm families in improving their farming techniques through learning programmes (Axinn, 1988). As a result, extension services enable technology transfer. Farmers who receive extension services are more likely to practice new technologies.

Farmers' belongingness to an FBO allows them to gain pertinent farm inputs and processes information. Furthermore, FBOs display a more powerful front, which tends to increase farmers' negotiating strength during marketing. (Kamau et al., 2014).

The overall farmland under farming is referred to as the farm size. A larger landholding may encourage farmers to fund and implement new technology. Furthermore, a small farm size could motivate the farmer to intercrop to achieve maximum land utilization. As a result, in an empirical model, farm size may not affect the practice of ISFM technologies in a given pathway. Farm size is expressed in acres (Kwadzo & Quayson, 2021).

In this study, the researcher measured the adoption of the ISFM technologies to reveal those technologies that have been carefully examined by the farmers given the technologies' characteristics, and are judged worthy of use (Kolady et al., 2021). The adoption of ISFM technologies can, therefore, inform stakeholders about the technologies that are in use by farmers, and the number of farmers practising them, for further decision-making.

Concept of Integrated Soil Fertility Management (ISFM)

In the last few decades, soil fertility studies in SSA have established ISFM as a basic concept for improving crop yields in multifaceted smallholder farming systems sustainably. ISFM includes the utilization of enhanced crop germplasm as well as the utilization of mineral fertilizer in a variety of organic resources such as residues from crops and animals, compost manure, and legume residues. ISFM also includes the efficient allocation of nutrient resources to enhance fertilizer agronomic efficiency while minimizing environmental impact (Sanginga & Woomer, 2009).

The first fundamental ISFM concept is the utilization of both organic and inorganic fertilizers. Notwithstanding, this is enveloped in several arguments. For starters, neither is available or affordable in sufficient amounts in several smallholder conditions. Second, and perhaps most relevantly, both sources contain separate sets of nutrients, managing various soil fertility limitations in a coordinated way. When practised at reasonable levels, organic inputs alone are highly improbable to discharge adequate nutrients to increase crop output levels adequately on drained soils in Africa (Vanlauwe et al., 2010, 2015). However, deteriorated soils with lower doses of soil organic matter, poor soil moisture, or increased deficiencies of other output-limiting nutrients regularly have lesser productivity of inorganic fertilizers (Barrett & Bevis, 2015; Place et al., 2003; Vanlauwe, 2013).

The availability of additional inorganic nutrients for plant usage is governed by soil moisture and soil organic matter (SOM) levels, which are intrinsically linked to soil carbon stocks. Reprocessing organic materials can raise SOM amounts over the long term, maintain soil moisture, and add additional nutrients, all of which can greatly improve the soil's tolerance to chemical fertilizers (Marenya & Barrett, 2009). Utilizing inorganic fertilizers effectively can, in essence, enhance the amount of organic matter available and, consequently, organic matter established through enhanced on-farm biomass production (Vanlauwe et al., 2013). Because of this, the ISFM concept holds that inorganic and organic nutrient sources interact and are associated in meaningful ways, potentially improving crop output and long-term soil quality (Place et al., 2003).

According to Vanlauwe et al. (2015), several inorganic fertilizers are not tailored to the particular nutrient inadequacies that are common in an area, which results in crop responses to fertilizer utilisation that are often below the threshold. The most common fertilizers used in SSA are nitrogen (N), phosphorus (P), or potassium (K), but these nutrients do not effectively replenish micronutrients such as sulfur (S), boron (B), calcium (Ca), zinc (Zn), or iron (Fe), which are exceptionally rare in densely populated regions where fallow periods are insufficient (Chianu et al., 2012; Vanlauwe et al., 2015).

The second key idea of ISFM is the use of resistant cultivars with improved characteristics that are indigenously necessary, such as increased yielding, drought- or disease-tolerant seeds. This results in better shock tolerance, adequate matching of nutrient availability and patronage, and increased output prospects (Vanlauwe et al. 2015). Recent studies have shown that better crop cultivars have a beneficial effect on crop outputs and well-being (Takahashi et al., 2020), but to fully realize their productivity-improving potential, they must be used in conjunction with required soil management practices (Sanchez, 2002).

Because of the theoretical grounds of ISFM, it is commonly assumed that the implementation of ISFM strategies will result in increased land productivity. Studies suggest that the whole and the interconnected package will have the biggest effect because of the complementary potentials of biofertilizer, chemical fertilizer, and enhanced seeds. But even so, for small-scale farmers, utilizing ISFM may come with significant opportunity costs in terms of time and money, like the purchase of enhanced seeds and inorganic fertilizer. This is due to the planning and transit of heavy organic fertilizers as well as the application to a particular of inputs are labour-intensive activities (Jayne et al., 2019; Takahashi et al., 2019).

In the Hohoe municipality of the Volta Region of Ghana, the ISFM technologies in which the maize farmers were trained are mulching, manure or organic fertilizer application, inorganic (chemical) fertilizer, intercropping with legumes, ploughing, improved seeds and planting materials use, zero tillage, slash-no-burn and good agricultural practices.

Benefits of ISFM

Various ISFM-based techniques have been investigated and have been shown to significantly improve climate-smart agriculture productivity, profitability, and resilience (CSA). For instance, Vanlauwe et al. (2005)'s 20-

year study on the IITA research farm in southwest Nigeria gives the data required for a thorough evaluation of the advantages of ISFM for CSA. The research concluded that maize grain outputs were between 0.26 and 2.4 ton ha-1 higher when NPK fertilizers and organic inputs were blended than when the same inputs were utilized separately. Furthermore, it was noted that in trials where only fertilizers were utilized, maize productivity fell to 1 ton ha-1, whereas in the ISFM system, maize grain yields were still well above 2 tons ha-1 after 10 years of crop production and with a lesser amount of input. As opposed to independently applied fertilizers or organic inputs, rotated cowpea crops in the ISFM system produced an average of 1.2 tons ha-1 as opposed to 0.7 tons ha-1. These findings demonstrate that using ISFM improves crop productivity and input use effectiveness over time, ultimately enhancing farmers' ability to support their families (Roobroeck et al., 2015).

In comparison to when only fertilizers were used, the yield of maize crops was significantly less affected by unsteady weather patterns in trials where fertilizers and organic inputs were blended. Particularly, it was found that organic inputs were crucial in lowering the responsiveness of maize crops to the climate (Rockström et al., 2009). The ISFM system's increased productivity and yield consistency demonstrate that the practices significantly increase crops' resistance to the influence of change in climate (Vanlauwe, 2015).

Knowledge level of ISFM

First of all, farmers can only utilize a certain technology if they are aware of it (Diagne & Demont, 2007; Kabunga et al., 2012; Lambrecht et al., 2014). Numerous farmers merely do not consider incorporating certain agricultural technologies because they are not widely known in some regions (Lambrecht et al., 2014), even if they complement other already known technologies. Additionally, it is frequently discovered that the application of technologies like improved seed varieties or mineral fertilizer is constrained by an inadequate supply (e.g. Croppenstedt et al., 2003; Shiferaw et al., 2008). The fact that technologies are commonly introduced at varying periods, and that awareness and access expand through the inhabitants at distinct periods and varying rates, provides a very simple explanation for sequenced practice patterns. Other times, innovation is packaged and distributed in the same way that seeds and fertilizer are, which promotes simultaneous practice patterns (Smale & Heisey, 1993).

As adoption requires awareness (Lambrecht, Vanlauwe, Merckx & Maertens, 2014), the researcher started by examining farmers' knowledge of ISFM technologies in my area of study. A farmer was considered to be knowledgeable if they were familiar with the technology. I described aware households at the household level as these households where at least a farmer is familiar with the technology (Lambrecht et al., 2016).

The Adoption of ISFM technologies

It has been discovered that agricultural philosophies that are sustainable conform to a mixture of various combined agricultural innovations. What farmers do with these innovations in their fields will determine whether such a concept endures in reality (Lambrecht, Vanlauwe & Maertens, 2016). Farmers' utilization of various technologies may involve associations that fall into one of three groups: free from influence from others, in regular succession, or concurrent. If the likelihood of applying a technology is not affected by the uptake of another technology, then the two technologies are distinct. When the likelihood of implementation is dependent on the practice of a different technology that comes before it, sequential adoption occurs. Last but not least, concurrent practice happens when the likelihood of using a technology depends on the practice of the other technology (Rauniyar & Goode, 1992).

The presence of linkage on output is the primary justification for farmers to incorporate various technologies. Utilization of multiple technologies in concert or sequentially can have significant nonlinear impacts that can reduce or increase the impact of one technology on agricultural produce and/or have a long-term influence on the fertility of the soil and subsequent productivity (Vanlauwe et al., 2010). For instance, when manure is added to inorganic fertilizers, the agronomic efficiency of nitrogen (NAE) significantly increases, and when enhanced cultivars are used, NAE also significantly increases (Vanlauwe et al., 2011).

Nevertheless, these interrelations do not always result in true complementarity (Feder, 1982). Numerous research shows that farmers only use a portion of available technologies, even though doing so would increase their profitability (Byerlee & De Polanco, 1986; Leathers & Smale, 1991; Moser & Barrett, 2006). This phenomenon can be explained by a variety of factors. Farmers must consider access to and allotment of agricultural resources (cash, labour, land, etc.), risk, and social or cultural limitation when making strategic decisions for their farms (Byerlee & de Polanco, 1986; Feder, 1982; Moser & Barrett, 2006). Such limitations for various technologies can interact, resulting in a socio-economic justification for connections between different technologies' applications that may be at odds with the biophysical justification.

In this research, adoption represents the utilisation of the technology on at least a farm plot or a portion of a plot during the previous agricultural year (Lambrecht et al., 2016).

Effects of ISFM practices on productivity and livelihood: Empirical review

Hörner and Wollni (2021) examined if the adoption of core ISFM technologies in Ethiopia is related to changes in household welfare (total household income, food security, and education). The study discovered that the adoption of ISFM technologies is linked to higher household income and food security.

Similarly, research to evaluate the effects of the Integrated Soil Fertility Management Dissemination Programme in Burkina Faso discovered that the programme increased farmer productivity by improving cowpea yields during the programme's execution period. The same effect, however, was not reproduced in the medium term (i.e. during the subsequent season following the programme implementation) (Bouguen et al., 2020).

According to Bouguen et al. (2020), the programme's limited livelihood effect on farmers' livelihoods in the medium term is due to a scarcity of financial resources to buy fertilizer, a lack of agricultural tools required for the execution of some of the technologies (for example, ploughs and traction animals to carry out line seeding or special tools called "triangles A" that allow farmers to identify points of the same level across the slope), and an absence of transportation. As a result, these factors hampered the programme's long-term acceptance.

Another research that examined how integrated soil fertility management affected the productivity of wheat and tef as well as the chemical characteristics of the soil in the highland tropical environment resulted in the following conclusion: The application of 60/20 kg N per hectare and 30/10 kg N per hectare with 50% manure and compost as N equivalence increased wheat mean grain yield by 151 and 129%, respectively, compared to the control, and by 85 and 68%, respectively, compared to the farmers' treatment (23/10 kg N per hectare). In a similar vein, the same showed higher tef grain output by 141 and 122%, respectively, in comparison to the control, and by 44 and 33 per cent (Agegnehu et al., 2014).

Furthermore, Leerzem (2015) discovered that market access can help overcome asset limitations due to its positive impact on credit access to resolve capital difficulties, which in turn affects ISFM technology adoption. This discovery was made as part of his research into how market access affects the adoption of Integrated Soil Fertility Management in Tanzania's Mbeya Region. Once again, the author discovered that household membership, along with gender and education, has a positive influence on ISFM technology adoption. According to Hörner and Wollni (2020), both partial and full adoption of the ISFM enhances land productivity and the total value of crops significantly, especially if better seeds are utilized.

Yebo (2015), asserts in his study "Integrated Soil Fertility Management for Better Crop Production in Ethiopia" that the use of ISFM including combining manure, compost, crop rotation, soil conservation practices such as minimum tillage, tied-ridging, residue management and other practices together with chemical fertilizer and improved germplasms gives the better production and keeps the soil fertility status to a better level.

A review of the Integrated Soil Fertility and Plant Nutrient Management in Tropical Agro-Ecosystems revealed that soil fertility and nutrient management studies in Ethiopia under on-station and on-farm conditions showed that the combined application of inorganic and organic fertilizers significantly increased crop yields compared to either alone in tropical agroecosystems. From the same study, yield benefits were found to be more apparent when fertilizer application was accompanied by crop rotation, green manuring or crop residue management. The combination of manure and NP fertilizer could increase wheat and faba bean grain yields by 50%–100%, whereas crop rotation with grain legumes could increase cereal grain yields by up to 200% (Getachew, Agegnehu & Amede, 2017).

At Bako in Ethiopia, maize rotated with nug and at Jimma maize following soybean reduced the recommended fertilizer rates by 50%, and a yearly application of 4-ton FYM ha^{-1} with 46/10 kg NP ha^{-1}gave maize yield comparable to 110/20 kg NP ha^{-1}. and use of compost also had similar trends at Bako. It was further discovered that the use of legumes such as mucuna and Dolichos lablab at Bako and crotalaria, sesbania and mucuna at Jimma as short fallows and green manures enhanced soil fertility and confirmed to replace either partially or fully the N-fertilizer requirement of maize from external sources (Debele, 2016).

According to Kanyamuka (2017), the adoption of ISFM technologies has a 10.52% increase in the yield of maize from average among the ISFM adopters while non-adopters would have increased their maize yield by16.2% had they adopted the ISFM technologies. Ellis-Jones et al. (2019), add that the income benefits of adopting ISFM technologies far exceed the cost of adoption.

From the empirical review presented above, it can be inferred that farmers' socioeconomic and demographic characteristics affect their practice of ISFM technologies, whereas increment in crop yield and income correlated in the positive direction with the practice of ISFM technologies, as are enhanced soil fertility and increased food security.

Agricultural Productivity in the Context of ISFM Technologies

Researchers admit that increasing agricultural productivity is difficult because it necessitates a comprehensive and integrated production strategy that is appropriate and long-term for a farming system (Nordjo & Adjasi, 2019). According to Beets (1990), there are three categories of elements that influence the output of agriculture: physical, technological, and human. He claims that the location, climate, and soil are the physical elements. Similarly, Martinussen (1997) emphasized the importance of climate by highlighting how unpredictable and unstable climatic conditions affect agricultural production and named soil fertility as the most significant element in crop output.

Beets (1990) notes that the technological factors include the know-how, or the practical understanding needed by farmers to increase agricultural production. That is, to achieve the goal towards production growth, farmers need technical and practical knowledge of the farming system. The use of this technical and practical expertise will, however, vary depending on what needs to be produced and when. Production inputs are also included in the technological factors. Improved or higher-output seeds, chemical fertilizers, and agricultural implements were recognized as the resources that help to increase the output of small-scale farmers by Beets (1990), Reardon, Kelly, Crawford, Jayne, Savadogo and Clay (1996), and Hazell (2009). Additionally, they provide tractor services, agricultural chemicals, and irrigation facilities.

According to Beets (1990), to obtain the highest result in enhancing agricultural output, the human component should involve the effective integration of physical and technological factors. The importance of managing physical and technological factors is shown by this: to increase productivity, this calls for increasing farmers' managerial capabilities. Given this, Bowman (1976) cited in Nordjo and Adjasi (2019) made it evident that smallholder farmers learn fundamental competency through reading, numeracy, and general cognitive skills with access to education, which aids them in processing and disseminating information about factors related to productivity and farm management. As a result, organizations that directly collaborate with farmers, such as the Agricultural Extension Service, play crucial roles in enhancing the skills of farmers. Therefore, it is hypothesized that farmers' increased knowledge and abilities will promote development and, ultimately, raise productivity (Appleton & Balihuta, 1996; Dahms, 2003; Zepeda, 2001). Owing to this, agricultural productivity is anticipated to rise as a result of the information obtained and the effective application and usage of farm inputs through the training of smallholder farmers utilizing a variety of approaches, including farm demonstration, coaching, and observations.

According to Fairhurst (2012), the growth in the conversation about crop productivity and agricultural production is a result of the development of Integrated Soil Fertility Management (ISFM) practices. The ISFM is the utilization of soil fertility management practices and the understanding to customize these to environmental circumstances, which enhances crop productivity and the effective utilisation of fertilizer and organic resources. These procedures unavoidably involve managing organic inputs and fertilizer appropriately, as well as utilizing better germplasm (Sanginga & Woomer, 2009).

According to Nordjo and Adjasi (2019), the ISFM contributes to increasing farm productivity by focusing on enhancing the nutrition or health of the soil. To increase agricultural output, the ISFM practices consider proper research and knowledge of the physical, technological, and human elements. Chambers and Cleaver (1997) reveal that the ISFM aims to improve productivity by utilizing the GEM (genotype, environment, and management) approach. The permutation and interaction of the genotype (G), which stands for the seeds or plants utilized within agricultural units, and the environment (E), which stands for the soil, climate, or agroecological factors within a certain geographical area, determine the production output. Developing the necessary production and farm management knowledge and abilities is what management (M) is all about for farmers to improve their farm productivity (Fairhurst, 2012).

In this study, productivity was determined by measuring the ISFM indicators such as fertiliser usage, quality of maize produced for the market and consumption, the quality of land for growing maize, farmers' satisfaction with extension delivery, and so on.

Factors influencing the adoption of ISFM technologies: Empirical review

Socio-demographic and socioeconomic characteristics

According to Mugwe et al. (2009) age of the household head and the number of mature cattle owned negatively influence the practice of ISFM technologies whereas, in farming management, the ability to hire labour and the number of months in a year household bought food for the family positively influence the practice of ISFM technologies. However, Kinyangi (2014) disagrees with Mugwe et al. (2009), as they found age to have a positive and significant influence on the adoption of agricultural technologies. Simtowe et al. (2016) on the other hand, revealed that the adoption of agricultural technologies is high among older farmers than among youngsters. Adams and Jumpah (2021) also indicated that age has a positive and significant impact on agricultural technology practice. This indicates a dichotomy in the literature regarding the effect age has on the adoption of agricultural technologies and that the influence of age on technology adoption may be purely dependent on the kind of technologies involved and the social system practised in the community.

The size of land owned by households is discovered to be a significant physical capital that influences the degree to which ISFM technologies are practised. According to a study about farmers in Nsipe, farmers who use more ISFMs technologies have larger land. This indicates that larger farm sizes are linked to higher financial capital availability, which may make an investment in ISFM more doable (Akinola et al., 2010). Harris and Orr (2014) also noted that small-plot farmers will not benefit from economies of scale when using inputs because the gains will be too small, particularly in a rain-dependent farming system. This argument is valid, but only when the outcome variable—a variable used in these studies and others—is the amount of land allotted to each technology (Bekele & Drake, 2003; Mponela et al., 2016).

It has been discovered that farmers' educational status has a positive impact on how they use ISFM technologies. Higher-educated farmers are more likely to employ ISFM. Older farmers who can read are more likely to adopt ISFM technologies in Nsinpe in Furancungo, Mozambique. This observation most likely results from the fact that ISFM is a knowledge-intensive option, which affects its rate of practice and necessitates the development of awareness and adequate training (Marenya & Barrett, 2007; Mponela et al., 2016). According to Adams and Jumpah (2021), educational status recorded as a level has a significant but negative impact on agricultural technology practice.

While newly established farmers are more likely to shy away from risk and use a limited range of choices, households with knowledgeable farmers have chosen from a variety of technological combinations that produce the best results (Grazhdani, 2013). In regions with low levels of agricultural extension service, farmers' own accumulated knowledge can be crucial for participating in ISFM technology assessment and testing (Ogunlade et al., 2009; Masangano & Mthinda, 2012). Consequently, it is not surprising that educated farmers and individuals who have enormous experience with farming have embraced a variety of technology to benefit from their complementary advantages (Mponela et al., 2016).

Gender is an important factor that determines ISFM usage. A study by Mponela et al. (2016) shows that male-headed families are more likely than female-headed households to combine inorganic fertilizers with residue incorporation and/or farmyard manure. This discovery can be explained by the fact that men and women have different levels of access to technology. Studies show that women frequently underuse the land they own and manage because they have insufficient access to labour, relevant data, schooling, and inputs (Njuki et al., 2008). Even though women contribute 70% of agricultural productivity, most small-holder farms only have access to male land use planning and commercialization techniques (Lubwana, 1999).

According to several studies, belonging to a group can positively affect the practice of ISFM technologies. Due to the poverty experienced by the majority of smallholder farmers and the possibility of social capital development (Njuki et al., 2008). Other works, such as those by Asante et al. (2011) and Adimassu et al. (2012), disagree with this viewpoint, claiming that most farmers are members of non-farming groups and that those who do join farming do so primarily for marketing reasons. It is also possible that farmers that utilize ISFM tools like mulching and liming do so to address a particular constraint independent of social networks Mponela et al. (2016). Despite the view that groups are a bonding social capital and significant at promoting diversified adoption of improved innovations (Njuki et al., 2008), Winters et al. (2007) disagree with the notion that group members serve as a social capital that fosters diversity in the practising of several improved technologies, they rather encourage farmers to adopt fewer technologies.

The adoption and use of ISFM technologies are significantly influenced by rural residents' access to credit and savings (Sanginga & Woomer, 2009). If linked to well-established input supply and market access infrastructures, having access to credit makes it simpler to purchase inputs, especially better seed varieties and inorganic fertilizers (Geta, Bogale, Kassa, & Elias, 2013; Jeannin, 2012; Teklewold, et al., 2013).

The adoption of practices for managing soil fertility was greatly influenced by differences in land ownership. Compared to farmers with three acres or less, those with more land (over three acres) tended to use the majority of the reported soil fertility management techniques (Wawire et al., 2021). While farmers with larger land parcels were more likely to use organic manure, mulching, agroforestry, waterways, and following, those with smaller land parcels were more likely to use inorganic fertilizers and foliar sprays as well as intercropping and crop rotation. The most common cause attributed to these variations was increased land fragmentation (Parachini et al., 2020). Similar results were found among smallholder farmers in rural Tanzania by Kassie et al. (2013) who found that farmers with less land were more likely to use conservation tillage, chemical fertilizers and intercropping as their integrated soil fertility management practices.

Patrick et al. (2011), found that married respondents are more likely than unmarried respondents to use rabbit technology. This is because married people are more likely to adopt technology that will assist in reducing the burden on their resources. After all, they have more responsibilities, especially at home. However, Onuekwus and Okezie (2007) found that the marital status of respondents does not have a positive influence on their adoption of rabbit technologies. This suggests that married farmers who participated in the ISFM technologies training may use more of the ISFM technologies to improve their maize productivity.

Farmers are given best practices through extension services, and those who come into contact with them should be better able to apply ISFM technologies. There is a greater chance that farmers may profit from the service because extension officers may occasionally be embedded with initiatives or projects. Therefore, frequent extension visits may not always result in a higher level of technology utilization. The government's extension personnel target farmers with limited resources who may have few options to adopt or implement the necessary inputs to their farms. The extension may therefore compromise ISFM technologies (Mponela et al., 2016).

Market, transport and information access

Market accessibility is regarded as a relevant factor in determining accessibility and profitability. Because the agricultural product is heavy and there are few good roads, the point of sale can be crucial. Therefore, selling at the farm gate provides the farmer with the immense benefit of being in a better negotiating position and of delaying selling until a later time when prices are favourable. Farmers' use of ISFM when there are formal markets at the far-off district centre is impacted by the distance to the market. Farmers who sell their produce to a far-off output market are more likely to employ more ISFM technologies. Conversely, those who purchase inputs from far-off markets combine inorganic fertilizer, residue inclusion, and/or farmyard manure less frequently (Mponela et al., 2016). Mobility enhances the likelihood of utilizing more ISFMset2 and ISFMset3 in the area because bicycles are the most popular form of transportation (Mponela et al., 2016). The use of a bicycle is comparable only to the utilization of a head, which is used by a 35percent of households in the Chinyanja Triangle. Bicycles are the second most popular mode of transportation for rural towns (Starkey et al., 2002). (Amede et al., 2014).

To provide agricultural services and share information among smallholder farmers, telecommunication is becoming increasingly important (Mittal and Tripathi, 2009; Baumuller, 2012). Mobile phone ownership has a big impact on how ISFM technologies are utilised in homes, according to Mponela et al. (2016). Inferring from this, it can be said that farmers who have smartphones have access to a variety of sources of information on sound agronomic methods that may help them to practice several complementary technologies.

Impact Assessment

Every programme or intervention implemented is expected to result in some kind of change, usually a positive one, in the lives of the beneficiaries, the community, and the nation as a whole. To assess the impact of a programme, a scientific and systematic examination of the programme's implementation process, outputs, and outcomes is required. The term "impact assessment" refers to one method of carrying out this research. Impact assessment is a technique for assessing the importance of changes caused by a program's activities and their efficacy. It is both at once, neither art nor science. Impact assessment is strongly intertwined with the mission and, as such, has effects on the entire organization (Hulme, 2000).

Connell and Kubisch (1998) assert that being able to evaluate and articulate impact is a potent way to convey the contribution of executed activities to funding agencies to inform policy and future program design. Impact assessment works to determine a link between input and output and variations in enormity, scale, or both. The impact is an indicator of the transformations that have taken place. Impact evaluation ought to be seen as the contribution of an intervention's outputs and outcomes to the reason for and ultimate objective.

The positive and negative, intended or unintended long-term effects of an intervention are referred to as its impact. Impact evaluation focuses on looking at projects as a whole and determining whether or not the project meets real needs, which necessitates verification (Leeuw & Vaessen, 2009). In his view, Roche (1999) argues that the simplest method whether a project meets real needs is to ask the project beneficiaries. Drawing from Roche's view, the study seeks to determine from the ISMF project beneficiaries' view, how the ISFM project has affected their economic life by measuring variables such as productivity and livelihood outcomes, which were primary foci of the ISFM projects.

Analytical Tools

This section explains the major tools used to analyse the study's data.

Binary Logistic Regression

This was employed to forecast how sociodemographic and socioeconomic traits would affect the farmers' intensity of ISFM practice, which is a dummy variable. Regression analysis calculates the likelihood that the target variable will occur given a linear combination of the predictors. 0 or 1 are the only two possible values for the binary target variable in a regression model called binary logistic regression (LR). Given that the output is modelled as readmitted (1) or not readmitted, it is the most widely used regression model for readmission prediction (0) (van Smeden et al., 2019).

Dependent sample t-test

The dependent sample t-test, also known as the paired sample t-test, is a statistical technique for figuring out whether there is no significant difference between two groups of observations. A dependent sample t-test generates pairs of observations by measuring each subject twice. It is necessary for the test that the dependent variable (different scores) be measured on an interval or ratio scale, that the observations be made independently of one another, that the variables be normally distributed, and that there be no outliers (Gerald, 2018).

The test was used in this study to test the mean differences in the mean scores of the level of farmers' knowledge, attitude, skills and aspirations of the ISFM technologies before and after the ISFM technology project. This was to determine whether a significance in differences in means existed, to aid the researcher to attribute the change in the variables to the project or otherwise. The test was suitable for the analysis because the same variables (knowledge, attitude, skill and aspiration) were measured twice on a ratio level to obtain paired observations for comparison.

Chi-Square Test of Independence

The Chi-square test of independence was used to determine whether there is any relationship, if any, between the perceived qualities of the ISFM technologies and the degree to which the ISFM technologies are practised. When the dependent variable is measured nominally, the Chi-square statistic is a non-parametric (distribution-free) tool for analyzing group differences. Like all non-parametric statistics, the Chi-square statistic is unaffected by the distribution of the data. It does not, for instance, require homoscedasticity in the data or equality of variances between study groups. It enables the evaluation of dependent and independent variables that are dichotomous (McHugh, 2013) when the data being studied consists of frequencies or 'counts' (Zibran, 2007). This statistic suited the analysis because the researcher is interested in finding the association between the nominal variables without quantifying the effect of the associations. The variables are also suitable for the analysis because the dependent variable, adoption, is dichotomous and is measured on "Yes" or "No". Likewise, the independent variable, the perceived characteristics of technology, was measured on a “Yes” or “No” dichotomy. Additionally, the data used for the analysis were in frequencies or counts.

Conceptual Framework

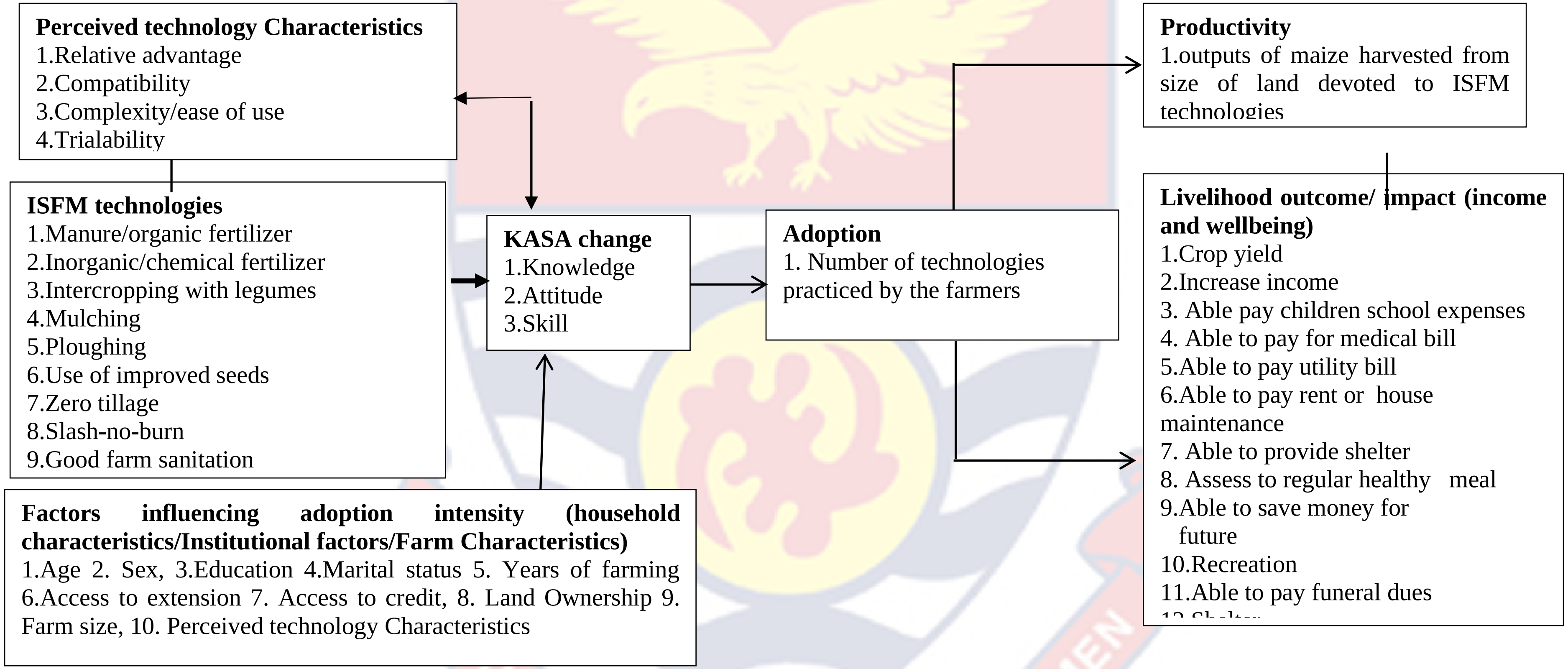

Figure 1: ISFM Technologies and its Effects on Productivity and Livelihood Outcomes

Source: Author's construct

Figure 1 depicts farmers' adoption of the ISFM techniques and their impact on livelihood and productivity. First, the farmers must be introduced to a set of technologies to gain knowledge, skill, attitude and aspiration (KASA) to practice the technologies. Farmers' KASA change about the technologies can be impacted by a host of factors including perceived qualities of the technologies and the background information of the farmers. Mediated by their perceived characteristics of the technologies and their KASA change over time, farmers will practice or not practice the ISFM technologies based directly on their demographic and socioeconomic characteristics coupled with institutional factors such as extension services, credit and membership of farmer organisations (Kwadzo & Quayson, 2021).

The farmers' adoption of the ISFM technologies will then lead to an increase in productivity and ultimately improved livelihood outcomes.

CHAPTER THREE

METHODOLOGY

Introduction

This chapter describes the methods and procedures used in data gathering, collection and analysis of factors that influence the practice of integrated soil fertility technologies and its effects on productivity and livelihood outcomes among smallholder farmers in the Hohoe municipality in the Volta Region. The chapter mainly comprises the study area, research design, population, sampling technique and sample size, sampling procedure, data instrument, data collection and analysis.

Study Area

The Hohoe Municipality in Ghana's Volta region served as the study's location. Geographically, Hohoe Municipal is located in the centre of Ghana's eastern Volta Region. It shares common borders with the Republic of Togo on the east, the Ho Municipal on the south, the Kpando District on the west, and the Jasikan District on the northwest. Part of the Akwapim-Togo ranges, which stretch beyond the nation's eastern border into western Nigeria, is located in the Municipal. The Mountain Afadzato, which has the highest elevation in Ghana, is located within these ranges (880.3m). It is possible to use small irrigation systems, particularly for the dry season cultivation of vegetables, thanks to the River Dayi (a perennial water source) and other smaller ones that drain the entire municipality (MoFA, 2017).

The Municipality has a sizable amount of land that is ideal for growing both upland and lowland rice, and the bimodal rain pattern offers additional potential for crop production. The Municipality's soils are divided into four (4) categories, with the forest ochrosols and their interior savanna types and integrated groundwater laterite ochrosols serving as the major constituents. The other elements are different types of forest zones, such as forest ochrosols and oxysol intergrades, which are interspersed with strips of forest hiltosols along the country's eastern border with the Republic of Togo. Heavy clay to sandy loams is among the different soil types. The municipality benefits from the soil groups because both savanna and forest crops thrive there. The region has a tropical climate, characterized by moderate temperature, 12 ^{o}C—32 ^{o} C for most of the years. Agriculture plays a vital role in the Hohoe Municipality (MOFA, 2017). The Hohoe municipal assembly was selected for the research since it is home to the communities that took part in the ISFM technology project.

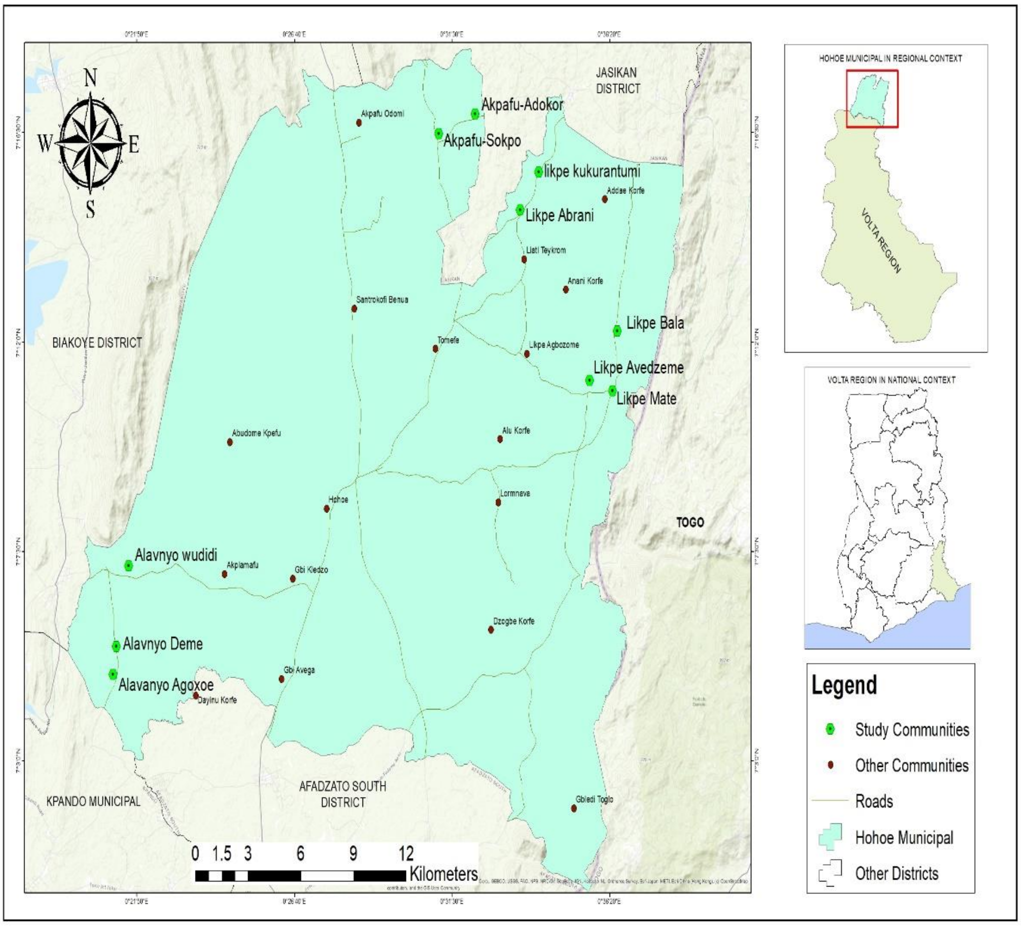

Figure 2: Map showing the research area and the communities

Source: Department of Geography, University of Cape Coast (2021).

Research Design

A cross-sectional survey methodology and a quantitative research approach based on positivist research philosophy were used in the study. Positivism employs the hypothetico-deductive method to test a priori hypotheses involving functional relationships between independent variables and outcomes (Ponterotto, 2005). This concept allows for the testing of hypotheses. This philosophy enables hypotheses like the demographic background of farmers and the technology characteristics that influence the practice of ISFM technologies to be tested to determine their relationship

Quantitative research entails gathering numerical data and analyzing it to explain events using mathematically based approaches (Muijs, 2010). In general, surveys collect data in a period to characterize the state of the current situation, set a threshold by which current situations can be evaluated, or determine the linkages existing in a particular occurrence (Cohen et al., 2007). According to Levin (2006), cross-sectional research provides a picture of the result and the factors that influence it in a single period. The cross-sectional survey design collects data on a population or a population sample only in a period to satisfy research objectives (Portier et al., 2000).

Population

The population of interest in the research comprised all smallholder maize farmers in Ghana's Hohoe Municipality who took part in the ISFM training project. According to Levy and Lemeshow (2013), the population of a study is a group of persons whom the findings of a study are to be extrapolated. The total population of the maize farmers participants in the ISFM programme in the Hohoe district is 998 with 748 males and 250 females in the district, according to the records of the Department of Agriculture in the Hohoe Municipality.

Sample Size and Sampling Technique

The research's sample was obtained from the total number of maize farmers from the Hohoe Municipality who participated in the ISFM project which is a subset of the target population. The sampling method is the criterion by which a researcher selects the sample of interest (Muijs, 2010). According to Muijs (2010) and Trochim (2006), a sample well represents the population to allow for the generalization of results to the population, and its selection is based on the study's aim, population size, risk of choosing an inappropriate sample and the permitted sampling error (Barreiro & Albandoz, 2001). The representative sample for this research was derived using the formulae specified in equation 1. Using the formulae, 278 representative samples were chosen. The sample was stratified to obtain a representation of male and female samples for the research (Table 1).

$$s = \frac{X2*NP(1-P)}{d2(N-1)+X2P\ (1-P)} \qquad (1)$$

s = required sample size.

X^2 = the table values of chi-square for 1 degree of freedom at the desired confidence level (3.841)

N = the population size.

P = the population proportion (assumed to be .50 since this

d = level of accuracy in terms of proportion (.05).

Using the formulae above, a population of 998 maize farmers in the Hohoe municipality who participated in the ISFM technology training gave a sample size of 278 for the study.

Male sample size	= 748/998*278
	= 208
Female sample size	= 250/998*278
	= 70

Table 1: Sample size of ISFM project participants from the Hohoe Municipality

Sex	Proportion	Sample size
Male	748/998*278	208
Female	250/998*278	70
Total		278

Source: Addai (2021).

The sampling procedure for the research followed the two-stage method. The procedure divides a large population into stages to make the sampling process more practical using purposive, stratified or cluster, simple random and systemic sampling methods to arrive at the final sample and sample size of interest (Stephanie, 2014). Using this sampling technique, the population of the study--obtained from the Department of Agriculture in the Hohoe municipality--was stratified into male and female proportions. Because the ISFM project included both male and female maize growers, the study's population was stratified by sex. The researcher ensured that a proportionate number of both sexes were included in the final sample to produce a representative sample of the farmer community for the project. This avoided the risk of randomly picking more of a single sex to make up the study sample. (Table 1). Lastly, a random sampling procedure was used to select the proportion of male and female samples from the list obtained. Overall, 278 farmers (208 males and 70 females) were selected for the study (Table 1).

Instrumentation

The research employed a validated structured interview schedule to gather data for the study. The instrument was designed to generate the primary data to address the research's objectives. The questions were designed to elicit data on such items as farm firm durable assets in cedis, farm size in acres, the quantity of input used in kilograms, type of labour used in farm production activities in man-hours, market access status, membership of farmer-based organizations, number of years in farmer-based-organization, managerial and technical training received, perception about livelihood outcomes and the perceived factors influencing the intensity of the ISFM technologies. The researcher and the supervisor ensured the instrument's validity in terms of face and content. Face validity was achieved by wording the instrument with basic, easy-to-understand phrases that communicated the instrument's purpose. This was done by the researcher. The supervisor validated the instrument's content validity by carefully inspecting the content of the instrument concerning the research questions and objectives to ensure that it accurately reflected the objectives and research questions.

The structured interview schedule was made up of eight (8) sections below:

Section A: Household demographic/socio-economic characteristics

Section B: Knowledge, attitude, skills and aspirations on ISFM technologies.

Section C: Adoption of project technologies and their impact on yield

Section D: Perceived factors influencing the practice of ISFM technologies

Section E: Productivity.

Section F: Access to inputs

Section G: Access to financial services

Section H: ISFM programme impact on livelihood (income and wellbeing)

Measurement of Variables

The items in Section A were assessed through a variety of question types including open, closed and partially closed-ended. Variables in Section B were measured in four constructs namely Knowledge, Attitude, Skills and Aspiration. A five-point Likert-type scale with a range of 1 to 5 was used to assess each construct. For Knowledge: (Having information about the existence of ISFM technologies), 1=Very low, and 5=Very High. For Attitude (Perceived importance of the ISFM technologies used), 1= Not very important, and 5=Very highly Important. For Skills (The ability to practice ISFM technologies), 1=Very low skill, and 5=Very High Skills. For Aspiration (The extent to which you were motivated to practice the ISFM technologies before and after the project), 1=Very lowly motivated, and 5=Very highly motivated.

Farmers' Adoption of the ISFM Technologies

The adoption of the ISFM technologies constituted the item in Section C. it was measured on the dichotomous scale "1" and "0". 1 represented "Yes, already using" and 0 represented "No, not using". This was analysed using frequency and percentage.

Productivity

The quantity of output produced from a specified level of inputs in an economy or a sector is known as productivity (Olaoye & Rotimi, 2010). The ratio of output to input is another way to define productivity. For instance, the ratio of total output to hours worked can be used to calculate labour productivity, whereas yield is used to calculate land productivity. Additionally, the proportion of total output to hours worked can be used to calculate labour productivity. By dividing the total average output by the typical area under cultivation, one can calculate the amount of land that is productive (Department of Agriculture, Water and the Environment, 2020).

Productivity is frequently measured using total factor productivity (TFP), also referred to as multifactor productivity (MFP). This includes both inputs and all production outputs, such as crops, animals, wool, and dairy products (labour, capital, land, materials, and services)(Department of Agriculture, Water and the Environment, 2020). In particular, the ratio of the two indexes produces the TFP index, and a change in the TFP index over time denotes productivity growth (Sheng et al., 2017).

Two different methods have been used in the literature to calculate the productivity in Australia's agricultural sector. The "bottom-up" method, which is the first strategy, is deduced from farm-level data. For example, Islam, Xayavong and Kingwell (2014) based their estimation on the Färe-Primont index method, while Mullen (2007); Yun, Chung, Zimmermann, Zhao, Joo and Lee (2012) and Mullen and Cox (1996) used the Fisher or Törnqvist indexes to estimate TFP in the Australian broadacre agriculture industry. The bottom-up method has some drawbacks despite being commonly used. The technique is unable to predict TFP for the agricultural sector as a whole or to assist analysis of long time series because survey data are not accessible for all Australian agricultural industries (such as horticulture) or a long historical period (Sheng et al., 2017).

The second method, known as the "top-down" method, emanates productivity directly from national accounts data. Productivity Commission, (2005) and the Australian Bureau of Statistics, (2007) used this approach to construct TFP estimates. The Australian Bureau of Statistics (ABS) in particular frequently releases two different types of TFP forecasts, one predicated on value-added and the other on the gross output. The former is accessible since 1986, whereas the latter is only accessible since 1995. Both measures, however, also cover the forestry and fishing industries. The estimates of TFP that are deduced from them are appropriate for cross-sector and cross-country comparisons because the data used in this research are gathered from the national accounts. These analyses do have one noteworthy flaw, though: some of the methods used to compile the data are outdated. For instance, when developing the TFP measure, land quality should be considered, and the treatment of self-employed labour and intermediate inputs might be enhanced to allow TFP to properly represent its key causes. Since it provides broad evidence of how efficiently farmers merge all inputs to generate outputs, the TFP is widely used to measure agricultural productivity performance (Australian Bureau of Statistics, 2007).

There are various productivity indicators described in the preceding literature, and according to Krugman (1994, the selection among them is determined by the intention of the productivity measurement and/or the accessibility of data. The researcher measured land productivity in this research. This was calculated as the ratio of the average total maize output to the average total cultivated land size.

Knowledge and practice levels of ISFM technologies

A Likert scale was used in this study to evaluate the knowledge and application levels of ISFM technologies. According to Likert, one needed to express a series of statements that ranged from mildly positive to strongly positive regarding the "attitude object (underlying construct)" to have a Likert Scale, and then the opposite concerning a series of negative statements. Respondents should logically agree with the positive statements and disagree with the negative ones when it comes to the positive attitude object (hence the need for "reverse item scoring"). Consequently, the construction protocol includes a logical check and validity (Carifio & Perla, 2008). The farmers who would benefit from the ISFM technologies were also given a set of questions to respond to regarding their knowledge of those technologies. Frequencies, percentages, means, and standard deviations were used to analyse the data.

The Rest of the Variables in the Data Collection Instrument

Items in Section D were also measured on a dichotomous scale of “1” and “0”. 1 represented “Yes” and 0 represented “No”. Items in Section E were measured on a ratio scale and “Yes” or “No”. The section also contained closed-ended items. Section F contained closed-ended items which the respondents were required to choose from the options provided. Section G contains items measured on natural dichotomy (Yes/No) as well as closed-ended items. Items in the final section, H, were scored on a Likert-type scale from 1 to 5. LeA = Least Able, VHA = Very Highly Able (VHA). The section also contains closed-ended items to which the respondents were required to assign numbers from 1 to 4. 1 denoted Moderatel Poor, 2 Moderately Better Off, 3 Better Off and 4 Well Off.

Pre-Testing of Research Instruments

To ascertain the internal consistency of the research instrument, pretesting was done to help ascertain the degree of reliability of the research instrument and to fine-tune the items in the research instrument, especially the Likert-type scales used in the instrument (Carmines & Zeller, 1979). In this regard, the research instrument was pretested on 30 rice farmers from the Likpe Bakua community in the Hohoe municipality in the Volta region of Ghana from the 20th to the 21st of October, 2021. This was done by three (3) well-trained research assistants and the student researcher. During the data collection, the enumerators took their time to read out the questions to the farmers and the responses were recorded. It was observed that the enumerators did not face much difficulty in asking the questions. This could be attributed to the fact that the questions were plain concerning meaning and understanding. The Statistical Package for Social Sciences (SPSS) version 25 was used to code and enter the Likert type scale questions from the research instrument to produce the scales' Cronbach alpha coefficients of reliability (Table 2).

Table 2: Reliability Coefficient of subscales of Research Instrument

Variables	Number of Items	Cronbach Alpha
Knowledge scale before the ISFM	13	0.929
Attitude scale before the ISFM	13	0.830
Skills scale before ISFM	13	0.886
Aspirations before ISFM	13	0.903
Knowledge scale after ISFM	11	0.744
Attitude scale after ISFM	11	0.754
Skills scale after ISFM	13	0.908
Aspirations after ISFM	13	0.841
Impact of ISFM on livelihood outcomes before the project	10	0.782
Impact of ISFM on livelihood outcomes after the project	10	0.885

Source: Addai (2021).

The results of the reliability test revealed Cronbach alpha coefficients ranging from 0.744 to 0.929. Gliem and Gliem (2003) assert that the internal consistency of the scale's items increases with Cronbach's Alpha coefficient in a descriptive study. Gliem and Gliem (2003), coefficients greater than 0.9 are excellent, greater than 0.8 are good, greater than 0.7 are acceptable, greater than 0.6 are questionable, greater than 0.5 are poor, and less than 0.5 are unacceptable. Straub et al. (2004) contend that in a pre-test, a Cronbach alpha score of 0.6 is acceptable for the internal consistency of the research instruments, despite Taherdoost (2016) recommendation that a coefficient of 0.7 is more appropriate when deciding the internal consistency of sub-scales for data collection. Comparing the results in Table 2 with Gliem and Gliem (2003) and Straub et al. (2004), the subscales were reliable enough to be used to elicit the needed data for the study.

In addition to Cronbach's alpha coefficients, some modifications were made to some of the questions in the form of rewording or deletion to ensure clarity and reduce redundancy as observed on the field. For instance, it was observed that Q 10 and 17 sought to elicit the same data, as a result, Q17 was removed. Also, Q 5 did not include basic school qualifications in the list of options, but the pre-test data revealed that some of the farmers fall within that class of qualification. Hence, that was included in the final instrument.

Data Collection Procedure

This research employed primary data to answer the research questions which according to Surbhi (2016), are the first-hand raw texts and figures gathered by the researcher herself. To gather this data, five trained enumerators were recruited from AEAs in the office of the Department of Agriculture (DoA) in the study area. The enumerators were given a day's training on how to administer the structured interview schedule. The farmers were identified to participate in the study through the extension officers in the municipality. A brief explanation of the aim of the research was given to the farmers after which they were given the option to opt-out if any of them wanted to. Moreover, they assured of the confidentiality of their responses. On the field, each structured interview schedule was administered for an average duration of 45mis. To increase the response rate, each enumerator stayed with each respondent for as long as it took to complete a questionnaire.

Data Processing and Analysis

Statistical Packages for the Social Sciences were used to enter the data (SPSS version 25). The data was then cleaned to make sure it would be suitable for analyses to address the goals of the study. The sociodemographic and socioeconomic characteristics of farmers, the level of ISFM technology use, KASA change, productivity, and livelihood outcomes were all examined using percentage, frequency, mean, and standard deviation. Inferential statistics such as dependent sample t-test, Chi-Square Test of Independence and binary logistic regression were used to test differences in means of some constructs and variables such as KASA change, change in productivity and livelihood outcomes. The binary logistic regression was particularly used to identify the factors (socio-economic and socio-demographic) that influence the practice of farmers' intensity of the ISFM technologies.

Variables for Regression Analyses

Dependent variable: Adoption of ISFM technologies.

In this research, a count model was used to examine the predictors of the intensity of the practice of ISFM technologies. Utilizing a count model that concentrates on the number of technologies adopted is advantageous when there are numerous component technologies and their use intensities are the subject of research. The number of technologies practised was used to calculate the adoption because this research concentrates on ISFM technologies, which include multiple component technologies. Agriculture programme implementers, agribusinesses, and policymakers will be interested in knowing the factors that affect the number of technologies practised by the farmers (Kolady et al., 2021). Thus, the count model used in this study is binary logistic regression.

In comparison to "regular" linear regression, logistic regression goes further. It is applied in situations where the dependent variable, Y, is categorical. Y is a "Yes" or "No" type variable in binary logistic regression. The numerical representation of the two categories of Y is "1" and "0". In the world of general database marketing, the two categories could be "responded to an offer" (i.e., made a purchase) vs. "did not respond to the offer," but they could also be "adopted the search engine vs. did not adopt the search engine" or "completed a task vs. did not complete a task."

With binary logistic regression, it is possible to determine the best-fitting, simplest model and make the appropriate statistical inferences. In addition to allowing researchers to assess the "goodness-of-fit" of their model and evaluate how well their set of variables predicts their categorical dependent variable, binary logistic regression also provides a summary of the accuracy of the classification of cases. This helps researchers determine the proportion of conclusions reached from this model which will be precise (Fritz & Berger, 2015). The binary logistic regression was used to predict the adoption of the ISFM technologies because the dependent variable (adoption) is a binary (“Yes/No”) variable.

Independent Variables for Regression Analyses:

According to a review of the literature on the adoption of new technologies, institutional features such as land ownership, extension services and membership in farm-based organizations, as well as individual characteristics (such as age, gender, education level, and years in farming) and farm characteristics (such as size) all play a role in the intensity practice or adoption (Kassie et al., 2013; Kwadzo & Quayson, 2021). The independent variables of the study, therefore, were

a) Demographic characteristics

b) farmer-related characteristics

Table 3: Variables for Binary logistic regression and chi-square analyses

Independent variable	Description	Measurement	Expected relationship with the dependent variable
	Independent variables for Binary logistic regression		
1. Age	Years	Ratio	+/-
2. Sex	1, if male and 0 if female	Nominal	+
3. Marital status	1, if married and 0, if not married	Nominal	+
4. Educational level	Level of education	Ordinal	+
5. Farm size	Size of farm	Ratio	+
	Variables for chi-square analysis		
1. Observability	1, if yes and 0, if no	Nominal	
2. Relative advantage	1, if yes and 0, if no	Nominal	
3. Compatibility	1, if yes and 0, if no	Nominal	
4. Trialablity	1, if yes and 0, if no	Nominal	
5. Ease of use	1, if yes and 0, if no	Nominal	

Source: Addai (2021).

Table 4: Analytical Framework

Objective	Variables	Measurement level	Analytical tool
1. Determine the knowledge, skills, attitude and aspiration levels of the beneficiary farmers before and after the project	Knowledge Attitude Skills Aspiration	Ordinal	Mean, standard deviation, Dependent sample t-test
2. Determine the adoption of the ISFM technologies by the farmers.	Number of technologies practised Number of farmers that practised the technologies.	Ratio	Frequency, percentages
3. Analyse the factors influencing the practice of ISFM technologies by the farmers	Age, sex, farm size, membership of farmer organisation, education level, land ownership, farming experience.	Ratio, nominal	Frequency, Percentage
4. Determine farmers' perceived characteristics of the ISFM technologies that influenced their decision to practice the ISFM technologies	Relative advantage, observability, compatibility, trialability, complexity/ease of use.	Nominal	Frequency, percentage Chi-square
5. Determine the productivity of farmers before and after practising the ISFM technologies	Output before and after the practice of the ISFM technologies Size of land devoted to production before and after practising the ISFM technologies	Ratio	Mean, standard deviation Dependent Sample T-test
6. Examine the livelihood outcomes (income and well-being) of farmers involved in the ISFM technologies training	Livelihood outcomes (Well-being, Income)	Ordinal	Mean, standard deviation, dependent sample t-test

Source: Addai (2021).

Ethical Considerations

The consent of the Municipal Director of the Department of Agriculture was sought before data was collected in the Municipality. In addition, respondents were well informed about the motive and purpose of the research and their consent was sought before data was collected. The respondents also had the option to opt-out of the study. The confidentiality of the respondents was also ensured.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

The findings of this study are presented in this chapter in precise detail. The presentation includes information on the sociodemographic background of the producers, the KASA change of the farmers, the level of practice of the ISFM technologies, the factors that influence the level of practice of the ISFM technologies, and the effect of the ISFM technologies on the farmers' quality of life.

Socio-Demographic and Socioeconomic Characteristics of Respondents

Sex of Respondents

The research aimed to explain the gender composition of the respondents used in the study. The research showed that more than half (70%) of the respondents were males while about a quarter (25.2%) of the farmers were females (Figure 3). It is obvious from the study that males are more inclined toward maize production than their female counterparts.

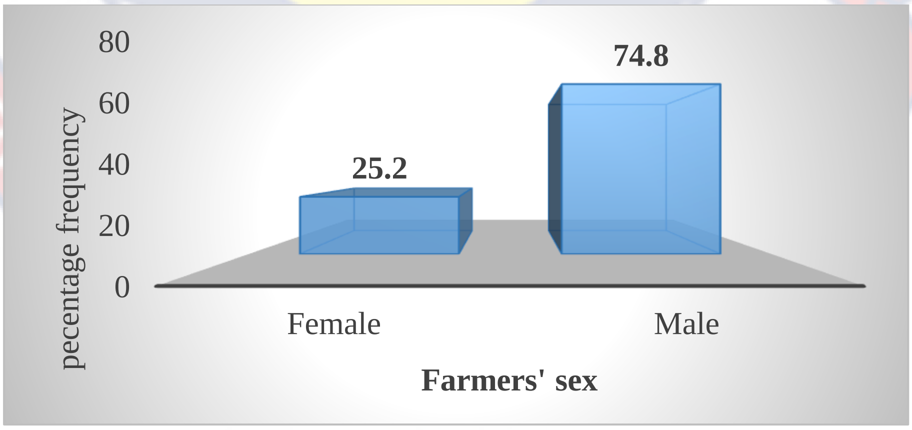

Figure 3: Farmers' sex

Source: Addai (2021).

Sex is considered an important determinant of the use of ISFM. This is because it is observed that there is a discrepancy in the access to the ISFM technology between males and females due to the power play between genders in most African communities. For example, Mponela et al. (2016) revealed that there is a high probability of male headed-households blending inorganic fertilisers and residue incorporation and/or farmyard manure than female-headed households. The result of this study, therefore, implies that most of the farmers may adopt the technologies, as the majority of them are males.

Age of Maize Farmers

According to the research, the majority (41 per cent) of the farmers were in the age bracket of 41-50, followed by farmers between 31-40years. The study also revealed that an overwhelming majority (83.1 per cent) were below the age of 51 years. The mean age (M=42, SD=10) denotes that, the farmers are quite youthful in the research area, with a wide range of ages. However, A little over one-tenth (14.7%) were between 51 to 60 years old whiles about (2%) were in their retirement ages, thus 61-70 years old (Table 4).

Table 5: Respondents' age

Age (years)	Freq.	%
≤30	44	15.8
31-40	73	26.3
41-50	114	41.0
51-60	41	14.7
61-70	6	2.2
Total	278	100

Mean=42 SD =10

Source: Addai (2021).

Age is a significant factor in how farmers practice agricultural technologies. Younger farmers are more open to practising new agricultural technologies because they are more willing to experiment and learn new things than older farmers, who tend to be more traditional and less likely to practice new practices (OECD, 2008). According to Ghadim and Pannell (1999), age has a significant influence on farmers' decisions to practice new ideas because younger farmers are more receptive to them. This research's finding appears that the majority of the relatively younger farmers are likely to adopt the ISMF technologies.

Respondents' Marital Status

The research's findings indicated that most of the farmers (82.4%) were married, 9.4% of them were single, 4.3% divorced and 4% were widowed, as presented in Figure 4.

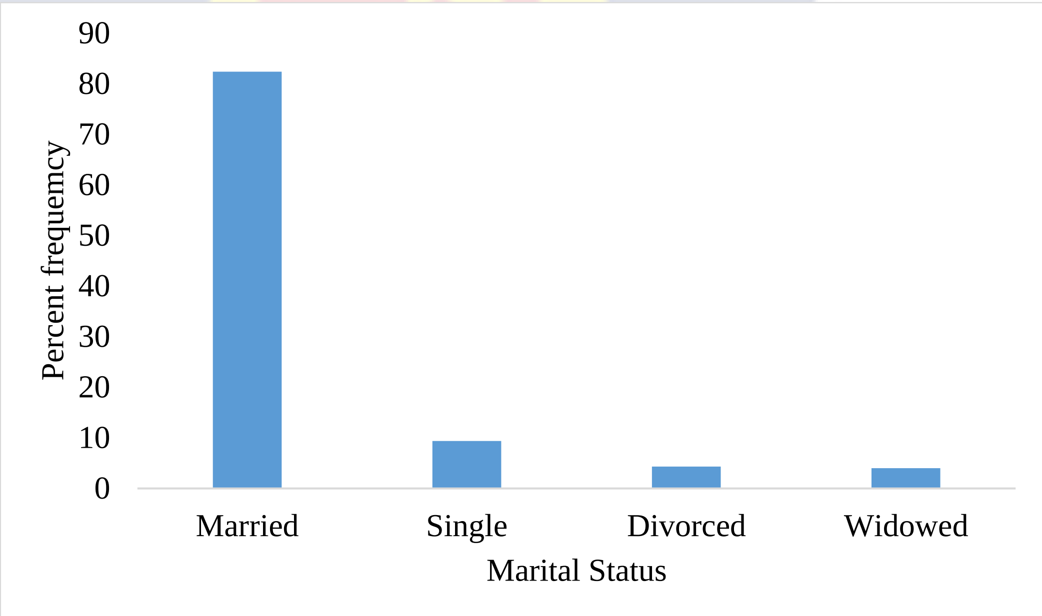

Figure 4: Marital Status of Respondents

Source: Addai (2021).

Patrick et al. (2011) found that married farmers are more probable than single farmers to use technologies. Married people tend to use technologies that will help them utilize their resources more efficiently due to their many responsibilities, especially at home. The marital status of the respondents, according to Onuekwus and Okezie's 2007 research, has no positive impact on their intensity of practising rabbit technologies. The findings of the research indicate that farmers are more probable to practice ISFM technologies because most of them are married.

Educational Qualification of Respondents

Over half of the respondents (56.1%) had primary and junior high school academic qualifications, according to the result in Table 6. It was revealed that out of the 278 respondents 42 (15.1%) of them had no formal education whiles about one-fifth (20.5%) had senior high school qualifications (Table 6).

Table 6: Educational Qualification of Respondents

Educational Qualification	freq	%
No formal education	42	15.1
Primary School	52	18.7
Junior High School	104	37.4
Senior High School	57	20.5
Certificate in General Agric.	6	2.2
Diploma	15	5.4
Postgraduate	2	0.7
Total	278	100

Source: Addai (2021).

The use of ISFM technologies is positively impacted by the educational level of farmers. Farmers with higher education levels typically use more ISFM (Marenya & Barrett, 2007). In Nsinpe, Ngwandu et al. (2014) found that older farmers in Furancungo, Mozambique, who are literate are more likely to practice ISFM technologies. This conclusion results from the fact that ISFM is a knowledge-intensive option that affects its adoption, requiring awareness-raising and appropriate training (Marenya and Barrett, 2007; Ngwandu et al., 2014). According to the study's findings, 84.9% of farmers have a formal education. Given that formal education is positively correlated with the practice of ISFM technologies, it follows that the majority of farmers are very likely to use these methods.

Land Ownership Status

According to the study's findings, 51.1% of farmers grew maize on land that belonged to them. A few (15.1%) of the respondents' farm on their land. Whiles about one-tenth (10.4%) cultivate maize on inherited lands, 17.6%, on the other hand, produced maize on rented lands. However, the study pointed out that out of the 278 respondents, only 16 produced maize on lands they had acquired (Table 7).

Table 7: Land Ownership Status

Land ownership status	Freq.	%
Own Land	42	15.1
Family Land	142	51.1
Bought	16	5.8
Inherited	29	10.4
Rented	49	17.6
Total	278	100

Source: Addai (2021).

The study shows that 82.4% of the farmers are entitled to the land they use for their maize production. The physical capital of a household plays a significant role in determining how widely ISFM technologies are practised (Akinola & Alene, 2010). Agrarian economies may benefit from improvements in land rental markets by adopting new crop varieties, according to a study by Zeng et al. (2018). Lack of land ownership can deter the practice of agricultural innovation. In implication, the farmers' entitlement to the land they use for maize production can encourage the practice of ISFM technologies to improve their welfare.

Years in Maize Production

According to the study, out of the 278 respondents, about 231 of the respondents had between 1 to 20 years of experience in growing maize. About 38 of the respondents have been cultivating maize for over 20 years, but not more than 40 years (Table 8).

Table 8: Years in Maize Production

Years	Freq.	%
1-10	92	34.2
11-20	139	51.7
21-30	34	12.6
31-40	4	1.5
Total	269	100

Source: Addai (2021).

Households with more farming experience frequently choose from a variety of technology test mixes that offer the greatest returns, whereas new farmers typically are risk-averse and practice a limited range of options

(Grazhdani, 2013). In the absence of extension officers to guide farmers, studies have found that farmers depend on their accumulated knowledge and experience to test and evaluate technologies aimed to improve their productivity and select the most beneficial ones. Therefore, farmers with extensive farming experience practice a variety of technologies to capitalize on their complementary advantages (Mponela et al., 2016). The result from this study indicates that the majority of the farmers have more than a decade-long experience in producing maize. In line with Grazhdani (2013) and Mponela et al. (2016), the farmers are most likely to practice more of the ISFM technologies based on their long-time experience in producing maize which can aid them to evaluate the efficacy of the ISFM technologies.

Farm Size

According to the research, most farmers farmed between 1 and 5 acres of land. However, the study also found that out of the 278 respondents, 77 cultivated land that is between 6 and 25 acres in size (Table 9).

Table 9: Maize Farm size cultivated

Farm Size in Acres	Freq.	%
5 and less	200	71.9
6-10	49	17.6
11-15	24	8.6
16-20	1	0.4
21-25	3	1.1
26-30	-	-
31-35	1	0.4
Total	278	100

Source: Addai (2021).

The amount of land owned and dedicated to crop production by households is a significant physical capital that influences how widely ISFM technologies are practised. According to an analysis of farmers in Nsipe, farmers who use more ISFMs technologies have larger plots of land. This implies that larger farm sizes are associated with more readily available financial resources, investing in ISFM much more viable (Akinola & Alene, 2010). Additionally, research by Harris and Orr (2014) demonstrated that farmers with smaller plots will not benefit from scale economies when using more inputs because the returns will be too small, particularly in a rain-dependent farming system. Moreover, Wawire et al. (2021) found that variations in land ownership had a significant impact on the use of reported soil fertility management practices, with farmers who had more land (more than 3 acres) using the reported practices more frequently than those who had three acres or less. Based on the aforementioned results, the study's conclusion suggests that farmers who took part in the ISFM project may be able to practice more ISFM technologies.

Quantity of Maize Harvested

The study further sought to ascertain the quantity of maize harvested by farmers in kilograms. It was revealed from the study that, out of the 278 respondents interviewed, the majority of them (79.7%) harvested from 1 to 11 (50kg) bags of maize, while about 20.4 % harvested over 21 (50kg) bags of maize during the planting season (Table 10).

Table 10: Quantity of Maize harvested in (50Kg) bags

Quantity harvested (50kg) bag	Freq.	%
1-10	107	39.5
11-20	109	40.2
21-30	36	13.3
31-40	9	3.3
41-50	8	3.0
51-60	1	0.4
61-70	-	0
71-80	1	0.4
Total	271	100

Source: Addai (2021).

Membership in a Farmer-based Organization

A farmer's participation in farmer organizations serves as a conduit for knowledge transfer and facilitates the implementation of novel technologies to boost production. Most development agencies prefer to work with organized groups of farmers rather than individual scattered farmers. Figure 5 depicts the results of farmer organization membership among those interviewed. The vast majority of farmers (98.2%) belonged to farmer organizations or cooperatives, with only a few (2%) belonging to no farmer organization (Figure 5).

Figure 5: Membership of farmer organization
Source: Addai (2021).

It has been demonstrated that membership to a group impacts the degree to which ISFM is practised. This is because the majority of farmers in smallholder farming systems are impoverished, and groups can build social capital (Njuki et al., 2008). Other studies, such as Asante et al. (2011) and Adimassu et al. (2012), oppose this point of view, claiming that farmers mainly participate in non-farming groups for marketing purposes. It is also probable that farmers who use ISFM techniques like mulching and liming do so independently of social networks Mponela et al (2016).

Despite the belief that organizations are a bonding social capital and are essential for encouraging the diverse practice of improved technologies (Njuki et al., 2008), Winters et al. (2007) concur with the idea that group affiliation is not necessary for facilitating the practice of several technologies, and instead motivate farmers to practice fewer technologies. Given the foregoing scholarship, the study's result, although indicates that all the farmers are members of farmer organisations, neither implies that the farmers have a greater likelihood of practising the ISFM technologies nor the likelihood of not practising the technologies. However, the researcher associates herself with Njuki et al. (2008) that farming group membership may build social capital to benefit especially poor farmers to help them decide on the practice or non-practice of the ISFM technologies.

Knowledge, attitude, skills and aspiration (KASA) levels of the beneficiary farmers of the ISFM project.

The first objective of the study was to determine the KASA level of the farmers who participated in the ISFM project. To achieve this, the KASA was measured before and after the ISFM project to ease the attribution of results to the project or otherwise.

Knowledge of farmers on the ISFM Technologies before and after the project

The farmer's knowledge before and after their participation in the ISFM project was examined. Knowledge refers to whether or not farmers are aware of the availability of ISFM technologies. The finding showed that the mean knowledge level of the farmers before and after they participated in the ISFM project were low (1.57) and moderate (3.11) respectively (Table 11).

Table 11: Knowledge of ISFM technologies Before and After the project

ISFM Technologies	Before		After	
	Mean	SD	Mean	SD
Manure/organic fertilizer	1.67	0.58	3.38	0.74
Inorganic/ chemical fertilizer	1.90	0.43	3.58	0.60
Intercropping with legumes	1.49	0.60	3.11	0.51
Mulching	1.48	0.62	3.06	0.49
Ploughing	1.14	0.67	2.82	1.04
Improved seed and planting material	1.44	0.63	3.18	0.63
Zero Tillage	1.66	0.60	3.39	0.58
Slash-no burn	1.63	0.59	3.74	2.42
Good farm sanitation	1.70	0.72	3.63	0.77
Weighted mean	1.57	0.38	3.32	0.51

Scale: Knowledge: 1= Very Low, 2= Low, 3= Moderate, 4= High, 5= Very High.

Source: Addai (2021).

Knowing farmers' knowledge of programme components or practices before project implementation is essential for project implementers. This is because such data allows researchers to assess the impact of projects by comparing KASA levels before and after the project. All else being equal, the difference assists the researcher in determining the programme's impact. The findings show that farmers' awareness of ISFM technologies was generally low (M = 1.57), indicating that they knew little about such practices. Strikingly, the farmers retained a moderate level of knowledge (M=3.32) after participating in the programme. This indicates an improvement in farmers' knowledge of ISFM technologies, which is a good sign for technology practice. The findings agree with Xia et al (2022), who found that participants' knowledge of drug abuse and confidence in providing addiction counselling improved after they participated in a programme aimed at teaching people how to counsel drug addicts.

As a result of this research, farmers' knowledge of ISFM practices has increased due to the ISFM programme.

1H$_o$: No statistically significant difference exists in the knowledge level of farmers before the ISFM programme and after the ISFM programme

A dependent sample t-test (paired sample t-test) was run at a 5% significant level, two-tailed, to statistically ascertain the change in farmers' knowledge concerning the ISFM technologies and to enable attribution of the change to the ISFM project. The finding showed that the difference in the mean score of farmers' knowledge before (M= 1.57, SD=.38) and after the project (M=3.32, SD=.46), was significant t(296)= -60.34, p=0.000 (Table 12).

Table 12: Dependent Sample T-test for Knowledge before and after ISFM Project

Variable	N	Mean	SD	t-value	df.	Sig. (2-tail)
Knowledge before the ISFM project	278	1.57	0.38			
Knowledge after the ISFM project	278	3.32	0.51	-60.34	296	**0.000
Paired Difference		-1.75	0.13			

*p<0.05; **p<0.01

Source: Field Data (2021).

According to the findings, there is a statistically significant difference in the mean score of maize farmers' knowledge of ISFM technologies before and after the programme's implementation. Farmers' knowledge level after participating in the programme (M=3.32, SD=0.51) was significantly higher than their knowledge level before the project (M=1.57, SD=0.38) (Table 12). The result shows that the knowledge of maize farmers increased statistically significantly after the project. This confirms that farmers' KASA improved after being exposed to agricultural interventions (Lambrecht et al., 2014) and that the ISFM intervention increased farmers' awareness of soil conservation practices. The result again conforms with Xia et al (2022). The researcher, therefore, failed to reject the alternate hypothesis which stated that there is a statistically significant difference between farmers' knowledge before and after they participated in the ISFM project.

The attitude of farmers towards ISFM technologies Before and After the programme

This section determined farmers' attitudes toward ISFM technologies before and following their participation in the ISFM programme. The perceived value of ISFM technologies from the perspective of maize farmers is referred to as attitude. According to the research, farmers' attitudes toward ISFM technologies had a mean value of 1.59 before they participated in the programme. However, after participating in the project, the mean value increased to 3.26 (Table 13).

Table 13: Farmers' attitude towards ISFM technologies before and after the project

ISFM Technologies	Before		After	
	Mean	SD	Mean	SD
Manure/organic fertilizer	1.63	0.57	3.41	0.63
Inorganic/ chemical fertilizer	1.71	0.52	3.64	2.37
Intercropping with legumes	1.54	0.57	3.16	0.46
Mulching	1.49	0.59	3.13	0.49
Ploughing	1.20	0.68	2.76	1.02
Improved seed and planting material	1.48	0.62	3.13	0.42
Zero Tillage	1.61	0.61	3.29	0.55
Slash-no burn	1.72	0.59	3.43	0.59
Good farm sanitation	1.92	0.59	3.42	0.59
Weighted mean	1.59	0.59	3.26	0.46

Attitude: 1= Not very important, 2= Not important, 3= moderately important, 4= highly important, 5= Very highly important

Source: Field Data (2021).

According to the report's result, farmers did not consider ISFM technologies to be important before experiencing (watching a demonstration of) them (M=1.59). However, after experiencing the technologies, the farmers assigned the technologies moderate importance (M=3.26) (Table 13). This demonstrates that demonstrating and educating farmers about ISFM technologies helped them realize how important they are for maize production. This finding is consistent with the findings of Xia et al (2022), who discovered that participants' attitudes toward drug abuse and confidence in providing addiction counselling improved after they participated in a programme aimed at teaching people how to counsel drug addicts.

As a result, this study confirms that programmes or interventions, particularly in the agricultural sector, improve farmers' attitudes toward a set of technologies that may influence their practice.

2Ho: There is no statistically significant difference in the attitude of farmers about the ISFM technologies before and after their participation in the ISFM technology training project

The study then used a paired sample t-test to see if there was a statistically significant difference in maize farmers' attitudes before and after the programme. Table 14 displays the outcome. The outcome shows that maize farmers' attitudes after the ISFM project were far better than their attitudes before the project. Farmers' mean score after participating in the project (M=3.26, SD=.42) was significantly higher than farmers' mean score before participating in the project (M=1.59, SD=.42), t(-46.24)= 296, p=0.000.

Table 14: Dependent Sample T-test for Attitude Before and After ISFM Project

Variable	**N**	**Mean**	**SD**	**t-value**	**df.**	**Sig. (2-tail)**
Attitude before the ISFM project	278	1.59	0.42			
Attitude after the ISFM project	278	3.26	0.42	-46.24	296	0.000**
Paired Difference		-1.67	0.62			

*p<0.05; **p<0.01

Source: Field Data (2021).

The analysis revealed that the attitude of maize farmers improved significantly after the project. As a result, the researcher failed to accept the null hypothesis.

Skills of farmers in adopting the ISFM technologies before and after the project

The farmers' skills in the ISFM technologies were assessed before and after they participated in the ISFM project. The skill component explains the extent to which farmers could adopt ISFM technologies on their initiative. According to the study, the farmers' mean score of skill in the ISFM technologies before taking part in the project was1.58. It subsequently increased to 3.34 after they partook in the ISFM project (Table 15).

Table 15: Farmers' skills in adopting the ISFM technologies before and after the project

	Before		After	
ISFM Technologies	Mean	SD	Mean	SD
Manure/organic fertilizer	1.71	.55	3.44	.60
Inorganic/ chemical fertilizer	1.75	.55	3.54	.60
Intercropping with legumes	1.56	.55	3.24	.51
Mulching	1.56	.59	3.14	.52
Ploughing	1.52	.59	2.84	1.00
Improved seed and planting material	1.29	.67	3.24	.54
Zero Tillage	1.51	.60	3.52	2.43
Slash-no burn	1.59	.63	3.52	.58
Good farm sanitation	1.74	.59	3.58	.60
Weighted mean	1.58	.55	3.34	.51

Skills: 1= Very low skills, 2= Low skills, 3=Moderate skills, 4= High Skills and 5= Very high skills.
Source: Field Data (2021).

Farmers' skills in the application of agricultural technologies are imperative to increasing production and impacting positively on their livelihoods. The results imply that the ISFM training programme improved the farmers' skills in the application of the ISFM technologies. This mimics the finding of Fetsch and Jackman (2015) that the United State Department of Agriculture's AgrAbility which AgrAbility programme whereby Extension and non-profit professionals provided information, education, and service to individuals with disabilities within the agricultural population improved almost all the farmers' KASA. In implication, more agricultural interventions should be implemented to equip farmers with more skills to enable them to apply improved agricultural technologies.

3H$_0$: There is no statistically significant difference in the mean score of farmers before and after the ISFM project based on their skills

This section presents the findings of the dependent sample t-test for a significant difference in maize farmers' skills before and after participation in the ISFM project activities. The findings (Table 16) revealed a statistically significant difference in the skills of maize farmers in the ISFM activities before and after the project's implementation. Farmers' mean score after participating in the project (M=3.34, SD=.47) was significantly higher than before participating in the project (M=1.58, SD=.40), t(-46.03)=296, P=0.000. According to the findings of the study, maize farmers' skills have significantly improved after the project.

Table 16: Dependent Sample T-test for Skills before and after ISFM Project

Variable	N	Mean	SD	t-value	df.	Sig. (2-tail)
Skills before the ISFM project	278	1.58	0.40			
Skills after the ISFM project	278	3.34	0.47	-46.03	296	**0.000
Paired Difference		-1.76	.64			

*p<0.05; **p<0.01

Source: Field Data (2021).

The study revealed a statistically significant difference between the mean of skills before and skills after the project implementation, hence the study refused to accept the null hypothesis (Table 16). In implication, the ISFM technology training programme significantly improved the farmers' skills in practising the ISFM activities. The study, therefore, failed to accept the null hypothesis which states that there is no significant difference between farmers' attitude before and after participating in the ISFM project.

Aspiration of farmers about the ISFM technologies before and after the project

Farmers' aspiration for ISFM technologies was measured by how motivated they were to use ISFM technologies. This is important in determining whether farmers develop and sustain interest in agricultural interventions before and after experiencing them. This was evaluated both before and after they took part in the ISFM project. According to the study, farmers' mean aspiration value increased from 1.65 before participating in the ISFM project to 3.45 after participating in the project (Table 17).

Table 17: Farmers' aspiration about the ISFM technologies before and after the project

ISFM Technologies	Before		After	
	Mean	SD	Mean	SD
Manure/organic fertilizer	1.75	0.53	3.52	0.59
Inorganic/ chemical fertilizer	1.79	0.49	3.71	0.57
Intercropping with legumes	1.61	0.57	3.30	0.54
Mulching	1.53	0.63	3.27	0.62
Ploughing	1.34	0.69	2.94	1.04
Improved seed and planting material	1.54	0.63	3.39	0.59
Zero Tillage	1.64	0.61	3.59	2.37
Slash-no burn	1.78	0.57	3.64	0.57
Good farm sanitation	1.89	0.59	3.67	0.56
Weighted mean	1.65	0.57	3.45	0.54

Aspirations: 1= Very lowly motivated, 2= Lowly motivated, 3= moderately motivated, 4= highly motivated and Very highly motivated.

Source: Addai (2021).

The study revealed that the ISFM technology training programme improved farmers' aspirations or motivated them more, to apply the soil-improving technologies. The result aligns with Fetsch and Jackman (2015) and supports the assertion that agricultural interventions oftentimes positively affect farmers’ KASA.

$4H_0$: No significant difference exists in the aspiration of farmers before the ISFM programme and after they participated in the ISFM programme

This section presents the findings of the dependent sample t-test for a significant difference in maize farmers' aspirations before and after participation in the ISFM project activities. The findings (Table 18) revealed a statistically significant difference in the aspirations of maize farmers in the ISFM activities before and after the project's implementation at 1% Farmers' mean score after participating in the project (M=3.45, SD=.57) was significantly higher than before participating in the project (M=1.67, SD=.54), t(-48.3480)=252, P=0.000.

Table 18: Dependent Sample T-test for aspiration before and after ISFM Project

variable	N	Mean	SD	t-value	df.	Sig. (2-tail)
Aspiration before the ISFM project	278	1.65	0.54			
Aspiration after the ISFM project	278	3.45	0.57	-48.348	252	**0.000
Paired Difference		-1.80	0.03			

*p<0.05; **p<0.01

Source: Field Data (2021).

According to the findings of the study, the ISFM technology training programme significantly increased the maize farmers' aspiration or motivation to practice the ISFM technologies, confirming Fetsch and Jackman (2015). The study, therefore, failed to reject the alternate hypothesis.

The adoption of the ISFM technologies

According to the result of the study, more than half of the respondents (60.1%) practised and were using manure/ organic fertilizers on their farms while (39.9%) were not using this technology. Out of the 278 respondents interviewed, an overwhelming number (94.6%) apply inorganic/ chemical fertilizers on their maize farms whiles less than one-tenth (5%) did not use inorganic fertilizers. It was also realized that most of the farmers adopted the slash- no burn technology (93.9%) as compared to ploughing (21.2%). Whiles more than half of the farmers have adopted and are using intercropping (58%), mulching (58%), and improved seed and planting (56.3%), quite the majority (90.3%) have adopted and are practising good sanitation in their maize farms (Table 19).

Table 19: The adoption of ISFM technologies

ISFM technologies	Yes, practising		No, not practising	
	freq.	%	freq.	%
Manure/organic fertilizer	167	60.1	111	39.9
Inorganic/ chemical fertilizer	264	94.6	14	5.0
Intercropping with legumes	150	54	128	46
Mulching	158	58	113	40.5
Ploughing	57	21.2	212	78.8
Improved seed and planting	156	56.3	121	43.4
Zero Tillage	241	86.7	37	13.3
Slash-no burn	262	93.9	16	5.7
Good farm sanitation	251	90.3	27	9.7

Source: Addai (2021).

The adoption of the ISFM technologies by the farmers is generally high, with the least being 21.2% and the highest at 94.6%. Chemical fertilizer application and slush-no-burn were the most widely practised ISFM technologies, practised by almost all (94.4% and 93.9% respectively) of the farmers. Generally, the study result compares better with Awuni et al. (2018) who found the highest percentage of farmers practising improved agricultural technologies among rice farmers to be 59. The results, however, contrast Mwaura et al. (2021) who determined that most farmers practice manure (97%) in Kenya. Interestingly, ploughing was adopted by the least number of farmers, according to the result (Table 19). This may be because the farmers do not have access to ploughs. The result of the study implies that overall, the ISFM technologies are still being practised by a substantial number of farmers in the Hohoe Municipality.

Factors influencing the adoption of the ISFM technologies

The study determined the socioeconomic and socio-demographic factors that influenced the farmers' intensity of practising each of the ISFM technologies. This was achieved through binary logistic regression,

Factors influencing the adoption of Manure/ Organic fertilizer

The research determined the factors that influenced farmers' adoption of manure/organic fertilizer technology. The results revealed that Sex (p=0.004), age (p=0.010), education (p=0.018), and farm size (p=0.000) were found to have a significant influence on the adoption of manure/organic fertilizer usage. (Table 20).

Table 20: Factors influencing the adoption of manure/organic fertilizer application

Independent variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	-1.160	0.397	0.314	0.144	0.683	0.004*
Age	0.051	0.020	1.052	1.013	1.094	0.010*
Marital status	0.550	0.295	1.734	0.973	3.091	0.062
Education	-0.305	0.129	0.737	0.573	0.949	0.018*
Farm size	0.381	0.094	1.464	1.218	1.760	0.000*
Constant	-3.265	0.927	0.038			0.000*
Model X^2 = 0.308						
Pseudo R^2 = 0.484						
N =278						

Note: The dependent variable in this analysis is the adoption of Manure/Organic Fertilizer coded so that 0= No, not using, and 1= Yes already using.

Source: Addai (2021)

The result revealed that sex is significantly associated with the likelihood of adoption of manure/organic fertilizer at a 1% significant level. The resuls showed that male farmers were less likelily to adopt manure (OR=0.397, p=0.00) than female farmers (Table 20). Sex plays a significant role in ISFM usage. According to Mponela et al. (2016), male-headed households are more likely than female-headed households to combine inorganic fertilizers with residue incorporation and/or farmyard manure. This is explained by the fact that men and women have different levels of access to technology, and men have more resources than women (Pampi & Brajendra, 2016). Mponela et al. (2016) also revealed that male farmers adopt ISFM technologies, particularly manure, more than female farmers. This is because manure application is characterized by drudgery and so men who are muscular and stronger than women have an advantage of applying manure on their farms over women The study's result contrast. The results of the study, however, constrast Mponela et al. (2016).

The age of the farmers was associated with the likelihood of the adoption of manure/organic fertilizer at a statistical significance of of 1% (Table 20). From the result, increase in the age of farmers also increases the likelihood of the adoption of manure/organic fertilizer (OR=1.05, p=0.01). In other words, older farmers are more likely to adopt the manure/organic fertilizer technology of the ISFM. The result concurs with Mutua-Mutuku et al. (2017) that age has a significant influence on the adoption of ISFM technologies. The study's result has revealed a more likelihood and a significant effect of age on the adoption of organic fertilizer. The result again agrees with other studies such as Abdulai and Huffman (2014) that elderly household heads adopted new agricultural technologies compared to younger household heads. Abdulai and Huffman (2014) attributed this to the high capital requirement for the adoption of some agricultural technologies; older households may have accumulated more capital over time and can afford labour to assist in the application of manure. Further, the credit institution may prefer the elderly to young farmers. Further, a possible explanation of the study's result is that even though organic fertilizer application is thought of as tiresome to adopt, older farmers may still be attracted to adopting it as a result of their experience with manuring and observed effect on yield. Older farmers, thus, may practice manuring on their farms regardless of its associated drudgery.

The education level of the farmers was a associated with the likelihood of the adoption of manure at a statistical significance level of 1%. According to the study, highly educated farmers seven times likely to adoption manure/organic fertilizer technology (OR=0.737, p=0.018) than farmers with low educational level. The results confirma the common position of adoption scholars that higher education enhances the adoption of agricultural technologies (Ajewole, 2010; Okunlola, Oludare and Akinwalere, 2011; Waller, Hoy, Henderson, Stinner and Welty, 1998). As farmers attain higher education, they are exposed to more alternative sources of information based on which to assess the best alternatives of fertilizer to apply and have higher effectiveness in a relatively shorter period. The result of the study, therefore, implies that the more highly educated farmers are the more likely they are to apply manure/organic fertilizer on their farms.

The farm size was associated with the likelihood of adopting manure at a statistical significance level of 1%. According to the study, large acreage of farm size of the farmers will result in increased likelihood of adopting manure/organic fertilizer (OR=1.464, p=0.000). This finding suggests that households were more inclined to employ larger plots of land for the manure as the amount of land under cultivation increased than they were for households using smaller plots. In agriculture, the land serves as a sign for a variety of factors, including the production factor, risk-taking ability, level of wealth, and collateral for loans (Enki, Belay & Dadi, 2001). The revenue raised from farming helps pay for labour to implement organic-based technologies (Enki et al., 2001). This result supports the findings from Danso-Abbeam et al. (2018). Land under cultivation, according to Nigussie et al. (2017), is a gauge of available financial resources and the readiness to adopt new technology. This study's result is also similar to the finding of Mwaura et al. (2021) that cultivated land size had a positive association with the adoption intensity of manure in Murang'a, Kenya.

Factors influencing the adoption of inorganic/ chemical fertilizer

The results as shown in Table 21 demonstrates the outcome of the logistics regression run at a 95% confidence interval between the adoption of inorganic/chemical fertilizer and demographic variables. The results indicate that there was no statistically significant association between the demographic characteristics of farmers and the adoption of inorganic/chemical fertilizer.

Table 21: Binary logistics regression on the adoption of Inorganic/ chemical fertilizer

Independent variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	0.420	.605	1.522	.464	4.984	0.488
Age	0.025	.036	1.026	.957	1.100	0.475
Marital status	-0.299	.384	.741	.349	1.574	0.436
Education	0.170	.263	1.185	.708	1.984	0.519
Farm size	0.373	.197	1.452	.987	2.137	0.058
Constant	0.493	1.514	1.638			0.744
Model X^2 = 0.704						
Pseudo R^2 = 0.113						
N =278						

Note: The dependent variable in this analysis is the adotpion of Inorganic/ chemical fertilizer coded so that 0= No, not using, and 1= Yes already using.
Source: Addai (2021).

From the result (Table 21), none of the dependent variables was found to be statistically associated with the adoption of inorganic/chemical fertilizer. Further analyses may, therefore, be required to ascertain what factors can influence farmers' adoption intensity of the inorganic-based or chemical fertilizer.

Factors influencing the adoption of intercropping with legumes

The result of a logistics regression on the adoption of intercropping with legumes technology with age, sex, marital status, education, and farm size indicated significance with only farm size (p=.040) (Table 22). It was, however, noted that the other independent variables do not have any statistically significant interaction with the dependent variable.

Table 22: Binary logistics regression on the adoption of intercropping with Legumes Technology

Independent variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	-.104	.295	.902	.506	1.606	0.725
Age	-.021	.015	.979	.950	1.009	0.171
Marital status	-.166	.175	.847	.600	1.194	0.343
Education	.114	.098	1.121	.924	1.359	0.246
Farm size	.079	.040	1.082	1.001	1.170	0.048*
Constant	.634	.716	1.884			.376
Model X^2 = .861						
Pseudo R^2 = .040						
N =278						

Note: The dependent variable in this analysis is the adoption of Intercropping with legumes coded so that 0= No, not using and 1= Yes already using.
Source: Addai (2021).

The study revealed that farm size is statistically significantly associated with the likelihood of adoption of intercropping with legumes. Specifically, the larger the farm size, the more likely it is for farmers to adopt inorganic fertilizer application (OR=1.082, p=0.048). Land is very important in agriculture, as it serves to determine the production factor, risk-taking ability, level of wealth, and collateral for loans (Enki, Belay & Dadi, 2001). The revenue raised from framing helps pay for labour to implement organic-based technologies (Enki et al., 2001). This result supports the findings from Danso-Abbeam et al. (2018). Land under cultivation, according to Nigussie et al. (2017), determines the availability of financial resources and the readiness to adopt new technology. This study’s result is also similar to the finding of Mwaura et al. (2021) that cultivated land size had a positive association with the adoption intensity of organic-based technologies in Murang'a, Kenya.

Factors influencing the adoption of mulching

Sex, age, marital status, education, and farm size were regressed against the adoption of mulching technology using a binary logistics regression. There is no significant influence of any of the independent variables on the dependent variables, according to the result (Table 23).

Table 23: Binary logistics regression on the adoption of mulching Technology

Variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	-0.004	0.302	0.996	0.551	1.800	0.989
Age	-0.028	0.016	0.972	0.942	1.003	0.073
Marital status	-0.023	0.175	0.977	0.694	1.377	0.896
Education	0.078	0.100	1.081	0.889	1.316	0.434
Farm size	0.081	0.042	1.084	0.998	1.177	0.056
Constant	0.555	0.726	1.742			0.444
Model X^2 = .238						
Pseudo R^2 = .046						
N =278						

Note: The dependent variable in this analysis is the adoption of mulching coded so that 0= No, not using and 1= Yes already using.

Source: Addai (2021),

From the result of the study (Table 23), none of the independent variables predicted the likelihood of adoption of the mulching technology of the ISFM.

Factors influencing the adoption of ploughing Technology

The result of the study showed that only education out of the five independent variables was statistically significantly associated with the likelihood of the maize farmers to adopt ploughing technology (Table 24).

Table 24: Binary Logistics regression on the adoption of Ploughing Technology

Independent variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	0.306	0.388	1.358	0.635	2.907	0.430
Age	-0.002	0.019	0.998	0.952	1.035	0.917
Marital status	0.169	0.207	1.184	0.789	1.778	0.415
Education	0.224	0.114	1.251	1.000	1.565	0.050*
Farm size	0.018	0.040	1.019	0.942	1.101	0.643
Constant	-2.833	0.874	0.059			0.001
Model X^2 = .834						
Pseudo R^2 = .035						
N =278						

Note: The dependent variable in this analysis is the adoption of ploughing coded so that 0= No, not using and 1= Yes already using.

Source: Addai (2021).

At a 5% significance level, the result showed that the more highly educated farmmers are, the more likely thay will adopt ploughing (OR=1.251, p=0.05). Education, which is often viewed as a learning process and is often used as a proxy for human capital (Asfaw & Admassie, 2004), can help to raise awareness of soil conversation technologies (Udayakumara, Shrestha, Samarakoon & Schmidt-Vogt, 2010). Farmers with a higher level of education, according to Asfaw and Admassie (2004), are more likely to apply new technologies efficiently. The findings of this study revealed a significant positive relationship between the level of education of farmers and the intensity practice of ploughing technology practice. The findings are consistent with those of Mwaura et al. (2021) that farmers with a higher level of education were more likely to have higher level of adoption of ploughing than farmers with a lower level of education.

Factors influencing the adoption of improved seeds and planting materials

Table 25 presents results on the binary logistics regression output on the adoption of improved seeds and planting materials. Out of the five independent variables, only two showed statistically significant association with the likelihood of the adoption of improved seed and planting materials. The significant variables are education and farm size. The strongest predictor of adopting improving seeds and planting material was education, recording an odd ratio of 1.412. The independent variables; age, education and farm size all together explained the variance in adoption of improved seeds and planting by R^2 = 11.8%.

Table 25: Binary logistics regression on the adoption of improved seeds and planting materials

Independent variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	-0.182	0.306	0.834	0.458	1.518	0.552
Age	-0.040	0.016	0.960	0.931	0.991	0.11
Marital status	-0.119	0.181	0.888	0.623	1.266	0.511
Education	0.345	0.107	1.412	1.145	1.742	0.001*
Farm size	0.110	0.043	1.116	1.025	1.215	0.011*
Constant	0.832	0.741	2.298			0.262
Model X^2 =.182						
Pseudo R^2 = 0.118						
N =278						

Source: Addai (2021)

Note: The dependent variable in this analysis is the adoption of improved seeds and planting materials coded so that 0= No, not using and 1= Yes already using.

Farmers' education level had a significant association with the likelihood of adoption of improved seeds and planting materials, at a statistical significance level of 1%. According to the study, increasing farmers' educational level results an increased likelihood of adopting improved seeds and planting materials (OR=1.142, p=0.001). As revealed by numerous studies, educational level of farmers positively influences the practice of agricultural technologies (Ajewole, 2010; Okunlola, Oludare and Akinwalere, 2011; Waller, Hoy, Henderson, Stinner and Welty, 1998). Farmers having high education, according to Asfaw and Admassie (2004), are more inclined to employ new technologies efficiently. This study found a significant positive relationship between farmers' education level and the intensity with which they practised improved seeds and planting materials. According to Mwaura et al. (2021), education indicates the ability to make adoption decisions.

Farm size was associated with the likelihood of adoption of improved seeds and planting materials at a statistical significance level of 5%. According to the study, the larger the farm size, the more likely farmers are to adopt improved seeds and planting materials (OR=1.116,p=0.011). This finding suggests that farmers were more inclined to employ larger plots of land for the manure as the amount of land under cultivation increased than they were for households using smaller plots. In agriculture, the land serves as a sign for a variety of factors, including the production factor, risk-taking ability, level of wealth, and collateral for loans (Enki et al., 2001). Enki et al. (2001) posit that the revenue raised from farming helps pay for labour to implement organic-based technologies. This result supports the findings from Danso-Abbeam et al. (2018). Land under cultivation, according to Nigussie et al. (2017), can be used to determine the readiness to adopt new technology. This study’s result is also similar to the finding of Mwaura et al. (2021) that cultivated land size had a positive association with the adoption intensity of manure in Murang'a, Kenya.

Factors influencing the adoption of Zero Tillage

The study's findings demonstrated that the independent variables had no statistically significant association between the independent variables and the likelihood of adoption of zero tillage technology (Table 26).

Table 26: Binary logistics regression on the adoption of Zero Tillage

Independent variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	0.194	0.428	1.215	0.525	2.808	0.649
Age	-0.036	0.022	0.964	0.923	1.008	0.107
Marital status	-0.113	0.216	0.893	0.585	1.363	0.601
Education	0.221	0.151	1.247	0.927	1.678	0.144
Farm size	-0.024	0.045	0.976	0.894	1.066	0.591
Constant	2.96	1.107				0.007
Model X^2 = .492						
Pseudo R^2 = .057						
N =278						

Note: The dependent variable in this analysis is the adoption of Zero-Tillage coded so that 0= No, not using and 1= Yes already using

Source: Addai (2021).

The implication of the result (Table 26) is that none of the independent variables influences the likelihood of adoption of zero tillage. This, therefore, indicates that there could be more factors that affect the adoption of zero tillage than the socio-demographic and socio-economic characteristics.

Factors influencing the adoption of Slash-no-Burn

According to the study, none of the independent variables significantly associated with the likelihood of the adoption of slash-no-burn technology (Table 27).

Table 27: Binary Logistics Regression on the adoption of Slash-no-Burn

Independent variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	0.367	0.591	1.444	0.453	4.59	0.534
Age	-0.001	0.032	0.999	0.938	1.064	0.969
Marital status	-0.202	0.307	0.817	0.448	1.490	0.509
Education	0.067	0.214	1.069	0.703	1.626	0.754
Farm size	-0.042	0.060	0.959	0.852	1.080	0.490
Constant	3.147	1.53	23.275			

Model X^2 = .807

Pseudo R^2 = .024

N =278

Note: The dependent variable in this analysis is the adoption of Slash no burn Technology coded so that 0= No, not using and 1= Yes already using

Source: Addai (2021).

Factors influencing farmers' adoption of good farm sanitation

The binary logistics regression analysis as presented in Table 28 denotes that the independent variables inputted in the model showed no statistical significance to the model. The variables; sex, age, marital status, education, as well as farm size did not have statistically significant association with the likelihood of the farmers to adopt good farm sanitation.

Table 28: Binary Logistics Regression on the factors influencing farmers' adoption of Good Farm Sanitation

Independent variables	B	SE	Odd Ratio	Lower CI	Upper CI	P.value
Sex	.061	.480	1.063	.415	2.722	0.898
Age	.027	.026	1.027	.976	1.081	0.300
Marital status	.055	.331	1.057	.552	2.022	0.868
Education	.341	.193	1.406	.963	2.055	0.078
Farm size	.134	.102	1.143	.936	1.396	0.190
Constant	-.884	1.248	0.413			0.479

Model X^2 =

Pseudo R^2 = 0.26

N =278

Note: The dependent variable in this analysis is the adoption of Good farm sanitation coded so that 0= No, not using and 1= Yes already using

Source: Addai (2021).

The result implies that farmers' adoption of good farm sanitation may be influenced by characteristics other than the farmers' background characteristics.

Perceived characteristics of the ISFM technologies that influenced farmers' adoption of the technologies

As revealed by some of the regression analyses above, the adoption of some of the ISFM technologies was not influenced by any of the hypothesised socio-economic and socio-demographic characteristics. This informed further analyses to test whether another variable could affect the adoption of the ISFM technologies. As a result, this section of the study determined the farmers' perceived technological attributes influencing the adoption of ISFM technologies in the Hohoe municipality. The study established that more than half (55.8%) of the respondents adopted manure /organic fertilizer usage because they have seen the technology being demonstrated and they can practice it by themselves, thus observability. An overwhelming majority of the respondents (92.1%) indicated that they practised inorganic/ chemical fertilizer due to the availability of the technology, thus the fertilizers can be found within the reach of farmers and can be accessed by them (Table 29).

Furthermore, close to half of the farmers (47.5%) intercropped with legumes due to their compatibility. This is because farmers perceived intercropping with legumes to fit well into what they already knew and are thus practising. More than half of the maize farmers (53.7 %) adopted mulching because of its relative advantage. As much as ploughing is essential in enhancing aeration in the soil to enhance crop growth, less than half (26.6%) of the farmers have adopted this technology because of its relative advantage but the majority of the farmers (53.6%) adopted it due to factors other than the listed factors. Again, most of the farmers (46%) used improved seeds and planting materials due to their observability, while (83.5%) practice zero-tillage as a result of observability. Like zero tillage, most of the farmers (88.7%) practised slash-no-burn because of its observability and finally, almost all the farmers practised good farm sanitation (93.2%) because of its observability (Table 29).

Table 29: Farmers' Perceived attributes of the ISFM technologies influencing the adoption of the ISFM technologies.

	Relative advantage		Trialability		Compatibility		Ease of Use		Observability		Other	
Technologies	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Manure/organic fertilizer	28	10.1	59	21.2	14	5.0	14	5.0	155	55.8	8	2.9
Inorganic/ chemical fertilizer	-	-	10	3.6	6	2.2	6	2.2	256	92.1	-	-
Intercropping with legumes	11	4.0	17	6.1	11	4.0	6	2.2	132	47.5	101	36.3
Mulching	40	14.4	11	4.0	5	1.8	6	2.2	107	38.5	109	39.2
Ploughing	74	26.6	14	5.0	1	0.4	1	0.4	39	13	149	53.6
Improved seed and planting	19	6.8	10	3.6	10	3.6	12	4.3	128	46	99	35.6
Zero Tillage	9	3.2	2	0.7	17	6.1	13	4.7	232	83.5	5	1.8
Slash-no burn	6	2.2	2	0.7	12	4.3	12	4.3	246	88.7		
Good farm sanitation	2	0.7	6	2.2	4	1.4	7	2.5	259	93.2	-	-
Weighted freq.		8.5		5.2		8.9		3.1		62		28.2

Source: Addai (2021).

Generally, the study showed that each specific ISFM technology was practised by a varied number of farmers based on its relative advantage, trialability, compatibility, ease of use, observability and "others". The findings support Rogers' (2004) claim that farmers' judgments of new technology's features often influence their decisions to practice it. Thus, farmers' decisions to practice or adopt agricultural technologies are heavily influenced by these perceived attributes (Doss, 2006; Mignouna et al., 2011).

According to the study, the perceived technology attribute that influenced the majority of farmers to practice almost all the ISFM technologies was observability, with a mean percentage of 62%. This was followed by “others” (28.2%), compatibility (8.9%), the relative advantage of the technology (8.5%), trialability of the technology (5.2%) and ease of use of the technology (3.1%). Although it was expected that the relative advantage would be the most influencing technological attribute to the practice of the ISFM technologies among the farmers in the Hohoe Municipality as posited by Rogers (2004), the study discovered otherwise. According to the study, observability of the ISFM technologies rather influenced the farmers’ practice the most.

The relative advantage of technology shows the level at which an innovation is considered better than the current ones (in terms of economic benefit, social prestige and the like). The findings imply that the ISFM technologies were practised not mainly because they were better than the existing ones but because they (the farmers) had observed them (the technologies).

After relative advantage, trialability was the second factor influencing farmers' adoption of ISFM technologies. Trialability is the extent to which an innovation can be experimented with or tried on a limited basis. According to Rogers (2004), technologies that can be started on a relatively small scale are more likely to be practised quickly than technologies that are not divisible. . Rogers (2004) added that attempting technology allows prospective adopters to see how it works in the context and conditions of the individual adopter. This implies that maize farmers observed the ISFM technologies to be suitable for their maize production techniques and environment; thus, trialability is the second factor considered by several farmers when practicing the ISFM technologies.

5H$_0$: There is no statistically significant association between the adoption of the ISFM technologies and the perceived characteristics of the technologies

Although the analysis in Table 29 showed that the adoption of the ISFM technologies was influenced by the farmers' perception of their characteristics, their association was not proven. Thus, one cannot be certain whether the recorded perception significantly impacted the farmers' intensity to practice the technologies. To clear this uncertainty to statistically establish a relationship between the adoption of the ISFM technologies and the perceived characteristics of the technologies, a Chi-Square Test of Independence was performed for all the ISFM technologies against their perceived characteristics.

The Chi-Square Test was run to assess the association between the adoption of manure and the perceived characteristics of manure. According to the study's result, there was a significant relationship between the variables, $X^2(5, 278) = 158.92$, $p = 0.000$ (Table 30).

Table 30: A Chi-square test of association between the adoption of manure and the perceived characteristics of manure

ISFM technology			Perceived characteristics of manure: None of the factors	Relative advantage	Availability of technology	Compatibility	Ease of use	Observability	Total	X^2 value	df	p-value
Maure/organic fertilizer	No, Not using	Count	4	15	57	12	9	14	111	158.93	5	.000***
		Expected Count	3.2	11.2	23.6	5.6	5.6	61.9	111.0			
	Yes already using	Count	4	13	2	2	5	141	167			
		Expected Count	4.8	16.8	35.4	8.4	8.4	93.1	167.0			
Total		Count	8	28	59	14	14	155	278			
		Expected Count	8.0	28.0	59.0	14.0	14.0	155.0	278.0			

N=278, ***p<0.001; **p<0.01; *p<0.05.

Source: Addai (2021).

Perceived technology characteristics of agricultural technologies are found to be significantly related to farmers' adoption of the technologies (Rogers, 2004; Doss, 2006; Mignouna et al., 2011). The result supports the literature and concludes that the maize farmers' adoption of manure was significantly influenced by their perception of the characteristics of the manure technology. Premised on this finding, the researcher failed to accept the null hypothesis.

The study again determined the association between the adoption of inorganic/chemical fertiliser and the perceived characteristics of the inorganic/chemical fertiliser with the help of the Chi-Square Test of Independence. The study showed a significant relationship between the variables, $X^2(3, 278) = 31.603$, $p = 0.000$ (Table 31).

Table 31: A Chi-square test of association between the adoption of inorganic/chemical fertiliser and the perceived characteristics of inorganic/chemical fertilizer

ISFM technology			Availability of technology	Compatibility	Ease of use	Observability	Total	X^2 value	df	p-value
			Perceived technology characteristics							
Use of inorganic/ chemical fertilizer	No, Not using	Count	2	3	0	9	14	31.603	3	.000**
		Expected Count	.5	.3	.3	12.9	14.0			
	Yes, already using	Count	8	3	6	247	264			
		Expected Count	9.5	5.7	5.7	243.1	264.0			
Total		Count	10	6	6	256	278			
		Expected Count	10.0	6.0	6.0	256.0	278.0			

N=278, **p<0.01; *p<0.05.

Source: Addai (2021)

The adoption of the inorganic/chemical fertiliser by the maize farmers in the Hohoe municipality was significantly influenced by the farmers' perceived characteristics of the chemical fertiliser such as its availability, ease of use and observability, among others. The result, in agreement with the literature (Doss, 2006; Mignouna et al., 2011), points out that perceived characteristics of the technology (inorganic/chemical fertilizer) influenced its adoption. Hence, the study failed to accept the null hypothesis.

Table 32 shows a significant association between the adoption of intercropping with legumes and perceived characteristics of intercropping with legumes, $X^2(5, 278) = 89.94$, $p = 0.000$.

Table 32: A Chi-square test of association between the adoption of Intercropping with legumes and the perceived characteristics of intercropping with legumes

ISFM technology			Perceived technology characteristics: None of the factors	Relative advantage	Availability of technology	Compatibility	Ease of use	Observability	Total	X^2 value	df	p-value
Intercropping with legumes	No, Not using	Count	82	2	9	1	4	30	128	89.94	5	.000**
		Expected Count	46.5	5.1	7.8	5.1	2.8	60.8	128.0			
	Yes, already using	Count	19	9	8	10	2	102	150			
		Expected Count	54.5	5.9	9.2	5.9	3.2	71.2	150.0			
Total		Count	101	11	17	11	6	132	278			
		Expected Count	101.0	11.0	17.0	11.0	6.0	132.0	278.0			

N=278, **p<0.01; *p<0.05.

Source: Addai (2021).

From the study, the adoption of intercropping with legumes is significantly associated with the perceived characteristics by the farmers, consistent with Rogers (2004). The study, therefore, refused to accept the null hypothesis

Table 33 displays the result of the association between the adoption of ploughing and perceived characteristics. According to the study, there was a statistically significant association between the adoption of ploughing and perceived characteristics of ploughing, $X^2(5, 268) = 97.93$, $p = 0.000$.

Table 33: A Chi-square test of association between the adoption of ploughing and the perceived characteristics of ploughing

ISFM technology			Perceived technology characteristics: None of the factors	Relative advantage	Availability of technology	Compatibility	Ease of use	Observability	Total	X^2 value	df	p-value
Ploughing	No, Not using	Count	134	58	12	1	0	6	211	97.93	5	.000**
		Expected Count	115.7	55.1	11.0	.8	.8	27.6	211.0			
	Yes, already using	Count	13	12	2	0	1	29	57			
		Expected Count	31.3	14.9	3.0	.2	.2	7.4	57.0			
Total		Count	147	70	14	1	1	35	268			
		Expected Count	147.0	70.0	14.0	1.0	1.0	35.0	268.0			

N=268, **p<0.01; *p<0.05.

Source: Addai (2021).

The study's result implies that farmers' adoption of ploughing was significantly influenced by the perceived characteristics of ploughing. The findings mirror Rogers (2004) that farmers' adoption of agricultural technologies is influenced by their perception of the technologies' attributes. The study, therefore, refused to reject the alternate hypothesis.

Viewing Table 34, the adoption of mulching was statistically significantly associated with the perceived characteristics of mulching, $X^2(5, 271) = 71.58$, $p = 0.000$.

Table 34: A Chi-square test of association between the adoption of mulching and the perceived characteristics of mulching

ISFM technology			Perceived technology characteristics							X^2 value	df	p-value
			None of the factors	Relative advantage	Availability of technology	Compatibility	Ease of use	Observability	Total			
Practice mulching and cover cropping	No, Not using	Count	76	6	5	0	4	22	113	71.58	5	.000**
		Expected Count	44.6	16.7	4.6	1.7	2.5	42.9	113.0			
	Yes, already using	Count	31	34	6	4	2	81	158			
		Expected Count	62.4	23.3	6.4	2.3	3.5	60.1	158.0			
Total		Count	107	40	11	4	6	103	271			
		Expected Count	107.0	40.0	11.0	4.0	6.0	103.0	271.0			

N=271, **p<0.01; *p<0.05.

Source: Addai (2021).

The result (Table 34) implies that farmers' adoption of mulching was based on the consideration of the perceived characteristics of mulching. The study, therefore, refused to reject the alternate hypothesis.

Based on the result in Table 35, it is evident that the adoption of improved seeds and planting materials was statistically significantly associated with the perceived characteristics of the technology, $X^2(5, 277) = 125.26$, $p = 0.000$.

Table 35: A test of association between the adoption of improved seeds and planting materials and perceived characteristics

ISFM technology			Perceived technology characteristics: None of the factors	Relative advantage	Availability of technology	Compatibility	Ease of use	Observability	Total	X^2 value	Df	p-value
Improved seeds and planting material	No, Not using	Count	87	5	4	2	3	20	121	125.26	5	.000**
		Expected Count	43.2	8.3	4.4	4.4	5.2	55.5	121.0			
	Yes, already using	Count	12	14	6	8	9	107	156			
		Expected Count	55.8	10.7	5.6	5.6	6.8	71.5	156.0			
Total		Count	99	19	10	10	12	127	277			
		Expected Count	99.0	19.0	10.0	10.0	12.0	127.0	277.0			

N=277, **p<0.01; *p<0.05.

Source: Addai (2021).

The result implies that farmers' adoption of improved seeds and planting materials was based on the perceived characteristics of the technology. The study, therefore, failed to reject the alternate hypothesis.

The result in Table 36 revealed that there was no statistically significant association between the adoption of zero tillage and perceived characteristics of the technology, $X^2(5, 278) = 5.99$, $p = 0.3$.

Table 36: A Chi-square test of association between the adoption of zero tillage and perceived characteristics

ISFM technology			Perceived technology characteristics: None of the factors	Relative advantage	Availability of technology	Compatibility	Ease of use	Observability	Total	X^2 value	df	p-value
Use of Zero Tillage	No, Not using	Count	1	1	0	5	3	27	37	5.996[a]	5	.307
		Expected Count	.7	1.2	.3	2.3	1.7	30.9	37.0			
	Yes already using	Count	4	8	2	12	10	205	241			
		Expected Count	4.3	7.8	1.7	14.7	11.3	201.1	241.0			
Total		Count	5	9	2	17	13	232	278			
		Expected Count	5.0	9.0	2.0	17.0	13.0	232.0	278.0			

N=278, p>0.05; **p<0.01; *p<0.05.

Source: Addai (2021).

It was discovered from the study that the adoption of zero tillage did not have any association with the perceived technology characteristics. This implies that the adoption of the technology may either be influenced by variables other than the perceived characteristics or be due to chance. The latter is not surprising because zero tillage may have been used by the farmers before the ISFM project. That given, the farmers may have not considered any attributes before practising it. Based on the result, the research failed to accept the alternate hypothesis.

From Table 37 there was no statistically significant association between the adoption of slush-no-burn and perceived characteristics of the technology, $X^2(4, 246) = 3.85$, p = 0.4.

Table 37: A Chi-square test of association between the adoption of slash-no-burn and perceived characteristics

ISFM technology			Perceived technology characteristics: Relative advantage	Availability of technology	Compatibility	Ease of use	Observability	Total	X^2 value	df	p-value
Practice slash-no-burn	No, Not using	Count	0	0	2	0	14	16	3.857[a]	4	0.426
		Expected Count	0.3	0.1	0.7	0.7	14.2	16.0			
	Yes, already using	Count	6	2	10	12	232	262			
		Expected Count	5.7	1.9	11.3	11.3	231.8	262.0			
Total		Count	6	2	12	12	246	278			
		Expected Count	6.0	2.0	12.0	12.0	246.0	278.0			

N=246, p>0.05; **p<0.01; *p<0.05.

Source: Addai (2021).

The result may be explained by the fact that slash-no-burn has been practised by the farmers so they may not need to consider any attributes before accepting to practice it. The result, therefore, informed the study failed to reject the null hypothesis.

Table 38 displays the result of the Chi-square test of independence of the association between the adoption of good farm sanitation and perceived characteristics. According to the result, no significant association existed between the adoption of good farm sanitation and perceived characteristics $X^2(4, 278) = 2.19$, $p = 0.7$.

Table 38: A test of association between the adoption of good farm sanitation and perceived characteristics

ISFM technology			Perceived technology characteristics: Relative advantage	Availability of technology	Compatibility	Ease of use	Observability	Total	X^2 value	df	p-value
Good sanitation	No, Not using	Count	0	0	0	0	27	27	2.194	4	.700
		Expected Count	0.2	0.6	0.4	0.7	25.2	27.0			
	Yes, already using	Count	2	6	4	7	232	251			
		Expected Count	1.8	5.4	3.6	6.3	233.8	251.0			
Total		Count	2	6	4	7	259	278			
		Expected Count	2.0	6.0	4.0	7.0	259.0	278.0			

N=278, **p<0.01; *p<0.05.

Source: Addai (2021).

Ensuring cleanliness on the farm like the avoidance of defecating haphazardly and leaving non-compossible materials on the farm may happen to be the daily routine of most farmers. This means that they may not need any consideration before they adopt it, or their adoption may be based on their discretion more than on a set of characteristics. Based on the result, the study failed to accept the alternate hypothesis.

Productivity of the farmers after adopting the ISFM Technologies

To determine the productivity of the farmers, the average maize produced and the average land size devoted to maize production in 2014 and 2020 were calculated. According to the results, the farmers harvested 8.83 (50 kg) bags of maize on average, from a mean land size of about 3.2 acres in 2014. On almost the same average size of land as in 2014 devoted to maize production in 2020 (3.1 acres), the farmers harvested an average of 19.2 (50kg) bags of maize. These land sizes and quantities of maize harvested in the respective years resulted in the maize productivity of about 2.8 (50kg) bags in 2014 and about 5.3 (50kg) bags in 2020. There was a 3.04 (50 kg) bags increase in maize productivity from 2014 to 2020, as indicated in Table 39.

Table 39: Maize productivity in 2014 and 2020

Variable	Mean	Std
Quantity of maize produced in 2014 (50kg) bag	8.8367	4.39894
Quantity of maize produced in 2020 (50kg) bag	19.1776	9.74975
land size for maize production in 2020 (acre)	3.0781	1.67592
Land size for maize production in 2014 (acre)	3.1805	1.88599
Productivity in 2014	2.7943	1.20488
Productivity in 2020	5.8397	1.95404
Difference in productivity (2020-2014)	3.0454	-

Source: Addai (2021).

6H0: No significant difference exists in the productivity of farmers before they participated in the ISFM programme and after they participated in the programme.

A dependent sample t-test was conducted to confirm whether the increase in productivity (Table 39) is statistically significant to enable attribution to the ISFM intervention or not. From the result, the increase in maize productivity between 2014 and 2020 was statistically significant at a 1% significance level (Table 40).

Table 40: Dependent sample t-test of maize productivity

Variable	N	M	SD	t-value	df.	Sig. (2-tail)
Farmers' maize productivity before participating in the ISFM programme	146	2.79	1.20			
Farmers' maize productivity after participating in the ISFM programme	146	5.84	1.95	-22.80	145	0.000**
Paired Difference		3.03	1.61			

**p<0.01; *p<0.05.

Source: Addai (2021).

The result revealed that the ISFM technology was effective in improving maize productivity in the Hohoe Municipality. The result of the study confirms Nordjo and Adjasi's (2019) assertion that having knowledge of and adapting ISFM practices result in the improvement of crop productivity. This study, therefore, in agreement with other studies (Nordjo & Adjasi, 2019), affirms that farmers' knowledge and application of ISFM practices lead to an increase in crop productivity. The research, therefore, failed to accept the null hypothesis.

Impact of ISFM Programme on livelihood outcomes (income and well-being)

According to the research, the mean well-being ranged from 1.90 to 2.18. This indicates that before they participated in the ISFM project, the farmers were now able to meet those means of livelihood listed in Table 26. However, after they participated in the project, the mean well-being ranged from 2.9 to 3.5 indicating that the farmers were moderately able to meet the means of livelihood. Specifically, the composite means of income and well-being before the ISFM project (M=2.05, SD =.38) was low and that after the project (M=3.27, SD=0.39) was moderate (Table 41). Thus, there was a statistically significant difference between the mean score of impact on livelihood before and impact of livelihood after the project implementation, hence the null hypothesis is thereby rejected.

Table 41: Impact of the ISFM programme on livelihood outcomes after participating in the ISFM programme

livelihood outcomes	Before		After	
	Mean	**SD**	**Mean**	**SD**
Purchase of household items	2.18	0.59	3.55	0.64
Improved children's Health	2.18	0.57	3.59	0.55
Improved/increased crop yield	2.20	0.53	3.79	0.46
Payment of Medical Bills	2.20	0.53	3.61	0.57
Payment of children's school fees	2.21	0.57	3.64	0.59
Saving money for the future	1.96	0.55	3.53	0.60
Access to a regular healthy meal	2.03	0.45	3.45	2.3
Payment of rent	1.97	0.50	3.23	0.48
House maintenance	1.90	0.50	3.12	0.49
Increased Income	1.95	0.41	3.27	0.55
Able to pay funeral dues/levy	1.88	0.50	3.05	0.47
Enhanced Recreation	1.90	0.72	2.89	0.58
Composite mean	2.05	0.38	3.27	0.39

Scale: 1= Least Able (LeA), 2= Lowly Able (LoA), 3=Moderately Able (MA), 4=Highly Able (HA) and 5=Very Highly Able (VHA).

n=278

Source: Addai (2021)

Generally, the farmers' ability to afford the means of livelihood was low (2.05) before they participated in the project. But, after they participated in the project, they are now moderately able (3.27) to afford the means of livelihood. The results depict that the ISFM project has had a positive impact on the livelihood outcomes of the participating farmers by impacting their ability to meet their means of livelihood. This agrees with Nordjo and Adjasi (2019) that

ISFM technologies improve the livelihood outcomes of farmers if they adopt them.

$7H_0$: There is no statistically significant difference between the livelihood of farmers before and after participating in the ISFM project

A dependent sample T-test was conducted to test the significance of the difference between the farmers' ability to meet the means of livelihood before and after the implementation of the ISFM project. The results demonstrated a significant difference between the mean score of impact on livelihood outcomes after the ISFM project (M= 3.27, SD= .36) and impact on livelihood outcomes before the ISFM programme (M= 2.05, SD=.38), t(296) = -45.48 at $p<0.05$ (Table 42).

Table 42: Dependent Sample T-Test on the Impact of ISFM Programme on livelihood Before and After

Variable	N	Mean	SD	t-value	df.	Sig. (2-tail)
Livelihood before participating in the ISFM project	278	2.05	0.38			
Livelihood after participating in the ISFM project	278	3.27	0.36	-45.48	296	0.000
Paired Difference		-1.22	0.46			

Source: Addai (2021).

The study revealed that the ISFM project significantly impacted the livelihood outcomes of the farmers. This implies that the livelihood of the farmers after the ISFM project was quite better and enhanced than their livelihood before the ISFM project. The result agrees with Varejkova (2020) who observed that the ISFM has a significant impact on farmers' livelihood outcomes such as crop yield. However, this study found a significant impact of ISFM technologies on farmers' income. Bouguen et al. (2020) observed the opposite. Despite this contradiction, the result, however, mirrors Hörner and Wollni (2020) who determined that ISFM adoption leads to significant increases in net crop value. Such increase as a result of the ISFM technologies practice has been demonstrated by this study to help farmers afford means of livelihood such as payment of rent, maintenance of the house, and payment of children's school fees among others. This study, therefore, corroborates existing evidence that the adoption of ISFM technologies positively influences farmers' livelihood outcomes.

Income status of farmers before and after participating in the ISFM Project

The result of the income status of the maize farmers before participating in the ISFM project is presented in this section. According to the study, more than half of the respondents (53.2%) were moderately better off before participating in the project while 11.6% were better off, (33.2%) were poor and 1% were well off (Table 43). The farmers' income status after participating in the ISFM programmes, on the other hand, showed that out of the 278 participants interviewed, the majority (75.4%) were better off after participating in the ISFM technologies training programme. About one-fifth (17.3%) indicated that their financial status is moderately better as compared to before participating in the ISFM project. Moreover, 4.3% indicated that they are well off financially due to the ISFM project. Only 2% indicated that they are moderately poor after participating in the ISFM project (Table 43).

Table 43: Income status of farmers before and after participating in the ISFM Project

Responses	Income status before the ISFM project	Income status after the ISFM project
	%	%
Moderately poor	33.2	2
Moderately better off	53.2	17.3
Better off	11.6	75.4
Well off	1.0	4.3

N=278

Source: Addai (2021).

From the result, the researcher observed that a significant number of the farmers (33.2%) were moderately poor in terms of income, before participating in the ISFM project. More than half (53.2%) of them were moderately better off while only about 12 % and 1% of the farmers were better off and well off respectively. Comparing the results in Table 28, a huge reduction of about 31.2% in moderately poor farmers is observed (from 33.2% to 2%). It is also observed that the percentage of farmers who are better off has increased by 22.2.

This demonstrates that the practice of ISFM technologies by the farmers has positively affected their income levels.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

Chapter Five summarises the results, presents the conclusions and recommendations from the research and provides suggestions for further research.

Summary of Major Findings

The ISFM programme was implemented in Ghana's Volta region in response to the region's growing food insecurity, which was primarily caused by soil infertility. Even though the region is one of the few in the country with the poorest soil fertility status, farming is one of their main sources of income. The program aimed to improve crop productivity and farmers' livelihoods. Although anecdotal evidence suggests that the program has had a positive impact on farmers' livelihoods, empirical evidence to support this is limited. As a result, the purpose of this study was to assess the impact of the use of ISFM technologies on the productivity and livelihood outcomes of farmers in the Hohoe Municipality.

The study sought to achieve six specific objectives. These were to determine the knowledge, attitude, skill and aspiration levels of the farmers on ISFM technologies before and after participating in the ISFM project, determine the adoption of the ISFM technologies by the smallholder farmers, analyse the factors that influence the practice of the ISFM technologies by the farmers, determine the farmers' perceived characteristics of the ISFM technologies that influenced their practice of the ISFM technologies, determine the productivity of the farmers before and after adopting the ISFM technologies and to examine the livelihood outcomes (income and wellbeing) of the farmers involved in the ISFM technologies training programme.

The study employed a cross-sectional survey design to collect data from 278 farmers randomly selected from the Hohoe Municipality. The statistical tools used to analyse the data were frequencies, percentages, means, standard deviations, dependent sample t-tests, Chi-Square Test of Independence and binary logistic regression.

The study revealed that the majority (70%) of the farmers were males and close to half of them (41%) were in the age range of 41-50. The majority (58%) of the farmers were formally educated and out of this, 37.4% had attended junior high school. 51.7% of the farmers had been growing maize for 11 to 20 years and the majority (71%) of them cultivated maize on up to 5 acres of land in the 2020 production season. Also, most (79.7%) of the farmers produced from 1 to 20 (50kg) bags of maize in the 2020 production season.

Key Findings

The study discovered a statistically significant improvement in the farmers' knowledge, attitude, skills and aspiration towards ISFM technologies after the implementation of the programme.

All the ISFM technologies were practised by the farmers, although there was heterogeneity in the practice intensities of the technologies. Inorganic/ chemical fertilizers application recorded the highest adoption (94.6%) followed by slash- no burn (93.9%), good farm sanitation (90.3%) zero tillage (86.7%).

Although ploughing was expected to be practised by many of the farmers, it recorded a high non-practice intensity of 78.8%.

Overall, the major perceived characteristics of the ISFM technologies that played a key role in influencing the farmers' aadoption of the ISMF technologies were observability (with a mean percentage of 62%), compatibility (8.9%) and relative advantage (8.5%). Interestingly, "Other" factors (about 28%) also influenced the farmers' decision to practice the ISFM technologies. These characteristics significantly influenced all the ISFM technologies except slash-no-burn, zero tillage and good farm sanitation.

The study found that a host of demographic and socioeconomic factors influenced the farmers' adoption intensity of the various technologies. The factors are educational level, age, sex and farm size.

The study revealed that the farmers' productivity improved after participating in the ISFM technologies training. Specifically, the farmers' mean productivity improved from 2.8 (50kg) bags before the project to 5.8 (50 kg) bags after the project. This indicates a 3.0 (50 kg)) bags increase in productivity which was statistically significant.

Finally, the study showed that the ISFM technology had a statistically significant impact on the farmers' well-being.

Conclusions

The following conclusions were drawn from the study's findings:

1. The ISFM technologies training programme significantly improved farmers' knowledge, attitude, skills and aspiration towards the use of the ISFM technologies.

2. Among the ISFM technologies, Inorganic/ chemical fertilizers application, slash- no burn, good farm sanitation, zero tillage and ploughing are adopted by the majority of the farmers in the Hohoe municipality.
3. The sociodemographic and socioeconomic characteristics that significantly influence farmers' adoption of the ISFM technologies are educational levels, age, sex and farm size: more males adopted the ISFM technologies than females; farmers with high education and large farm sizes adopted more of the ISFM technologies.
4. The most important characteristics of the ISFM technologies perceived by farmers as influencing their adoption of the ISFM technologies are observability, "Others", compatibility and relative advantage.
5. Farmers' maize productivity improved significantly after participating in the ISFM technologies training programme.
6. Farmers' livelihood improved significantly through the ISFM technologies training programme.

Recommendations

The study recommends that:

1. MoFA should increase the frequency of extension visits to the maize farmers in the Hohoe municipality to help sustain their knowledge, attitude, skills and aspiration towards the use of the ISFM technologies.
2. MoFA should ensure regular visits to the Hohoe municipality to help farmers maintain the adoption of inorganic/ chemical fertilizers

application, slash- no burn, good farm sanitation, zero tillage and ploughing.

3. Farmers are encouraged to increase their farm sizes to facilitate higher adoption of the ISFM technologies.
4. MoFA and all other organisations who implement agricultural programmes should prioritise demonstration of agricultural innovation to increase observability by farmers to increase adoption of agricultural innovations.
5. MoFA and other stakeholders should implement more soil management related programmes to improve farmers' yield.
6. MoFA and other stakeholders should implement more related programmes to improve farmers' income.

Suggestions for Further Studies

1. Investigation into other perceived technology characteristics that can influence adoption.
2. Determining the adoption rate of the ISFM technologies in the Hohoe municipality.

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APPENDIX : STRUCTURED INTERVIEW GUIDE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION

COLLEGE OF AGRICULTURE AND NATURAL SCIENCES

UNIVERSITY OF CAPE COAST, CAPE COAST

Structured Interview Guide

This questionnaire is to solicit information on the **Factors Influencing the Practice of Integrated Soil Fertility Management Technologies and Its Effects on Productivity and Livelihood Outcomes Among Smallholder Farmers in the Hohoe Municipality in the Volta Region of Ghana** from the participants of the Alliance for Green Revolution in Africa (AGRA)'s Soil Health Programme (SHP). This questionnaire is an input for the master thesis research purely in pursuit of academic purposes. All information provided will be treated confidential and will be used solely for the study.

RESPONDENT'S INFORMED CONSENT

My name is……………………………………………………………………

I am here to research the impact of the Alliance for Green Revolution in Africa's (AGRA) Soil Health Programme (SHP) on productivity and households' livelihood outcomes. Your honest responses are highly required to fulfil this academic purpose. You are assured of utmost confidentiality. Your participation is very important. You are free to ask me anything about this survey.

Identification Information

Questionnaire number: ______________________________

Name of interviewer: ______________________________

Date of interview: ______________________________

Name of Respondent ______________________________

Community ____________________

SECTION A: HOUSEHOLD DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

A1: Demographic Characteristics

1. Sex:
   1. Male [ ]
   0. Female [ ]
2. What is your age on your last birthday? ____________ (in years)
3. Please indicate your marital status
   1. Married [ ]
   0. Not Married [ ]
4. Indicate your highest educational qualification. Please tick [√]
   1. No formal education
   2. Primary School
   3. Certificate in General Agriculture [ ]
   4. Junior High School
   5. Senior High School
   6. Diploma [ ]

7. Degree (Bachelor) [ ]
8. Postgraduate Diploma [ ]
9. Masters [ ]
10. PhD
11. Other [ ] (specify)

5. Please indicate the number of dependents (household size) _______________

6. How long (**in years**) have you been producing maize? _______________

7. How did you acquire the land you use for maize farming?
   1. Own land [ ]
   2. Family land [ ]
   3. Bought [ ]
   4. Inherited [ ]
   5. Rented [ ]
   6. Other [ ] (specify)

8. If rented, how did you pay for it?
   1. Cash [ ]
   0. Sharecropping [ ]

9. What is the size (in acres) of your maize farm? ________________

10. Where do you obtain financial capital for your farming? (multiple answers possible)
    1. Personal savings [ ]
    2. Relatives [ ]

3. Cooperatives [ ]
4. Bank [ ]
5. Farmers association [ ]
6. Others [ ] (specify) _______________

11. What is the total quantity (kg/ha**)** of maize you harvested last year (2020)?

12. What is the current market price per sack (50kg) of maize? ______ (GH¢)

13. Which source(s) do you obtain your inputs from (multiple answers possible)?
    1. Government [ ]
    2. Friends [ ]
    3. Farmer's Cooperative Society [ ]
    4. Open market [ ]
    5. Input dealers [ ]
    6. NGO [ ]

14. Did you engage in any non-farm activity?
    1. Yes [ ]
    0. No [ ]

15. If yes, what were the sources of your non-farm income? Please indicate below:

No.	**Tic k**	**Non-farm income Activity**	**Amount (GH¢)**
1.		Non-farm wage income e.g. security etc. [ ]	
2.		Self-employed income: e.g. trading, artisan, carpentry, etc.[ ]	
3.		Award (s) [ ]	
4.		Others e.g. pension, capital earnings, etc. [ ]	
Total Amount GH¢			

16. Do you have a ready market for maize in this area?

    1. Yes [ ]

    0. No [ ]

17. Did you cultivate maize in 2020?

    1. Yes [ ]

    0. No [ ]

18. If yes (Q17), what was the size (in acres) of the area you grew maize on?

    ____

19. Where did you obtain seed for your maize cultivation? (**Multiple answers possible**)

    1. Own farm

    2. Other farmers

    3. Local market

4. Rural agro-dealer
5. Urban agro-dealer
6. Seed company
7. Extension worker (government)
8. Cooperative
9. Other (specify)________________________________

A2: Farmer organization

20. Have you participated in Farmer Organization/Association (FBO)?

    1. Yes [ ]
    0. No [ ]

21. If yes, name the organization. ____________________________

22. When did you join this organization? (Year)____________

23. Are you still active in the organization? ______________

    1. Yes [ ]
    0. No [ ]

24. If you are no longer active with the organization, why did you stop?

    ____

25. (If AFRICARE supported) What sort of training did your group receive to run farmers' organization?

    1. ____
    2. ____
    3. ____
    4. ____

SECTION B: KNOWLEDGE, ATTITUDE, SKILLS AND ASPIRATIONS ON ISFM TECHNOLOGIES

Choose from the appropriate scale to indicate the level of your knowledge, attitude, skill and aspiration of the following ISFM activities using the scale below.

Knowledge: Having information about the existence of ISFM technologies; 1=Very low, 2=Low, 3= Moderate, 4=High and 5=Very High.

Attitude: Perceived importance of the ISFM technologies using; 1= Not very important, 2=Not Important, 3= Moderately important, = Highly important and 5=Very highly Important.

Skills: The extent to which you can practice the ISFM technologies using 0=No Skill, 1=Very low skill, 2= Low skill, 3=Moderate Skills, 4=High, 5=Very High Skills.

Aspiration; Extent to which you were motivated to practice the ISFM technologies before and after the project. 1=Very lowly motivated, 2=Lowly motivated, 3=Moderately motivated, 4=Highly motivated, 5=Very highly motivated.

1. **Very low** knowledge, skills and attitude mean the farmer can barely tell

   the degree of knowledge, skill and attitude he or she has gained as a result of the ISFM technologies.
2. **Low** knowledge and skills mean the farmers are having relatively less knowledge and skills in ISFM technologies.

3. **Moderate** knowledge and skills mean that the farmers have a reasonable

   or average limit of knowledge and skills about ISFM technologies.
4. **High** knowledge, importance (attitude) aspiration and skills mean that the farmers have above average knowledge, attitude, aspiration and importance about the ISFM technologies.
5. **Very high** knowledge, skills, aspiration and attitude means that the farmers have an extremely high degree of knowledge, skill, attitude and aspiration about the ISFM technologies.

26.

		KNOWLEDGE (Having information) 1=VL, 2=L, 3=M, 4=H, 5=VH		ATTITUDE (perceived importance) 1=NVI, 2=NI, 3=MI, 4=I, 5=HI		SKILLS (Ability) 1=VLS, 2=LS, 3=MS, 4=HS, 5=VHS		ASPIRATION (Motivation to practice) 1=VLM, 2=LM, 3=MM, 4=HM, 5=VHM	
	ISFM technologies	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
1	Manure/organic fertilizer								
2	Inorganic/chemical fertilizer								

3	Intercropping with legumes								
4	Mulching								
5	Ploughing .								
6	Improved seed and planting materials.								
7	Zero tillage.								
8	Slash-no burn.								
9	Good farm sanitation.								

SECTION C: ADOPTION OF PROJECT TECHNOLOGIES AND THEIR IMPACT ON YIELD

27. If you have information (knowledge) about ISFM techniques, have you used the ISFM technologies on your farm?

SN	ISFM Technologies	1=Yes, already practising	0=No, not Practising	If not practising, reasons	If practising, when did you start
1	Manure/organic fertilizer				
2	Inorganic/chemical fertilizer				
3	Intercropping with legumes				
4	Mulching				
5	Ploughing				
6	Improved seeds and planting materials				
7	Zero tillage				
8	Slash-no burn				
9	Good farm sanitation				

SECTION D: PERCEIVED FACTORS INFLUENCING THE PRACTICE OF ISFM TECHNOLOGIES

Note: 1. **Relative advantage** means the technologies are better in terms of effectiveness,

than the known practice.

2. **Availability** of technology means that the particular technologies advocated for

can be found within the reach and can be accessed by intended users.

3. **Compatibility** means the technologies can fit well into the characteristics of the

farmers and their farms, and are also consistent with the already known technologies or farming practices.

4. **Ease of use** means the technologies can be easily applied.

5. **Observability** of technology means that the farmers have seen the technology

being demonstrated and they can practice the technologies by themselves.

28. What determines your choice of practice the ISFM technology? (TICK)

ISFM practices	Determinants					
	1=Relative advantage	2=Availability of technology	3=Compatibility	4=Ease of use	5=Observability	6=other
Manure/organic fertilizer						
Inorganic/chemical fertilizer						
Intercropping with legumes						
Mulching						
Ploughing						
Improved seeds and planting materials						
Zero tillage						
Slash-no burn						
Good farm sanitation						

SECTION E: PRODUCTIVITY

29. For the field where you are practising ISFM practices

Crop	Area acres	Production this year 2020		Production in 2014	
		in Local units (specify)	*Kg*	*in Local units (specify)*	*Kg*
Maize					

30. For the Field where you are **NOT** practising ISFM technologies: (**note, if you are practising ISFM technologies on all your maize fields, skip this**)

Crop	Area acres	Production this year 2020		Production in 2014	
		in Local units (specify)	*Kg*	*in Local units (specify)*	*Kg*
Maize					

31. Have you observed any of the following changes as a result of adopting SDRLRP techniques?

Parameters	**Improving? 1 = yes 0 = no**	**If yes, Reason**	**Worsening 1 = yes 0 = no**	**If yes, Reason**	**Same as before? 1 = yes 0 = no**
Land preparation					
quality of maize grown for household consumption					
Area under crop					
Quality of maize for market					
Use of improved seed varieties					
Use of improved agronomic and post-harvest practices					
Use of fertilizer					
Food availability especially during the lean season					
Water holding capacity of land for producing maize					

32. How satisfied are you with extension service component of the ISFM project? (TICK ONE)

1. Highly satisfied [ ]
2. Satisfied [ ]
3. Neither satisfied nor dissatisfied [ ]
4. Not satisfied [ ]
5. Highly unsatisfied [ ]

SECTION F: ACCESS TO INPUTS

33. Do you use any of the following inputs, for how long, and what are the sources?

Input	*1= Yes 0= No*	*Sources of input **(see code below)***	***After project (2020)***		***Before project (2014)***	
			The quantity used (Kg)	Amount spent in purchasing (GHS)	The quantity used (Kg)	Amount spent in purchasing (GHS)
Chemical fertilizer (specify)						
Agro-chemicals						

Improved seed of maize						
Other ______________ ______						

Codes Sources: 1= Own farm; 2= Other farmers; 3= Local market; 4= Rural agro-dealer; 5= Urban agro-dealer; 6= Seed company; 7= Extension worker (government), 8= NGO; 9=Farmers group; 10= Cooperative; Other (specify).

34. How far do you have to travel to find an agro-dealer selling agro-inputs?

Input	**1=Less than one km**	**2=1-5 km**	**3=6-10 km**	**4=11-15 km**	**5=16-25 km**	**6=Over 25 km**
Improved Seed						
Manure/organic fertilizer						
Inorganic fertilizer/Agro-chemicals						
Other (specify)						

35. If there are agro-dealers in the area, how has the distance changed after the ISFM project?

    1. Improved [ ]
    2. Worsened [ ]
    3. No change [ ]
    4. Don't know [ ]

36. How do you rate the quality of fertilizer/inputs available with your nearest agro-dealer?

Inputs	***1=Good quality***	***2=Average quality***	***3=Poor quality***
Improved seed			
Manure/ organic fertilizer			
Agro-chemicals/inorganic fertilizer			
Other (specify)			

37. Does your agro-dealer provide you with reliable advice on inputs?

Inputs	***1=Always***	***2=Sometimes***	**0=Never**
Improved seed			
Manure/organic fertilizer			
Inorganic fertilizer/Agro-chemicals			
Other (specify)			

38. If you do not buy seed and fertilizer from agro-dealers, what are the reasons? (TICK)

1. Expensive [ ]
2. Not always available [ ]
3. Distance too far/difficult accessibility [ ]
4. Insufficient inputs from agro-dealers [ ]
5. Other (specify) [ ]

SECTION G: ACCESS TO FINANCIAL SERVICES

39. Do you receive credit/loan to purchase inputs? (TICK)

Inputs	***1=Yes, in cash***	***2=Yes, in-kind***	**0=No**
Improved seed			
Manure/organic fertilizer			
Inorganic fertilzerz/Agro-chemicals			
Other (specify)			

40. If you applied for Credit, from what source and the amount received?

Source of Credit	**Tick √**	**Amount received (GH¢)**
Neighbour		
Farmer Group		
Cooperative Bank		
Commercial Bank		

Friend/Relative		
NGO/MFI		
Agricultural Finance/bank		
Village Bank		
Informal Moneylender		
Agrodealer		
Input subsidy (estimate value)		
Other (specify)		

41. If you did not apply for credit, what are the reasons? (TICK)

1. High-interest rates……………………
2. Non-availability of credit institutions ………

   Lack of procedure awareness to access credit …………

3. Other (specify)………………………………………

SECTION H: ISFM PROGRAMME IMPACT ON LIVELIHOOD (INCOME AND WELLBEING)

Choose from the appropriate scale to indicate your level of ability to perform the under listed activities. 1= Least Able (LeA), 2= Lowly Able (LoA), 3=Moderately Able (MA), 4=Highly Able (HA) and 5=Very Highly Able (VHA)

42. Have you observed the following changes in your household?

Parameters	**BEFORE PROJECT**					**AFTER PROJECT**				
	1= LeA	**2= LoA**	**3= MA**	**4= HA**	**5= VHA**	**1= LeA**	**2= LoA**	**3= MA**	**4= HA**	**5= VHA**
Purchase of household items										
Children's health										
Crop yield										
Payment of medical bills										
Payment of children School Expenses										
Saving money for future										
Access to a regular healthy meal										
Payment of rent										
House maintenance										
Income										

On an income status scale of 0 to 5 where 0=Very Poor, 1=Poor, 2=Moderately Poor, 3=Moderately Better Off, 4=Better Off and 5=Well Off,

43. What was your income status before the ISFM project (2014)_________________?

44. What is your income status after the project (2020 _______________?

45. Do you think your current income status is due to the ISFM project?

1. Yes [ ]
0. No [ ]

THANK YOU VERY MUCH!