UNIVERSITY OF CAPE COAST

SUSTAINABLE FARM MANAGEMENT PRACTICES AND THEIR EFFECTS ON HOT PEPPER YIELD IN THE AGONA WEST MUNICIPALITY

GODWIN ABBEY

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BY

GODWIN ABBEY

Thesis submitted to the Department of Agricultural Economics and Extension of the College of Agriculture and Natural Sciences, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy Degree in Agricultural Extension

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DECLARATION

Candidate's Declaration

I hereby declare that except reference to other people's works which have been duly cited and acknowledged, this work is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

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

Name: Godwin Abbey

Supervisors' Declaration

I hereby declare that the thesis preparation and presentation were supervised in accordance with the University of Cape thesis supervision criteria.

Principal Supervisor's Signature: ……………….. Date……………………...

Name: Prof. Ernest Laryea Okorley

Co-Supervisor's Signature: ………………..… Date……………………....

Name: Dr. Lawrence Acheampong

ABSTRACT

This study investigates the effects of sustainable farm management practice (SFMP) on the yield of hot pepper in the Agona West Municipality in the Central Region of Ghana. It adopted a correlational descriptive survey design using a structured interview schedule to elicit information from 140 farmers engaged in hot pepper production. The study found that farmers in the Agona West Municipality of the Central Region who are engaged in hot pepper production frequently practice Integrated Pests Management (IPM), fungicide application, Integrated Weed Management (IWM) and conservation tillage, and occasionally practice irrigation and pruning. A statistically significant and positive relationship was found between the perceived use of IPM, fungicide application, IWM, irrigation and conservation tillage, and yield of hot pepper, except for pruning which was positive but not significant. The major challenges faced by the farmers in the Agona West Municipality in the use of SFMP in hot pepper production were inadequate capital, inadequate labour, land tenure problems and inadequate access to water for irrigation. It is recommended that, government, through the Ministry of Food and Agriculture (MoFA), and other stakeholders, should intensify extension training and facilitate farmers’ access to loans and problem-free land to promote SFMPs in the study area to boost hot pepper production. The farmers can also form cooperatives to raise capital through group loans.

Key words: Sustainable farm management practice, adoption, hot pepper farmers, hot pepper yield, vegetable production.

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DEDICATION

To my mother, Cecilia Edith Sackey.

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LIST OF ACRONYMS

AWMA	Agona West Municipal Assembly
ANOVA	Analysis of Variance
CERSGIS	Center for Remote Sensing and Geographic Information Services
CT	Conservation Tillage
EIL	Economic Injury Level
FAO	Food and Agriculture Organization
FFD	Farmer Field Day
FFS	Farmer Field School
SFMP	Sustainable Farm Management Practice
GDP	Gross Domestic Product
GSS	Ghana Statistical Service
IFJ	Investing for Food and Jobs
IPM	Integrated Pest Management
IWM	Integrated Weed Management
MoFA	Ministry of Food and Agriculture
PEOU	Perceived Ease of Use
PERD	Planting for Export and Rural Development
PFJ	Planting for Food and Jobs
PU	Perceived Usefulness
SD	Standard Deviation
TAM	Technology Acceptance Model
WABS	West African Business Solutions
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

Low vegetable consumption is one of the six major risk factors contributing significantly to global mortality rate (Ngome, Shackleton, Degrande, & Tieguhong, 2017). It is estimated that, roughly 1.7 million people die annually due to insufficient vegetable consumption (Rekhy & McConchie,2014; Tritscher, Miyagishima, Nishida, & Branca, 2013). This situation is largely attributed to low production of vegetables, which is partly influenced by farmers' use of improved sustainable farm management practices. As such, understanding the management practices of vegetable farmers can contribute in decision on improving the production and consumption of vegetables. The background of the study, the statement of problem, the purpose of the inquiry, the expected findings, the research questions, and the hypotheses that will be tested are all explained in this chapter. This section also discusses the structure of the study as well as its significance, scope, limitations, and delimitations.

Background to the Study

Agriculture is a critical human activity because it satisfies basic human needs like food, clothing, and shelter. It has been demonstrated that every 1% increase in agricultural productivity results in a 0.6% – 1.2% decrease in the global population of absolutely poor households (Thirtle, Irz, Lin, McKenzie-Hill, & Wiggins, 2001). Agriculture serves as a very important driver of development in so many ways. For instance, it provides raw materials for industries, provided employment, generated income and most importantly food for all (Meijerink, 2007). Agriculture is perhaps Ghana's biggest national asset because the economy and most people depend on it. The sector is the most important to the economy in terms of both GDP and employment. Employment in agriculture mirrors regional economic growth by providing a diverse range of opportunities. While just a small fraction of workers in industrialized nations are involved in agriculture, more than half of all people worldwide are employed in this field in developing nations. In Sub-Saharan Africa, 57% of the active population is employed in agriculture while only 4% are employed in agriculture in Europe (World Bank, 2018).

With population growth predicted to reach an estimated 9.7 billion by the year 2050, an increase in food production to about 70% is required to meet the demand (Leung, 2008). Presently, the world's food demand is not being met and this has been a problem. The problem will escalate if interventions are not put in place to increase production to meet the world's food demand. Both the agricultural sector's share of GDP and the number of people employed in it have been declining in recent years in Ghana. The agricultural industry in Ghana contributed GH₵ 35,047,000,000 to the country's GDP in 2017, accounting for 18.3% of the country's overall GDP (GSS, 2018), and it also employed 41.0% of the country's labour force in 2018. (World Bank, 2018). Agriculture slowed to 4.6 percent growth in 2019 from 4.8% in 2018. Its GDP contribution decreased from 19.7 percent in 2018 to 18.5% in 2019. Despite this, agriculture has still been the backbone of Ghana's economy.

Crops are Ghana's third largest economic sector, accounting for 13.8 percent of GDP. It added a percentage point of 0.7 to the annual growth rate of Ghana's economy in 2019. Considered to be the largest in the agricultural sector is the Crop sub-sector. It is critical not only for food and nutrition security but also for agro-industrial activities and exports. It supports a sizable portion of the population, particularly in rural areas, by providing jobs and livelihoods. Key exports include cocoa, cashews, rubber, and oil palm, while staples like corn, plantain, rice, cassava, sorghum, and yam are important sources of food security. Vegetables that are most commonly grown in Ghana are tomato (*Lycopersicon esculentum*), onion (*Allium cepa*), shallots (*Allium escalonicum*), okra (*Hibiscus esculentus*), eggplant (*Solanum melongena*), local spinach (*Amaranthus spp*), Indian or Gambian spinach (*Basella alba*), sweet pepper (*Capsicum annuum*), and hot pepper (*Capsicum frutescens*).

More recently, besides the cash and food security crops, vegetables are gaining importance in Ghana because of their health benefits and their contribution to livelihood. Vegetables are a critical component of Ghanaian diets and offer numerous health benefits. Vegetables are a rich source of essential vitamins, minerals, and fiber that are crucial for maintaining good health and preventing chronic diseases (Adom, Baah, Yeboah, & Quaye, 2016). A study by Doku, Neupane, and Doku (2015) found that consuming vegetables, particularly dark green leafy vegetables, is correlated to a lower hypertension risk among Ghanaian adults.

Vegetable cultivation also plays an essential role Ghanaian smallholder farmers' livelihood. Vegetable farming provides a year-round source of income for farmers and generates higher incomes than traditional staple crops (Amos, Asante, Owusu-Sekyere, & Opoku, 2020). Furthermore, a study by Asare-Kyire and Fialor (2020) demonstrated that vegetable farming can contribute to poverty reduction and improve household nutrition. Vegetables enjoy a receptive market throughout the country (urban areas, rural areas and foreigners). Not only do vegetable growers earn a living, but so do traders and processors. As a result, it serves as a reliable employment source for people living in both rural and urban areas. This is because it is cultivated in many rural areas by means of truck farming, as well as on the outskirts of towns and cities by means of market gardening and backyard gardening, with the goal of supplying fresh food to urban markets (Owusu & Amuzu, 2013). Vegetable production plays a vital role in income generation and subsistence. It provides employment to both rural and urban dwellers because it requires a low level of investment, its production system is largely short, labour intensive, and its yields are high (Schippers, 2000).

The Ghana Export Promotion Authority (2020) reported that the export earnings from the vegetable sector in Ghana amounted to $213 million between January and September 2020. The domestic market alone is developing at a pace of more than 10% each year. For the industry to profit from these improvements, its competitiveness must increase. This will need investments, innovations, and enhancements to the business environment, ranging from loan availability to quality inspection services, enhanced export logistics to quicker and more economical agricultural ingredient imports (Gonzalez, Giordano, Carranza & Rodriguez 2014).

As a result of the numerous benefits of vegetable production, Successive governments and other development partners have attempted to boost vegetable farmer yields with the goal of alleviating poverty in the nation by introducing small-scale irrigation projects and dug-outs, among other things. These efforts have greatly contributed to the enhancement of vegetable production and availability in the country (Yakubu, 2018). It has been argued that urban vegetable production alone can meet the greater part of the urban demand for fresh vegetables (Yakubu & Kumah, 2019).

Vegetable consumption requirement is based on the FAO/WHO global recommendation of not less than 400g of fruit and vegetables per day (5 servings of 80g), as there is no particular guideline for vegetables alone (WHO,2003). The majority of countries recommend that at least three servings (240g/day) of vegetables be consumed (Kalmpourtzidou, Eilander, & Talsma, 2020). According to an analysis by Kalmpourtzidou et. al. (2020), global vegetable consumption is generally less than the recommended 240 grams per day and the supply of vegetables is sometimes insufficient to meet the standards. Asia had the highest vegetable intake, with ten countries meeting the requirements. The daily weighted mean intake of vegetables in Africa ranged from 98 to 135 grams, depending on the country. Only in North Africa did the average satisfy the 240g/day requirement (Kalmpourtzidou, et.al., 2020).

In light of the recent emphasis placed on diets consisting primarily of plant foods, efforts need to be made to boost vegetable production, accessibility, and affordability, as well as creative techniques to establish a persistent behaviour change targeted at increasing vegetable consumption globally. With health disorders such as cardiovascular diseases, digestive disorders, cancer, metabolic disorders, and depression among others associated with insufficient intake of vegetables, there is a need to pay attention to the vegetable sector (Lassen, Christensen & Trolle, 2020). Thus, for the past few years, the government of Ghana has made some interventions with the hope of boosting the agricultural sector to increase production.

Through the Ministry of Food and Agriculture, the government has launched programmes as part of the National Agricultural Investment Plan (NAIP): Investing for Food and Jobs (IFJ). The key initiatives being carried out are Planting for Export and Rural Development (PERD), Rearing for Food and Jobs (RFJ), Planting for Food and Jobs (PFJ), Agricultural Mechanization, and Greenhouse Villages. Other supplementary treatments include water and irrigation management, agricultural marketing, and post-harvest planning.

The Ministry of Agriculture has assisted farmers in increasing production through the PFJ initiative by providing fertilizers, improved seeds, and extension services (Amoah, Drechsel, Abaidoo & Ntow, 2021). For example, the government provided 81% of the intended 19,533 million tonnes of seeds and 86% of the targeted 342,200 tonnes of fertilizer to 92% of the targeted 1 million recipient farmers (Amoah et al., 2021). As part of the second phase of the Brazilian More Food Program facility, the government has imported various agricultural equipment, such as tractors, power tillers, planters, sprayers, combine harvesters, shellers, threshers, irrigation kits, seed cleaners, silo dryers, and greenhouses, which will be sold to farmers at a 40% subsidy (Amoah et al., 2021). In 2020, the government subsidized organic and inorganic fertilizer distribution to farmers by 50% and this has been maintained in 2021 (Amoah et al., 2021). This intervention aims to make fertilizer more affordable to farmers who are unable to purchase it due to the high cost, and to encourage farmers to fertilize their crops to increase productivity (Amoah et al., 2021).

In the vegetable production sector, the government, through the MoFA, has subsidized seeds and fertilizer to alleviate the financial strain on vegetable producers. This is to promote vegetable production. Despite these interventions, the yield of vegetables is below the expected tonnage. WABS Consulting (2018) reported that vegetable yields in Ghana, when compared to the yields of developed countries, is low. In many areas of the country, vegetable yields have seen a further decrease over the course of the last several years, with the reason being attributed to inadequate sustainable farm management practices including limited input of fertilizers and irrigation facilities (Abu, 2011; Braimoh & Vlek, 2006; Owusu-Sekyere, Alhassan, & Nyarko, 2011).

SFMP has a major influence on vegetable yield and subsequently their production. Sustainable farm management practices refer to farming methods and techniques that prioritize environmental stewardship, economic viability, and social responsibility. These practices aim to maintain or improve the long-term health and productivity of the farm while minimizing negative impacts on the environment and supporting the well-being of the farming community. Farm management strategies such as pest and disease control, soil water management, plant nutrition management, and weed control all have a direct impact on vegetable output, consequently influencing productivity. Shock, Feinerman & Karki (2005) and Huang, Pray and Rozelle (2002) both demonstrated that the amount of irrigation water applied has a considerable effect on crop yield. Crop yields grow in direct proportion to irrigation water usage to an optimum level.

Similarly, El-Desouky, Islam, Bergefurd, Gao, Harker, Abd-El-Dayem, ... and Zewail (2021), found that fertilization dramatically boosts tomato output by enhancing vegetative development and photosynthetic efficiency in plants. Weed infestation has also been found to have effects on crop yield and quality in crop production systems due to competition for water, nutrients, light, and carbon dioxide (Hance & Holly, 1990). Weeds, on average, impair the yield potential of many crops by up to 34%. Other agricultural management strategies, such as the control of pests and diseases, as well as the management of soil cover, among others, have been shown to have a major impact on crop output (Liliane, 2020). The yield of vegetables produced is determined by the farm management methods used by vegetable farmers and the manner in which they employ such farm management strategies.

Statement of the Problem

Agriculture is important to the economy of Ghana and provides the main source of food, income and employment to a substantial number of people, and the role of vegetable production in the process cannot be over-emphasized. Vegetables serve as a major source of nutrients, particularly in households that are under-resourced in the country (Schreinemachers, Simmons, & Wopereis, 2018), and the case is not different in the Agona West Municipality (AWM) of the Central Region of Ghana. Ghanaians consume significant quantities of green vegetables cultivated in the Municipality due to their nutritional value (Amagloh & Nyarko, 2012). For the important role vegetables play in Ghana, successive governments and other development partners have attempted to improve upon the yields of vegetable farmers through a number of innovations in management practices. These innovations to a large extent have contributed significantly to the improvement in vegetable production in Ghana (Yakubu, 2018), but demand for vegetables, especially in the urban areas outweighs production (Yakubu & Kumah, 2019).

As reported by MoFA (2012), the production level of vegetables in Ghana is low despite its comparative advantage. Ghana's hot pepper production is way below its potential (MoFA & IFPRI, 2020), despite it being profitable than staple foods such as rice and maize (van Asselt, Masias, & Kolavalli, 2018). Low production is as a result of low yields which have been linked to limited use of improved seeds and poor agronomic practices (van Asselt et.al, 2018).

In desperation to increase the yields and production level of vegetables in Ghana, there are reported cases of application of poor and unhealthy farm management practices resulting in degradation of the environment, pollution of water bodies and poor crop yields (Kim, Thomas, Pelster, Rosenstock, & Sanz-Cobena, 2016; Vanlauwe, Wendt, Giller, Corbeels, Gerard & Nolte, 2014). Poor farm management methods, according to Mawazo, Mwema, Mwamburi and Shitanda (2020) is one of the reasons why farmers have low yields. When crop yields fall, households whose livelihoods rely on vegetable farming lose a considerable amount of money, contributing to poverty by preventing them from providing essential services to their members.

When it comes to factors that influence crop yields, there is a wealth of information available. Some researchers examine the physical elements that impact agricultural output, such weather and disease (Danso-Abeam & Baiyegunhi, 2018; Asante, Dawoe, Acheampong & Bosu, 2017; Andres, Li, & Barrett, 2018), while others investigate the cultural and economic aspects that have impact on agriculture (Andres et al., 2018; Danso-Abeam & Baiyegunhi, 2018; Abbey, Tomlinson & Branston, 2016; Asante et al., 2017; Curry, Koczberski, Lummani, Nailina, Peter, McNally & Kuaimba, 2015). The variables influencing the adoption of sustainable farm management strategies, the extent to which these management practices are used, and how these management practices affect yields are areas that have received little attention in the discussion on factors that determine crop output.

Vegetable producers in the Agona West Municipality, like most farmers in Ghana are making frantic efforts to improve their yields, income levels and household livelihoods, especially, through pepper production which is the vegetable grown predominantly in the area.

A relevant gap that remains unaddressed is how sustainable farm management practices influence vegetable yield within the Agona West Municipality. Understanding these practices and their determinants is essential for implementing appropriate measures to enhance vegetable production. This study seeks to examine fill this gap by examining how sustainable farm management practices influence vegetable (hot pepper) yield within the Agona West Municipality. Addressing this gap can serve as a basis upon which they can best be assisted with appropriate measures to boost vegetable production.

Aim and Objectives of the Study

The aim of the study is to examine sustainable farm management practice and its effects on pepper production among farmers in the Agona West Municipality.

Specific Objectives

To achieve the above-stated objective, the study specifically aims to:

1. determine the level of adoption of sustainable farm management practice by the hot pepper farmers.

2. ascertain the factors influencing the adoption of sustainable farm management practice.
3. find out the challenges faced by the farmers in the use of the sustainable farm management practice.
4. examine the effects of the sustainable farm management practice on the yield of hot pepper in the Agona West Municipality.

Research Questions

1. What is the level of adoption of sustainable farm management practice by hot pepper farmers within the Agona West Municipality?
2. What are the factors influencing the adoption of sustainable farm management practices among the hot pepper farmers within the Agona West Municipality?
3. What challenges do the hot pepper farmers face in using the sustainable farm management practice?
4. What is the influence of sustainable farm management practice on the yield of the vegetable in the Agona West Municipality?

The Hypothesis of the Study

1. There is a statistically significant difference between the different categories of socio-demographic characteristics and adoption of sustainable farm management practices.
2. There is a statistically significant difference between the different levels of farm related characteristics and adoption of sustainable farm management practices (IPM, irrigation, fungicide application, pruning and integrated weed control).

3. There is a statistically significant positive relationship between the institutional factors and adoption of sustainable farm management practices.
4. There is a statistically significant positive relationship between the characteristics of technology and adoption of sustainable farm management practices.
5. There is a significant positive relationship between sustainable farm management practice (IPM, irrigation, fungicide application, pruning and integrated weed control) and pepper yield.

Significance of the Study

The study will inform farmers of the management practice that brings about a higher yield so that they can intensify the practice in their farm management. This research will help extension agents in the development of their training programmes as findings from this research will sensitize the extension agents on the kind of assistance farmers need regarding their vegetable crop management. This research will also serve as a foundation for the Ministry of Food and Agriculture and non-governmental organizations to formulate policies and build future training programmes for vegetable farmers. Additionally, the research will help to understand different dynamics with technology adoption considering benefits and downsides. Finally, knowledge would be increased thanks to the research. This is because it would contribute to a better understanding and appreciation of vegetable production, and as well lay a foundation for research in Ghana's vegetable industry in future.

Delimitation of the Study

The sustainable farm management practice (SFMP) in this study is limited to cultural practices in crop management, and to six farm management activities which are Integrated Pests Management (IPM), pruning, application of fungicides, integrated weed management (IWM), conservation tillage and irrigation. These measures have been advocated as key to sustainable farm management practices for optimal crop yields (Badgley, Moghtader, Quintero, Zakem, Chappell, Aviles-Vazquez & Perfecto, 2007; Okalebo, Othieno, Woomer, Karanja, Semoka, Bekunda, ... & Mukhwana, 2007; Dile, Karlberg, Temesgen, & Rockström, 2013). Pepper (*Capsicum frutesence*) was used as a proxy for vegetables as it is a dominant vegetable crop grown all year round in the studied municipality. Agriculture is primarily a small-holder activity in Ghana (Essegbey, & MacCarthy, 2020) so open-space small-scale farmers were considered in this study because their livelihood depends on the vegetable farms and also, they are the target for government interventions. Farms that are less than 2 hectares are considered to be small-scale farms according to Lowder, Skoet and Raney (2016). Only perceived usefulness, perceived ease of use, and adoption of sustainable farm management practice were considered as TAM factors. The farmer and farm-related characteristics were limited to sex, marital status, household size, level of education, age, years of experience in vegetable farming, household labour size, farmer association membership, farm size and land tenure system. The institutional factors were limited to access to credit, extension contacts, environmental regulations, government policies, and access to the market to purchase farm inputs and sell farm produce.

Limitations to the Study

1. The research was restricted to the minimum amount of time needed to complete the inquiry. As a result, this research was based on farmer opinions instead of quantitative data from experimental research that could be tested to see how sustainable farm management practice affects the yield of hot pepper grown.
2. The data for this study depended mostly on the recollection ability of the farmers. There is the chance of perception errors since a substantial amount of the data acquired relied on the opinion of the farmers.
3. The current investigation was restricted to one vegetable (hot pepper) because of time and logistical constraints.

Definition of Key Terms

Sustainable Farm Management Practice: This involves activities carried out both before planting, to prepare and maintain the soil for planting, and after planting, to sustain crops in the field until the time of harvesting. This comprehensive approach ensures that the entire farming process, from soil preparation to harvest, aligns with sustainability principles with the goal of balancing the needs of the environment, the economic aspects of farming, and the welfare of the community throughout the entire agricultural cycle. It covers fertilization, eradicating weeds, control of pests and diseases, and irrigation among others.

Perceived Usefulness: The degree to which an individual thinks that utilizing a particular technology will improve their performance at work. Perceived usefulness describes the degree to which farmers believe that the continued use of Sustainable Farm Management Practice (SFMP) is beneficial or advantageous.

Perceived Ease of Use: The degree to which farmers think that a sustainable farm management practice is free of effort (relatively easy to use).

Integrated Pest Management: A system that is designed to keep pest populations below the levels that cause economic loss by integrating several pest management techniques into a single, cohesive system.

Integrated Weed Management: The application of all feasible weed control strategies to lower weed populations than what would cause economic harm, that is, below the economic injury level (EIL). Cultural practices, the employment of biological, genetic control agents, physical, and the selective application of herbicides are some of the methods.

Conservation Tillage: Any agricultural method that attempts to conserve soil and water, decrease soil erosion by covering the soil's surface with crop straw, or disturb the subsurface as little as possible.

Pruning: Pruning is the practice of carefully and strategically removing a plant's dead or diseased parts to encourage new growth, improve blooming and fruiting, and generally improve the plant's aesthetic appeal and yield. It is done to transmit a portion of plant energy from one component to another area of the plant.

Irrigation: The application of a controlled amount of water to the soil to supply moisture essential for plant growth.

Vegetable: The term "vegetable" refers to the soft edible stem, fruits, roots and leaves, of spices and plants that are taken whole or in part, either raw or cooked as a supplement to starchy foods and meat. Vegetables can also be used to refer to the plant and spice species themselves. Hot pepper (*Capsicum frutesence*) was used as a proxy for vegetables in this study.

Agricultural Technology: Techniques used in agriculture to increase productivity, efficiency, and sustainability.

The Organization of the Study

The study is divided into five chapters namely: Introduction; literature review; research methods; results and discussion; summary, conclusions and recommendations.

Chapter One presents the introduction of the study which focuses on the background to the study, statement of the problem, general objective, specific objective, significance of the study, delimitation of the study, limitations of the study, definition of key terms and organization of the study. Chapter Two deals with the review of literature relevant to the study. It centres on the key concepts, theories and empirical review, leading to the development of a conceptual framework for the study. The focus of Chapter Three is on the research methods. The research methods involve the research design, description of the study area, the population of the study, sample size and sampling procedure, instrumentation, pretesting and reliability, data collection and data management and analysis. The presentation and discussion of findings based on the analysis of data is presented in Chapter Four. A summary of the study, the conclusions, recommendations and implications for future research have been presented in Chapter Five.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter contains the conceptual review, theoretical review, empirical review and conceptual framework for the study. It presents a review of the technology acceptance model; thereafter, extant literature on the implications of sustainable farm management practice on vegetable production is reviewed. Finally, the conceptual framework of the study is presented.

Conceptual Review

This section provides an overview of the main concepts of this study. Sustainable farm management practice and the adoption of innovations are the key concepts in this study.

Sustainable Farm management practice (SFMP) is an agricultural practice that is used to maximize crop growth, development, and yield taking into consideration the health of the environment. SFMPs encompass the implementation of environmentally conscious and economically viable methods across the entire crop cultivation and harvesting process, aiming to maximize crop growth, development, and yield while minimizing adverse effects on the ecosystem, ensuring both short-term productivity and long-term agricultural sustainability. Sustainable farm management practice typically includes weed control, conservation tillage and pest management, as well as other practices aimed at increasing crop yields, such as irrigation and fertilizer application. These practices may vary slightly depending on the crop being considered, as different crops grow at varying rates and are subject to varying growing conditions and insect and disease attacks (Fanadzo, Chiduza, &

Mnkeni, 2010). Adopting sustainable farm management practice increases crop productivity and may result in increased yields of higher quality (Maninder, 2021).

Six sustainable farm management practices which are integrated pest management (IPM), pruning, application of fungicides, integrated weed management (IWM), irrigation and conservation tillage were considered in this study.

Integrated Pest Management (IPM)

A system that is designed to keep pest populations below the levels that cause economic loss by integrating and harmonizing all possible pest control approaches into a single cohesive and coordinated strategy (FAO 2020). IPM is a method for controlling pests that is both efficient and gentle on the environment (Kabir & Rainis, 2015). Protection is given against the return of existing pests, the emergence of new pests, and the spread of diseases. IPM is a method used to eliminate unwanted pests that employs a number of methods to make biological management of pest insects in crops more practicable, with subsequent benefits for the economy, public health, and the environment.

Effective IPM techniques must include monitoring populations of pest, finding plant varieties that are resistant to pest, and changing cultural, biological, chemical and mechanical controls as necessary to meet production objectives (Adams, 1996). A good IPM approach must take into account farmers' conventional agricultural understanding of insect behaviour and life cycles (Petit, Haysom, Pywell, Warman, Allen, Booth, & Firbank, 2003; Roitberg, 2007; Vinatier, Lescourret, Duyck, & Tixier, 2012), as well as utilizing farmers' present farming techniques and expertise in a particular agro-ecosystem (Rahman, 2012; Craig, 2015).

In order to control insect pests in agricultural production, integrated pest management (IPM) combines the use of physical, cultural, chemical and biological approaches. The aforementioned management technique is covered in the sections that follow.

Physical control

The methods in this category make use of a physical aspect of the environment — such as temperature, humidity, or light — to control pest populations or damage. Physical and mechanical pest control techniques include the following: tillage, flaming, flooding, soil solarization, row covers, traps, handpicking, use of water pressure sprays, and the use of insecticidal soap.

Screens to keep out insects and animals such as flies, possums, and rats and pest detection through physical means like trapping may be the most efficient and feasible forms of pest control for certain infestations (Zschekel, Afful, & Agyepong, 1997).

Cultural Control

The objective of cultural controls is to encourage the pest's natural predators and parasites by fostering an environment less conducive to the pests' survival, dissemination, growth, and reproduction. To make conditions less favorable for nuisance pests, cultural control approaches such as improving ventilation to prevent termite assaults and enhancing sanitation and hygiene practices to lower the likelihood of an infestation caused by pests should be implemented. These techniques should be utilized to produce environments that are less hospitable to pests that cause problems (Shimada, Simon, & Cunha, 2021). According to Ahowe, Coulibaly, and Djagba, (2008), intercropping, mixed cropping, destruction of volunteer plants, alternative host administration, trap crop management, early harvesting, and crop rotation are routinely employed to manage and control pests and diseases to some extent.

Biological Control

When organisms are used with the goal of lowering pest populations, this method is known as biological control. Biological control is the process of using living organisms to keep pest populations at safe levels. Plants or animals can be used to control pests in this control method. (Altieri, Nicholls, & Fritz, 2005; Mahr & Ridgway, 2008).

According to Unruh (1993), “There are three fundamental approaches to biological pest control: classical (importation), which entails introducing a pest's natural enemy in the hopes of gaining control; inductive (augmentation), which entails administering a large population of natural enemies for quick pest control; and inoculative (conservation), which entails taking steps to preserve natural enemies through routine re-establishment”.

Insect pests or biological control agents have many natural enemies, including predators, diseases, competitors and parasitoids. Antagonists are frequently used to refer to biological control agents for plant diseases. Seed predators, herbivores, and plant pathogens are all biological control agents for weeds (Unruh,1993).

After an initial investment, biological control can be cost-effective, because natural enemies may maintain themselves in the environment, often by diminishing the pest population they are meant to control. This means that once the system is up and running, less effort will be needed to keep it that way. Additionally, biological control can be maintained for significantly longer periods than other pest control methods. On the other hand, it is a lengthy process that occasionally fails to be specific and does not eliminate a pest (Hajek & Eilenberg, 2018).

Chemical Control (Use of pesticides with a chemo-synthetic base)

Chemical pest control utilizes substances that are harmful to the target insects. Chemical pesticides can be classified into two distinct categories: non-selective and selective. The most hazardous products are non-selective ones, as they kill a diverse variety of organisms, with useful and harmless ones inclusive. The range of selective pesticides is somewhat limited. Other organisms are unaffected, and only the targeted pest is eliminated (Zacharia, 2011).

Chemical pesticides are widely used because they are inexpensive, simple to use, highly effective, and long lasting. It's common for chemical pesticides to start working quickly, limiting the amount of harm done to crops (Lacey, Grzywacz, Shapiro-Ilan, Frutos, Brownbridge, & Goettel, 2015). Chemical pesticides, however, are frequently poisonous to a variety of creatures in addition to the ones for which they were created. Chemical pesticides can potentially cause pests to become resistant if they are applied excessively (Zacharia, 2011).

Farmers often resort to chemical control as a last resort to protect their vegetable crops (Amoah, Drechsel, Abaidoo, & Ntow, 2006). Similarly, to vegetable growers in the Ashanti area of Ghana, Okorley and Kwarteng (2002) report that those in the Central Region of Ghana depend nearly exclusively on chemical pesticides. An investigation of the use of pesticide in the Offinso North District discovered that several communities, including Akomadan, were doing so in order to protect their vegetable crops (Ntow, 2001).

Pruning as Sustainable Farm Management Practice

Pruning is the practice of removing certain parts of a plant, such as leaves, stems, or branches, in order to promote healthy growth and increase yields. Pruning is an important part of vegetable gardening, and can have a substantial impact on the yield of crops. To improve the appearance and health of a plant, pruning involves the strategic and selective removal of shoots, spurs, leaves, roots, terminal sections, etc. By doing so, we can maximize our harvest's yield and quality, extend the plant's life span, give it a shape we can easily manage, and get the greatest financial benefits from our labour (Bhat & Mehvish, 2021). The goal of pruning is to eliminate non-productive sections of the plant so that energy can be directed to the areas that can bear fruit, maintain the right root-to-shoot ratio, and generate higher-quality fruits through better light penetration (Thakur, Kumar & Singh, 2018). When a branch is severed, the potential leaf surface and stored carbohydrates are lost. It promotes new growth near the incision, which increases fruit size and nitrogen content per growing point (Bhat & Mehvish, 2021). According to Bhat and Mehvish (2021) “the most common reasons to undertake pruning are to: constrain the plant's expansion; to manage the form (structural make-up of the plant), including the number, placement, relative size, and angle of branches; to improve the quality of the fruits through increased exposure to light; to remove diseased, tangled, dried, and broken branches; to redirect energy from the less productive parts of the plant to the more productive parts; and to develop the plant's structure."

By removing dead or diseased branches, pruning promotes the rapid development of healthy, flowering new growth. Vegetable crop productivity and quality can be improved by paying attention to pruning techniques. In a beneficial way, it affects photosynthesis, growth, and the equilibrium between vegetative and reproductive development in plants (Thakur et. al., 2018). There hasn't been much study here on ways to boost vegetable harvests without sacrificing quality or crop viability. Pruning controls fruit load, and fruit load controls the proportion of a plant's development that goes toward vegetative and generative processes, as well as the size of its fruits, via a process of reciprocal competition for assimilates (De Koning, 1995). In order to maximize dry matter partitioning to the fruit and commercial yield, truss trimming is essential. In order to reduce the prevalence of diseases, hasten fruit ripening, and facilitate picking, leaf trimming is performed (Heuvelink, Bakker, Elings, Kaarsemaker & Marcelis, 2004). The vegetative sink may be reduced by trimming leaves, which then allows more of the plant's resources to go toward producing fruit (Xiao, van der Ploeg, Bakker, & Heuvelink, 2003)

Application of Fungicides

Crop losses due to plant diseases can result in famine and starvation, notably in developing nations with inadequate infrastructure and annual crop losses of 30–40% due to a lack of available disease management techniques (Flood, 2010). A plant is afflicted with the disease when it is frequently injured by a pathogen, leading to an abnormal physiological function which disrupts the plant's typical development, growth, or functioning. This disturbance of one or more important physiological or biochemical systems of a plant results in the appearance of diseased diseases or symptoms. Temperature, humidity, soil moisture, soil type, pH, and soil fertility are all major environmental factors that might affect the establishment of plant diseases (Winter, & Pereg, 2019).

Fungicides are chemical substances used to control the spread of fungus and fungal pathogens, as well as the spores that may spread them (Reis & Carmona, 2013). On the basis of (1) their mobility, (2) their method of action, and (3) the phases of infection they are most effective against, they can be categorized into three classes (Hewitt, 1998).

Classification of Fungicides According to Mobility

Non-penetrating Fungicides—Non-Mobile

These are fungicides that do not penetrate plant tissue. Thus, they are not absorbed by the plant, and as a result, they do not move throughout the plant. On plant surfaces, these fungicides create a protective barrier, sometimes known as a "shield," that inhibits the germination of spores and/or the establishment of mycelial networks. Rain or irrigation can therefore remove this form of fungicide from the plant's surface.

Penetrant and Mobile (Systemic) Fungicides

Penetrating fungicides are deposited on the plant surfaces, where they are then absorbed by the leaf tissues and transported upward by the xylem arteries. From the point of absorption, chemical components can travel very short distances within the plant (local systemic movement), or they can travel large distances throughout the plant (true systemic fungicide), depending on the qualities of the chemical component.

Classification of Fungicides According to Mode of Action

When applied to fungi, fungicides disrupt a wide range of vital cellular processes. One criterion for classifying fungicides is their mode or mechanism of action (MOA), which describes the specific process by which they inhibit or kill a certain fungus.

Classification according to the stages of infection they are most effective against

It is possible to categorize fungicides based on the specific pathogenic event or developmental stage that they inhibit (Reis & Carmona, 2013). When a pathogen makes a parasitic link to a host, a cascade of dynamic processes begins that ultimately results in the growth and establishment of an infection; this is known as pathogenesis. The whole disease cycle consists of dissemination and deposition of spores, spore germination and penetration, infection, colonization and invasion of a host, reproduction, spread, and survival (Agrios, 2005). Based on whether they inhibit, treat, or eradicate infection, fungicides fall into one of three categories; eradicant, preventive or curative (Hewitt, 1998).

Foliar-sprayed fungicides are excellent at controlling airborne diseases. Fungicides are sprayed on the leaves of hot pepper plants to prevent infections (Panth, Hassler, & Baysal-Gurel, 2020). Boatman (1992) discovered a considerable increase in spring barley output following the use of fungicides. Similarly, Hřivna, (2003) discovered a relative improvement in crop yield following the application of fungicides to combat disease. According to a study conducted by Esker, Shah, Bradley, Conley, Paul, and Robertson (2018) on the opinions of crop consultants and farmers in the Midwest about the usage of foliar fungicides in corn, farmers apply a lot of fungicides to their crops because they believe the fungicides will increase crop yield. It is hypothesized that fungicide spraying has a statistically significant effect on vegetable yield.

Integrated Weed Management (IWM)

Weed management is a system for keeping the infestation of weeds on a farm or in an area to a level that does not cause economic harm without degrading the environment. Weed management strategies seek to mitigate the negative effects that weeds have on crop plants when they coexist. Weeds can be controlled in a variety of ways, including preventative measures, biological control, cultural control, and chemical control, which involves the use of synthetic herbicides. When all of these methods, or two or more of these weed control methods are unified as one, it is termed integrated weed management.

Preventative, mechanical, biological, cultural and chemical methods are all used in IWM. Integrated weed management, is the practice of incorporating many different strategies for dealing with weeds into a single overarching plan for weed management. Integrative weed management (IWM) makes use of many methods to maintain weed suppression throughout time (Harker & O'Donovan, 2013). It is impossible to implement a universal strategy for weed management due to the wide variety of weed species, life cycles, and techniques used by these organisms to stay alive. Using just one or two strategies to manage weeds is ineffective because weeds may quickly adapt to the new conditions. Utilize agronomic methods that restrict the entry and spread of weeds (avoid weed problems before they begin), help the crop compete with weeds ('choke out' weeds), and use practices that keep weeds 'off balance' (do not allow weeds to adapt); these are the fundamental concepts around which an IWM program is built.

The following sections discuss the weed management practices that integrated weed management encompasses:

Preventive Measures

Preventative measures encompass any type of weed management used to prevent unwanted plants from growing in agricultural areas such as fields, pastures, and greenhouses. Utilizing certified weed-free seeds, using well-decomposed farm yard manure or compost, thoroughly cleaning farm equipment before relocating, screening irrigation water to stop weed seeds from traveling along irrigation ditches, and regularly inspecting and maintaining your irrigation system and the careful monitoring of seedlings in nurseries to ensure they do not become mixed with weed seedlings and get carried to the fields are all examples of preventative weed control measures (Buhler, 2002).

Cultural Control

The term "cultural weed management" encompasses a wide range of practices aimed at preventing weeds from establishing themselves and spreading over a field. Crop rotation, planting leguminous cover crops to suppress weed growth, planting crops at the optimal seed rate to help the crop cover the ground and deprive the weeds of light, and maintaining good soil fertility are all examples of cultural weed control (Blackshaw, Anderson & Lemerle, 2007).

Mechanical

Mechanical weed control is any physical activity that suppresses the growth of undesirable plants. It entails weed control through the use of farm equipment. Tillage, flooding, fire, hoeing, hand pulling, mowing, and mulching are the most frequently used mechanical control techniques (Blackshaw, et.al, 2007).

Biological

Biological weed control is any technique that employs natural enemies or living organisms (plants or animals) to suppress weed seed germination or spread. These are referred to as bioagents, and they prey exclusively on weeds, not crop plants (Abbas, Zahir, Naveed, & Kremer, 2018). For example, Cochineal insects controlled prickly pear or Nagphana weed in South India. In Australia (Hawaii Islands), several species of moths have been used to control Lantana Camara, which consumes the flowers and fruits, and sheep have been used to control tansy ragwort or leafy spurge (Davis, Yoshioka, & Kageler, 1992).

Chemical

Any weed control techniques that utilize chemicals (herbicides) to kill existing weeds or prevent new ones from sprouting in a given area is considered to be chemical weed control. These chemicals aid in the eradication of weeds or their growth inhibition. This is extremely effective in some cases and has a broad application if the chemicals are inexpensive, efficient, and readily available (Zhang, 2003). 2,4-DB, Atrazine, Glyphosate, Bromoxynil, and Paraquat are all examples of commonly used weed control chemicals.

By reducing the number of weeds in an area, IWM can have positive effects on both the environment and the economy. One of the methods used in IWM is the application of herbicides, whereas the other methods are chemical-free. This implies that the use of chemical-free weed management techniques is essential for IWM to be successful. There are many options for non-chemical weed control that can be chosen depending on the type of crop, the level of weed infestation, the growing conditions, the time of year, the stage of both the weeds and the crops, the resources at hand, and the desired yield (Harker & O'Donovan, 2013; Bajwa, Mahajan & Chauhan ,2015). If sustainable IWM is to be achieved, advancements in non-chemical weed control are unavoidable.

Gains in production from advances in agrotechnology and the introduction of high-yielding cultivars would not have been possible without careful weed control. Reduced pesticide usage does not necessarily increase weed infestation and yield loss (Boström & Fogelfors, 2002; Kudsk & Streibig, 2003; Kudsk 2008; Salonen 1993), although it does cause large production losses and long-term increases in numbers of less sensitive species (Hossard, Philibert, Bertrand, Colnenne-David, Debaeke, Munier-Jolain, ... & Makowski, 2014).

Excess weeds compete for nutrients with crops and also serve as breeding grounds for pests and some disease-causing organisms around vegetable crops. To an average of 2.3 times per year, Ghanaian farmers keep weeds under control on their fields, according to MASDAR (1998). This is in contrast to the findings of Aneani and Ofori-Frimpong (2013), who determined that farmers weed their fields twice a year. Numerous studies have established a positive correlation between weeding frequency and crop yield (Dimes, Muza, Malunga, Snapp, Friesen & Palmer, 2004).

Irrigation

Vegetative development in plants requires sufficient amounts of high-quality water within reach of their roots. Most of the water absorbed by plants translocate dissolved nutrients to the aerial organs, from where it is delivered to the atmosphere through transpiration. Plants have different water needs depending on the weather patterns in their region (Holding & Streich, 2013). Agriculture in Ghana is largely rainfed. With increasing variabilities in climate, there have been inconsistent rainfall patterns, and this has had an impact on agricultural production. The degree of expected rainfall changes varies greatly depending on geographic location and spatial scale (Bates, Hope, Ryan, Smith & Charles, 2008), and the magnitude of potential effects are still debated. The variabilities in climate have necessitated the integration of irrigation in crop production.

Irrigation is the practice of artificially delivering a measured amount of water to land for the purpose of growing crops, ornamental plants, and grass. It's a technique for giving plants the water they need right when they need it, hence the name. Crop cultivation, landscape maintenance, and revegetation of damaged soils are all aided by irrigation in arid regions and during periods of below-average rainfall. As well as preventing frost damage, reducing the prevalence of weeds in grain fields, and preventing soil from compacting, irrigation serves a number of important functions in the agricultural industry. (Adeyemi, Grove, Peets, & Norton, 2017). By contrast, rain-fed agriculture is agriculture that is entirely dependent on direct rainfall. Water for irrigation can come from a variety of sources, depending on the land's water link. It can originate in wells, surface water, rivers, lakes, or ground waters, as well as other unidentified sources.

Irrigation systems come in a variety of configurations, each with its unique way of distributing water throughout the field. Surface irrigation, sprinkler irrigation, localized irrigation, center pivot irrigation, lateral movement irrigation, drip irrigation, sub-irrigation, and hand-watering (use of watering cans) are all types of irrigation systems.

Conservation Tillage

Conservation tillage refers to any method of farming that reduces the amount of soil and water lost during cultivation, prevents soil erosion by keeping the soil's surface covered with crop straw, or causes minimal disturbance to the soil's subsurface (Yang, Huang, Huang, Chen, Liu & Chen, 2018). Soil and water conservation may arise from the use of conservation tillage in intensive cropping systems, where field and weather conditions are of the utmost importance (Sayre & Govaerts, 2011; Yang et al., 2018). Many countries throughout the world have adopted conservation tillage strategies include minimizing soil disturbance, keeping the soil covered with stubble return, and working straw into the soil (Derpsch, Friedrich, Kassam, & Li, 2010).

It is well known that conservation tillage techniques boost soil nutrients and subsequent crop production (Han, Li, Zhao, Zhao & Li, 2020; Hirzel, Brazee, & White, 2020; Zhao, Huang, Ren, & Zhang, 2019; Omara, Nasr, & Saad, 2019). By instituting and enforcing better soil conservation measures, it may be possible to establish economically sustainable agriculture

(Zhao et al., 2019). In an effort to improve crop agronomic qualities and soil nutrients, many methods have been tested. Using No-Tillage (Hirzel et al., 2020), returning residue to the soil (Han et al., 2020), incorporating residue into the soil, or mulching residue on the surface of the soil are the most effective methods (Wang, Wang, Gao, Zhao & Yang, 2017; Han et al., 2020). More than 83% of the world's annual fertilizer usage can be found in agricultural wastes, according to a study published in 2019 by Jinghua et al. There are favorable effects on soil nutrient levels after residue integration is applied and after residue is returned to the soil, both of which increase crop yield (Han et al., 2020; Zhao et al., 2019).

Adoption of Innovation

Adoption is the process by which new technology is integrated into established practices. In most cases, it follows a time of "experimenting" and adjusting to the situation (Loevinsohn, Acre, & O'Reilly, 2013). In terms of quantification, adoption may be broken down into two categories: rate of adoption and intensity of adoption. Time is a factor in the rate of adoption, which is the pace at which farmers take up a new technology. The term "adoption intensity" refers to the frequency with which a particular technology is used over a specified period (Bonabana-Wabbi, 2002).

The choice to fully utilize an innovation as the most effective course of action is known as adoption of innovation, which is governed by a five-step procedure. This process happens gradually among individuals within a comparable social system through a chain of communication channels. The adoption procedure is comprised of five phases: instruction, convincing, decision-making, execution, and validation. (Source: Extension Principles and Techniques: Stages in the adoption process, 2021).

Loevinsohn et al. (2013) claim that the properties of the technology interact dynamically with a farmer's context to determine whether or not the farmer adopts the technology. Growth economists and others involved in creating and disseminating such technologies would benefit greatly from a better understanding of the variables that impact this decision (Hall & Khan, 2002). Individual qualities and endowments, lack of comprehensive knowledge, risk, uncertainty, institutional restrictions, input availability, and infrastructure are among factors that the economic study of technology adoption has looked at in an effort to explain adoption behaviour (Feder, Just, & Zilberman, 1985; Kohli & Singh, 1989; Koppel, 1995; Uaiene, 2011). Newer studies have shown that people's social networks and level of education are also important determinants of whether or not they embrace new technologies (Uaiene, 2011). Economic, social, and institutional aspects were identified by Akudugu, Guo, and Dadzie (2012) as drivers of agricultural technology adoption. There may be several categories of variables that influence technology adoption, but there is little differentiation between them. Technologies are classified in accordance with their being studied, geographical location, the researcher's personal preferences, and the client's demands (Bonabana-Wabbi, 2002).

Theoretical Framework

For decades, agricultural development was largely fueled by technological advancement (OECD, 2001). Although food insecurity persists in various areas of the world as a direct effect of agricultural technological advancement, the situation would have been much more precarious in the absence of technological development (Brooks & Loevinsohn, 2011). There are a number of theories propounded to explain the factors that influence farmers' decision to adopt an innovation (Mercer, 2004; Negatu & Parikh, 1999; Pannell, Marshall, Barr, Curtis, Vanclay, & Wilkinson, 2006; Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008; Pulido & Bocco, 2014). These include the diffusion of innovation theory which focuses on how ideas or technologies are acknowledged and adopted over time within a social system (Dearing, & Cox, 2018); the Theory of Reasoned Action which posits that individuals' behavioural intentions, and subsequently their actual behaviour, are determined by their attitudes toward a behaviour and the subjective norms influenced by the perceived social pressure associated with that behaviour; and the Theory of Planned Behaviour and Reasoned Action, which explains that human behaviour is influenced by three factors: attitude, subjective norm, and perceived behavioural control (Rossmann, 2021).

The Theory of Reasoned Action

The Theory of Reasoned Action, formulated by Fishbein and Ajzen in 1988, is a social psychological model that explores the determinants of human behaviour by examining individual attitudes, subjective norms, and behavioural intentions. Theory of Reasoned Action posits that an individual's likelihood of engaging in a specific behaviour is shaped by their attitude toward that behaviour and the perceived social pressure indicated by subjective norms. These behavioural intentions, in turn, serve as a reliable predictor of actual behaviour. Theory of Reasoned Action has been widely applied across diverse fields such as health, marketing, and social psychology, providing a foundational framework for understanding and predicting human behaviours (Fishbein & Ajzen, 1988).

The Theory of Planned Behaviour

The Theory of Planned Behaviour, introduced by Ajzen in 1991, is a social psychological theory designed to explain human behaviour by considering the role of individuals' intentions and perceived behavioural control. According to the Theory of Planned Bahaviour, behavioural intentions are the primary predictors of actual behaviour, and these intentions are influenced by three key factors: attitude toward the behaviour, subjective norm, and perceived behavioural control. Attitude toward the behaviour reflects the individual's positive or negative evaluation of performing a specific behaviour. Subjective norm represents the perceived social pressure to engage or not engage in a particular behaviour, and perceived behavioural control refers to the individual's perception of the ease or difficulty of performing the behaviour. These factors collectively shape an individual's intentions, subsequently influencing their actual behaviour. The Theory of Planned Behaviour has been widely applied in various fields, including health, marketing, and technology adoption, providing a comprehensive framework for understanding and predicting human behaviour in diverse contexts (Ajzen, 1991).

The Theory of Reasoned Action and the Theory of Planned Behaviour informed the development of the Technology Acceptance Model (TAM) was used for this analysis because it is widely recognized as one of the best explanations for why people accept new technologies.

Technology Acceptance Model (TAM)

Davis (1986) presented his model of accepting new technologies which he called the Technology Acceptance Model (TAM). It suggests that people's willingness to accept a new technology depends on their impressions of how simple and helpful it will be to them. Technology Acceptance Model (TAM) theorizes that a user's actual usage of a technology system is affected by the user's behavioural goals, attitude, perception of the system's utility (PU), and perception of its ease of use (PEOU). Perceived ease of use relates to the extent to which a user believes the target system will facilitate the completion of a task, while perceived usefulness refers to the extent to which the user believes the system will reduce the perceived difficulty of that task (Davis, 1989). TAM also suggests that variables external to the user might influence their intent to use and their actual use via the medium of their perceptions of the product's utility and its usability. The TAM served as the foundation for the development of this study's theoretical framework. TAM may provide a more solid theoretical grounding for developing a farmer-specific technology acceptance model, as shown by the available data. TAM has had some more features added to it so that it may be used to create the Farmer Technology Acceptance Model. TAM provides a basis for investigating the role that extraneous elements play in shaping individuals' conviction (perception), behavioural intent, and acceptance of technological solutions.

Technology Acceptance Model (TAM), which provides a foundation for discovering the impact of external variables on internal beliefs (perception), attitudes, and intentions (Rafique, Almagrabi, Shamim, Anwar, & Bashir, 2020).

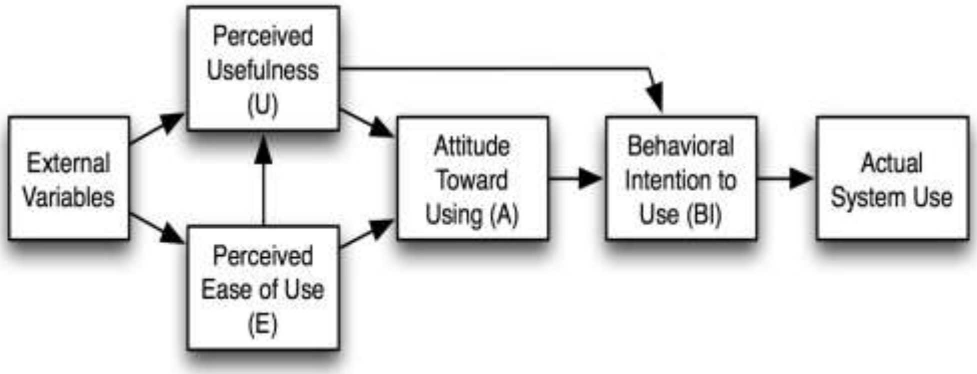

Figure 1: Technology Acceptance Model
Source: (Davis, 1989)

Application of the Technology Acceptance Model to this study

According to Kebede, Gunjal and Coffin (1990), many small-scale farmers in Ghana face sociocultural and economic barriers to adopting packaged technologies/innovations in farm management. Among these are the farmers' perceptions of the innovation's attributes, their age, their aims as farmers, the size of their families, their degree of familiarity with the innovation, their family's farming background, and their understanding of and adherence to the recommendations.

The Technology Acceptance Model is in some way applicable to this study. This study looks at some adopted sustainable farm management practices and investigates the factors influencing the adoption of these sustainable farm management practices taking into consideration, farmers' perceptions of the Sustainable Farm Management Practice (SFMP) and external variables such as the characteristics of the farmer and the farm, and institutional factors. The usefulness of the SFMP and the perceived ease of use of the SFMP form the component of the perceived characteristics of the

SFMP. The influence of these sustainable farm management practices on the yield of vegetables is examined.

The simplicity, wide use, adaptability, comparability, and good predictive power make the Technology Acceptance Model a valuable theoretical framework for this research.

Empirical review

Literature on vegetable farming; an overview of vegetable farming in Ghana; and an examination of the factors influencing the adoption of sustainable farm management practices (including farm and farmer characteristics, technology characteristics and performance, and institutional factors) are all included in the empirical review.

Adoption of sustainable farm management practices by vegetable farmers

Researchers in Ghana have compiled data on the prevalence of farmers' employment of different agricultural methods and the results for crop yields (Agula, Akudugu, Dittoh & Mabe, 2018; Adomako & Ampadu, 2015; Kotu, Alene, Manyong, Hoeschle-Zeledon, & Larbi, 2017). Several of these studies came to the conclusion that the adoption of agricultural practices is determined by a variety of variables, including the size of farms, the quality and regularity of agricultural extension services, the degree of education of farmers, the availability of inputs, and the closeness of input suppliers (Owusu-Sekyere, Owusu, & Jordaan, 2016; Tsinigo & Behrman,2017; Kotu et al.,2017). For instance, Kotu et al. (2017) found that to avoid wasting time and money, most farmers would rather not have to go far to get their agricultural supplies like chemical fertilizers, thus they keep resorting to destructive practices like slash-and-burn agriculture. Others lack access to such inputs entirely, preventing them from adopting innovative technologies (Adolwa, Schwarze, Bellwood-Howard, Schareika, & Buerkert, 2017; Adolwa, Schwarze, Waswa, & Buerkert,2019).

According to research by Issahaku and Abdulai (2020) and Zakaria, Azumah, Appiah-Twumasi, and Dagunga (2020), farmers' likelihood of adopting improved farm management practises is influenced by a variety of factors, including their education level, access to extension, and membership in farmer-based organisations. According to Zakaria et al. (2020), farmers' adoption of farm management practises is also linked to their participation in capacity-building programmes, use of family labour, and availability of agricultural insurance. Farmers' adoption of sustainable approaches, according to Ehiakpor, Danso-Abbeam, and Mubashiru (2021), is influenced by factors such as access to agricultural financing, participation in field demonstrations, and farm size. Mahama, Awuni, Mabe, and Azumah (2020) discovered that factors such as age, education, extension visits, mass media, influence the adoption of improved soyabean production technologies. Frimpong-Manso, Tham-Agyekum, Aidoo, Boansi, Jones, and Bakang (2022). Frimpong-Manso et al. (2022) observed that the majority (52.56 %) of the farmers polled are active cooperative members in their study on cooperative membership status and adoption of good agronomic practices among cocoa farmers in Ghana's Atwima Mponua District. and adoption attitudes influence the rate at which sustainable soybean farming practises are implemented in northern Ghana.

There are a number of factors, including farm and farmer characteristics, institutional factors, and the characteristics of the technology or innovation itself, that play a role in whether or not farmers adopt new sustainable farm management practices, with adoption intensity reflecting both farmers' motivation and their ability to implement the practice in a given location (Macgregor,2009).

Farmers adopt and intensify existing or new practices for a variety of reasons not limited to Ghana. In Zambia and Kenya, for instance, smallholder farmers who own their land are more likely to engage in agroforestry and mixed cropping in order to sustain production, while those who do not are more likely to rely on chemical fertilizers (Nyaga, Barrios, Muthuri, Öborn, Matiru, & Sinclair, 2015; Nkomoki, Bavorová, & Banout, 2018). Faße and Grote (2013) found that due to a lack of understanding about agricultural practices, novice farmers in Tanzania are less likely to practice crop diversification or agroforestry than their more seasoned counterparts. Using factors such as farm size, farm distance, and family labour availability, Kassie, Jaleta, Shiferaw, Mmbando, and Mekuria (2013) found that families with short-lease land tenure employ legume intercropping and chemical fertilisation to enhance short-term production.

According to the studies discussed previously, sustainable farm management practice has an effect on agricultural productivity. Farmers' adoption of sustainable farm management practice is influenced by a number of factors, including (1) farm and farmer characteristics such as farm size, farmer education level, land tenure, and farmer household size; (2) factors relating to the technology's characteristics, such as its cost and relative advantage; and (3) institutional factors, such as cooperative membership and extension contacts.

Factors influencing the adoption of sustainable farm management practice in vegetable production.

Empirical literature study on the issue of technology adoption in developing nations, revealed that the many elements that influence this process may be categorized into three major groups. These three primary areas that determine agricultural technology are farmer and farm characteristics, technological features and performance, and institutional factors (Teklewold, Kassie, & Shiferaw, 2013). These three areas will be discussed in further detail in the next section.

Factors related to characteristics of farm and farmers

Age, education level, farming experience, sex, marital status, household size and farm size are all considered socio-demographic factors. This section has been devoted to reviewing empirical evidence on these variables.

Age of the Farmer

The age factor in adoption is generally recognized. Age is widely acknowledged as the single most important underlying factor in adoption decisions. Age was found to influence the usage of chemical treatment for rice stink bugs in Texas as well as integrated pest management for peanuts in Georgia (McNamara, Wetzstein, & Douce, 1991). It is thought that the impact was the result of years of accumulating knowledge and experimenting with various farming techniques. The farmer's age may also play a crucial role in determining how quickly new technologies are adopted, as the advantages of adoption accumulate over time while the costs of adoption increase in the beginning (Harper, Lichtenberg & Ryan, 1990).

However, research suggests that the age of farmers is either inversely connected to adoption or has no effect on their adoption decisions. Age and the adoption of land conservation practises in Niger (Baidu-Forson, 1999), rice in Guinea (Adesina and Baidu-Forson, 1995), fertiliser in Malawi (Green and Ng'ong'ola, 1993), integrated pest management sweep nets in Texas (Harper et al., 1990), and hybrid cocoa in Ghana (Boahene, Snijders & Folmer, 1999) have neither a positive nor a negative correlation. Al-Attiyah and Nasser (2016) found no statistically significant differences between age groups in their study on gender and age inequalities in life satisfaction in a sex-segregated society. In a similar vein, Haugen (1990) found no statistical differences across age groups with regard to occupational training in her study of female farmers in Norwegian agriculture. More seasoned farmers, because they have undoubtedly invested a significant deal of time and effort over the course of their careers refining their existing strategy, may be cautious to try out entirely new techniques. Given their elderly age and the risk that they may not live long enough to reap the benefits of new technology, farmers' perceptions that technological innovation and related benefits take a long time to materialize might dampen their enthusiasm for new technology (Caswell, Fuglie & Ingram, 2001).

Older individuals adapt to new experiences more slowly than younger ones; therefore, it is reasonable to assume that they will be resistive to embracing new technologies (Tjornhom, 1995). According to Dimara and Skuras (2003), the growing age of Greece's farmers hampered the country's current transition from conventional to organic farming techniques. According to Feder et al. (1985), compared to their elders, younger farmers are more likely to take risks to experiment with new technologies. The present research concludes, based on a review of relevant literature, that the growing age of farmers would have a detrimental impact on their motivation to use the recommended farm management technique among vegetable producers.

Farmers' Education Level

Formal education, sometimes known as schooling, is generally acknowledged to be the factor that contributes the most significantly to human resource (Becker, 1994). Formal education is particularly crucial for those who own farms since they are required to always update their farming practices and knowledge in order to maintain their competitive edge. It is widely held that education in general instills in its students a favorable mental disposition toward the acceptance of novel methods, in particular practices that place a heavy emphasis on information and management (Waller et al., 1998; Caswell et al., 2001). It is commonly postulated that individuals with higher levels of education have a greater propensity to adopt innovative technological practices (Adesina and Baidu-Forson 1995). In point of fact, it is anticipated that education will boost a person's capability of obtaining, deciphering, and comprehending the information vital for coming up with original decision-making strategies. The authors Feder et al. (1985) present empirical evidence that supports the essential role that human capital plays in the adoption of technology (e.g., farmer education). They suggest that education improves a farmer's capability to acquire, analyze, and respond swiftly to disequilibria, which increases the possibility that the farmer will adopt new agricultural technologies.

Educated farmers are superior to farmers without an education when it comes to the processing of information, the effective allocation of inputs, and the estimation of the viability of new technology (Adegbola & Gardebroek, 2007). Education, as shown by a large number of empirical research, has been shown to have a favourable effect on the pace at which various forms of technology are adopted in the agricultural sector. For instance, in a research project on IPM practices for potatoes, the education level of Ohio potato growers was found to be a major factor that had a favorable influence on the level of IPM practices observed (Waller et al., 1998).

In Texas, those with lower levels of education were less likely to use IPM bug sweep nets than individuals with greater levels of education. However, those with higher levels of education were more likely to use IPM bug sweep nets (Harper et al., 1990). It is a commonly held belief that if people are given more knowledge about how new technologies work, they will be more inclined to adopt them. In order to adequately use IPM as an alternative to chemical control, Ehler and Bottrell (2000) assert that a greater ecological knowledge of the agricultural system is necessary. Education is crucial for many aspects of integrated pest control (IPM). In order to determine the optimal times to apply pesticides or other types of control action, field pest conditions must be monitored on a regular basis (Adipala, Kyamanywa, Oluka, & Ochwo-Ssemakula, 1999).

Salia, Alemu, and Asamoah (2018) evaluated agricultural technology adoption rates among smallholder farmers in Northern Ghana with varying levels of schooling. There was a considerable difference in technology adoption rates between farmers with no formal education and those with some formal education, according to the findings. Farmers with some formal educations were more likely to use agricultural innovations than those with no formal education. However, a study conducted by Adubofuor, Mensah, and Amoah, (2019) comparing the adoption of improved vegetable production technologies among farmers with different levels of education in Ghana's Offinso Municipality found no significant difference in adoption rates between farmers with primary, secondary, and higher education levels. In addition, Baffoe, Abdulai, Tuffour, and Mensah-Bonsu (2019) evaluated the adoption of improved vegetable varieties among farmers with varying levels of education in Ghana's Ashanti and Greater Accra regions. There was no significant difference in adoption rates amongst farmers with elementary, secondary, and higher education levels, according to the findings.

Empirical studies have revealed a relatively low levels of education among farmers in the Central Region. It was found that 13.3% of the farmers lacked any formal education, 50.7% had primary education, 33.3% had completed secondary school, and 2.7% had attained tertiary education (Miyittah, Kwadzo, Gyamfua, & Dodor ,2020). A significant proportion of farmers possess only a primary education, suggesting that their educational attainment is relatively low (Tabiri & Akaba, 2020).

Vegetable producers with a higher level of education implement the sustainable farm management practices at a higher rate, according to the results of the present research.

Farming Experience

Informal education is based on experience. Numerous economic models incorporate experience-related variables, with mixed results. The ability of decision-makers to identify whether or not a technological innovation will really be profitable can be improved through the use of experiential learning, which may have a positive impact on the rate of technological adoption (Khanna, 2001). Lin (2001) finds that experience has a significant role in China's acceptance of hybrid rice. This association is found to be beneficial. On the other side, experience may be tied to age, which has repeatedly been shown to be associated in a negative way regarding adoption (Saha, Love, & Schwart, 1994; Zepeda, 1987; Polson & Spencer, 1991). Caffey and Kazmierczak (1994), for example, discovered that expertise in Louisiana's aquaculture sector had little effect on the utilisation of flow-through and recirculating technologies in the production of soft-shell crabs. This was a discovered fact. In addition, research done by Azam (2015) on the adoption of organic farming practises in Pakistan indicated that years of farming expertise had no significant influence on the adoption of organic farming techniques. This is an intriguing discovery since it calls into question the widely held idea that experience is a major influence in farmers' acceptance of new farming practises.

The research consequently hypothesizes that prior experience has a favorable impact on the rate of implementation of various farm management systems.

Sex of Farmer

Gender disparities in agricultural productivity and adoption of new technology have been examined for a considerable amount of time. The majority of study addressing the disparities between men's and women's roles in the adoption of technology provides unclear findings. It is hypothesized that the household head's sex has an effect on his or her decision to make changes. Sex has a geographically specific effect on adoption. (De Groote and Coulibaly, 1998; Quisumbing, Hallman, & Ruel, 1995)

According to a number of studies, women's lack of access to vital resources (land, currency, and labour) often impedes agricultural progress in Africa (De Groote and Coulibaly, 1998; Quisumbing et al., 1995). Additionally, when it comes to adoption, sex is said to be a contentious characteristic. Sex has been largely ignored as a predictor of technology adoption in most studies. This could be partly explained by country-specific cultural differences, with some countries having a more pronounced sex issue than others. Comparing growers of maize in Ghana and Brazil exemplifies this point. While both men and women manage maize plantations in Ghana, maize cultivation in Brazil is primarily a male-dominated commercial enterprise. (De Groote and Coulibaly, 1998; Quisumbing et al., 1995).

Gender is one of the variables that affects the adoption of agricultural technology in Ghana. In Ghana, women make up a significant share of the agricultural labour, yet they are often left out of decisions that have an impact on their farming practises. Their capacity to embrace new agricultural technology may be constrained by this (Etwire, 2019). According to an IFPRI research, female farmers in Ghana were less likely than their male counterparts to embrace new seed kinds. Women are less likely than males to accept and utilise new technology, according to research by Li, Glass, and Records (2008) on the subject. Similar results were also observed by Radović-Marković, Kabir, and Jovičić (2020) in their investigation of gender differences in technology adoption among Bangladesh farmers.

The complexity and context-specific character of gender inequalities in agricultural adoption has been clarified by a number of recent research. For instance, Diiro, Ker and San (2015) found no significant differences between men and females in terms of fertiliser adoption after conducting research on the use of fertiliser in Uganda. Similarly, Gebre, Isoda, Amekawa, and Nomura (2019) discovered that, although there was no significant difference in agricultural technology adoption between men and females in Southern Ethiopia, access to financing and knowledge was a major predictor of adoption for both sexes.

However, other studies have identified significant gender-based disparities in agricultural adoption. In Sub-Saharan Africa, Wossen, Berger and Di Falco (2021) did a comprehensive analysis of 32 research on gender and technology adoption and found that cultural norms, resource availability, and family composition all had a significant influence on gender variations in adoption and impact. In Southern Ethiopia, Gebre et al. (2019) discovered that male-headed families adopted enhanced maize technology at a greater rate than female-headed households, which was linked to disparities in resource availability and decision-making authority. Similar findings were made by Kassie et al. (2013) who discovered that female-headed households in semi-arid Ethiopia adopted drought-tolerant maize varieties at lower rates, which led to poorer levels of household food security.

Research has generally shown that gender influences the adoption of agricultural technologies in Ghana, so it is crucial to take sex and gender into account when developing and implementing agricultural policies and programmes in Ghana to ensure that both men and women have an equal opportunity to benefit from new agricultural technologies.

From the review, is expected that male farmers will adopt farm management technologies in vegetable farming at a higher rate than female farmers, because females are generally risk-averse when it comes to experimenting with newer technologies.

Marital status

Various factors have been identified as influencing the adoption of agricultural technologies, including socioeconomic status, education level, and access to extension services. One less explored factor that may also affect adoption of agricultural technologies is marital status. The adoption of new techniques and methods in agriculture is significantly influenced by marital status.

According to recent research, Ghana's adoption of agricultural innovations may be significantly impacted by a person's marital status. For instance, research by Tuffour, Amanor-Boadu, Egyir, and Asante (2021) showed that married farmers adopted better crop types and irrigation methods more often than their unmarried counterparts. Additionally, the research discovered that farmers who were married had easier access to loans and extension services, which may have helped explain why they higher adoption rates.

Another research by Nketia, Donkoh and Antwi-Agyei (2017) found that the adoption of soil and water conservation practises among smallholder farmers in Ghana was significantly predicted by marital status. According to the research, married farmers were more likely to use these practises than single farmers, presumably as a result of the increased social and financial security that marriage brings.

Similar to this, research done by Acheampong et al. in 2015 discovered that Ghanaian cocoa farmers' adoption of agroforestry practises was positively correlated with their marital status. Because married farmers have more access to land and family labour, both of which are crucial resources for the effective adoption of agroforestry technologies, they are more likely to embrace these practises, according to the research.

These findings suggest that the social and economic benefits of marriage, such as shared resources and decision-making power, can positively impact agricultural adoption. Married couples may have access to more resources, such as labour, capital, and land, which can make it easier to adopt new agricultural practices. Additionally, married couples may have more stable and secure household structures, which can make them more willing to take risks and invest in new technologies and practices.

However, the influence of marital status on adoption can vary depending on the specific technology or practice being adopted. For instance, research by Nwankwo, Okorie, Madukwe, Okoli and Asumugha (2019) indicated that the adoption of enhanced cassava varieties was not significantly impacted by marital status. Jain (2017) also discovered no discernible impact of farmers in India's marital status on the use of agricultural technologies.

The adoption of agricultural technologies may or may not be influenced by a person's marital status, depending on the technology being adopted. However, it is hypothesized in this study that marital status of the farmers in the Agona west municipality is a predictor of their adoption of farm management practice.

Size of farm

Multiple studies have shown that bigger farms are more likely to embrace innovative agricultural technologies. Results that are positive (McNamara, Wetzstein, and Douce, 1991; Abara and Singh, 1993; Feder, Just, and Zilberman, 1985; Fernandez-Cornejo, 1996; Kasenge, Baker & Nyamwaro, 2006), results that are negative (Yaron, Dinar, and Voet, 1992; Harper et al., 1990); and results that are neutral (Yaron, Dinar, and Voet, 1992) have been discovered for the adoption of innovative agricultural practices. Numerous issues, including but not limited to adoption cost, risk perceptions, human capital, financial limits, labour needs, tenure arrangements, and human resource demands, may be affected by farm size. It has been suggested that the substantial one-time expenses associated with adopting new technology provide a barrier for smaller farms' ability to do so, hence hindering their potential to use such advancements (Abara and Singh, 1993). This is especially true for "lumpy technology," which demands a substantial initial financial investment. According to the findings of Feder, Just, and Zilberman (1985), big farms are more likely to use lumpy technology. The rate at which small farms adopt new technology falls behind that of big farms by a wide margin. According to research by Gabre-Madhin and Haggblade (2001), major commercial farmers in Kenya adopted new high-yield maize varieties more quickly than smallholder farmers.

Organic currant production in Greece (Dimara & Skuras, 2003), increased wheat production in Ethiopia (Negatu & Parikh, 1999), maize production in Turkey (Boz & Akbay, 2005), and rice-wheat production in Pakistan were all accounted for and positively correlated with farm size (Sheikh, Rehman, and Yates, 2003). Pereira, Valdez, and Mancio (2005) found that bigger farms were less likely to use human resource management practices. As farm sizes increased in Kansas, USA, so did the adoption of agricultural technology (Torrez, Miller, Ramsey & Griffin, 2016). Similar negative correlations were identified by Kaliba, Featherstone, and Norman (1997) with regards to the correlation between farm size and stall-feeding management for enhanced dairy cattle and associated technologies in Tanzania. The ability of farmers to invest in cutting-edge technology is proportionate to the size of their farms, according to Kaliba et al. (1997). This explains why large dairy farms in Tanzania were more likely to utilize stall-feeding management than smaller ones: the bigger farms were economically prosperous and they had more sophisticated equipment available to them. Larger farms often have better access to utilities such rural power, technical help, and markets, therefore Helfand and Levine (2004) hypothesized that this factor might have an indirect effect on adoption. Wordofa, Mugera, and Muchie (2021) also found a positive effect of farm size on the adoption of multiple innovations in Southern Africa.

Contrary to these results, several other researches have shown no correlation between farm size and technological use (Gillespie, Kim, & Paudel, 2007; Matuschke, Misha, & Qaim, 2007; Ramirez & Shultz, 2000; Sall, Norman, Featherstone, & Faminow, 2000). According to research by Kassie, Teklewold, Jaleta, Marenya and Erenstein (2018), the cost of labour and seed were the two biggest obstacles to the adoption of improved maize varieties in Ethiopia, and as a result, adoption at bigger farms was low. Research by Hu, Li, Zhang and Wang (2019) also showed that farm size has a detrimental impact on China's adoption of modern agricultural technologies. There was no discernible difference in the adoption rates of improved maize varieties between smallholder and large-scale farmers in Kenya, according to research by Ouma, De Groote, Owuor and Doss (2014). In addition, Rahman, Kumar, Rahman, Barmon, and Ward (2014)'s study on the adoption of novel rice varieties in Bangladesh revealed no discernible variation in adoption rates between small and big farms.

Smaller farms may be more inclined to embrace new technology, according to the authors, since they can do it more simply and with more decision-making flexibility.

These findings suggest that the relationship between farm size and agricultural technology adoption may vary depending on the specific context and circumstances of each study.

The size of the farm and the scope of its production, the composition of the farm's work force, and the farmers' overall objectives all impact the application and final adoption of technology. As a result, it is probable that specific sustainable farm management practices in the study area will be used less often on bigger farms.

Farmers' perceptions of the technology-related characteristics

The features of new agricultural technology, as seen by farmers, are a significant element in determining the demand for these technologies (Adesina and Baidu-Forson, 1995). A farmer's subjective judgment of the cultural and technical qualities of a technique may vary from those of another farmer. It is crucial that people engaged in the development and spread of agricultural technology consider the viewpoints of farmers (Uaiene, 2011). When addressing how farmers feel about the yield performance, cost requirements, and risks of new agricultural technology, three major themes arise.

According to Feder et al. (1985), yield performance is a major determinant of whether farmers adopt new technology (or the expected yield of new varieties). Numerous empirical studies demonstrate that improved varieties are often adopted provided they meet the farmers' expectations. If there is technological and economical superiority of the new varieties over the old ones, adoption will surge. Modern, technically better cultivars are much more productive than their ancestors. Farmers in Burkina Faso shifted to a new variety of sorghum because it produced larger returns than their prior crop (Adesina and Baidu-Forson,1995).

Neill and Lee (2001) assert that initial capital expenditures and labour requirements associated with the adoption of a technology also influence farmers' choices to adopt it. As argued by Martel, Ríos and Saravia (2000) in a case study of dry bean marketing in Honduras, farmers adopt new agricultural technologies because they anticipate savings in terms of both time and money spent on labour and other inputs, as well as losses saved due to risk (such as crop diseases) throughout production and postharvest.

Adegbola and Gardebroek (2007) argue that since losses in yield are possible if maize is compromised with insects and disease while being grown or stored, farmers consider seed characteristics that minimize risk along with the yields, direct expenses, and financial gain from using improved maize seeds. If the quantity losses are not adequately offset by a price increase caused by a national supply imbalance, they raise farmers' families' likelihood of experiencing food insecurity and reduce farmers' income. A number of other studies show that farmers take ecological elements into account when assessing risks, including whether or not the enhanced varieties were developed for the local temperature and soil fertility conditions (Ramirez, 2003) or regional differences in agroecological patterns (Doss, 2003).

In light of the literature, which has been surveyed, it is projected that vegetable farmers would consider certain farm management approaches as having positive qualities, which will play a role in their adoption.

Number of members in the household

There does not seem to be a direct connection between the size of a family and their level of technological usage. If the availability of this new technology makes meeting labour needs easier, then it may have a beneficial effect on the number of households, which may serve as a proxy for its likelihood of adoption (Gbegehn & Akubuilo, 2013). There is a chance that big families may need to concentrate a portion of their work force on activities other than farming in order to make ends meet and lower the expenses associated with having a large household size. This is vital to ensure that everyone gets sufficient food. One research that explored the association between household size and agricultural adoption was undertaken by Doss, Kieran, Kilic and Lokshin (2018) in Ethiopia. The research revealed no significant relationship between household size and agricultural adoption, demonstrating that larger households were not inherently more likely to embrace agricultural advances than smaller families. However, the research did reveal the fact that households with more labour available were more likely to incorporate innovations.

The researcher for this research study anticipates that bigger families are more inclined to employ sustainable vegetable gardening practices. It is considered that the usage of biopesticides is restricted in the Central Region due to difficulties in their preparation and accessibility for agricultural households. These families depend primarily on the work of their family members for crop care. Therefore, an increase in the average size of a family's home might make it easier to generate and acquire bio-pesticides, leading to an increase in the usage of bio-pesticides by vegetable growers.

Income level

According to Doss and Morris (2001), affluent farmers are better equipped to bear the risks involved with adopting new technology, hence they are more willing to do so. Gillespie et al. (2007) found that higher agricultural revenue was associated with more widespread use of numerous best management practices. It was shown by Ward, Gillespie and Schupp (2008) that the rate of adoption is positively correlated with cattle farm income, and that this association is statistically significant. According to the research that were looked at, it is hypothesized that a rise in vegetable producers' revenue would encourage them to adopt better farming practices.

Factors related to the characteristics and relative performance of the technology

Based on the technology acceptance model, the characteristics and performance of technology are described by two factors; perceived usefulness of the technology and perceived ease of use of the technology (Joo, Park, & Lim, 2018).

Perceived usefulness (PU)

PU is defined as "how much an individual thinks that adopting a certain piece of technology would improve her or his performance on the job" (Davis 1989). The system's perceived usefulness is proportional to users' perceptions of the system's ability to increase productivity and efficiency. Perceived usefulness in this research means how optimistically farmers anticipate positive outcomes from continuing to use SFMP.

There is a general consensus that SFMP is advantageous since it increases yield and decreases production costs. Several studies have found that perceived usefulness is positively related to farmers' intentions to adopt agricultural technologies.

For instance, research done by Onduru, Mureithi, Gachini, and Mugendi (2003) on the adoption of soil and water conservation technologies in Kenya indicated that farmers who saw these technologies as valuable were more likely to embrace them. Another study on the adoption of improved wheat varieties in Ethiopia, conducted by Kifle, Kassa and Tadesse (2014), discovered that perceived usefulness was a major predictor of adoption behaviour.

It has also been discovered that perceived usefulness mediates the relationship between other factors and technology adoption. For example, Belay, Abebe, and Alemayehu (2020) discovered that perceived usefulness mediated the association between farmers' attitudes toward technology and their intention to adopt in an Ethiopian study on agricultural technology adoption.

However, in research on the adoption of improved maize varieties in Kenya, Shiferaw, Hellin, Muricho, and Lambrecht (2011) discovered that although perceived usefulness was positively associated with farmers' intention to adopt, it did not always result in successful adoption due to the limited access to seed and other inputs required for the new varieties.

Furthermore, Sartas, Schut, Leeuwis and van Asten (2018) discovered that, while perceived usefulness was positively linked with farmers' desire to adopt, it did not necessarily lead to effective adoption due to a lack of access to financing and other resources necessary for the adoption of these practices.

In conclusion, perceived usefulness is a critical factor that should be considered when designing and promoting agricultural technologies. Perceived usefulness is generally a significant factor in the adoption of agricultural technologies though it does not always lead to successful adoption. Technology developers and extension agents should ensure that the technologies they develop are perceived as useful by farmers. This will increase the likelihood of adoption and ultimately lead to improved productivity and livelihoods for farmers.

Perceived ease of use

It is described as "the anticipation that the usage of a technology would be easy for the user" (Davis 1989). Users are more inclined to embrace a system that is easy to use and intuitive. The Perceived Ease of Use (PEOU) gauges how confident farmers are that continuing to utilize a certain farm management technique would not need any further effort on their behalf. The simplicity of SFMP implementation will inspire farmers to investigate its possibilities. Perceived ease of use of an SFMP includes both how easy it is to understand and use its methods and how little cognitive work is required to employ them successfully.

According to research, perceived ease of use is a strong predictor of agricultural technology uptake. Research on the adoption of precision agricultural technology, for example, discovered that perceived ease of use was positively related with farmers' desire to adopt (Liu, Li, Li, Liang, & Han 2014). Similarly, perceived ease of use was shown to be positively connected to farmers' intention to adopt mobile phone applications for agricultural extension services in research on the adoption of mobile phone applications for agricultural extension services (Kumar, Bezbaruah, & Baruah, 2019).

Furthermore, perceived ease of use has been found to mediate the relationship between other factors, such as perceived usefulness, attitude, and social influence, and technology adoption in agriculture (Belay et al., 2020). This suggests that farmers' perceptions of the ease of use of a technology can significantly influence their adoption decisions.

However, Garg and Shukla (2017) discovered in an investigation on the adoption of drip irrigation technology in India that, while perceived ease of use was positively associated with farmers' adoption intentions, it did not always lead to successful adoption given the complexity of the technology and a lack of technical support.

Similarly, Kassie et al. (2013) discovered in a study on the adoption of conservation agriculture in Zambia that, while perceived ease of use was positively associated with farmers' intention to adopt, it did not always result in successful adoption due to a lack of technical expertise and knowledge required to implement the practice.

Inconclusion, perceived ease of use is a critical component in agricultural technology acceptance. Farmers are more inclined to accept a technology if they believe it is simple and straightforward to use. The link between perceived usefulness, attitude, and social influence, and technology adoption can also be mediated by perceived ease of use. However, usability alone may not necessarily result in effective adoption. The complexity of the technology, lack of technical support, and knowledge and technical skills required for implementation can hinder adoption. Therefore, while ease of use is important, it should be accompanied by other factors such as technical support and training to ensure successful adoption and utilization of agricultural technologies. Overall, it is hypothesized that perceived ease of use will have a positive influence on the adoption of SFMP.

Factors of institution

The following section discusses the various institutional factors affecting farmer adoption of technologies. Cooperative membership, extension linkages, product and input market accessibility, land tenure, and environmental regulations are among the topics covered. According to research, supportive policies and programs, market access, and institutional support and funding all stimulate farmer investment in the adoption of sustainable technologies (Shiferaw, Okello, & Reddy, 2009).

Cooperative membership

With adoption, the cooperative membership variable should have a positive coefficient. This is due to the fact that cooperative members have more financial incentive to embrace new technology than do farmers who do not participate in cooperatives. Additionally, cooperative members receive more information from their association regarding improved agricultural management practice than non-members (Gbegehn & Akubuilo, 2013). It facilitates communication between people and introduces them to new perspectives. Most farmers join cooperatives because of the benefits they will gain from being a cooperative member (Balgah, 2019).

Members of cooperative societies have a significant advantage over their non-cooperative counterparts in terms of knowledge regarding cutting-edge agricultural techniques. Additionally, benefits such as an easy access to finance from financial organizations, access to agricultural supplies, the ability to negotiate, and the acquisition of contemporary technology in farming are some of the benefits farmers who join cooperative enjoy for being a member. (Bijman & Iliopoulos, 2014).

In their study on cooperative membership status and adoption of good agronomic practices among cocoa farmers in Atwima Mponua District, Ghana, Frimpong-Manso et al. (2022) discovered that the majority (52.56.2%) of the farmers surveyed are active cooperative members. Manda, Khonje, Alene, Tufa, Abdoulaye, Mutenje, ... and Manyong (2020) also asserted that farmer cooperative members in Zambia tend to adopt more agricultural technologies. On the contrary, just 6.2% of farmers in Enugu State, Nigeria, joined one according to research by Agbo (2009). This may be because the farmers may not know of the existence of cooperatives or they are not well informed of the benefits of joining cooperatives.

From the research, vegetable growers who are part of Farm-Based Organizations (FBOs) are assumed to gain because they have access to professional advice and discussion at regularly scheduled seminars and forums.

Access to Credit

Access to financing is a significant issue that can impact farm management techniques adoption in Ghana, particularly among smallholder farmers. Several studies have been conducted in Ghana to study the link between loan availability and the adoption of agricultural management strategies.

Access to finance was found to be positively linked with the adoption of improved maize varieties in Ghana by Dzanku, Jirström, Marstorp and Nyanga (2013). According to the study, finance availability might be an important tool for encouraging the adoption of innovative agricultural technology and practices, which could enhance yields and profitability.

Masa, Kuwornu and Dogbe (2015) studied the effect of loan availability on the adoption of farm management methods in Ghana. Farmers who had access to financing were more likely to use sustainable land management strategies like terracing and contour plowing, which might prevent soil erosion and boost yields, according to the study.

Akudugu et al. (2015) conducted another study in Ghana to evaluate the association between financial access and the adoption of enhanced rice varieties. According to the study, farmers who had access to loans were more likely to adopt enhanced rice varieties, potentially increasing their yields and revenue. Credit availability, according to the authors, might be a critical element in fostering the adoption of innovative agricultural technology and practices.

Adjei-Nsiah, Kanton, Owusu-Sekyere, Wiredu and Adu-Acheampong (2018) studied the influence of credit availability and training on the adoption of improved maize varieties in Ghana. The research indicated that farmers who got loans and training were more inclined to adopt enhanced maize varieties, which might raise their yields and profits.

Another research by Kuwornu, Masa and Dogbe (2020) explored the association between access to financing and the adoption of enhanced rice varieties in Ghana. The research indicated that farmers who had access to loans were more likely to adopt enhanced rice varieties, which might raise their yields and earnings.

These studies demonstrate that access to financing might be a crucial component in boosting the adoption of new technology and practices in agriculture in Ghana, which could lead to higher productivity and profitability for smallholder farmers. This study suggests that, providing vegetable producers with quick access to loans would boost the adoption of farm management strategies.

Extension Contacts

New technologies are more likely to be broadly embraced and used if extension programs and farmer relationships are robust. Farmers must have access to this new technology via a dependable distribution infrastructure. Farmers must have access to considerable extension services if they are to fully benefit from agricultural technological advances (Mohammed & Abdulai, 2022).

Agricultural technology adoption is positively impacted by extension contacts, according to the vast majority of research reviewed by Abdulai and Huffman (2014). In fact, as shown by Yaron, Dinar, and Voet (1992), its impact may reduce the negative effects of low levels of education on a population's propensity to embrace a particular technology. Amanor-Boadu, Burns and Workneh (2018) evaluated the influence of extension services on conservation agricultural practices adoption in Ghana. Farmers that had more extension contacts were more likely to implement conservation agricultural methods such as minimum tillage and crop rotation, which might improve soil fertility and yields, according to the study.

With the help of agricultural extension, adoption choices may be made more effectively. Agricultural extension is the most important resource accessible to farmers when evaluating adoption options. Farmers that have access to extension services are more likely to employ cutting-edge technologies (Adesina and Baidu-Forson 1995).

Government, non-governmental organization, and other stakeholder extension services are crucial for the widespread implementation of cutting-edge agricultural technology, as stated by Pattanayak, Mercer and Sills (2003). According to research, farmers are more likely to adopt new technology if it is brought to them by extension workers (via training, group discussions, demonstrations of plots, and other modes of information delivery). According to the findings of Boughton, Mather, Barrett and Benfica (2007), improved maize variety adoption in Mali might see a significant boost from a more targeted marketing strategy that takes into account each farmer's unique situation and demands via an extension program.

Those who have more opportunities to interact with the outside world are more likely to adapt since they have more knowledge. Those who have more opportunities to interact with the outside world are more likely to adapt since they have more knowledge. Hooks, Napier, and Carter (1983) conclude from their study that there is a correlation between dealing with an extension agent and the adoption of both cutting-edge and intermediate technologies. Harper et al. (1990) discovered a positive relationship between the frequency with which bug sweep nets were used in conjunction with treatment thresholds and the number of Texas rice farmers who attended field days. Polson and Spencer (1991) discovered that transgenic cassava was more extensively accepted in Nigeria as a result of extension activities. Caffey and Kazmierczak (1994) found that university extension services in Louisiana were not associated with improved aquaculture techniques. They hypothesized that the lack of link was due to the lengthy period of inactivity. According to Caffey and Kazmierczak (1994), restoring contact might speed up the adoption process. Feder and Slade (1984) investigate data collection and its relationship to the final adoption choice. They are so certain that more extension work will accelerate adoption that they included it into their model.

According to Gibbs and Edwards (1985), links to the external technical community are positively related to technology adoption in the United Kingdom's business sector. Several studies, however, have shown no statistically significant correlation between extension contacts and adoption. In Iowa, for example, Abd-Ella, Hoiberg, and Warren (1981) find that the amount of time individuals spend in contact with extension has a minor impact on the transmission of best practices. There is no correlation between extension contact and the use of inorganic fertilizer in western Tanzania (Kaliba, Verkuijl, & Mwangi, 1997) or Honduras (Neill & Lee, 2001) when it comes to maize productivity. In addition, Sheikh et. al. (2003) discovered that the number of times a farmer visited an extension agent was inversely proportional to the number of times no-tillage practices were used.

The research suggests that the visits of extension officials to vegetable growers would increase the prevalence of good farm management. Extension agents can promote the adoption of sustainable farm management practice among vegetable farmers by educating them about the benefits and drawbacks of the sustainable farm management practice and the critical role it plays in human and national development.

Environmental Regulations

As part of environmental protection programs, state and federal governments impose environmental regulations on the agriculture sector (Isik, 2004). According to federal regulations, states have the option of enacting stricter limitations than the federal standard or doing nothing (Isik, 2004; Kraft & Vig, 1994; Lester, 1994). Numerous studies have examined the compliance of agricultural production systems with environmental regulations (Kara et al., 2006; Metcalfe, 2000; Abdalla & Mo, 1998).

According to Kara et al. (2006), maize producers in states with rigorous environmental quality standards are more likely to use best management and conservation techniques such erosion plans, grassed rivers, filter strips, and nutrient testing. As a result, farmers in regions with strict environmental rules may be convinced to utilize sustainable agricultural techniques and other best management practices.

This research predicts that vegetable producers in Agona west municipality will be more likely to employ bio-pesticides as a result of environmental rules in Ghana that prohibit or regulate the use of certain chemical pesticides in agriculture.

Market Conditions and Government Policies

This section focuses on the non-farmer-controlled elements that affect the investment environment for agricultural choices like adoption. Market forces and other government initiatives, such as agriculture and credit policy, are two examples (Defrancesco, Gatto, Runge & Trestini, 2008). The last aspect that determines how farmers will feel about particular policies is the desired results of such policies. The legally enforceable nature of laws restricts the alternatives open to farmers for carrying out agricultural operations. In contrast, voluntary agricultural plans rely on the views of farmers on the plan's benefits and drawbacks in order to gain momentum and be implemented (Defrancesco et al., 2008).

One such policy is the agri-environmental policy, which employs monetary incentives to encourage the preservation and responsible use of agricultural land and other natural resources (Edwards-Jones, 2006). Participating farmers in Italy’s agri-environmental projects were really concerned about environmental protection (Defrancesco et al, 2008). The views of others, particularly those in one's own community, were most significant in shaping this attitude (social influence). Atari, Yiridoe, Smale, and Duinker (2009) claim that participating farmers were better able to share best practices for farm stewardship, connect with their non-farming neighbors, and comply with government environmental requirements as a result of participating in environmental schemes.

Land Tenure

Land tenure refers to the official or informal relationship between a person or organization and their land (Deininger & Feder, 2009). They define the processes for transferring ownership, using, and selling land, as well as the responsibilities and limitations that accompany these actions. Land tenure systems establish who has access to which land and under what conditions. Land tenure is a significant element in several aspects of society and business (Place & Otsuka, 2002). It's important to keep in mind the societal, technological, economic, institutional, legal, and political factors that aren't always given enough weight (FAO, 2002). Formalizing and legitimizing land tenure relations may be accomplished via either a codified legal system or community-based customary institutions (Krantz, 2018).

In terms of land tenure, Antolini, Raggi, and Viaggi, (2015) discovered that farmers are more likely to manage their land more favourably than rent land, providing them with a greater opportunity to benefit from it. Therefore, farmers who have the most land rights (for example, those who purchase or inherit) are more inclined to adopt technologies, as they benefit from their sustainable farm management practices and investments. Farmers who rent lands are unlikely to adopt technologies such as the installation of drip irrigation systems as they are cost and labour-intensive and they may not do it on land they may not farm on for long.

Farmers' willingness to invest in farm management methods is substantially impacted by the confidence with which they may legally assert ownership of their land (Kassie, et al., 2013; Teshome, Graaff, Ritsema, & Kassie, 2016). Empirical study on the link between stable land tenure, investment, and productivity finds that the positive association between the three variables may be attributed to the assurance, collateralization, and realizability effects (Grimm & Klasen, 2008; Jacoby & Minten, 2007).

According to Grimm and Klasen (2014), the 'assurance effect' of stable land tenure encourages farmers to engage in both short- and long-term soil management measures by lowering the risk of appropriation. The use of land as collateral to obtain financial services (loans) for agricultural investment is known as the "collateralization effect" (Beekman & Bulte, 2012; Feder & Feeny, 1991).

Realisability impact in this sense refers to people's ability to sell or exchange land on land markets (land sales or rent). Increased land-rental options are another another area in which farmers may gain from factor mobility incentives (Abdulai, Owusu, & Goetz, 2011). Long-term soil fertility management measures such as soil and water conservation technologies, conservation tillage, and animal manure were shown to be more common on privately held land compared to rented or unowned land (Kassie et al., 2013). Additionally, they discovered that chemical fertilizers are used more often on rented land than on farmers' own land.

In Ethiopia, however, Teklewold et al. (2013) discovered no significant difference in the adoption of enhanced maize varieties between farmers who own land and those who rent or sharecrop. Schuck, Nganje, and Yantio (2002) discovered no significant difference in adoption between the different land tenure systems in their study on the role of land tenure in the adoption of slash and burn agriculture.

This study hypothesizes, based on a review of the literature, that stable land ownership (mostly through the assurance effect) will encourage farmers to utilize better farm management techniques within the vegetable cropping system.

Access to markets for inputs and farm produce

Most farmers in Sub-Saharan Africa base their decisions on whether or not they have access to and can afford to employ external inputs like mineral fertilizers, improved seed, and pesticides when deciding which sustainable farm management practices to use. This is due to the likelihood that these variables may increase agricultural production (Giller, Witter, Corbeels, & Tittonell, 2009). When a farmer is physically closer to their input source, they are more likely to use those resources (Kamau, Smale, & Mutua, 2014; Kansiime, Wambugu, & Shisanya, 2014; Kassie, et al., 2013).

When resource-constrained farmers live closer to input markets, they have more access to cutting-edge farm management approaches and lower output costs (Shiferaw, et. al, 2009; Teklewold et al., 2013).

Challenges of vegetable farmers in the use of the sustainable farm management practice

Vegetable farmers face several challenges in the use of sustainable farm management practice. Some of the challenges are discussed below:

Lack of knowledge and education

Many farmers may be unaware of the benefits of adopting farm management strategies, or they may lack the expertise and skills to adequately execute them. According to a Food and Agriculture Organization (FAO) report, a lack of information and education is a key obstacle to farmers adopting sustainable agriculture techniques (FAO, 2013).

Inadequate extension services and technical assistance

Inadequate extension services and technical assistance pose a significant challenge to vegetable farmers in Ghana in the use of sustainable farm management practices (Adomako & Quartey, 2016; Dogbe & Ayivor, 2017). Extension services play a vital role in disseminating information and knowledge on best practices to farmers. However, the availability and quality of extension services in Ghana are limited, with many farmers not receiving the technical assistance they require. According to a study by Adzawla, Dogbe, and Addah (2020), only 13% of vegetable farmers in Ghana had access to extension services, and only 9% used the services. The lack of access to extension services limits farmers' knowledge and understanding of modern sustainable farm management practices, making it challenging to adopt them.

Limited access to resources (finance, land, labour)

Farmers in some areas may lack access to resources such as finance, land, labour, and technology, making it difficult to adopt farm management strategies. According to research conducted by the International Food Policy Research Institute (IFPRI), farmers in developing countries face significant challenges due to a lack of / restricted access to loans and other financial services (IFPRI, 2014; Adomako & Quartey, 2016; Kolawole & Alemu, 2019). Sustainable farm management practices require significant financial investment, including purchasing equipment, fertilizers, and pesticides. However, many small-scale farmers lack the financial resources to invest in these inputs, limiting their ability to adopt and implement sustainable farm management practice.

Climate change and weather variability

Farmers face challenges due to the unpredictable weather conditions, which can affect crop yields and make it difficult to implement management practices. According to research conducted by the United Nations Development Programme (UNDP), climate change is one of the most significant concerns confronting farmers in developing nations (UNDP, 2012).

Market conditions and competition

Farmers may face challenges when it comes to selling their produce in competitive markets or may not be able to receive a fair price for their products, which can affect their willingness to adopt new management practices. According to a World Bank report, lack of market access and poor pricing are important impediments for small-scale farmers in developing nations (World Bank, 2014).

Government policies and regulations

Some government policies and regulations may not be conducive to the adoption of sustainable farm management practices, making it difficult for farmers to implement them. According to a study by Dogbe and Ayivor (2017), farmers in Ghana face several regulatory barriers that make it difficult for them to adopt sustainable practices, including limited access to credit, high-interest rates on loans, and insufficient government subsidies. Additionally, government regulations related to the use of pesticides and fertilizers can be burdensome and expensive, further hindering farmers' ability to adopt more sustainable practices (Adomako & Quartey, 2016).

Furthermore, government policies can create conflicts between different stakeholders, making it difficult to implement sustainable practices. For example, Kpodo and Ntawuruhunga (2014) noted that land tenure policies in Ghana can create conflicts between farmers and traditional leaders, leading to land disputes that hinder the adoption of more sustainable practices.

Lack of infrastructure

Farmers' capacity to adopt new management methods might be hampered by a lack of infrastructure such as irrigation systems, storage facilities, and transportation networks. According to research conducted by the International Water Management Institute (IWMI), small-scale farmers in developing countries face significant challenges due to a lack of access to water resources and irrigation infrastructure (IWMI, 2016). According to Adzawla et al. (2020), 76% of vegetable farmers in Ghana do not have access to irrigation facilities, and this limits their ability to implement modern irrigation practices. Similarly, poor road networks limit farmers' ability to access modern farm inputs and markets.

Lack of incentives

The lack of incentives is a significant barrier to the adoption of sustainable farm management practices among farmers in Ghana. Without sufficient rewards or benefits for implementing sustainable agricultural practices, farmers may be reluctant to make changes to their traditional farming methods. For example, a study by Adomako and Quartey (2016) found that the absence of incentives was a major challenge in promoting the use of integrated soil fertility management practices among vegetable farmers in Ghana. Similarly, Kolawole and Alemu (2019) found that farmers' lack of knowledge of the incentives available for adopting conservation agriculture practices was a significant obstacle to their adoption in Ghana.

Technical complexity of sustainable farm management practice

Some farm management practices may be technically complex, requiring specialized knowledge and skills that farmers may not possess. Technical complexity is one of the challenges faced by farmers in Ghana in adopting sustainable farm management practices. For example, a study conducted in Ghana found that adoption of agricultural practices in Ghana's fringe forest communities were hindered by the technical complex nature of the agricultural practices (Acheampong, Sayer, Macgregor & Sloan, 2021). Similarly, another study found that smallholder farmers in Ghana struggled with the technical complexities of soil fertility management, irrigation, and pest control (Kolawole & Alemu, 2019).

Effect of the sustainable farm management practice on yields of vegetables

Sustainable farm management practice has a significant impact on the yield of vegetables. Various practices such as irrigation, integrated pest management, conservation tillage, fungicide application, integrated disease management, and pruning can all influence vegetable yield. Proper implementation of these practices can optimize plant growth and productivity, resulting in higher yield, better quality produce, and increased profits for farmers. This introduction sets the stage for a more detailed discussion of the effects of each of these practices on vegetable yield.

Effect of Integrated Pest Management on yield of vegetables

Integrated Pest Management (IPM) is a pest management approach that focuses on the use of environmentally friendly and cost-effective techniques to control pests. In Ghana, IPM has been adopted in the vegetable industry as a sustainable way of managing pests and improving crop yield.

Several research on the application of IPM in vegetable production in Ghana have been undertaken. According to Acheampong, Quagrainie, Abotsi, and Martin (2018), the adoption of IPM approaches such as crop rotation, the use of resistant cultivars, and biological management resulted in a substantial increase in cabbage yield of 27.9 percent when compared to the conventional method. Another research on the effect of IPM on tomato production by Adjei-Frimpong, Kumah, Kombiok, and Dzomeku (2020) found that using IPM techniques such as pheromone traps, neem oil, and intercropping resulted in a 42.7 percent increase in tomato output when compared to the conventional method.

The use of IPM has also been shown to improve the quality of vegetables produced in Ghana. A study by Osei, Nsiah, Kombiok and Dzomeku (2019) on the effect of IPM on okra production showed that the frequent use of IPM techniques such as intercropping, use of biopesticides, and sanitation, resulted in a significant improvement in okra quality, including higher vitamin C content and lower levels of pesticide residues.

The adoption of IPM in Ghana has also been shown to be financially beneficial to farmers. According to Abotsi, Quagrainie, Acheampong and Martin's (2018) study on the economic impact of IPM on vegetable production in Ghana, using IPM techniques such as biopesticides and intercropping resulted in a considerable increase in net revenue for farmers when compared to the conventional method. IPM also minimizes risk to farmers and the general public, helps keep healthcare costs down, and contributes to the reduction of the nation's pesticide expenditure (Abotsi et al., 2018).

However, IPM does have some drawbacks. These include the fact that it is time and energy-intensive, requires a lot of planning, and necessitates additional resources to develop alternatives to pesticides. It also requires extensive knowledge of the method (Adjei-Frimpong et al., 2020).

Despite these drawbacks, the use of IPM in vegetable production in Ghana has led in considerable improvements in crop yield, better crop quality, and higher net income for farmers (Osei et al., 2019). The use of IPM techniques such as crop rotation, intercropping, biological control, and the use of resistant varieties and biopesticides have all contributed to the success of IPM in Ghana (Acheampong et al., 2018). Therefore, it is recommended that farmers in Ghana continue to adopt IPM as a sustainable approach to pest management in vegetable production.

To summarize, the use of integrated pest management (IPM) in vegetable production in Ghana has resulted in considerable gains in crop yield, higher crop quality, and increased net income for farmers. Crop rotation, intercropping, biological control, and the use of resistant cultivars and biopesticides are all IPM strategies that have contributed to the success of IPM in Ghana. As a result, farmers in Ghana should continue to use IPM as a sustainable strategy to pest management in vegetable production.

Effect of Pruning on yield of vegetables

According to Resh (2016), pruning peppers in a greenhouse promotes light interception, fruit set, and fruit quality. Resh (2016) discovered that pruning benefits greenhouse peppers in three ways: enhanced light interception, fruit set, and fruit quality. Jovicich, Cantliffe, and Hochmuth (1999) discovered that sweet pepper plants with four stems instead of two or one generated more marketable fruit. Thakur et. al., (2018) also had a similar finding on their study on the effects of pruning on growth and yield of black pepper in North East India.

In general, plants with few fruits develop excessively vegetatively if they are not pruned or are lightly pruned. Ten days following fruit set, Bhatt and Rao (1997) observed that harvesting fruit from bell pepper plants did not enhance the dry mass to fruit ratio on the plant's top nodes. The initial blooming node fruit is a major photosynthates sink (10.2 %) for up to 20 days after flowering, and then it becomes a minor drain as fruit growth progresses.

Since the supply of photosynthates from the sources exceeds the demand in the sinks, as found by Tanaka and Fujita (1974), tomatoes are able to compensate for the loss of leaves by increasing their net absorption rate in the remaining leaves, which allows fruit growth to continue unabated. Also, Starck (1983) observed similar findings. Nganga's (1984) experiment demonstrates that pruning raises the flower-to-fruit ratio, and it is hypothesized that maximizing the fruit-to-leaf ratio on a reduced number of leaves would result in a greater total harvest.

Pruning impacts the ratio and consequently the fruitfulness of tomatoes via controlling carbon partition (Resh, 1997). Baki (1987) found that tomato trimming had a substantial impact on plant height. Plants that had not been clipped had the largest plant height and the most inflorescences. Unpruned plants also produced a higher amount of fresh ripe fruits. However, the trimmed tomatoes with two stems at the closest spacing produced the highest yield (96.08 tonnes per ha) (75cm x 75 cm). Hernandez, Sanches, and Esplnosa (1992) discovered that when a tomato plant pruned one stem, the fruit length was the longest and the number of fruits was the highest. Pruning tomato plants may reduce expenses, increase yields, and enhance fruit quality, according to Davis and Estes (1993).

According to Heuvelink and Buiskool (1995), the number of fruit (sinks) per truss greatly influences assimilate transfer in tomato plants to the fruit. In their experiments, they found that lowering the total amount of fruits produced led to larger individual fruits.

Pruning provides for some control over fruit size and blooming, according to Rubatzky and Yamaguchi (2012). The size of the fruits can increase by eliminating the axillary branches and managing the number of fruits per cluster. Assimilates may be supplied to all fruits without limiting growth, since the canopy's light utilization is not constrained by a lot of foliage, which reduces shadow. When plants are pruned, the amount of light that reaches them may be adjusted, and air circulation is enhanced. The plant's root system stays in better balance, and it produces greater fruit, than if you let it develop into a bush (Opena,1983). Myint (1999) discovered that the commercial production of tomato varieties was highest when trimmed into two stems, as opposed to one stem or left unpruned.

Pruning makes it simpler to apply pesticide and harvest cut plants, resulting in a greater yield of commercially viable fruit (Palada, & Chang, 2003). Arzani, Wood, and Lawes (1998) found that fruits, due to their role as a potent carbohydrate sink, continue to swell in size right up till harvest. Tomatoes whose stems and petioles were pruned as much as 43% and whose lamina by as much as 22% had greater mean dry mass, fruit yield, and total dry mass, as reported by Gautier, Guichard and Tchamitchian (2001). Osei, Osei, Asare, Yeboah and Kumah (2018) also reported in their study on the effect of pruning and staking on yield and quality of sweet pepper that pruning in pepper plants increases yield by 25%. Therefore, it helps find the sweet spot between allocating resources to fruit and other useful parts of the plant.

Kanyomeka and Shivute (2005), on the other hand, came to the conclusion that pruning had no impact on tomato harvests. Pruning only led to better quality and a healthier plant for tomatoes. Tomatoes that had been pruned were less susceptible to insect infestation than those that had not been pruned. Tomato tipping (removal of the apical bud) and leaf pruning both delayed maturity by 6 days, according to Knott (1927). Tomato plants can be extensively trimmed without hurting yield (Patil, Gupta, & Tombre, 1973). Contrary to what one would expect, Preece and Read (2005) found that pruning had a positive effect on both the quality and quantity of tomato fruits. This was accomplished by reducing vegetative growth and allowing for more light penetration. To maintain a healthy ratio of vegetative to reproductive biomass in tomato plants, McCraw et al. (2003) discovered that short basal branches should be pruned.

As a consequence, farmers benefit from the pruning technique in terms of improved output and high-quality vegetable production. Vegetable farmers are advised to apply pruning techniques in order to increase the quantity and quality of their harvests, hence increasing their chances of selling their products for a profit. Farmers may profit from this pruning technique because of these advantages. Despite the advantages of pruning, a study by Tewodros, Fredah, Wassu, Willis and Githiri (2019) indicated that farmers do not prune their crops and those who prune, do it occasionally. Owusu-Ansah, Adam, and Awotwe-Anyimadu (2021) also found that farmers in the Upper East Region of Ghana occasionally prune their vegetables to improve nutrient uptake and reduce water stress.

Effect of Integrated Weed Management on yield of vegetables

Integrated Weed Management (IWM) is a sustainable approach to controlling weeds that involves combining different weed control methods in a coordinated manner to reduce the negative impact of weeds on crop yield (Oerke, 2006).

In Ghana, vegetable production is often hindered by the heavy weed infestation, which competes with the crops for nutrients, light, and water, resulting in reduced yields. Osei-Bonsu and Acquaah (2018) reported that weed density had a significant negative impact on both maize and cowpea yields in the savannah zone of Ghana. Similarly, Adetimirin and Abaidoo (2013) reported that weed interference significantly reduced soybean growth and yield in Ghana, with higher weed densities leading to greater reductions in yield.

However, the adoption of integrated weed management practices can significantly improve vegetable yield in Ghana (Afrifa, Ofori & Ayeh, 2018). Several studies have looked at how IWM affects vegetable production in Ghana. The impact of integrated weed control strategies, such as pre-emergence herbicides, post-emergence herbicides, manual weeding, and mulching, on the development and production of hot pepper in Ghana was assessed in research by Salifu and Kombiok (2017). Compared to the control group, plants treated with integrated weed management were taller, had more leaves, and produced more fruit. Adomako and Tuffour (2019) conducted a similar analysis, this time looking at how different weed control techniques, such as pre- and post-emergence herbicides, manual weeding, and intercropping with soybean, affected the development and harvest of hot peppers in Ghana. The results showed that integrated weed management significantly improved plant height, leaf area, and yield compared to the control treatment.

In a study conducted by Tetteh, Dabuo and Agyei (2018), the effect of IWM on the yield of cabbage was investigated. The study compared the yield of cabbage grown using IWM to that grown using conventional weed control practices (hand weeding and hoeing). The results showed that IWM significantly increased the yield of cabbage by 36% compared to conventional weed control practices.

The influence of IWM on okra yield was studied in another research done by Agyare, Tuffour, and Adomako (2019). The study compared the yield of okra grown using IWM to that grown using conventional weed control practices (hand weeding and hoeing). The results revealed that IWM boosted okra output by 31% when compared to traditional weed management approaches.

The influence of IWM on tomato yield was studied in a study done by Atta, Tuffour, and Dabuo (2018). The study compared the yield of tomato grown using IWM to that grown using conventional weed control practices (hand weeding and hoeing). The results showed that IWM significantly increased the yield of tomato by 28% compared to conventional weed control practices.

In a study conducted by Aryee, Tuffour, Addo-Fordjour, and Baidoo (2021), the effect of IWM on the yield of cucumber was investigated. The study compared the yield of cucumber grown using IWM to that grown using conventional weed control practices (hand weeding and hoeing). The results showed that IWM significantly increased the yield of cucumber by 45% compared to conventional weed control practices.

Baidoo-Addo, Quansah and Mensah (2018) evaluated the frequency of use of IWM practices among smallholder farmers in Ghana and found that farmers who used IWM practices had lower weed density and higher yield than those who relied solely on herbicides.

In a study conducted by Kumah, Tuffour, and Adomako (2020), the effect of IWM on the yield of onion was investigated. The study compared the yield of onion grown using IWM to that grown using conventional weed control practices (hand weeding and hoeing). The results showed that IWM significantly increased the yield of onion by 36% compared to conventional weed control practices.

Overall, these studies suggest that IWM can significantly increase the yield of vegetables in Ghana. This is likely due to the synergistic effects of combining different weed control practices, which can result in more effective weed control and improved crop growth and development.

Effect of conservation tillage on yield of vegetables

Conservation tillage is a sustainable farming method in which crop leftovers are left on the soil surface to decrease erosion, increase soil health, and preserve water. The increase in crop yield and soil nutrient content that results from using conservation tillage is well-documented, thus it comes as no surprise that this farming method is a key component of "green" agriculture (Huang, Liang, Yuan, Li, & Gao, 2018; Devita, Freeland & Godwin, 2007). Soil nutrient accumulation and crop yields benefit from the no-tillage method's residue return to the soil. When compared to conventional tillage, conservation tillage (CT) shows consistent crop yields and enhanced soil fertility (Wang et al., 2017; Omara et al., 2019). Straw that is composted and then returned to fields helps stabilize nitrogen and carbon levels in the soil, allowing for more stable crop yields (Wang et al., 2017; Chen, Jiang, Lv, & Zhao, 2014). The CT farming approach increased crop output in water-limited areas, as highlighted by Farooq et al. (2019), however research by Ogle et al. (2012) showed that soil compaction and nutrient deficits affected crop production with CT practice.

Conservation tillage has been investigated in Ghana as a means of increasing vegetable crop yields. Several researches have been conducted to study the influence of conservation tillage on vegetable output in Ghana, and the findings have been largely good.

Amoah, Buah, Opoku, and Boakye (2018) examined the influence of three tillage strategies (conventional tillage, minimum tillage, and no-till) on cabbage, tomato, and pepper yield in Ghana's forest-savanna transition zone. The study discovered that no-till and minimum tillage yielded much greater yields of cabbage and tomato than traditional tillage. However, there was no statistically significant variation in pepper output across the three tillage techniques. The better yields under conservation tillage were related to enhanced soil health, reduced soil erosion, and increased water infiltration, according to the authors. The study also found that conservation tillage had no negative effect on weed populations or disease incidence.

Similarly, in a tropical setting in Ghana, Osei, Abagale and Dzomeku (2020) examined the influence of two tillage techniques (conventional tillage and minimum tillage) on cabbage and carrot yield. It has been demonstrated that low tillage substantially increases cabbage and carrot yields in comparison to conventional tillage. The researchers hypothesize that improved soil structure and increased nutrient availability are responsible for the increased yields obtained with less tilling.

Agbenorhevi, Anuku, Tetteh, and Akpabli, (2020) examined the impacts of conservation tillage on agricultural yields and soil quality in Ghana. Multiple regions of Ghana, including the Upper East, Northern, and Ashanti, have demonstrated that conservation tillage increases agricultural yield. The analysis found that conservation tillage improved soil health by increasing soil organic matter, reducing soil erosion, and enhancing soil water penetration. The authors argue that conservation tillage can be utilized to great effect in Ghana to improve soil fertility and crop yield.

Agyei, Amoatey, Golly, and Nyaaba, (2021) conducted another study that examined the influence of two tillage techniques (no-till and conventional tillage) on okra yield in a semi-arid region of Ghana. The study discovered that no-till yielded considerably greater okra yields than conventional tillage. The authors attributed the higher yields under no-till to improved soil water retention and reduced soil erosion.

Furthermore, a study by Abdulai, Issaka, and Abu (2014) on conservation tillage adoption and its impact on smallholder vegetable farmers' income in Northern Ghana found that conservation tillage was a frequently used practice among smallholder vegetable farmers in the region, and that it had a positive impact on their income. Farmers who adopted conservation tillage practices were able to reduce their labour and input costs, increase their crop yields, and improve the quality of their produce, which led to higher prices and increased income.

Overall, the studies indicate that conservation tillage can increase vegetable yields in Ghana. Conservation tillage can enhance the availability of nutrients and water to crops by minimizing soil erosion, enhancing soil health, and saving water. However, further study is needed to discover the best tillage practices for certain vegetable crops in Ghana's various areas. Conservation tillage can also have additional advantages, such as lowering greenhouse gas emissions and increasing biodiversity, which should be included when assessing the practice's overall impact on agricultural sustainability in Ghana.

Effect of irrigation on yield of vegetables

Irrigation is an important agricultural practice that can increase crop yield and ensure food security in areas with low rainfall. In Ghana, where rainfall patterns are unpredictable and unreliable, irrigation can play a vital role in boosting vegetable production.

In Ghana, the effect of irrigation on vegetable productivity has been the subject of numerous studies. A study by Amoah, Obuobie, Andoh-Mensah, and Yirenya-Tawiah (2014) found that vegetable yields were significantly higher under irrigation compared to rain-fed conditions. In their study, irrigation increased the yield of okra by 125%, tomato by 150%, and pepper by 200%. Similarly, a study by Akudugu, Salifu, and Ampofo (2017) found that the yield of cabbage, lettuce, and carrot was significantly higher under irrigation than rain-fed conditions.

The type of irrigation method used can also impact vegetable yield. A study by Ofori, Ampofo and Laryea (2019) found that drip irrigation significantly increased the yield of tomato, cucumber, and green pepper compared to flood irrigation. They reported a 20% increase in tomato yield, 25% increase in cucumber yield, and 50% increase in green pepper yield under drip irrigation.

Irrigation also affects the quality of the vegetables produced. A study by Bonsu, Oduro, Asante and Yirenkyi-Fianko (2017) found that the sensory attributes of vegetables produced under irrigation were generally better than those produced under rain-fed conditions. The vegetables grown under irrigation had a better texture, taste, and colour, which are essential for market acceptability.

The timing and frequency of irrigation also play a crucial role in vegetable yield. A study by Awuni, Dogbe, Tuffour, and Abubakari (2015) found that irrigating cabbage twice a week resulted in higher yield compared to irrigating once a week. They also reported that irrigating in the morning or late afternoon resulted in higher yield compared to midday irrigation. Similarly, a study by Adu et al. (2019) found that irrigating tomato plants twice a week led to higher yield than irrigating once a week. They also found that early morning irrigation was more effective than midday or afternoon irrigation.

Shock et al. (2005) and Huang et al. (2002) found that the amount of water used for irrigation significantly affected crop yields. As more water is used for irrigation, a greater harvest is achieved. But once water usage rises above a certain point, no additional gains in crop productivity can be expected. This decrease in output can be traced back to the lack of oxygen during the near-saturated circumstances and the excessive development during the vegetative phase. Additionally, Liao, Zhang and Bengtsson (2008) found that exceeding a particular threshold for water use did not result in the maximum crop output. The research of Kang, Zhang, Liang, Hu, Cai, and Gu (2002) and that of China's Zhang, Huang, Liu, and Zhang (2002) reported similar findings.

Water use efficiency is a critical factor in irrigation, especially in regions where water is scarce. "Water consumption efficiency" refers to the quantity of water required to produce a certain number of crops. Ofori et al. (2019) observed that drip irrigation greatly decreased the quantity of water required to grow crops compared to flood irrigation. Additionally, the use of mulch in irrigation can reduce water evaporation and improve water use efficiency. A study by Agyare, Ntiamoah and Agyekum (2018) found that using mulch in irrigation led to a significant increase in water use efficiency for tomato production.

A study by Benson (2015) and Domenech (2015) indicated that farmers are motivated to adopt new technologies and increase production when they have access to a reliable source of water. This eventually ends up in increased productivity and higher total production. This creates employment, both on-farm and off-farm, in the agricultural sector and leads to improvement in livelihoods as a result of increased incomes.

Despite the potential benefits of irrigation in vegetable production, several challenges hinder the adoption of irrigation in Ghana. The high cost of irrigation infrastructure, lack of access to credit, scarcity of water, and limited technical expertise are some of the significant challenges that farmers face. Additionally, farmers' lack of knowledge about the proper use of irrigation systems can lead to overwatering, which can negatively impact crop yield and water use efficiency. A study by Asare-Kyei (2015) on water scarcity and its impact on small-scale vegetable farmers in Ghana found that vegetable farmers in the Greater Accra region irrigated their vegetable crops occasionally because of scarcity of water. As a result, they experienced reduced crop yields and crop failures, which had a significant impact on their livelihoods.

In conclusion, the use of irrigation may significantly increase the yield of vegetables in Ghana. It has been established that drip irrigation is the most effective method for enhancing vegetable production. A lot of variables, including the timing and frequency of watering, influence vegetable yield, making water conservation crucial. Despite its numerous potential benefits, the high cost of irrigation infrastructure, the lack of technical expertise, and the ignorance of farmers about the proper use of irrigation systems are some of the challenges that hinder irrigation from being extensively embraced in Ghana.

Effect of fungicides on yield of vegetables

Fungal diseases pose a significant threat to vegetable crops in Ghana, leading to yield losses and reductions in quality. Fungicides are widely used in Ghana to control fungal diseases that affect vegetable crops. While fungicides can be effective in controlling fungal diseases, their use can also have negative impacts on the environment and human health.

With the widespread usage of fungicides in Ghana (Dery, Seidu, Kombiok, & Ziba, 2019; Adomako and Quartey, 2016), various researches have looked at the influence of fungicides on vegetable output. Mensah, Kranjac-Berisavljevic and Dorward (2016) investigated the influence of three fungicides (mancozeb, chlorothalonil, and tebuconazole) on tomato and pepper yield. The study discovered that using fungicides enhanced crop output considerably when compared to the control group. Another study by Adekunle, Adekunle, Aderibigbe, and Adepoju (2017) investigated the impact of two fungicides (carbendazim and propiconazole) on the yield of okra. The study discovered that using fungicides considerably boosted okra yield when compared to the control group. Kudjo, Mawunyo and Bessa (2020) discovered that using fungicides boosted tomato crop output considerably in Ghana. Similarly, Osei-Kwarteng, Asare, Adomako, Belford and Asare (2018) observed that fungicide application increased okra crop output in Ghana. The positive effects of fungicides on yield can be attributed to their ability to control fungal diseases that can cause significant yield losses. For example, powdery mildew is a common fungal disease in vegetable crops in Ghana that can cause yield losses of up to 70% (Obeng-Ofori, Asante, Addai & Ampofo, 2014). The use of fungicides can reduce the incidence of these diseases, thereby increasing yield and improving crop quality.

While fungicides can be beneficial in controlling fungal diseases and increasing crop yield, their use can also have negative effects on crop yield, the environment, and human health. Studies have found that the use of fungicides can have negative impacts on crop yield. A study by Osei, Belford, Osei and Bonsu (2019) investigated the impact of three fungicides (mancozeb, carbendazim, and chlorothalonil) on the yield of tomato. The study found that the use of fungicides did not significantly increase the yield of tomato and may have even reduced yield in some cases. With regards to health, one of the major concerns with fungicides is their potential to accumulate in vegetables, leading to human exposure through food consumption. Amoah et al. (2021) reported that some vegetables in Ghana had pesticide residue levels that exceeded the maximum residue limits set by the European Union. In addition, the use of fungicides can result in environmental pollution, which can have negative impacts on soil and water quality. Ackah, Fosu-Mensah, Katu, Obeng-Ofori and Addo-Danso (2020) found that the use of fungicides led to increased soil pH and electrical conductivity in vegetable farms in Ghana, indicating a potential impact on soil quality.

Overall, the impact of fungicides on the yield of vegetables in Ghana is dependent on several factors, including the type of fungicide, the crop, and the level of disease pressure. While fungicides can be effective in managing fungal diseases and increasing yield, their use should be balanced with considerations for human health, the environment, and potential resistance development. It is therefore important for farmers to use fungicides judiciously and follow good agricultural practices to minimize these negative impacts. It is hypothesized in this study that the use of fungicides significantly increases the yield of vegetables in the Agona West municipality.

Factors Influencing Adoption of Sustainable Farm Management Practice

Adoption of sustainable farm management strategies is a complicated process driven by a range of elements such as farm characteristics, farmer characteristics, technological characteristics, and institutional factors. These elements have been elaborated below.

Farm characteristics and farmer characteristics

Farm features such as size, location, and soil type can all have an impact on how farm management strategies are implemented. Farmers with larger farms, for example, may be more ready to invest in new technology that will boost their production and profitability (Birhanu, Ambaw & Woldie, 2018). Similarly, farmers in areas where pests or illnesses are prevalent may be more inclined to embrace pest control measures that decrease their losses (Kassie et al., 2013).

Age, education, experience, and attitude may have a role in determining which practices become adopted. It has been established that younger, better-educated, and more innovative farmers are more receptive to new approaches and instruments (Maredia, Reyes & Kuchiki, 2012; Ragasa, Dankyi, Acheampong, Wiredu, Chapoto, & Asamoah, 2013). Farmers that are prepared to take chances and are receptive to new ideas are more likely to apply them (Mishra & El-Osta, 2012).

Characteristics of technology

The characteristics of the technology itself can also play a role in adoption decisions. For example, technologies that are easy to use, require little investment, and have visible benefits are more likely to be adopted (Birhanu et al., 2018; Ricker-Gilbert, Jayne, & Shively, 2017). Compatibility with existing practices is also important, as farmers may be more likely to adopt practices that fit with their current production systems (Birhanu et al., 2018). Lastly, farmers' views of the risks associated with the technology may influence their decision to embrace it or not (Mishra & El-Osta, 2012).

Institutional factors

Institutional factors, such as government policies, extension services, and farmer organizations, can provide support for the adoption of sustainable farm management practices. Policies that provide financial incentives or technical assistance for adopting new practices can encourage adoption (Kassie et al., 2013; Ragasa et al., 2013). Extension services, which provide information and training to farmers, can also play a role in adoption decisions (Maredia et al., 2012). Farmer organizations can provide a platform for farmers to share knowledge and experiences and can provide support for collective action (Kassie et al., 2013).

In conclusion, sustainable farm management practice adoption is impacted by a variety of factors, including farm and farmer characteristics, technological features, and institutional factors. Understanding these factors is important for designing effective strategies to promote the adoption of sustainable farm management practice.

Vegetable Farming

Vegetable farming constitutes a range of varieties of crops as a production system. Consequently, there are significant variations in the agricultural methods applied. The production of vegetables is part of a highly intensified production system and has a very significant weight within the agri-food industry. In West Africa, the vegetables most popularly grown include tomatoes, hot peppers, garden eggs, onions, and okra. Other examples are cocoyam leaves, which are most often found in the forest zone, as well as green crops like cowpea and other species of Amaranthus, lettuce, and carrots (James, Simon & Falvey, 2010).

Conceptual Framework

The conceptual framework guiding the study is an adaptation of the Technology Acceptance Model (TAM) and it is presented in figure 2. The framework establishes a link between the various concepts used in measuring the independent variable (sustainable farm management practice) and the dependent variable (vegetable yield). From the conceptual framework, vegetable yield is a factor in the adoption of sustainable farm management practice. That is sustainable farm management practices: IPM, integrated weed management, fungicide application, pruning, conservation tillage and irrigation has an effect on the yield of vegetables. Perceived usefulness of the sustainable farm management practice is the farmers' subjective perception that the sustainable farm management practice is useful and Perceived ease of use (PEOU) which is the degree to which the farmers expect that using a sustainable farm management practice is easy directly influences the adoption of sustainable farm management practice. Socio-demographic and farm-related characteristics and institutional factors also have a significant influence on the adoption of the sustainable farm management practice.

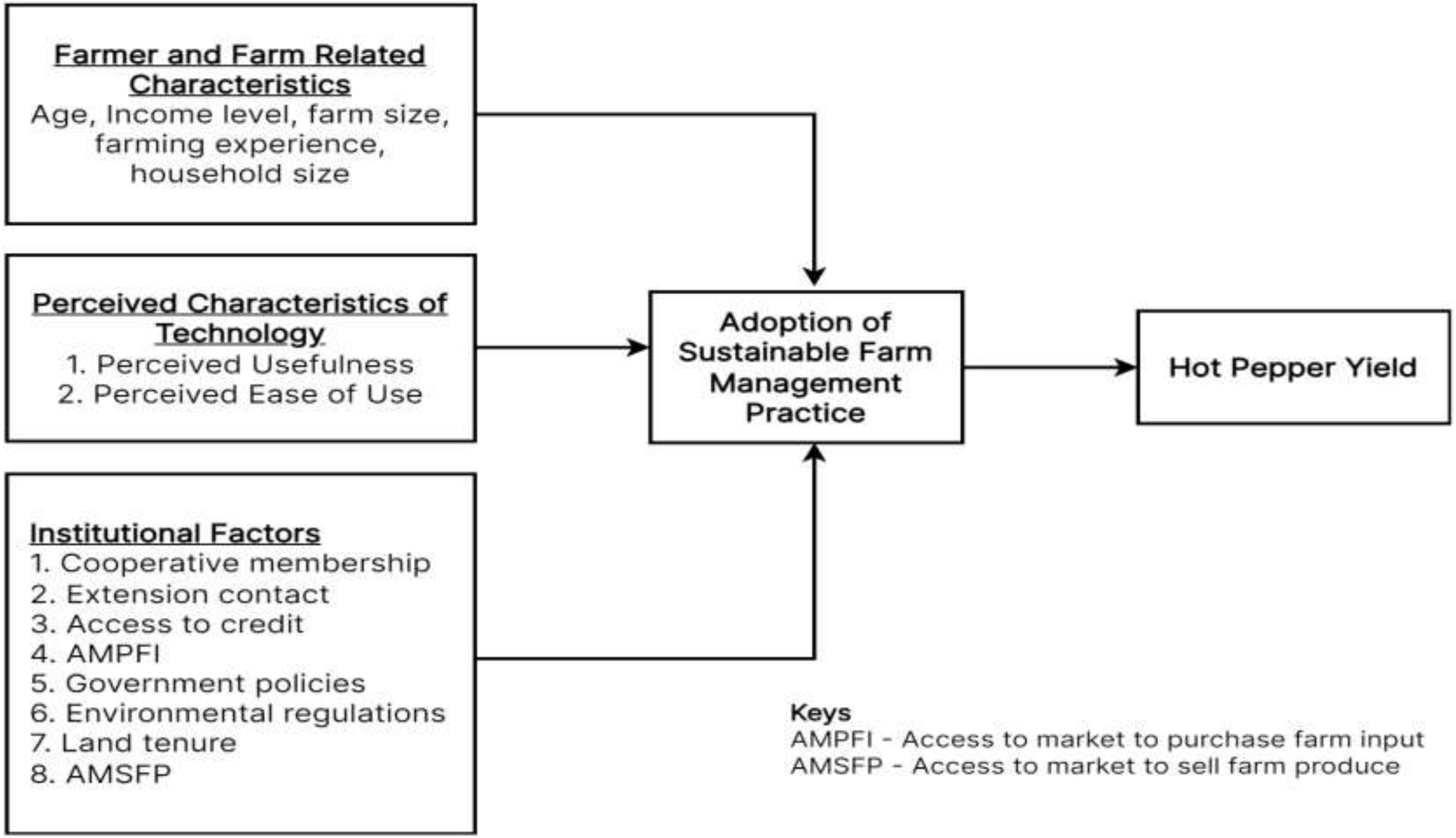

Figure 2: Conceptual framework depicting the influence of sustainable farm management practice on hot pepper yield.

Source: Author's construct (Adapted from TAM model, Davis, 1989)

CHAPTER THREE

RESEARCH METHODS

Introduction

The chapter presents the research paradigm, research design, study area, population sample size and sampling procedure, sources of data, research instruments and pre-testing of the data collection instrument, data collection and data analysis.

Research Paradigm

Research paradigm could be described as the reason for adopting a particular procedure in conducting a study. According to Fazlıoğulları (2012), there are essentially two primary traditional paradigms that are utilized when conducting research, and these are the positivist technique and the constructivist method. The perspectives of these two classic approaches regarding the methodology of a study play a crucial part in scientific inquiry (Saunders, Lewis & Thornhill, 2009). According to Antwi, and Hamza (2015), the positivist paradigm can be seen as objective epistemological positions that extend the methodologies of natural sciences to the study of social reality and beyond.

Proponents of this technique think that knowledge is formed deductively from a theoretical or hypothetical perspective; hence, theories are tested hypothetically with the intention of rejecting or failing to reject a theory. In this method, observations are analyzed using hypotheses that are derived from inductive and deductive reasoning, and then the results of these analyses are compared to observations in order to determine whether or not the hypotheses are supported by observations (Wahyuni, 2012).

The constructivist approach is a research method that focuses on the generation of new theories rather than the use of pre-existing theoretical frameworks to guide research. This is accomplished by inductive analysis of the data acquired from participants in the study. Constructivism is an approach to research that challenges the concept that there is a single method that can be used to generate knowledge. Constructivism advocates for the idea that knowledge is constructed by scientists. Because there are many different realities, constructivists believe that each of the several interpretations that are associated with the various studies should be considered valid. There is a reliance between the person who knows and the thing that is known (Fazlıoğulları, 2012). Constructivists believe that reality is the creation of the human mind, which is developed socially.

Because the constructs being investigated on were capable of being measured, evaluated, and interpreted by applying theoretical models, the positivist approach was chosen for the purpose of this study. The study is also entirely quantitative and established a number of hypotheses based on theoretical models; for these reasons, the positivist paradigm was selected as the appropriate research approach.

Research Design

The research design determines the extent of data gathering, measurement, and analysis. Research design is defined by Kothari (2004) as "a strategy, a road map, and a blueprint for illuminating research topics." A research design is a method for integrating the many parts of a study in a logical and well-considered way. The purpose of a research design is to ensure that the study's most important issues are adequately investigated. Data collection, sampling, and analysis strategies are all laid out in a study's research design (Creswell, 2003).

The research strategy utilized herein is a descriptive survey with a correlational approach. Mugenda and Mugenda (2003) state that when describing phenomena, attitudes, values, and characteristics, a descriptive design is sufficient. According to Orodho (2003), researchers can collect, present, and interpret data using a descriptive survey design. Most surveys gather data at a given moment with the goal of characterizing the "nature of existing circumstances," establishing norms against which those conditions may be assessed, or discovering the links between certain occurrences (Cohen, Manion, & Morrison, 2005). Relationships between variables are investigated using a correlational research design, in which no variables are manipulated or controlled for (Curtis, Comiskey, & Dempsey, 2016). Miller (2005) noted that correlational studies cannot demonstrate causation, but they may demonstrate a link between variables or the ability to predict one quality based on information about other(s). To better understand what characteristics, motivate vegetable producers to adopt sustainable farm management practice, a correlational research method was adopted. The researchers used a correlational approach to answer their research question about the impact of sustainable farm management practices on vegetable production.

Study Area

The municipality of Agona West served as the study's location. There are 260 Metropolitan, Municipal, and District Assemblies (MMDAs) in Ghana, and Agona West Municipal is one of them in the Central Region. Its population is 161,000 and it covers 540 square kilometers of land. The population of the capital city of Agona West municipality, Agona Swedru, is close to 40 thousand people. Located around 40 kilometers away from the Accra-Takoradi route, it is to the north of Winneba. There are eleven districts in the municipality. It sits between 5 30' and 5 50' north latitude and 0 3.5' and 0 55' west longitude. Effutu Municipal and Asikum/Odoben/Brakwa Districts form the eastern and western boundaries, while West Akim Municipal, Birim Central Municipal, and Gomoa Central District form the northeast, northwest, and southern ones. According to the 2010 census of population and housing, there are a total of 115,358 people living in the Municipality; of them, there are 54,159 men and 61,199 females. The average household size in municipality is 3.8 persons per household.

The Municipality of Agona West is located in the rainy semi-equatorial zone. Annual precipitation averages between 1000 and 1400 millimeters (bimodal) but this has been inconsistent for a while owing to climate change. From roughly December to March, the municipality has rather dry weather. Average temperatures range from a high of 33.80 C (in the months of March and April) to a low of 29.40 C (in the months of December and February) in this municipality (August). There are several valuable timber trees in the area's moist tropical and semi-deciduous forest, including mahogany, sapele, silk cotton, wawa, and odum. Over-logging has led to the widespread destruction of forest ecosystems. The silk cotton tree is the largest and most numerous of its kind.

The highest point of Agona West is 350 meters above sea level, yet the lowest point is only 75 meters above sea level. The terrain of Agona West is undulating and sloppy from north to south, with a few isolated hillocks in the north-east, most of which are composed of granite rocks. It is primarily traversed by the Akora River. Other minor rivers and streams like the Afo stream at Nkranfo, Otwe, Ebutuwa, Tutunkape, Baaware, Okese, Awombrew and Pepra at Bobikuma and Ayei Bura, Abena river and the Enchiwi river might be useful for irrigation as well though some of the water sources dry out in the dry season (Tutunkape, Okese, Ebutuwa, and Awombrew).

Forest ochrosols are the predominant soil type found in the Municipality. These soils are alkaline and nutrient-dense, making them ideal for growing a variety of agricultural commodities such as cocoa, citrus, and coconut, as well as vegetables (AWMA, 2010). Plantain, banana, cassava, cocoyam, and maize are also grown as traditional forest food crops. It is common to cultivate vegetables and sugar cane. Agriculture accounts for the majority of land use, but some areas are reserved for forestry and community settlements.

Agona West possesses a significant untapped capacity for overall production enhancement due to insufficient agricultural intensification and approximately 20% of arable land remaining uncultivated. A map created by CERSGIS categorises the municipality's agricultural land use into three types. This includes the mixed arable and tree cropping prevalent in Agona Swedru and Abodom, the mixed arable and tree cropping extending from Agona Nyakrom to Kwaman and Bobikuma, and the mixed arable and tree cropping prevalent in the Nkum area.

Hoes, cutlasses, and axes are examples of the types of farming implements that are used in the Municipality, which is one factor that contributes to the poor level of agricultural output in the Municipality.

Although a large number of farmers employ enhanced seed types and agrochemicals, these inputs have had minimal impact on productivity because crop farmers lack the capital required to apply these inputs in a sustainable manner. According to the Agona West Municipal Assembly Annual progress report 2017, Cassava, maize, plantain, cocoyam, and vegetables are all produced in large quantities by the Municipality. The major vegetables grown in the municipality are tomatoes and pepper of which pepper is the dominant. There is also production of cocoa, oil palm, and coffee.

The Municipality's resource base is dictated by the area's natural resources. As a result, the Municipality's economy is heavily reliant on agriculture. As a result, the Municipality's primary source of revenue is agriculture. Cash crop production, such as cocoa, citrus, oil palm, and coconut, dominates all farming activities in the Municipality. Crop yields in the municipality are low, with outdated farming practices, decreasing soil fertility, small farm holdings, the use of very basic technologies, and an excessive reliance on the weather being the key causes to this problem, along with an excessive reliance on the weather.

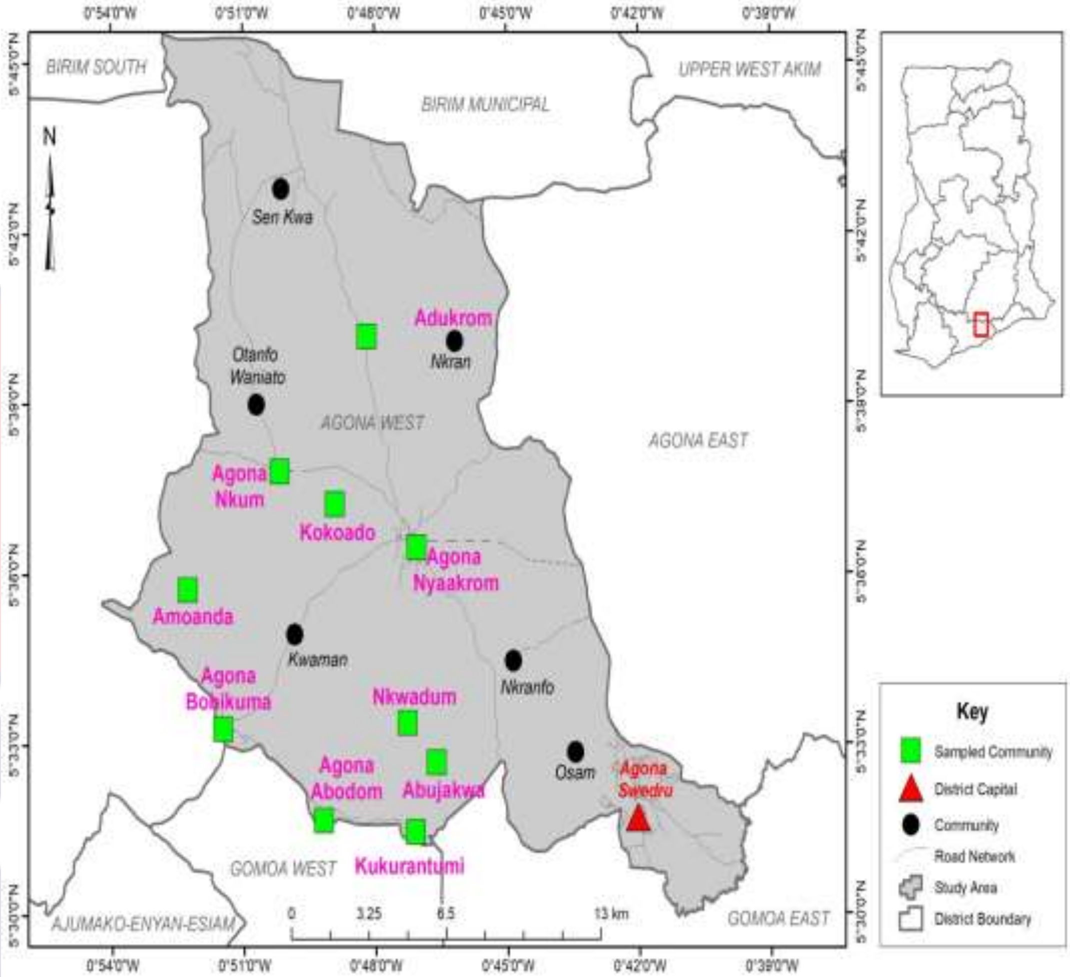

Figure 3: Municipal Map of Agona West
Source: GSS (2010)

Population

All of the people that are going to be investigated collectively make up what is known as the population (Bazeley, 2009). The population targeted for the study include all small holder open space hot pepper farmers in the Agona West municipality. The estimated population of small holder open space hot pepper farmers according to the Agona West Municipal Department of Agriculture is 140.

Sample Size and Sampling Procedure

Census was used to include all the 140 hot pepper farmers in the study. Census was used due to the small number of the population. Out of the 140 hot pepper farmers only 104 could be accessed for data collection. This represents about 74% response rate.

Data Collection Instruments

A structured interview schedule was used to gather information from the hot pepper farmers in the Agona West municipality. A structured interview schedule is a tool for gathering data in which respondents give their answers to a series of pre-established questions in a format that has been pre-established in advance (Ofori & Dampson, 2011). A structured interview schedule was used because empirical studies have shown relatively low levels of formal education among farmers in the Central Region (Miyittah et.al, 2020; Tabiri and Akaba, 2020). This use of structured interview schedule ensures clarity, simplicity, and consistency in data collection, recognizing that structured interviews provide a standardized approach that can be more accessible for individuals with limited educational backgrounds (Taherdoost, 2022). The use of predetermined questions and a systematic format helps mitigate potential misunderstandings and ensures that participants, despite their lower education levels, can effectively engage in the interview process. This approach aims to enhance the reliability of data collection and facilitate a more inclusive participation of respondents in the research study (Phellas, Bloch, & Seale, 2011).

The instrument was developed based on the objectives of the study. In order to ensure that all the relevant variables are included a thorough literature review was conducted. Additionally, the instrument was reviewed by the supervisor. The interview schedule for the study was structured into five sections. The first section gathered information on the demographic characteristics of the respondents. Section two of the instrument was elicited information on the respondents' extent of use of sustainable farm management practice using a five-point Likert-Type scale of 1= Very Rarely, 2= Rarely, 3= Occasionally, 4= Frequently and 5 = Very Frequently. Section three assessed the factors that influence adoption of sustainable farm management practice. Information elicited include farmer and farm characteristics, farmers' perceived characteristics of sustainable farm management practice and the institution that influenced their adoption of sustainable farm management practice in vegetable production. The factors were assessed using a five-point Likert-Type scale of 1= Very High Extent, 2= High Extent, 3= Low Extent, 4= Very Low Extent and 5= No Extent. The next section examined the vegetable farmers' perceived impact of sustainable farm management practice on vegetable production. The impact was measure in terms of yield of vegetables in maxi bags. The last section looked at the challenges in the adoption of the sustainable farm management practice.

Pre-testing

Prior to the major investigation, the instruments were pre-tested. The objective of the pre-test was to identify and correct any ambiguities or errors in the final instrument. Internal consistency and test reliability were also determined (*check Appendix B for reliability test result*). To assure success in this respect, one of the non-selected vegetable-producing zones in the Agona West municipality acted as a test bed for the device. Thirty (30) vegetable farmers were selected at random as responders for this research. Farmers who farmed the veggies in the study's random sample are comparable to survey respondents. The pre-test sample size meets Saunders, Lewis, and Thornhill's (2007) minimum requirement of not pre-testing instruments with less than 10% of the sample.

Data Collection Procedure

The researcher obtained an introductory letter from the Department of Agricultural Economics and Extension of the University of Cape Coast to enable him get approval from the Department of Agriculture in Agona West municipality for data collection. In the course of three weeks, interviews and data collecting were conducted. The collection of data involved five enumerators, including the student researcher, the extension agent, two field officers who assist the extension agent, and one student who was educated by the student researcher on how to administer the research instrument. The focus of the training was on helping participants read and understand the extensive interview questions. The interview began with a clear introduction, followed by the precise asking of questions as written, while allowing for probing techniques when needed. Responses were recorded accurately and consistently, adhering to predetermined categories or scales. The interview concluded with gratitude and clarification when necessary. Because it had been translated into the local language and tested, the structured interview schedule was simple for respondents to comprehend and complete. Data was collected in 10 communities in the Agona West municipality namely: Adukrom, Agona Nkum, Amoanda, Agona Bobikuma, Kokoado, Agona

Nyakrom, Nkwadum, Agona Abodom, Abujakwa, and Kukurantumi. Between the middles of July and August of 2021, the data was collected.

Data Processing and Analysis

All data used in the study was extracted from the primary data sources directly from the field. The data was cleaned and a coding manual was developed for the data set. Data was coded and analyzed using the Statistical Product and Service Solution (SPSS) Version 26.0, a computer application software programme. Each objective of the study was analysed as follows:

Objective one: to determine the level of adoption of sustainable farm management practice by the vegetable farmers. This objective was analysed using frequencies, percentages, mean and standard deviation.

Objective two: to ascertain the factors influencing the adoption of sustainable farm management practice. Means, standard deviations, independent sample t-test, ANOVA, Biserial correlation, and Pearson product moment correlation were used to achieve this objective.

Objective three: to find out the challenges faced by farmers in the practice of the SFMP. This objective was achieved through the use of means and standard deviations.

Objective four: To examine the influence of the management practice on the yield of vegetables in the Agona West Municipality. Pearson product moment correlation and multiple linear regression were used to analyze this objective. The use of the multiple regression technique requires that certain underlying assumptions will be met. These assumptions relate to sample size, linearity of variables, normality, homoscedasticity of residuals, multicollinearity and outliers. The post-estimation tests were carried out to ensure that these assumptions are met.

Empirical Model Specification of Multiple Linear Regression

To examine the influence of the sustainable farm management practice on the yield of vegetables in the Agona West Municipality, the following regression model was used.

$$Y = \beta_0 + \beta_1(IPM) + \beta_2(Pru.) + \beta_3(Irrig.) + \beta_4(IWM) + \beta_5(CT) + \beta_6(Fung.\ App) + \varepsilon_t$$

Y denotes vegetable production in terms of yield

IPM denotes Integrated Pest Management

Pru. denotes Pruning

Irrig. denotes Irrigation

IWM denotes Integrated Weed Management

CT denotes Conservation Tillage

Fung. App denotes Fungicide Application

β_0 is the constant term., β_1 *to* β_6 are coefficients and ε_t is the error term.

Ethical Considerations

The director of agriculture for the municipality of Agona West was issued an introductory letter describing the study's objectives and methods to confirm that all essential ethical guidelines were followed. Prior to selecting respondents for data collection, we also got their consent. Before commencing the research, participants were provided with information about the study and asked for their signed consent. The objective was to guarantee that study participants were willing to participate (Baxter & Jack, 2008). The opening paragraph of the questionnaire guarantees respondents privacy and confidentiality. This was done to ensure participants that their comments would be kept confidential and that their information would not be shared with unauthorized parties. These actions were conducted in conformity with widely recognized moral standards.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter presents and discusses the results of the study according to the specific objectives.

Background and Farm-related Characteristics of Farmers

This section summarizes the findings from the analysis of data on farmers' backgrounds and farm-related characteristic. Sex, age, years of farming experience, marital status, and household size are all covered. This part also presents information on household labour size, land tenure systems, and cooperative memberships.

Table 1: Descriptive Statistics of the Demographic Characteristics of vegetable farmers

Variables	Categories	Frequency	Percentage
Sex (*n=104*)	Male	78	75.0
	Female	26	25.0
Age	Less than 20	5	4.8
	20-29	24	23.1
	30-39	34	32.7
	40-49	25	24.0
	50 and above	16	15.4
Level of education	No formal education	44	42.3
	Primary education	43	41.3
	JSS/JHS	12	11.5
	SSS/SHS	3	2.9
	Tertiary	2	1.9
Marital status	Single	12	11.5
	Married	84	80.8
	Divorced	4	3.8
	Widowed	4	3.8

Table 1: Continue

Household size	5 and below	55	52.9
	6-10	46	44.2
	11-15	3	2.9
Household labour size	3 or less	64	61.5
	4-7	39	37.5
	8-11	1	1.0
Farm size	1 acre	12	11.5
	2 acres	31	29.8
	3 acres	33	31.7
	4 acres	27	26.0
	5 or more acres	1	1.0
Years of farming experience	3 or less	5	4.8
	4-7	22	21.1
	8-11	33	31.7
	12-15	35	33.7
	15 or above	9	8.7

n = 104 Source: Field data, Abbey, 2021

The results in Table 1 show that the majority (75%) of respondents (hot pepper farmers) are males. This indicates that hot pepper production in the study area is male dominated activity. The results further indicates that more than half (55.8%) of the respondents are between the ages of 21-40 years. This group represents the energetic and very active working group. This shows that young people in the study area are much interested in vegetable production. On education, the results of the study showed farmers involved in hot pepper production in the study area have very low level of education. The results indicate that about 42% of the respondents have no formal education. With those with formal education, 41.3% have up to primary education with a paltry 1.9% having tertiary education. This result is not surprising because educational level of most farmers in the rural areas in Ghana is low (Eric, Prince, & Elfreda, 2014). Also, hot pepper is a traditional vegetable that does not require special skills in its production; hence people with low level education can easily cope with its production.

The findings of the study revealed that the majority of the respondents (80.8%) of the respondents are married with more than 50% of them having a household size of 5 members. Most farmers in the rural areas in Ghana operate with family labour and as such having a large family size serves as source of labour for the farm family. Thus, the results further revealed that, 64 of the farmers representing a percentage of 61.5% engage 3 or less members of their household as labour of their farms. Thirty-nine farmers representing 37.5% of the vegetable farmers engage from 4 to 7 members of their household in their farms while only one farmer representing 1% of the farmers engage 11 members of his household on his farm.

Out of all the vegetable farmers surveyed, 31.7% of them (33 farmers) have a vegetable farm size of 3 acres. Additionally, 29.8% of the vegetable farmers (31 farmers) farm on 2 acres of land, while 26.0% (27 farmers) farm on 4 acres of land. This suggests that the majority of the farmers have small to medium-sized farms. Findings from the study also showed that the respondent have lot of experience in hot pepper production since most of them have been in hot pepper production for between 4-15 years.

The land tenure system used by the respondents is presented in **Figure 4**. The results from **Figure 4** show that about one third (35.6%) of the hot pepper farmers in the study area rent their land for hot pepper production. Renting land for production could sometimes be very expensive and this could reduce the profit margin of the farmers. The results further show that 27 farmers representing 26% are working on inherited lands.

With regards to the land tenure system of the farmer's land, 37 of the farmers representing 35.6% formed the majority and they rented the land on which they are farming while 19 farmers representing 18.3% purchased the land on which they are farming. Twenty -one farmers representing 20.2% are engaged in sharecropping. That is, they do not own the land on which they are farming but they share the produce they get on the farm with the land owners. This result is consistent with the findings of Darkey (2011), who examined the effect of urban vegetable production on the incomes of farmers in the Ashanti Region of Ghana's Kumasi Metropolis. This discovery is also in agreement with Cornish and Lawrence's (2001) results in the study on irrigation in peri-urban areas which says that more than half of farmers in Kumasi and in Nairobi do not own the land on which they work on. Similarly, Flynn-Dapaah (2002) in the study of land negotiations and tenure relationships in Sub-Saharan Africa, also found that farmers do not own the land on which they work.

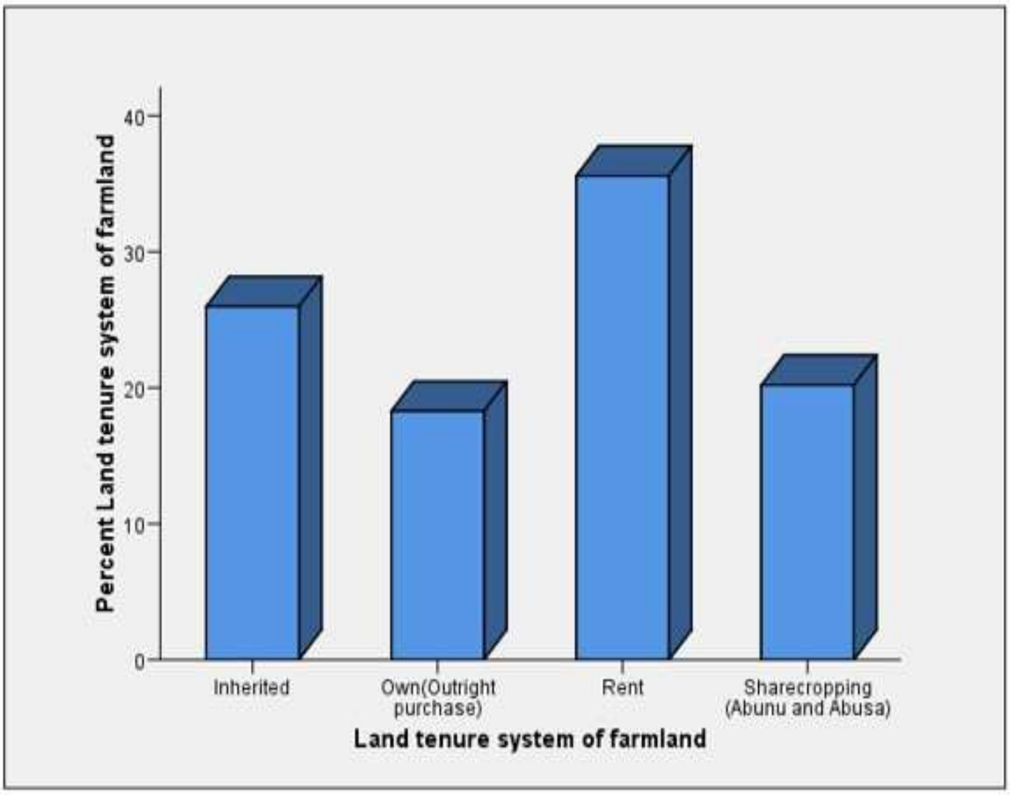

Figure 4: Land tenure system of farmers

Table 2: Cooperative membership of farmers

Member of a farmers' association	Frequency	Percent
Yes	84	80.8
No	20	19.2
Total	104	100.0

Source: Field survey, (2021)

It was found out that of the farmers engaged in this study, 84 of them representing 80.8% (majority) are members of farmers' association while the remaining 20 representing 19.2% do not join any farmers' association (**Table 2**). This result is consistent with Frimpong-Manso et.al. (2022) who in their research on cooperative membership status and adoption of good agronomic practices among cocoa farmers in Atwima Mponua District, Ghana, found out that majority (52.5%) of the farmers used in their study are active cooperative members. Farmers usually join cooperatives for the benefits they will receive (Balgah, 2019). Such benefits include: an easy access to credit from financial institutions, access to farm inputs, bargaining power, acquiring modern technologies in farming, among others (Bijman & Iliopoulos, 2014). Close to a quarter (19.2%) are not in any farmers' association. The findings are consistent with the key propositions of the conceptual framework

With regards to the benefits received by the farmers from the farmer associations, 29 farmers representing 34.5 % receive farm inputs while 42 farmers representing 50 %, forming the majority, receive credit. Consistent with these findings, Agbo (2009) found that the majority of farmers in Enugu State, Nigeria joined cooperatives in order to gain access to loans. Eight of the farmers representing 9.5% receive transport services to transport their farm inputs and produce while the minority, 5 farmers, representing 6% receive produce marketing services from the farmers' association (*See Figure 5*). Majority of the farmers were found to receive credit followed by those who receive farm inputs. This suggests that most of the farmers in the study require credit and farm inputs to invest into their farming business.

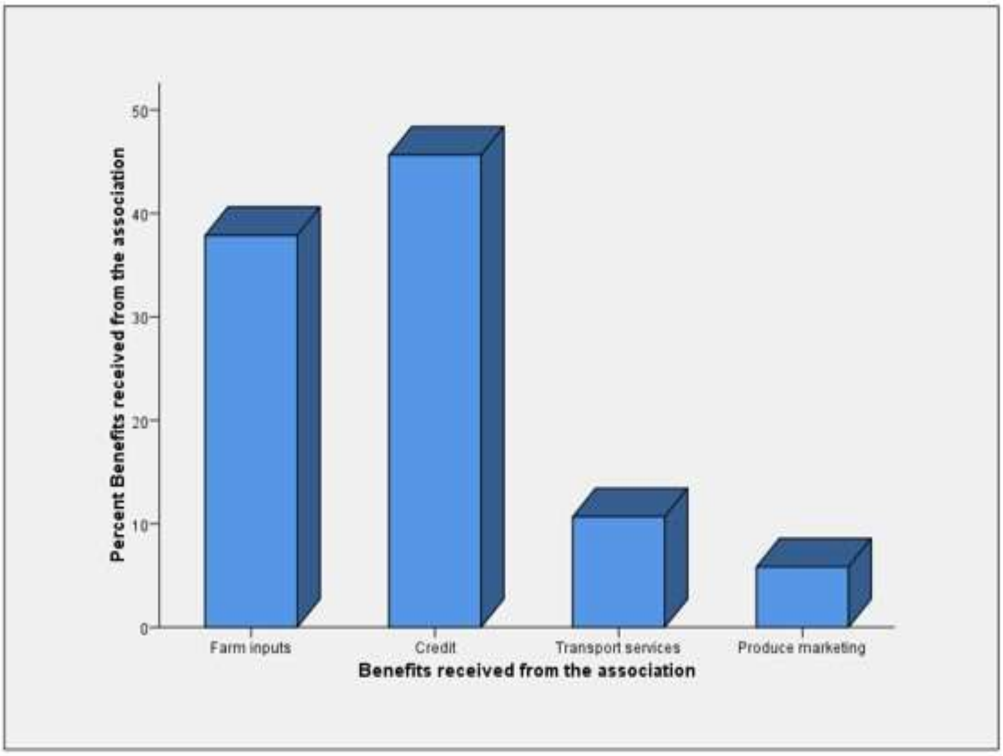

Figure 5: Benefits received from cooperatives

Level of Adoption of Sustainable Farm Management Practice

Table 3 presents the results of the extent to which the hot pepper farmers use the sustainable farm management practice in their hot pepper production. The farmers were asked to indicate on a five-point Likert scale the extent to which they use six selected sustainable farm management practices namely: Integrated Pest Management (IPM), the use of fungicides to control diseases, pruning, irrigation, integrated weed management, and conservation tillage. Regarding the extent of use of IPM, it can be seen from **Table 3** that 32 farmers representing 30.8% of the farmers use IPM occasionally. Forty-three farmers representing 41.3% use the IPM technology frequently. Seven of the farmers representing 6.7% rarely use IPM whilst 18 and 4 farmers representing 17.3% and 3.8% use the IPM technology very frequently and very rarely respectively. The mean or the extent of use of IPM was 3.62

(approximately 4) with a standard deviation of 0.978. This gives the indication that the vegetable farmers in Agona West municipality frequently practice Integrated Pest Management. The findings of Osei et al. (2019) that producers routinely use IPM techniques to improve vegetable quality are corroborated by their findings. This enhancement includes an increase in vitamin C content and a reduction in pesticide residue levels.

As a consequence, producers would do everything, including integrating various pest management technologies, to eliminate pests and restore agricultural output and production costs that were lost due to pest infestations. This may account for the frequent use of IPM.

Table 3: Extent of adoption of sustainable farm management practice

SFMP	Categories	Frequency	Percentage	Means (SD)
Extent of use of IPM	Very rarely	4	3.8	
	Rarely	7	6.7	
	Occasionally	32	30.8	3.62(**0.98**)
	Frequently	43	41.3	
	Very frequently	18	17.3	
Extent of use of fungicides	Occasionally	22	21.2	
	Frequently	55	52.9	4.04(**0.69**)
	Very frequently	27	26.0	
Extent of pruning	Very rarely	17	16.3	
	Rarely	21	20.2	3.13(**1.37**)
	Occasionally	16	15.4	
	Frequently	31	29.8	
	Very frequently	19	18.3	
Extent of irrigation	Rarely	25	24.0	
	Occasionally	31	29.8	
	Frequently	26	25.0	3.43(**1.08**)
	Very frequently	22	21.2	

Table 3: Cont'd

Extent of use of integrated weed management	Rarely	3	2.9	4.37(**0.73**)
	Occasionally	6	5.8	
	Frequently	45	43.3	
	Very frequently	50	48.1	
Extent of use of conservation tillage	Very rarely	3	2.9	3.84(**0.98**)
	Rarely	5	4.8	
	Occasionally	26	25.0	
	Frequently	42	40.4	
	Very frequently	28	26.9	

Source: Field data, Abbey, 2021.

Means were calculated from a scale of 1 = Very Rarely, 2 = Rarely, 3 = Occasionally, 4 = Frequently and 5 = Very Frequently.

With the use of fungicides to control diseases, it was found out more than half (52.9%) use fungicides frequently to control diseases on their hot pepper farms. Twenty-two farmers representing 21.2% engaged in this study use fungicides occasionally on their vegetable farms whilst 27 farmers representing 26.0% were found to apply fungicides very frequently on their vegetable farms to control diseases. The mean for the extent of use of fungicides was also found to be 4.05 with standard deviation of 0.69. This means that the hot pepper farmers in the Agona West municipality generally applied fungicides to their crops frequently. This conforms to the findings of Dery et al. (2019) and Adomako and Quartey (2016) who reported that farmers in the Upper East and Ashanti regions of Ghana, respectively, use fungicides frequently.

Regarding pruning, it was found out that only 19 farmers representing 18.3% of the farmers engaged in this study pruned their vegetable crops very frequently. Thirty-one farmers representing 29.8% frequently prune their vegetable crops whilst 16 farmers representing 15.4% prune their vegetable crops occasionally. Twenty-one farmers representing 20.2 % rarely prune their vegetable crops whilst 17 farmers representing 16.3% prune their vegetable crops very rarely. The mean for the extent of pruning was found to be 3.13 with standard deviation of 1.37. This means that generally, the vegetable farmers were found to be occasionally pruning their vegetable crops. This is similar to findings in a study by Tewodros et.al (2019) which says farmers do not prune their crops and those who prune, do it occasionally. Owusu-Ansah et al. (2021) observed that farmers in the Upper East Region of Ghana occasionally prune their vegetables to improve nutrient uptake and reduce water stress which confirms the study's findings. Farmers have occasionally been pruning their crops because perhaps, they may not have fully understood the importance of pruning on vegetable yield and they feel reluctant to be cutting away parts of the crops that will be bearing fruits for them to harvest despite the education being given to them by the Department of Agriculture.

With irrigation, it was found out that only 22 farmers representing 21.2% irrigate their vegetable farms very frequently whilst 26 farmers representing 25% irrigate their farms frequently. Meanwhile, it was also found out that 31 farmers representing 29.8% irrigate their vegetable farms occasionally whilst 25 farmers representing 24% rarely irrigate their vegetable farms. The mean for irrigation was found to be 3.43 with a standard deviation of 1.08. This means that, generally, the vegetable farmers irrigated their farms occasionally and this may be attributed to unavailability of water sources close to the farms or drying of these water sources. This is consistent with the Asare-Kyei (2015) who found that vegetable farmers in the Greater Accra region of Ghana irrigated their vegetable crops occasionally owing to the scarcity of water.

Regarding Integrated Weed Management (IWM), it was found out that 50 farmers representing 48.1% practise IWM on their vegetable farms very frequently while 45 farmers representing 43.3 % practise IWM frequently. Six farmers representing 5.8% use IWM occasionally while 3 farmers representing 2.9% rarely use IWM. The mean of the responses for the extent of use of integrated weed management was found to be 4.37 with standard deviation of 0.73. This means the vegetable farmers frequently integrated weed management in controlling weeds in their vegetable farms because they know very well that weeds competition with crops result in low crop yield. This is consistent with Baidoo-Addo et al. (2018) who found that smallholder farmers in Ghana frequently practice IWM and as a result, had lower weed density and higher yield than those who relied solely on herbicides.

With the practice of conservation tillage, **Table 3** showed that 42 farmers representing 40.4% frequently practise conservation tillage whilst 28 farmers representing 26.9% practised it very frequently. Twenty-six farmers representing 25.0% occasionally practise conservation tillage whilst 5 and 3 farmers representing 4.8% and 2.9%, respectively, practise conservation tillage rarely and very rarely. With the extent of use of conservation tillage, the mean was found to be 3.84 (approximately 4) with standard deviation of 0.98. This means that the vegetable farmers in the Agona West municipality frequently practised conservation tillage in their vegetable production. They may have understood the importance of conservation tillage through the training given to them by extension officers. In their study on conservation tillage adoption and its impact on smallholder vegetable farmers' income in Northern Ghana, Abdulai et al. (2014) found that smallholder vegetable farmers in the area frequently used conservation tillage, and that it had a positive impact on their yield and income. This finding is consistent with their findings.

Factors influencing adoption of Sustainable Farm Management Practice

This section of the thesis presents factors influencing the adoption of sustainable farm management practice by hot pepper farmers in the study area. The factors have been divided into three, namely: farm and farmer characteristics, characteristics of sustainable farm management practice, and finally, institutional factors.

Farm and Farmer Characteristics

Independent samples T-Test and Analysis of Variance were used to determine whether there is any significance difference between the various levels of farmer and farm characteristics with regards to the adoption of sustainable farm management practice.

Independent samples T-Test between Sex, Membership of Association and Adoption of Sustainable Farm Management Practice

To examine the differences in sustainable farm management practice adoption between male and female farmers and between farmers who are and are not members of a farmer's organization, an independent-samples t-test was carried out. There were no statistically significant differences [t (102) = 0.86, p =0.39] between male (M = 3.98, SD= 0.46) and female (M = 3.89, SD=0.47) farmers' scores on the SFMP adoption scale. Mean differences were just 0.09 (95% confidence interval [CI]: -0.12 to 0.30), indicating a negligible range of variation. Thus, the alternative hypothesis is rejected. This agrees with the results of Gebre et.al. (2019), who reported no statistically significant difference in the rate of adoption of agricultural technology between men and females in their research of gender differences in this area in Southern Ethiopia. In addition, Diiro et al. (2015) found no statistically significant variation in fertilizer use across sexes in their research on fertilizer adoption in Uganda. This study's results, however, are consistent with those of Gebre. (2019), who discovered that male-headed families in Southern Ethiopia were more likely to embrace agricultural technology than female-headed households.

There was a statistically significant difference between farmers who were members of a farmer's organization (M = 3.96, SD = 0.44) and those who were not (M = 3.93, SD = 0.57) on an assessment of their adoption of a particular farm management approach (t (102) = 0.27, p = 0.086). Thus, we cannot accept the alternative hypothesis. This suggests that there are differences between farmer association members and non-members with regard to the adoption of sustainable farm management practices. According to Manda et al. (2020), this is in line with the idea that cooperative members tend to be more progressive in their use of agricultural technology.

Table 4: Independent samples t-test between sex and adoption of SFMP, and farmer association membership and adoption of SFMP

	Sex	**Means**	**Standard Deviation**	**Significance**
Adoption of SFMP	Male	3.98	0.46	0.63
	Female	3.89	0.47	
	Farmer Asso. Membership	**Means**	**Standard Deviation**	**Significance**
Adoption of SFMP	Yes	3.96	0.44	0.086
	No	3.93	0.57	

Analysis of Variance between selected socio-demographic, farm related characteristics and Sustainable Farm Management Practice

The ANOVA of demographic and farm-related factors and SFMP is shown in **Table 5**. With the exception of age, the results demonstrate that no other socio-demographic or farm-related parameters significantly affect SFMP adoption. $F(4,99) = 2.55$, $p = 0.04$ at the 5% level of significance indicates that there is a significant age difference in the adoption of sustainable farm management practice. As a result, we conclude that there is a substantial variation in the implementation of sustainable farm management practice across age groups, and so reject the null hypothesis. Haugen (1990) observed no statistical differences across age groups with regard to occupational training in her study of women farmers in Norwegian agriculture, therefore this result does not square with her findings. Studying age and gender disparities in life satisfaction in a sex-segregated community, Al-Attiyah and Nasser (2016) found no statistically significant differences. To check the individual differences between the age categories, post-hoc multiple comparison was conducted.

The Levene's statistic from **Table 6** was found to be significant. This implies that equal variance was not assumed and therefore Games-Howell post-hoc test was employed to test the significant differences between the various age categories. The other assumptions of Games-Howell post hoc test (normality of data and independence of groups) were also met. The test indicated that the mean score for 20-29 age category (M= 4.14, SD = 0.49) was significantly higher than that of the 30-39 age category (M= 3.79, SD =

0.37) at 0.05 alpha level. For the other age groups, however, there were no significant differences between them (*See Table 7*).

$F(4,99) = 0.25$, $p = 0.91$ indicates that there is no significant variation in the adoption of sustainable farm management practice across educational levels. That is to say, there is no difference in the rate of adoption of sustainable farm management practice across educational levels. As a result, we cannot rule out the possibility that farmers with different degrees of education are simply adopting different methods of farm management. This runs counter to the research conducted by Salia et al. (2018), who found a significant difference in technology adoption rates between farmers with no formal education and those with at least some formal education among smallholder farmers in Northern Ghana. However, a study by Adubofuor et. al. (2019) conforms to the finding of this study as they found no significant difference in the adoption rates between farmers with primary, secondary, and higher education levels.

With regards to marital status of farmers, ANOVA results showed no significant differences between the categories of marital status with respect to the adoption of sustainable farm management practice, $F(3,100) = 0.18$, $p = 0.91$ (*See Table 5*). This indicates that there is no difference between singles, married people, divorced people, and widowed people when it comes to the adoption of sustainable farm management practice. Since no significant difference in adoption of sustainable farm management practice was found between marital status and other factors, the null hypothesis was not rejected. This supports Jain's (2017) results, which indicated no statistically significant difference in the adoption of agricultural technology depending on marital status. This study discovered that married farmers were less likely to adopt improved crop varieties and irrigation technologies than their unmarried counterparts, which is in contrast to the results reported by Tuffour et al. (2021), who studied the impact of socioeconomic factors on farmers' adoption of improved crop varieties and irrigation technologies in Ghana, and Nketia et al. (2017), who discovered that marital status was a significant predictor of the adoption of SFMP.

ANOVA findings in **Table 5** show that there was no statistically significant variation in household size among farmers, F (2,101) = 0.40, p = 0.67. There is no correlation between the size of a farmer's family and how likely they are to use a certain kind of farm management. As a result, we cannot rule out the null hypothesis, which holds that there is no discernible difference between the size of a farmer's family and the adoption of sustainable farm management practices. This supports the research of Doss et al. (2018), who found no statistically significant link between household size and Ethiopian agricultural adoption.

ANOVA results also showed that the various number of years of vegetable farming experience do not statistically differ significantly from each other with regards to the adoption of sustainable farm management practice, F (4,99) = 0.68, p = 0.61 (*See Table 5*). As a result, we cannot rule out the null hypothesis, which holds that there is no discernible difference between the years of vegetable farming experience in the adoption of sustainable farm management practice. This affirms the findings of Azam (2015) who also found no significant difference in years of farming experience in adoption of organic methods of cultivation.

With regards to farm size, the various sizes of farms were found not to statistically differ significantly from each other as demonstrated by the one-way ANOVA, F (4,99) = 0.99, p = 0.42 (*See Table 5*). This indicates that there is no difference between large and small farms when it comes to adoption of sustainable farm management practice. By this, we fail to reject the null hypothesis which states that there is no significant difference between farm sizes in the adoption of sustainable farm management practice. Ouma et al. (2014) came to similar conclusions. There was no apparent disparity in adoption rates between smallholder and large-scale farmers in their study of enhanced maize varieties in Kenya. In addition, Rahman et al. (2014) observed no statistically significant difference in the adoption rates of new rice varieties across small and big farms in Bangladesh.

Furthermore, there was no significant difference recorded between the different systems of land tenure in terms of sustainable farm management practice, F (3,100) = 0.54, p = 0.65 (*See Table 5*). This means the type of land tenure used by the farmer (whether inherited, own, rent, sharecropping, or gift) is not different from the other when it come to the adoption of sustainable farm management practice. By this, we fail to reject the null hypothesis which states that there is no significant difference between land tenure systems in the adoption of sustainable farm management practice. This confirms the findings of Teklewold et al. (2013) who found that there was no significant difference in the adoption of improved maize varieties between farmers who own land and those who rent or sharecrop in Ethiopia. Similar results were obtained by Schuck et al. (2002) in their investigation of the influence of land tenure on the adoption of slash-and-burn farming.

Overall, since the categories of age and cooperative membership were found to be significant, we are unable to rule out the possibility that there is a statistically discernable difference between the various categories of socio-demographic characteristics in the adoption of farm management methods. However, there is a statistically significant variation in the adoption of farm management strategies across the various levels of farm-related variables.

Table 5: Analysis of variance of the socio-demographic, farm related characteristics and sustainable farm management practice

Variable	Sum of Squares	*Df* Between Groups	*Df* Within Groups	Mean Square	*F*	Sig.
Age of farmer	2.04	4	99	0.51	2.55	0.04
Level of education	0.22	4	99	0.06	0.25	0.91
Marital Status	0.12	3	100	0.04	0.18	0.91
Household Size	0.17	2	101	0.09	0.40	0.67
Vegetable Farming Experience	0.58	4	99	0.15	0.68	0.61
Farm Size	0.84	4	99	0.21	0.99	0.42
Land Tenure System	0.35	3	100	0.12	0.54	0.65

Source: Author's Computation

Table 6: Levene's Test of Homogeneity of Variance

			Test of Homogeneity of Variances			
Age Category	**Mean**	**Std. Deviation**	**Levene's Statistic**	***Df* 1**	***Df* 2**	**Sig.**
Less than 20	4.07	0.35	2.52	4	99	0.05
20-29	4.14	0.49				
30-39	3.79	0.37				
40-49	4.04	0.53				
50 and above	3.88	0.41				

Source: Author's Computation

Table 7: Games-Howell Post Hoc Test Results on Age

Age of farmer	Age of farmer	Mean Difference	Sig.
Less than 20	20-29	-0.07222	0.994
	30-39	0.27255	0.533
	40-49	0.02667	1.000
	50 and above	0.19167	0.832
20-29	30-39	0.34477*	0.044
	40-49	0.09889	0.961
	50 and above	0.26389	0.364
30-39	40-49	-0.24588	0.291
	50 and above	-0.08088	0.959
40-49	50 and above	0.16500	0.5871

* Significant at 5%
Source: Author's Computation

Correlation of Farm and Farmer Characteristics, Institutional Factors and Perceived Characteristics of SFMP with Adoption of SFMP

Table 8 presents the correlation of adoption of sustainable farm management practice, institutional factors and perceived characteristics of sustainable farm management practice.

Table 8: Correlation of Farm and Farmer Characteristics, Institutional Factors and Perceived Characteristics of SFMP with Adoption of SFMP

Variable	Correlation Coefficient	Type of Correlation
Sex	0.085	Biserial (r_{bi})
Coop. membership	0.027	Biserial (r_{bi})
Farm Size	-0.037	Pearson's (r)
Institutional factors	0.003	Pearson's (r)
PU	0.095	Pearson's (r)
PEOU	0.065	Pearson's (r)

** significant at 5%, * significant at 10%
Source: Author's Computation

From **Table 8**, it could be realized that the six independent variables (demographic characteristics, institutional factors and characteristics of SFMP) display a very weak positive and a very weak negative correlation ($r \leq 0.095$) with the dependent variable (adoption of sustainable farm management practice). Specifically, it could be observed that sex, cooperative membership, institutional factors, perceived usefulness and perceived ease of use of sustainable farm management practice display a very weak positive linear relationship with adoption of sustainable farm management practice while farm size displays a very weak negative linear relationship. This may be attributed to the fact that some of the sustainable farm management practice requires many labour and financial investments which are challenges to most farmers (especially in vegetable production) and as such, preventing most of them with larger farm sizes from adopting or fully adopting SFMP. A study by Kassie et al. (2018) on the adoption of improved maize varieties in Ethiopia which found that the cost of seed and labour were major barriers to adoption, particularly for larger farmers confirms the finding of this study. As such, this may account for the negative correlation of farm size with adoption of sustainable farm management practice. Statistically significant test revealed no significant difference between the variables (sex, cooperative membership, farm size, institutional factors, perceived ease of use and perceived usefulness) and adoption of sustainable farm management practice as the p-values were less than the 0.05 accepted standard. Therefore, it cannot be concluded that the variables influence adoption of sustainable farm management practice.

Challenges Faced by Hot Pepper Farmers in Using Sustainable Farm Management Practice

The study assessed the challenges associated with the sustainable farm management practice used by the farmers. The results in Figure 6 indicates that not many farmers had challenge applying sustainable farm management practice, which include integrated weed management (12.5 %), irrigation (48.1%), the application of fungicides (29%), pruning (19.2%), and integrated pest management (15.4%). When it comes to conservation tillage, none of the farmers had a challenge.

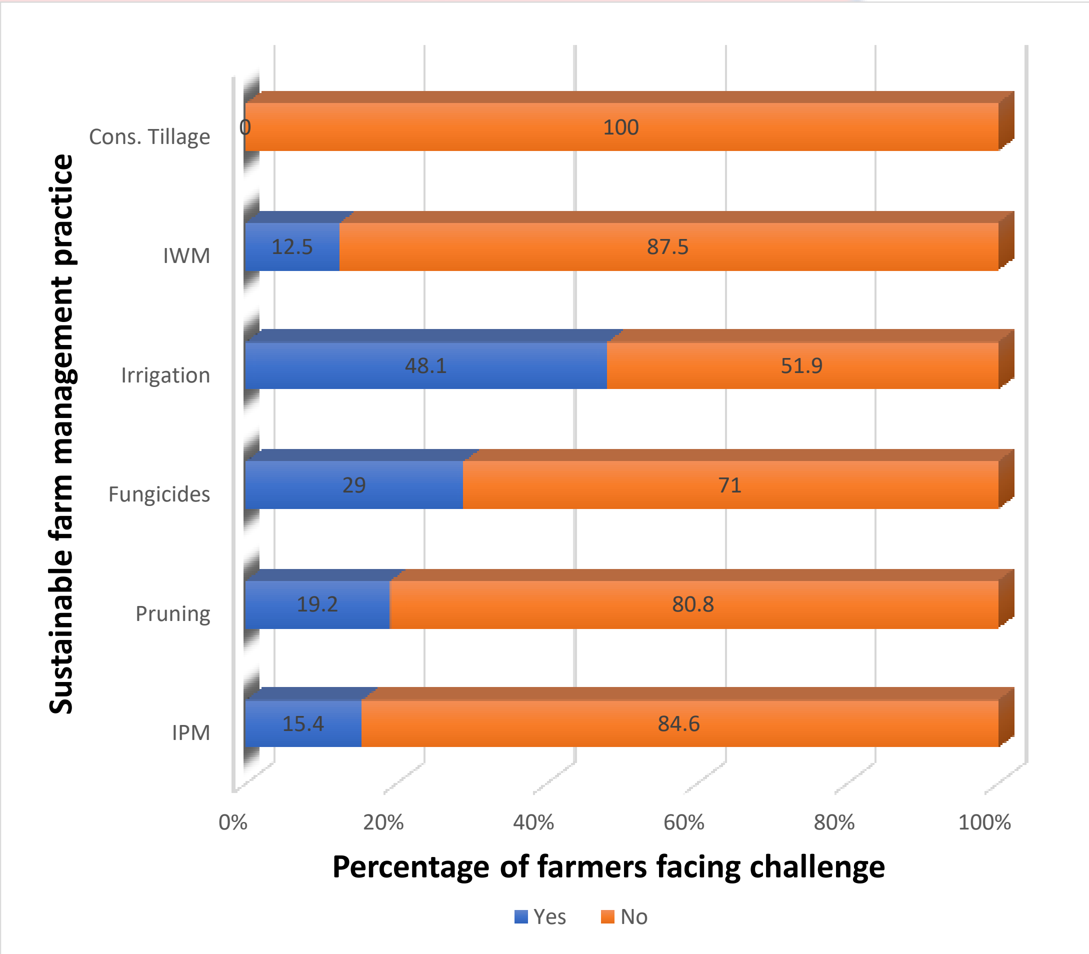

Figure 6: Challenges faced in using SFMP

Qualitative research showed the distinct difficulties that farmers have when carrying out the different farm management tasks. The challenges in question are grouped into four categories: financial, land tenure, access to water and labour.

Financial challenges

Most of the farmers are financially constrained and their income levels are quite low. It was revealed that 78.3% are financially challenged and this makes it more difficult for them to acquire agriculture inputs such as weedicides, insecticides, and fungicides. This may be the more reason they have adopted IPM to cut down the cost of controlling pest in their farms. Another aspect is that some of the farmers are elderly and would need hired labour to implement certain farm management measures, but their financial resources prevent them from completely performing these farm management activities. Access to credit has proved to be a challenge to most of the farmers and those who get access to credit have concerns with the size of the loans.

Access to labour challenges

Access to labour is sometimes a challenge for some of the farmers as some of the farm activities require extra hands. Labour, according to 32.8% of the farmers, sometimes become difficult when using some sustainable farm management practices. Practicing IPM is also time consuming and require some labour which sometimes may not be available.

Land tenure challenges

Land tenure was also cited as a challenge by 68.5% of the farmers in the use of sustainable farm management practice. The type of ownership of the land influences the choice of management practice they use. For example, some farmers said they wish to install drip irrigation systems as it is very efficient but they are unwilling to do it on a rented land. This is because these lands are not rented out to them on long term basis and since the installation of drip irrigation systems is cost and labour intensive, they would not want to risk installing it on a land on which they may not farm for long.

Access to water for irrigation challenges

Access to water for irrigation was also cited as one of the challenges 44% of the farmers faced in the production of their vegetables. Water sources are far from their farms and therefore they had to convey water from far places to their farm which requires a lot of work. Some water sources that are close to their farms dry up in the dry season and therefore they have difficulties in getting access to water to irrigate their crops. Some of these water sources are wells, and streams such as the Afo stream at Nkranfo, Otwe, Ebutuwa, Tutunkape, Baaware, Okese, Awombrew and Pepra at Bobikuma, and Ayei Bura. Some of these water sources dry out completely (Tutunkape, Okese, Ebutuwa, and Awombrew), and those which do not dry out completely have insufficient water for irrigation. Also, some of these streams are drinking water sources and they are not allowed to be used for irrigation when they begin drying.

Influence of Sustainable Farm Management Practice on Hot Pepper Yield

This section presents the effect of sustainable farm management practice on the yield of hot pepper in the Agona West Municipality.

Correlation Matrix Results of Hot Pepper Yield and Sustainable Farm Management Practice

Table 9 presents the results of the correlation between the dependent variable vegetable yield and the independent variables, extent of use of: integrated pest management, application of fungicides, pruning, irrigation, integrated weed management, and conservation tillage.

Table 9: Correlation Matrix results of Hot Pepper Yield and SFMP

Variable	Hot Pepper Yield in Tonnes	Extent of use of IPM	Extent of use of fungicides	Extent of use of pruning	Extent of use of irrigation	Extent of use of IWM	Extent of use of conservation tillage
Hot Pepper Yield in Tonnes	1.000						
Extent of use of IPM	.292	1.000					
Extent of use of fungicides	.271	.417**	1.000				
Extent of use of pruning	.090	.075	.044	1.000			
Extent of use of irrigation	.083	.224	.011	.098	1.000		
Extent of use of IWM	.324	.207	.132	.137	.477*	1.000	
Extent of use of conservation tillage	.243	.746**	.344	.002	.197	.131	1.000

** significant at 5%, * significant at 10%   Source: Author's computation

From Table 8, it could be realized that the six independent variables (sustainable farm management practices) display a weak positive and a moderate positive correlation ($r \leq 0.3$) with the dependent variable (vegetable yield).

Sustainable farm management practice recorded a weak positive correlation coefficient of 0.3 or below ($r \leq 0.3$). However, there were exceptions in the correlations between IPM and fungicides application, IPM and conservation tillage, and Irrigation and IWM. These recorded moderate positive correlation of 0.4, 0.7, and 0.48 respectively.

Multicollinearity Test

Multicollinearity is where two or more of the independent variables in a multiple regression model are linearly correlated. Although there are many ways of testing the presence and severity of multicollinearity between variables; such as the usage of eigen values, correlation matrix and condition index, the study adopts correlation matrix method to test for the presence of multicollinearity.

According to Bryman and Cramer (2002), multicollinearity arises when the correlation between two exogenous variables is more than 0.80, whereas Anderson, Sweeney, Williams, Camm and Cochran (1990) advocated a value of 0.70. In addition, Kennedy (2008) asserts that two independent variables have a correlation of 0.80 or 0.90 or higher. In consideration of Kennedy's (2008) paradigm, we set the cut-off at 0.90 and conclude that there is no multicollinearity between the independent variables.

Multiple Linear Regression of Sustainable Farm Management Practice on Hot Pepper Yield

This section presents the regression results of the second model (*see chapter 3*). The statistical influence of sustainable farm management practice on yield of vegetables is presented below.

Influence of sustainable farm management practice on hot pepper yield

Table 10 presents the results of the model using multiple linear regression with vegetable yield as the dependent variable and the use of six sustainable farm management practices (IPM, Fungicides, irrigation, integrated weed management, conservation tillage, and pruning) as the independent variables. Statistical significance of the variables was tested at 5% and 10% level of significance. According to Aron, Aron, and Coups (2019) in their book entitled 'Statistics for Psychology (7th ed.)', 10% significance level can be considered when dealing with a small population or sample size.

Table 10: Influence of sustainable farm management practice on hot pepper yield

Variable	B	Std. Error	Beta	T	Sig.	Part Correlation (Sr^2)
Constant	1.930	.824		2.343	.021	
Extent of use of IPM	.140	.078	.180	1.794	.076*	.162
Extent of use of Fungicides	.237	.113	.214	2.088	.039**	.188
Extent of practicing pruning	.156	.098	.149	1.602	.112	.144
Extent of use of IWM	.240	.102	-.216	-2.362	.020**	-.213
Extent of irrigation	-.115	.109	-.105	-1.051	.296	-.095
Extent of use of conservation tillage	.241	.121	.196	1.999	.048**	.180

R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	*F* Change *df*1	*Df*1	*Df*2	Sig. *F* Change	Durbin-Watson
.460	.211	.162	.696	.211	4.330	6	97	.001	1.595

** significant at 5%, * significant at 10% Source: Field survey, (2021) The model as a whole is significant to predict hot pepper yield, F (6,97) = 4.330, p < .001. The R^2 for the overall model was 21.1% with an adjusted R^2 of 16.2%, a small effect size is reported by the model of variations in hot pepper yield and it is accounted for by the linear combination of the predictor variables (extent of use of: fungicides, IPM, irrigation, integrated weed management, pruning, and conservation tillage).

According to Ozili (2023), a low R-squared value in social science research is not necessarily bad provided most of the predictor variables are significant. Frost (2018) posits that obtaining high levels of accuracy in predictions related to human behaviour and perception is challenging, resulting in low R-squared values in such pursuits. The rationale is that human behaviour is inherently more complex and less predictable than physical phenomena. Frost (2018) argues that if the statistical values regarding the predicted value are significant despite a low R-squared value, then it may be concluded that the changes in the predictor values are consistent with the changes in the responder value. With all other predictors held constant, statistically significant coefficients continue to represent the average change in the response per unit change in the predictor. Ozili's (2023) claim that a low R-squared value in social science research does not automatically signal a poor fit supports this statement.

In the final model, of the six independent variables, four of them were found to be statistically significant with IPM (t= 1.794, p< .076, β= .180), fungicides (t= 2.088, p< .039, β= .214), pruning (t= 1.602, p< .112, β= .149), integrated weed management (t= 2.362, p< .020, β= .216), irrigation (t= 1.051,

$p < .296$, $\beta = .105$) and conservation tillage ($t = 1.999$, $p < .048$, $\beta = .196$) in vegetable yield. The final predictive equation was

Hot pepper yield(Y) = 1.930 + 0.140(IPM) + 0.237 (fungicides) + 0.156 (Pruning) + 0.115 (irrigation) + 0.240 (IWM) + 0.241 (Cons. Tillage)

Integrated pest management recorded a statistically significant and positive relationship with hot pepper yield recording a *p*-value of 0.076 at 10% significance level. The positive slope coefficient (B) for extent of use of IPM (0.140) as predictor of hot pepper yield indicated there was about a 0.140 increase in vegetable yield for each 1 unit increase in extent of use of IPM. In other words, there is a little increase in the yield of hot pepper as extent of use of IPM increases. Referring back to the conceptual framework, we find that adoption of integrated pest management influences yield. The squared semi-partial coefficient (sr^2) that estimated how much variance in hot pepper yield was uniquely predictable from IPM was 0.162, indicating that about 16% of the variance in the hot pepper yield is uniquely accounted for by IPM when fungicides, pruning, irrigation, integrated weed management and conservation tillage are controlled.

Fungicide application recorded a *p*-value of 0.039 which indicates a statistically significant and positive relationship between fungicide application and vegetable yield. Relating our findings to the overarching concepts in our conceptual framework, it is evident that fungicide application to hot pepper influences yield positively. The positive slope coefficient (B) for extent of use of fungicides (0.237) as predictor of vegetable yield indicated there was about a 0.237 increase in hot pepper yield for each 1 unit increase in extent of use of fungicides. In other words, hot pepper yield tends to increase as extent of use of fungicides increases. The squared semi- partial coefficient (Sr^2) that estimated how much variance in hot pepper yield was uniquely predictable from the use of fungicides was 0.188, indicating that about 19% of the variance in the vegetable yield is uniquely accounted for by the use of fungicides when IPM, IWM, pruning, irrigation, and conservation tillage are controlled. This finding corroborates the findings of Boatman (1992) and Hřivna, (2003) both of which found significant increase in yield of crops subjected to fungicide treatments for the purpose of controlling diseases.

Pruning recorded a *p* value of 0.112 at 5% significance level which indicates a statistically insignificant relationship with vegetable yield. This is inconsistent to the theoretical underpinnings in the conceptual framework which state that pruning influences the yield of hot pepper. Although not significant, the finding is consistent with that of Thakur et. al., (2018); Resh (1997); Jovicich et al. (1999); which state that pruning in pepper enhances light interception, fruit set, fruit quality and ultimately higher marketable yields. This means that the farmers in the study area are not taking advantage of the beneficial effects of pruning though it is reported that pruning in pepper plants increases yield by 25% (Osei et al, 2018).

At 5% significance level, integrated weed management has a p-value of 0.020. This suggests that IWM and hot pepper yield have a statistically significant and positive association. Hot pepper yield increased by roughly 0.240 units for every unit that the degree of adopting integrated weed management (IWM) increased, according to the positive slope coefficient (B) for this indicator of hot pepper yield. This result is grounded in the conceptual framework, which posits that adoption of integrated weed management influences hot pepper yield. More simply, the amount of IWM usage seems to boost vegetable output. When IWM, fungicides, pruning, irrigation, and conservation tillage are controlled, the squared semi-partial coefficient (Sr^2) that determined how much variation in hot pepper yield was solely predictable from IWM was 0.213, meaning that about 21% of the variance in the vegetable yield is solely accounted for by the use of IWM. This finding is consistent with the findings of Tetteh et al. (2018) and Agyare et al. (2019) who in their investigation on the effects of IWM on crop yield discovered significant increase in the yield of hot pepper when IWM was employed. This means that the efficient management of weeds in crop fields results in an improvement in yield.

Irrigation recorded a *p*-value of 0.296 at 5% significance level which indicates a statistically insignificant relationship with hot pepper yield. This means that irrigation does not significantly affect the vegetable yield of farmers in the Agona West municipality. This result is inconsistent with the context of our conceptual framework which posits that irrigation influences hot pepper yield. This insignificant relationship may be as a result of low practice of irrigation and it can be associated to the inadequate access to water for irrigation purposes as cited by the farmers as a challenge they face. The results of Shock et al. (2005) and Huang et al. (2002), who found that the amount of irrigation water used significantly affects crop yields, are at odds with these results. The more water is utilized for irrigation, the greater the agricultural production will be. However, above a certain level of water use, no additional gains in crop output are seen. This decrease in output may be traced back to the shortage of oxygen during the near-saturated circumstances and the excessive development during the vegetative phase.

Conservation tillage recorded a *p* value 0.048 at 5% significance level which indicates that there is a statistically significant and positive relation between conservation tillage and vegetable yield. This result aligns with the theoretical underpinnings of our conceptual framework which posits that conservation tillage influences the yield of hot pepper. The positive slope coefficient (*B*) for extent of practice of conservation tillage (0.24) as predictor of vegetable yield indicated there was about a 0.241 increase in vegetable yield for each 1 unit increase in extent of practice of conservation tillage. In other words, vegetable yield tends to increase as extent of use of conservation tillage increases. The squared semi- partial coefficient (Sr^2) that estimated how much variance in vegetable yield was uniquely predictable from conservation tillage was 0.18, indicating that about 18% of the variance in the vegetable yield is uniquely accounted for by the use of conservation tillage when IPM, fungicides, pruning, irrigation and integrated weed management are controlled. This finding corroborates the findings of Huang et al., 2018; Devita et al., 2007; Han et al., 2020; Hirzel et al., 2020; Zhao et al., 2019 and Omara et al., 2019 which says that the practice of conservation tillage results in an increase in crop yield.

Overall, the results showed that conservation tillage (with slope coefficient of 0.241) had the highest influence on the yield of hot pepper followed by integrated weed management, fungicide application, and integrated pest management with slope coefficients of 0.240, 0.237, and 0.140

respectively. However, pruning and irrigation were found to be insignificant on the yield of vegetables in the Agona West municipality.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This chapter gives the summary of the findings, inferences from the finding and suggestions based on the conclusion of the study. Summary of the results and conclusions have been arranged according to the specific objectives of the study. This chapter also includes proposed topics for additional study and investigation.

Summary of research process

This study investigated sustainable farm managements practice hot pepper farmers in the Agona West municipality use and the effects the usage have on hot pepper yield. The study looked at the variables influencing the adoption of sustainable farm management practices, the extent to which these management practices are used, and how these management practices affect yield since these are areas that have received little attention in the discussion over the factors that determine crop output. In the quest to look at the implication of sustainable farm management practice on hot pepper yield, the study determined the level of adoption of sustainable farm management practice by the hot pepper farmers; ascertained the factors influencing the adoption of sustainable farm management practice; found out challenges faced by the farmers in the use of sustainable farm management practice; and examined the influence of the management practice on the yield of hot pepper in the Agona West Municipality.

A validated interview schedule was used to collect data from 104 hot pepper farmers in the research region in accordance with the study's specific objectives. Six predominantly used sustainable farm management practices advocated to be sustainable farm management practices were considered in this study. Measures of central tendency, descriptive statistics, independent sample t-test, analysis of variance, Biserial correlation, Pearson Product Moment Correlation and multiple linear regression were the statistical tools utilized to analyze the data.

Summary of Key Findings

With regards to the level of adoption of sustainable farm management practice activities including IPM, the use of fungicides to control diseases, pruning, irrigation, IWM, and conservation tillage, it came out that the producers of pepper in Agona West municipality generally use SFMP. They frequently use IWM (M= 4.37, SD= 0.73), fungicides (M= 4.04, SD= 0.69), conservation tillage (M=3.84, SD= 0.98) and IPM (M= 3.62, SD= 0.98), and occasionally carry out pruning (M= 3.13, SD= 1.37) and irrigation (M= 3.43, SD= 1.08).

With regards to the factors influencing the adoption of sustainable farm management practice, an independent samples T-test showed that there is no significant difference between males and females in the adoption of sustainable farm management practice in hot pepper production in the study area but a significant difference between membership and non-membership of cooperative society with regards to the adoption of sustainable farm management practice was found. However, an ANOVA test on age showed a statistically significant difference between the age categories in terms of adoption of sustainable farm management practice. A post-hoc estimation on age revealed that the mean score for 20-29 age category (M= 4.14, SD= 0.49) was significantly different from the 30-39 age category (*M*= 3.79, *SD*= 0.37) with a *p*-value of 0.04 at 0.05 alpha level. This means that, in terms of adoption of sustainable farm management practice, the 20-29 age category has a higher rate than the 30-39 age category. ANOVA results on the other farm and farmer characteristics showed that the various categories of marital status, household size, level of education, years of farming experience, farm size and land tenure do not differ significantly from each other. That is, the categories of these variables are not different from each other when it comes to the adoption of sustainable farm management practice. None of them ranks higher than the other. However, the other variables of socio-demographic and farm related characteristics showed no significant differences.

With regards to the farmers' perception on the influence of farm and farmer characteristics on the adoption of SFMP, the farmers generally perceive farm size as a factor that highly influences their decision to adopt sustainable farm management practice. Further, household size, income level and farmers' years of experience were all perceived to have low influence on farmers' decision to adopt sustainable farm management practice.

On institutional factors influencing adoption of sustainable farm management practice, access to credit from financial institutions and access to extension services were perceived by the farmers to have influence on their adoption of SFMP to a high extent, compared to environmental and government regulations and access to markets that were perceived to a low extent by the farmers.

Regarding the perception of hot pepper farmers on the characteristics of SFMP as influencing factors in the adoption of SFMP, it is highly perceived by the farmers that sustainable farm management practices are useful and easy to use because they produce the desired results.

On challenges regarding the use of the SFMP, the study found that the farmers had inadequate capital investment due to the small loan sizes, and high interest rates and huge collaterals demanded for large loan sizes and also, inadequate labour due to the scarcity of labour and the high cost of the available ones.

Land tenure was also noted as an issue by the farmers in the adoption of sustainable farm management practice as they are unwilling to install irrigation systems such as drip irrigation which is labour-intensive and expensive because the lands on which they farm are only rented out to them for a short period of time.

Access to water for irrigation was also noted as one of the challenges some farmers face in the production of their crops as water sources are not in close proximity to their farms and hence, they have to haul water from far locations to their farm which demands a lot of effort.

Integrated pest management recorded as statistically significant and positive relationship with vegetable yield with a 0.014 increase in hot pepper yield resulting from a unit increase in the usage of IPM. Fungicide application registered a statistically significant and positive link with hot pepper yield as a unit increase in the use of fungicides resulted in a 0.237 increase in hot pepper yield. While pruning showed a statistically inconsequential connection with vegetable yield, Integrated weed management recorded a statistically significant and positive relationship with hot pepper yield. It was demonstrated that vegetable yield went up by 0.240 unit for every unit increase in the extent of use of integrated weed management. Conservation tillage also recorded a statistically significant and positive link with vegetable yield. Results showed that there was a 0.241 gain in vegetable yield for every unit increase in the practice of conservation tillage. However, Irrigation recorded a statistically inconsequential connection with vegetable yield. This implies that irrigation does not appreciably impact the yield of vegetables in the Agona West municipality.

Conclusion

1. The vegetable farmers in Agona West Municipality frequently practice IPM, fungicide application, IWM, and conservation tillage and occasionally practice irrigation and pruning.
2. Farm size is perceived by hot pepper farmers to have high influence on adoption of sustainable farm management practice.
3. The Agona West Municipality has more youthful farmers in vegetable production who would be more receptive and willing to incorporate to new farming practices and technologies. Also, farmers who are members of cooperative societies adopt more inclined to adopt SFMP than non-members.
4. The vegetable farmers in Agona West Municipality highly perceive sustainable farm management practice as useful and easy to use because they produce the desired results.
5. Institutional factors such as access to institutional credit, extension services and government policies such as seed and fertilizer subsidy were found not to significantly influence adoption of sustainable farm management practice in the study area.

6. The major challenges faced by the vegetable farmers in the Agona West Municipality in the use of the SFMP are financial challenges, inadequate access to labour, land tenure issues, and inadequate access to water for irrigation purposes.
7. Integrated Pest Management, fungicide application, Integrated Weed Management, and conservation tillage were found to have a significant positively influence on the yield of vegetables in the Agona West Municipality.
8. Irrigation and pruning were found to have no significant influence on the yield of vegetables in the Agona West Municipality, largely because they are least practiced by the farmers.

Recommendations

According on the study's findings, the following recommendations are made:

1. The Department of Agriculture in the Agona West Municipality should encourage the farmers to intensify use of IPM, IWM, and Conservation tillage since they have been found to have a positive influence on yield.
2. The Department of Agriculture should assist hot pepper farmers in the Agona West Municipality invest in low-cost irrigation systems such as furrow irrigation to improve water use efficiency and reduce crop stress during dry periods.
3. Hot pepper farmers in the Agona West Municipality should prune their vegetables where appropriate to improve yields and quality.

4. The Department of Agriculture and NGOs in extension should promote farm intensification to increase the level of yield per unit of farm area in the Municipality.
5. The Department of Agriculture and NGOs in extension should prioritize outreach and support for younger farmers, in order to encourage greater adoption of best practices and technologies, including low-cost irrigation systems and pruning.
6. Hot pepper farmers in the Agona West Municipality should collaborate with the Department of Agriculture to establish viable groups and cooperatives to facilitate their access to institutional credit, labour and secured land to promote the adoption of sustainable farm management practice.
7. Bodies such as the MoFA, CSIR, International Institute of Tropical Agriculture and NGOs should conduct research to explore other variables that influence adoption of SFMP as most of the variables found in literature cited in this study was found not to be significant predictors of adoption of SFMP in the study area.

Suggestions for Further Research

Further study is recommended in the following areas

1. Further research should be conducted incorporating quantitative experimental methodologies to systematically examine the influence of sustainable farm management practices on hot pepper yield, moving beyond farmer opinions and allowing for rigorous testing of these impacts.

2. Further studies should incorporate real-time data collection methods or memory validation techniques, to reduce the likelihood of perception errors and enhance the accuracy of information in future studies.
3. The scope of future investigations should include a diverse range of vegetables, addressing the current limitation of focusing solely on hot peppers, to provide a more comprehensive understanding of how sustainable farm management practices may impact different crops.

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APPENDICES

APPENDIX A

UNIVERSITY OF CAPE COAST

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION

SUSTAINABLE FARM MANAGEMENT PRACTICES AND THEIR EFFECTS ON HOT PEPPER PRODUCTION AMONG FARMERS IN THE AGONA WEST MUNICIPALITY

STRUCTURED INTERVIEW SCHEDULE FOR FIELD DATA COLLECTION

Any information you provide will be kept strictly confidential. It is mainly for academic purposes and only pooled results will be reported or published to improve the vegetable enterprise in the Agona West Municipality.

INSTRUCTION: Please tick **[√]** in the boxes provided or write your answers where applicable to answer the questions.

Community: ……….…………………..…. **Interview Schedule no.: …..**

SECTION A – BACKGROUND INFORMATION

1. Sex: Male [ ] Female [ ]
2. Age at last birthday: 20 and below [ ] 20-29 [ ] 30-39 [ ] 40-49 [ ] 50 and above [ ]
3. Level of education: No formal education [ ] Primary [ ] JHS [ ]SHS [ ] Tertiary [ ]
4. Marital status: Single [ ] Married [ ] Divorced [ ] Widowed [ ]
5. Household size: 1-5 [ ] 6-10 [ ] 11-15 [ ] 15 and above [ ]
6. Household labour size : 3 and below [ ] 4-7 [ ] 8-11 [ ] 12-15 [ ] 15 and above [ ]
7. Number of years in vegetable production:1-3 [ ] 4-7 [ ] 8-11 [ ] 12-15 [ ] 15 and above [ ]
8. Do you belong to a farmer association? Yes [ ] No [ ]

9. If 'Yes' to Q 7 what major benefit(s) do you receive for belonging to this association?

   Farm inputs [ ] Credit [ ]

   Transport services [ ] Marketing of produce [ ] None [ ] Others (specify) . . . .

10. Please indicate your farm size in acres ……

11. Which of the following land tenure systems applies to your farmland?

    a. Inherited [ ]
    b. Own (Outright purchase) [ ]
    c. Gift [ ]
    d. Rent [ ]
    e. Sharecropping (Abunu and Abusa) [ ]

SECTION B: SUSTAINABLE FARM MANAGEMENT PRACTICES AND THEIR EXTENT OF USE

Using a scale of **1= Very Rarely, 2= Rarely, 3= Occasionally, 4= Frequently and 5 = Very Frequently**, please indicate the extent at which you use the under listed farm management practices on your farm.

No	Sustainable Farm Management Practice	USE		Extent of Use				
		Yes	No	1	2	3	4	5
1	Integrated Pest Management (IPM)							
2	Pruning							
3	Fungicide Application							
4	Irrigation (manual)							
5	Integrated Weed Management (IWM)							
6	Conservation Tillage							

SECTION C: FACTORS INFLUENCING ADOPTION OF SUSTAINABLE FARM MANAGEMENT PRACTICE

Perceived Characteristics of Sustainable Farm Management Practice in Hot Pepper Production

Please indicate your level of agreement to the following as factors that influence your decision to adopt the farm management practice. Use a scale of 1 to 5 where:

1= Very High Extent

2= High Extent

3= Low Extent

4= Very Low Extent

5= No Extent

Please tick **[√]** the appropriate box

	Perceived characteristics of SFMP	**Extent of Influence**				
		1	**2**	**3**	**4**	**5**
A	**Perceived Usefulness**					
1.	Using the SFMP is useful in my farm					
2.	Using the SFMP can increase my yield					
3	Using the SFMP reduce my cost of production					
B	**Perceived Ease of Use**					
1	Using the SFMP would not require a lot of mental effort					
2	The SFMP are easy to use					
3	The methodology of using the SFMP is easy to understand					

Factors of Institution

Please indicate the extent to which the following factors influence the adoption of farm management practice. Use a scale of 1 to 5 where: **1= Very High Extent, 2= High Extent, 3= Low Extent, 4= Very Low Extent and 5= No Extent.**

	Institutional factors	Level of Agreement				
		1	2	3	4	5
1	Access to credit from financial institutions					
2	Access to regular extension services					
3	Environmental regulations in Ghana					
4	Government policies such as seeds and fertilizer subsidy					
5	Land tenure system					
6	Access to market to purchase farm inputs					
7	Access to market to sell farm produce					

SECTION D: CHALLENGES FACED IN USING THE FARM MANAGEMENT PRACTICE

Do you face any challenges in the application of the following farm management practice?		Yes	No	If Yes, state the challenge faced
1	IPM			
2	Pruning			
3	Fungicide application			
4	Irrigation			
5	Integrated Weed Management			
6	Conservation Tillage			

SECTION E: PERCEIVED EFFECT OF SUSTAINABLE FARM MANAGEMENT PRACTICE ON HOT PEPPER YIELD

Kindly indicate the extent to which the underlisted farm management practices influence vegetable yield. Use a scale of 1 to 5 where:

1= Very large extent

2 = Large extent

3 = Moderate

4 = Least extent

5 = Very least extent

Please tick **[√]** the appropriate box.

	Sustainable Farm Management Practice The following management practices affect vegetable yield	**Level of Agreement**				
		1	**2**	**3**	**4**	**5**
1	Integrated Pest Management (IPM)					
2	Pruning					
3	Fungicide application					
4	Irrigation (in any form)					
5	Integrated weed management					
6	Conservation Tillage					

F. On average, how many mini-bags of pepper did you harvest in the following years?

Year	**No. of Mini-bags (25kg)**
2020	
2019	

APPENDIX B

CRONBACH'S ALPHA RELIABILITY TEST RESULTS

Variables	Number of items	Cronbach's Alpha Reliability Coefficient	Comment
Extent of Use of SFMP	6	0.674	Accepted
Characteristics of Technology	6	0.637	Accepted
Institutional Factors	7	0.683	Accepted
Effects of SFMP on Yield	6	0.721	Accepted