© University of Cape Coast https://ir.ucc.edu.gh/xmlui

UNIVERSITY OF CAPE COAST

USAGE OF IMPROVED INPUT TECHNOLOGIES IN MAIZE FARMING AND RURAL DEVELOPMENT IN THE KETU NORTH MUNICIPALITY OF GHANA

ROBERT KWAME AHIADZO

2021

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

UNIVERSITY OF CAPE COAST

USAGE OF IMPROVED INPUT TECHNOLOGIES IN MAIZE FARMING AND RURAL DEVELOPMENT IN THE KETU NORTH MUNICIPALITY OF GHANA

BY

ROBERT KWAME AHIADZO

Thesis submitted to the Department of Integrated Development Studies of the School for Development Studies, College of Humanities and Legal Studies, University of Cape Coast, in partial fulfilment of the requirements for the Award of Master of Philosophy Degree in Development Studies

April 2021

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

DECLARATION

Candidate's Declaration

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

Candidate's Signature……………………… Date…………………

Name: ………………………………………………………………………

Supervisor's Declaration

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

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

Name: ………………………………………………………………………

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

ABSTRACT

The purpose of the study was to determine proportion of sampled farmers who used improved input technologies, to examine the factors that affect usage of the technologies, and to estimate the outcomes for rural development in the Ketu North Municipality of Ghana. Theories of traditional agriculture, technological determinism, and technology acceptance underpinned the study. The study used a mixed-method approach, comprising a survey of 300 farmers, and key informant interviews to arrive at the findings. The quantitative data were analysed using descriptive statistics, Chi-square, Wilcoxon sum test, logit models and Foster-Greer-Thorbecke (FGT) poverty index, while the key informant interviews were transcribed and interpreted. The study found that majority (61%) of the farmers used improved maize varieties at erratic ratios of fertilizer application, and that the municipal crop office supplied the improved input technologies, which were introduced to farmers via demonstrations by extension agents. Membership of farm-based unions, quality of extension contacts, access to phone-based extensions, years of education, and access to credit facilitated usage of improved technologies, while years of experience explained the non-usage. The outcomes were that users of improved technologies had higher maize yield, income, food security, and lower poverty incidence, lower gap and lower severity than nonusers, whereas input maize price consistently increased food insecurity. The conclusion was that improved input technologies present potentials for poverty reduction through increased yield, income and food security as a pathway for rural development. Thus, it was recommended for the farmers to deepen the usage of improved technologies in farming for increased yield and associated benefits that are necessary for rural development.

Digitized by Sam Jonah Library

© University of Cape Coast   https://ir.ucc.edu.gh/xmlui

KEY WORDS

Agriculture

Development

Improved

Input

Rural

Technologies

Traditional

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

ACKNOWLEDGEMENTS

I am profoundly indebted to my supervisor, Prof. Francis Enu-Kwesi whose unequivocal suggestions, patience, support as well as critique helped clarify my thoughts to improve the final draft of this thesis. I would also like to express my gratitude to Mr. Dennis Korbla Amego Penu for encouraging me to pursue this master's programme. I express a cavernous gratitude towards all the research fellows at the School for Development Studies who readily provided the needed support. I am equally grateful to the trustees of the Samuel and Emelia Brew-Butler-SGS/GRASAG, UCC Research Grant for the apt financial supports for the thesis. Finally, I cannot end this expression of gratitude without citing the rural maize farmers, the crop officer as well as the extension officers in the Ketu North Municipality of Ghana who provided the data for this thesis.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

DEDICATION

To my twin sons, Kekeli Gilbert Ahiadzo and Klenam Herbert Ahiadzo and their mother, Christiana Zanu.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

TABLE OF CONTENTS

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

LIST OF TABLES

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

LIST OF FIGURES

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

LIST OF ACRONYMS

FAO	Food and Agriculture Organization
GSS	Ghana Statistical Service
ICT	Information Communication Technology
KNMA	Ketu North Municipal Assembly
KN-MoFA	Ketu North Ministry of Food and Agriculture
MoFA	Ministry of Food and Agriculture
OPVs	Open Pollinated Varieties
PFJ	Planting for Food and Jobs
STAT	Schultz's Traditional Agriculture Theory
STD	Schumpeterian Technological Determinism
STI	Science, Technology and Innovation
TAM	Technology Acceptance Model
US	United States of America
VIF	Variation Inflation Factor

VERITAS LUMEN NOBIS

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

CHAPTER ONE

INTRODUCTION

Background to the Study

Moseley (2003) referred to rural development as a process of improving the quality of life and economic well-being of people living in rural areas, often relatively isolated and sparsely populated areas. Correspondingly, Enu-Kwesi, Koomson and Baah-Mintah (2013) pointed out that most poverty in the world is rural, and reaching international development targets means giving high priority to rural development. FAO (2015) added that 75 percent of the world's poor are rural farm households. The World Bank (2017) has cited that mainly, Sub-Sahara Africa is dominated by rural areas and that the region harbors 50 percent of the world's extremely poor, or persons who live below US$1.9 per day. Boogaad (2019) linked poverty issues to human rights related to the notion of rights to food and to existence. Thus, worldwide, rural poverty reduction remains the main aim of rural development experts (Feliciano, 2019).

Rural development, by reduction in poverty incidence, gap, and severity, may occur through the usage of improved input technologies such as improved maize varieties and associated inorganic fertilizers in rural farming activities. Theoretically, Schultz's Traditional Agriculture Theory argues that traditional farmers are poor but efficient such that growth and development can occur provided the farmers are given access to improved technologies (Pasa, 2017). This argument is explained by the tenets of Schumpeterian Technological Determinism that the nature of output is explained by dominant technologies used in its production and that increasing the output demands constant renewal of those technologies (Dafoe, 2015). The Technology Acceptance Model also clarifies that

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

dprofit-oriented qualities of technologies and ease of using them attract people to accept to use them in their activities (Gollin, 2014).

FAO (2015) declared that the major economic activity in rural areas is traditional agriculture, which Zeng et al. (2015) observed is characterised by the usage of indigenous farming practices that are associated with low outputs. Thus, Mathenge, Smale and Tschirley (2015) argued that the usage of improved input technologies would enhance productivity for rural agriculture, hence catalyse growth of the non-agriculture economy. Burrell, Nobles, Dawson, McDowell and Hines (2018) maintained that this argument is exemplified by the Green Revolution in Southern Asian communities.

However, it was later shown by Ahmed, Martey and Anang (2019) that traditional farmers are risk averters such that facilitation of farmers is needed to encourage their usage of improved technologies. Concerning these facilitating factors, Houeninvo, Célestin Quenum and Nonvide (2019) emphasized institution of government policy interventions and farm-based organizations, while Abdulai, Nkegbe and Donkoh (2018) had focused on extension contacts, and Akumbole, Zakaria and Adam (2018) cited access to agricultural credits. Relatedly, Manda, Alene, Gardebroek, Kassie and Tembo (2016) suggested human capital such as schooling, years of experience in farming, while Grabowski, Kerr, Donovan and Mouzinho (2015) drew attention to information communication technology-based extensions for a participative extension.

In respect of institutional factors, Mwalupaso, Korotoumou, Eshetie, Alavo and Tian (2019) explained that extension services expose the farmers to improved agricultural technologies and boost their confidence in the use of such improved technologies. Mariyono (2019) advised that though few farmers may

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

have enough income to afford the price of improved technologies exposed to them, majority of them may have to fall on agricultural credits for similar purposes. Gupta, Ponticelli and Tesei (2019) also opined that due to their low collateral accumulation, some farmers may be limited by the credit repayment conditions such that they may have to unionize and combine their resources to serve as collateral. In order to overcome the credit constraint, Fang and Meiyan (2017) had suggested that governments may have to intervene by providing either subsidy or improved technologies as a pro-poor farmer policy.

In addition, Pasa (2017) pointed out that human capital factors such as schooling and years of experience in farming facilitate the usage of improved technologies by farmers. In this regard, Cavicchi and Vagnoni (2018) explained that schooling enables farmers to easily comprehend instructions on the usage of improved technologies and to respond quickly to agricultural innovations. Abdulai, Nkegbe and Donkoh (2018) added that even without schooling, the farmers with several years of experience in farming usually know about agriculture technologies that favour particular farming seasons. Similarly, Danquah, Ahiadzo, Appiah, Roberts, and Pappinen (2019) observed that schooling becomes most beneficial for usage of improved technologies as farmers remain in farming to put their educational experiences to practice.

Concerning information communication technology-based extensions, Chhachhar, Qureshi, Khushk and Ahmed (2014) suggested that traditionally, information vans, radios, and televisions serve such purpose in agricultural productions. However, Grabowski et al. (2015) observed that the usage of these technologies includes a top-down approach that has been resulting in poor uptake of extension information. Otte, Bernardo, Phinney, Davidsson and Tivana (2018)

Digitized by Sam Jonah Library

© University of Cape Coast   https://ir.ucc.edu.gh/xmlui

explained that unlike emerging mobile phones, radios and televisions make it difficult for information flow from farmers to extension officers and experts in various disciplines. Thus, Asongu, Nwachuku and Pyke (2019) have argued that access to ICT-based extensions, including mobile phone-based extensions would enhance accurate uptake of extensions, which is relevant to new technology usage in farming.

Even though agriculture includes fish farming, animal husbandry, and crop farming, FAO (2019) stated that maize is one of the most widely consumed and widely cultivated cereal crops in the rural areas across the world. Thus, Houeninvo, Célestin Quenum and Nonvide (2019) argued that facilitating the usage of improved maize varieties and associated inorganic fertilizers is most likely to have a greater impact on rural poverty reduction for rural development. Adam, Kandiwa, David and Muindi (2019) explained that improved maize varieties have attributes such as dry season resilience, disease impediment, short development rate, increased yield per unit of land, and enhanced quality of protein. Moreover, Ogada and Nyangena (2019) showed that the inorganic fertilizer can adapt to heterogenous conditions in most farming areas and overcome the problem of low output that result from low fertile soils.

Empirically, several studies verified that the usage of improved maize varieties and the associated inorganic fertilizers are a pathway for rural development. Kassie, Jaleta and Mattei (2014) found that sowing of improved maize varieties reduces food insecurity in rural Tanzania, while Zeng, Alwang, Norton, Shiferaw, Jaleta and Yirga (2015) revealed that the improved maize varieties significantly reduced rural poverty headcount ratio, poverty depth and severity in Ethiopia. Manda et al. (2016) also reported that education, financial

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

credit, and government aid facilitated the usage of improved maize varieties and associated inorganic fertilizers, which reduced rural poverty gap and promoted rural development in Zambia. Similar findings were conveyed in Nigeria (Abdoulaye, Wossen & Awotide, 2018), and Ghana (Ahmed, Martey, & Anang, 2019) as well as Benin (Houeninvo et al., 2019).

Relating to Africa, the FAO (2017) observed that the contribution of agriculture as the backbone of her development has been declining lately, while Rahmanian, Batelloz and Calles (2018) pointed out that over 75% of arable lands in the region is degraded. In response, Amankwah-Amoah (2019) cited that Africa is instituting policy measures to facilitate the usage of improved technologies, and Botchwey (2019) explained that the Forum for Agriculture Research in Africa is a technical arm that is rejuvenating agriculture science, technology and innovation. Aworawo (2020) added that the Lagos Plan of Action maintains that science, technologies and innovations can help solve the development challenges of Africa and accelerate a catch-up with the developed world. Thus, African states are expected to cede one percent of their Gross Domestic Product to the usage of improved technologies (Tetteh et al., 2020).

In respect of Ghana, Kansanga (2017) documented several policies that reiterate the essence of using improved technologies for the development of the country. Sims and Kienzle (2017) also pointed out that the National Science, Technology and Innovation (STI) Policy aims at harnessing the country's STI capacity for wealth creation, poverty reduction, competitiveness of enterprises, sustainable environmental management, and industrial growth. Specifically, PFJ (2017) elaborated that the nation's 2017 policy on 'Planting for Food and Jobs' has the specified goals to provide improved seeds and fertilizers at 50 percent

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

subsidised prices, free extension services, open up market opportunity, and electronic agriculture database for tracking farmers. Tanko et al. (2019) cited maize as one of the five main crops that are prioritised in this policy.

In the Ketu North Municipality of Ghana, 70.5 percent of the population is rural, of which 75.8 percent are farm households, and farming, particularly maize farming, is the main source of family income for more than 60 percent of the entire population (GSS, 2010). Acquah and Annor-Frempong (2011) also reported that farming in the district is dominated by the cultivation of local crop varieties that are associated with a high level of rural poverty due to low yield and income. The Ministry of Food and Agriculture (MoFA, 2017) further stated that maize remains a source of 'akple', the staple food for the people, and it is cultivated in almost every rural area of the District on an average land size of one to two hectares.

Statement of the Problem

The Ketu North Municipality of Ghana has a total population of 99,913 people and about 30 percent of them are extremely poor, or live below US$ 1.9 per day (GSS, 2015). In order to increase the yield of maize as the source of the staple food of the people, the extension officers of the Municipality introduced some improved maize varieties and associated inorganic fertilizers to farmers across four operational zones. Yet, for several years now after such intervention, the average yield of maize in the Municipality is 1.6 metric tons per hectare, which is less than the actual national average yield of 1.73 metric tons per hectare (MoFA, 2015). Even though the national actual yield of maize increased to 1.99 metric tons per hectare in 2017, with the usage of improved maize technologies,

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

MoFA reported from a trial farm in the same year that 5.5 metric tons per hectare are achievable (MoFA, 2017).

As explained by technological determinism, the low output from the maize farms in the Municipal could mean that majority of the farmers are not using the improved input technologies introduced (FAO, 2015). Schultz's traditional agriculture theory explains that low usage of improved agriculture technologies could mean that institutions such as extension contacts, credit services, farm-based organizations, governmental policy interventions are weak or none existent in the Municipality (Pasa, 2017). It could also mean that the farmers have limited human capital such as education and experience in maize farming (Houeninvo, et al., 2019). Technology Acceptance Model could be insightful that the farmers have limited access to radio, television, mobile phones for increasing awareness on the profitability and the ease of using those improved input technologies in maize farming (Gupta et al., 2019).

Given that farming has been the foremost means of societal growth (Haggblade, Me-Nsope & Staatz, 2017; Schultz, 1964), the low usage of the improved input technologies for increasing output has untold implications for the development of the municipality and the nation at large. For instance, as of 2019, the yield of maize in the country is below capacity such that over 15 percent of the maize consumed in the country was imported (MoFA, 2019). As maize is widely consumed in virtually every part of the country (Ahmed, Martey, & Anang, 2019), the low output means that human rights related to the notion of rights to food and existence are being undermined (Boogaard, 2019). Similarly, as most of the rural farmers in the Ketu North Municipality depend on the output

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

from maize farms for survival (KN-MoFA, 2019), the low output could weaken the tendency of reducing rural poverty as a pathway for rural development.

Thus, it is relevant to study the usage of improved input technologies in maize farming and rural development of the area. Previous studies were limited exclusively to impact analysis of the technologies (Abdoulaye et al., 2018; Kassie et al., 2014; Zeng et al., 2015), or facilitating factors analysis (Akumbole et al., 2018; Mmbando & Baiyegunhi, 2016), which did not provide a holistic overview. Though Manda et al. (2016) and Houeninvo et al. (2019) considered both facilitating factor and impact analysis, access to ICT-based extension was omitted. Though improved crop varieties are usually introduced together with their associated inorganic fertilizers to farmers (Bear & Holloway, 2015), none of the authors, except Manda et al (2016) considered that in their analysis. Thus, this study intends to narrow those gaps in the literature.

Objectives of the Study

The general objective of the study was to assess the usage of improved input technologies in maize farming for rural development in the Ketu North Municipality of Ghana. Specifically, the study sought to:

1. Determine the proportion of the sampled rural maize farmers who used improved input technologies in the Ketu North Municipality;
2. Examine the factors that affect usage of improved input technologies in maize farming;
3. Evaluate the outcomes of the usage of improved input technologies in maize farming for rural development in the study area; and
4. Make recommendations for intensification of improved input technologies in maize farming.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Research Question

In order to address objective one, an associated research question was posed:

1. What is the proportion of the rural maize farmers who used the improved input technologies in the farming activities of the Ketu North Municipality?

Research Hypotheses

The following alternate hypotheses were stated to address objectives two and three respectively:

2. H2: Institutional factors, human capital and access to ICT-based extensions significantly affect usage of improved technologies in maize farming;
3. H3: Usage of improved input technologies in maize farming significantly affects rural development indicators in the study area.

Significance of the Study

It is anticipated that the study will help policymakers to develop policies for increasing the output of rural maize farming in Ghana. It is hoped that Planting for Food and Jobs policy implementers will eventually be informed on the facilitating factors that should be provided to ensure that farmers renew their traditional technologies. The findings from the study will provide information on how to intensify the use of improved input technologies in maize farming to ensure increased production, income and food security for the rural poor. This relevance has been embedded within the broad spectrum of human rights related to the notion of rights to food and existence (Moyo, 2003). The study would also contribute to the literature on technology usage and rural development.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Scope of the Study

The study was confined to rural maize farmers who were introduced to improved maize varieties and associated inorganic fertilizers in the Ketu North Municipality of Ghana. Thus, improved input technologies in maize farming were limited to improved maize varieties and inorganic fertilizers. The study accredited financial and time constraints that necessitated the usage of a sample to represent the rural maize farmers in the municipality. Among other facilitating factors in agriculture, this study limited itself to institutional factors (extension services, financial credit, government policy, farmers' association), human capital (years of schooling, years of experience in farming), and ICT-based extensions (radio, television, mobile phone) as in Figure 1. The outcome of the improved input technologies for rural development was limited to maize yield, income and food security, and poverty issues limited to aggregate consumption expenditure.

Operational Definition of Terms

The following operational definitions, as used in the study, were derived after a systematic review of the literature.

Traditional agriculture: Type of farming in developing countries that is rain-fed, devoted to the usage of simple farm tools that farmers have used for decades.

Improved input technologies: New resources such as improved seeds and associated inorganic fertilizers.

Usage of improved input technologies: Using improved maize seeds and/or inorganic fertilizers in the previous farm season

Rural development: Reduction in rural poverty emanating from an increase in farm yield as well as income and food security.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Organisation of the Study

This study is organised into five chapters. Chapter One provides an introduction to the thesis, which constitutes the background discussion to the problem, the statement of the problem, the objectives and the research questions of the study. Other aspects of the introductory chapter are the scope of the study, the significance of the study, the operational definition of terms, and the organization of the thesis. Chapter Two covers related works on the theoretical underpinnings of the study coupled with conceptual and empirical issues underlining improved technologies usage and rural development. Lessons learnt from the reviews and the informed conceptual framework is presented to finalize Chapter Two.

Chapter Three begins with an introduction that summarises the methods adopted for the study. The issues discussed in the methodology comprise a review of the research paradigm, a description of the study design as well as the study area. These are followed by a discussion of the target populations, the sampling procedures, the data sources, instruments for data collection, the fieldwork, data processing, and analysis as well as ethical considerations of the study. Chapter four presents an analysis of the data collected and the discussion of the results of the analysis. These include the demographic features of the farmers, proportion of them who used improved technologies usage, facilitating factors for the usage, and the effects on maize yield, income, food security and poverty reduction for rural development. The last chapter which is chapter five focused on a summary of the study, conclusions, and recommendations.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

This chapter reviews some relevant literature on the usage of improved technologies and rural development. Kreuger and Neuman (2006) revealed that literature review demonstrates familiarity with a body of knowledge and shows a path of prior research and how this current thesis is linked to it. Zaremohzzabieh, Samah, Omar, Bolong and Shaffril (2014) suggested that this provides carefully joined and front-line information, and distinguishes richly written and most relevant studies that help to grasp and use methods that diminish bias and deepen precision. The supplementary theories like Schultz's Traditional Agriculture, Schumpeterian Technological Determinism, Technology Acceptance Model as well as the emanated concepts are discussed. Finally, empirical studies on the topic, the lessons learnt from the reviews, and the informed conceptual framework are presented.

Traditional Agriculture Theory

In traditional agriculture theory, Schultz (1964) projected a vital role for institutions and human capital as facilitating factors for the usage of improved input technologies in transforming traditional agriculture for increased profit, and capitalized on agriculture as the foremost means of economic growth. In the same manner, Schultz (1979) later added that knowing the economic aspects of agriculture, would help know a great part of the economic issues of being poor. According to Mathenge, Smale and Tschirley (2015) the theory maintains that unless productivity ensues from agriculture and catalyses the growth of the non-agriculture economy in developing countries, poverty remains inevitable.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

In an earlier contribution, Alston and Pardey (2014) had revealed that it is assumed that regardless of how rich a farmland is or how hard the farmer functions, the farmer who cultivates as his ancestors did, cannot escape poverty. Pasa (2017) has also pointed out that it is assumed that traditional farmers are poor but efficient in factor allocation such that they can bring about growth in agriculture and development provided that they are given access to improved technologies. Alston and Pardey (2017) supplemented that it is assumed that the traditional farmers are risk averters and that unless investments are made into institutions and human capital, the farmers are less likely to use the improved technologies. Another assumption, according to Dandekar (2017), is that the relative price of all factors of production remains unchanged and there is a perfect knowledge about the returns to various factors of production.

Fang and Meiyan (2017) cited that Schultz argued that by using these improved technologies, farmers can produce enough food to feed themselves and to feed their neighbours at a cheaper cost. Thus, Alston (2018) proposed that the main aim of Schultz's traditional agriculture theory is how to transform traditional agriculture into a form of farming that is dominated by the usage of high pay off inputs. A critical assessment of the contribution by Pardey and Alston (2019) suggests that traditional agriculture theory highlights the capability of the private and the public sector research institutions to create new input knowledge; the capability of the industrial sector to advance, produce, and make fresh technical inputs; and capability of the farmers to obtain new knowledge and use new agriculture technologies exceptionally.

Zeng et al. (2015) pointed out that the theory is widely accepted in rural development and economics due to high rates of returns associated with public

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

investments in rural farmers' usage of improved technologies in farming. Later, Alston and Pardey (2017) opined that the theory is able to explain why as rural farmlands lost fertility and there are limited lands available for farmers to continue with their traditional practice of shifting cultivation, donors to rural development are interested in farmers' usage of improved input technologies. Pasa (2017) shared a view that Schultz's ideas explain the food insecurity problems that confront the rural poor in Africa, while Pardey and Beddow (2017) stated that governmental investments in extension, financial credit, education of farmers and improved input technologies in agriculture are playing significant roles in the development of the United States.

Thus, Schultz's theory of traditional agriculture is dependable for the structure of this thesis on the usage of improved input technologies in maize farming and rural development. The theory provides a basis for the Ghana government's 2017 policy on 'Planting for Food and Jobs, a Campaign for Rapid Growth'. According to PFJ (2017), the policy aims to support farmers with improved seeds and fertilizers at 50 percent subsidised prices, free extension services, market opportunity, and electronic agriculture database for tracking farmers. The views shared by Tanko, Ismaila and Sadiq (2019) suggest that these objectives fall within Schultz's ultimate aim of transforming the traditional agriculture.

However, traditional agriculture theory has some weaknesses that seem to suggest that it is inadequate as a rural development theory. Ellis (2000) pointed out that rural livelihood diversification makes traditional agriculture transformation a less important aspect of rural livelihood strategies. Deere and Leon de Leal (2014) and Jacobs (2010) also critiqued that while the majority of

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

the rural poor are females, women receive little attention within the debate over the agrarian reform. Accordingly, Bernstein (2014) maintains that neither population nor technology could be stationary as suggested by the traditional agriculture theory because traditional agriculture is mostly associated with the search for new technologies or the faster diffusion of known innovations.

Udemezue and Osegbue (2018) further mentioned that even though traditional agriculture theory explained the facilitating factors for farmers' access to improved technologies, little attention is paid to what technologies mean. Similarly, though Schultz assumed that unless there exist an agriculture extension office in each rural community, traditional farmers are less likely to obtain agriculture extensions, Asongu et al. (2019b) maintain that this condition of close contact between farmers and extension sources may not apply in recent times due to the emergence of information communication technology-based extensions. As a way of overcoming these weaknesses, some researchers such as Manda et al. (2016), Pasa (2017), and Houeninvo et al. (2019) applied the Schumpeterian technological determinism theory.

Schumpeterian Technological Determinism Theory

Technological determinism trails Schumpeter's (1934) idea that changes that are produced in an economy emanate from technologies that ground-breaking producers come out with through 'trials and errors', which are later copied by less capable producers. Later, Schumpeter (2013) assumed that information about the technologies is of common knowledge to everyone, which leads into innovations disruptions and constant renewals such that unless technologies are updated, producers may be competed out of production. Nagy and Neff (2015) revealed that rewards of the technological renewal are kept in the forms of augmented flow

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

of goods and services, restructured production, reduced production costs, and the innovators' returns being altered into tangible income development.

Prior to that, Musson (2014) had pointed out that even though the profit that the pioneering innovation creates may be competed away by less capable producers as the innovation becomes a routine thing, competitors may also develop better versions of the initial innovation. Hence, McGaw (2014) had indicated that technological determinism is a lingering process of incorporating technologies to augment culture and extant growth and practices with slight respect for traditional cultural implications. Drew (2016) also contributed that there are hard technological determinists who maintain that technology has inherent ability to initiate changes while there are soft determinists who give much agency to social structure so deep that technology lost its power as an independent factor that is capable of initiating change in society.

McCarthy (2015) proved that whether technologies are accorded the qualities of originating changes that cause social adaption or not, technologies possess qualities that make them one of the basic needs of societal growth. Dafoe (2015) further explained that studies from technological determinism perspective treat technology and society as independent entities while technologies represent the determinants of the society's development. Surry and Baker III (2016) concluded that the technological determinism perspective is one of the long-lasting theoretical viewpoints that embrace technology as mainly a self-sufficient and beyond unswerving sociological regulations.

The idea of technological determinism contributes substantially to studies on usage of improved input technologies in farming and rural development. Schewe and Stuart (2015) explained that the renewal of the technologies in

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

agriculture can reorganize agriculture production and produce desirable changes. Bear and Holloway (2015) cited that rural areas serve as experimental stations for improved agriculture input technologies and the trials are mostly associated with increased agriculture output. Specifically, Otsuka and Larson (2015) showed that increasing maize yield in Africa demands improved input technologies such as improved maize varieties and associated inorganic fertilizers. Hence, Larson, Muraoka and Otsuka (2016) proposed that rural development in Africa depends on the usage of improved seed varieties and fertilizer technologies.

McCurry (2016) argued that the farmers in the rural areas of developed nations have embraced technological determinism to the extent that they can stay indoors and undertake all the processes of agriculture with the usage of automated robots. Even though Mmbando and Baiyegunhi (2016) mentioned that the farmers in rural areas of the developing countries may not be able to use such sophisticated technologies, Otsuka (2016) posited that the improved maize varieties and associated inorganic fertilizers are less sophisticated. Thus, Schumpeterian theory of technological determinism contributes greatly to this thesis on the usage of improved input technologies in maize farming and rural development.

However, critics cited some weaknesses of technological determinism. Chandler (2002) argued that the idea of technological determinism lacks historical perspective so much that it is an attempt to reduce via a naive approach, the complexities of the relationship between technology usage and societal growth. Bijker (2009) critiqued that technology does not follow its own momentum nor a rational goal-directed-problem-solving path but it is instead being shaped by social factors. In another contribution, Lin, Yip, Yang and Fu (2016) challenged that the emergence of modern technologies and the interactions between those

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

technologies and societies suggest that there is interdependency between societal growth and technological advancement. Murphie and Potts (2017) also argue that in the contemporary world, technology is shaped by politics and economic factors.

Other critics also suggest that the perfect competition suggested by Schumpeter is unlikely to occur in the rural areas (Dercon & Gollin, 2014). Haggblade, Minten, Pray, Reardon and Zilberman (2017) explained that even if a farmer incurs food and cash deficit in one year, his or her neighbours are more likely to help him or her than to compete him or her out of production. Pasa (2017) and Burrell (2018) also maintained that rural farmers are risk averters and are less likely to use the try and error approach suggested by Schumpeter. Thus, in order to overcome these challenges, there is the technology acceptance model, which suggests that rural farmers are more likely to be attracted by information on the profitable qualities and the ease of using the improved technologies to accept to use them in their farming activities.

Technology Acceptance Model

Technology Acceptance Model (TAM) follows an idea suggested by Davis (1989) for predicting and explaining technology usage behaviour. As revealed by Syiem and Raj (2015), perceived usefulness of the technology and perceived ease of using the technology form the basis of predicting the user's willingness to use a technology. Abdulai, Nkegbe and Donkoh (2018) pointed out that perceived usefulness denotes the level to which a person believes that using a particular technology augments work performance, while perceived ease of use means a level to which a person has confidence that using the technology would demand less effort.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

According to Chhachhar et al. (2014), it is assumed that people turn to use information communications technologies that increase ease of use and increase usefulness by allowing for information flow among users and producers. Syiem and Raj (2015) observed that traditionally, radios, televisions and information vans serve as information communication technologies in agricultural activities. Yet, Grabowski, Kerr, Donovan and Mouzinho (2015) maintain that the usage of these technologies has been resulting into poor uptake of extension services, because they involve the usage of top-down approaches which did not allow for information flow from the farmers to the researchers and to extension officers.

Aker, Ghosh and Burrell (2016) contributed that access to a two-way information technology could ensure that farmers easily communicate the difficulties involved in the usage of the improved input technologies to the extension sources. Asongu and Boateng (2018) also observed that mobile phones serve as two-way communication technologies, which ensure that farmers' detailed knowledge about their problems are combined with scientific problem-solving skills from different academic disciplines. Thus, Hamad, Eltahir, Ali and Hamdan (2018) suggested that serving as source of extensions, mobile phones promote ease of using improved input technologies in farming.

The idea of technology acceptance is therefore a substantial contributor to studies about the usage of improved input technologies in farming and rural development. Mabe and Oladele (2015) opined that farmers' usage of ICTs is contributing to rural development by distorting the traditional top-down extension approach. Specifically, Masuka et al. (2016) indicated that by avoiding a situation whereby technologies were first tested with experiments, and then transferred through extension workers to farmers, mobile phones promote easy usage of

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

improved seeds for rural development. Asongu and Boateng (2018) also explained that mobile phone usage for accessing information about improved technologies in farming is most relevant for rural development in Sub-Sahara African region that has huge infrastructure gaps for accessing extension offices.

In summary, having established that traditional agriculture, a basis of rural development in developing countries, demands improved technologies for optimising its profitability, Traditional Agriculture Theory recommends that governments should invest in institutions and education to facilitate the traditional farmers' easy access to improved agriculture technologies. This is explained by Schumpeterian Technological Determinism that maintains that technology is the principal initiator of societal growth, and that increasing output demands constant renewal of the input technologies. The Technology Acceptance Model explained that information about the profitability and the ease of using the technologies attracts people to accept to use them in their production activities. The ensuing sections elaborate on the concepts that emanated from the theoretical reviews.

Traditional Agriculture

Traditional agriculture was defined by Rostow (1960) as the type of farming in undeveloped nations that is undertaken by primitive farmers, in which improved technology usage is weak or non-existence, leading to a ceiling on productivity. Similarly, Schultz (1964) defined traditional agriculture as the kind of farming by poor but efficient farmers who devote their farming to the usage of simple farm tools and technologies that have been used for decades due to the fear of risking survival on unknown technologies. Thus, Chamberlin (2007) referred to a concept of traditional agriculture as smallholder farm characterized by limited inputs, small land size, and undertaken by the resource-poor mostly in rural areas.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Anderson (2014) explained that in traditional agriculture, the farmers hardly change their production practices because without interventions, it is nearly impossible to accept new farming technologies. Thus, Alston and Pardey (2017) concluded that traditional agriculture is the type of farming that is reserved for farmers who still rely on indigenous knowledge and practices, which Fang and Meiyan (2017) traced that they include rain-fed farming, usage of simple farm tools such as hoe, cutlass, and sowing of local crop varieties. Alston (2018) further highlighted that these traditional agriculture practices are in turn characterized by low yield and low income or profit.

Maxwell, Urey and Ashley (2001) had revealed that generally, traditional agriculture remains a dominant economic activity in rural areas, where Enu-Kwesi et al. (2013) pointed out that majority of the world's poor reside. Yet, Pardey and Alston (2019) maintain that the features of traditional agriculture do no always come in bulk, because a farm in which improved version of input technologies are not used, may fall within traditional agriculture. Yahya (2020) shared similar views that traditional agriculture is simply branded by consistent usage of input technologies without renewal. Hence, local maize seed farms fall within traditional agriculture, which is associated with poverty. Nonetheless, Salam (2020) suggested the usage of improved technologies for transforming traditional agriculture may reduce rural poverty and promote rural development.

Rural Development

Defining rural development has become an unending task even among scholars of rural development. On one hand, Bierschenk (1997) conceptualised rural development as a field within which there are several focuses of action and a place of real conflict between social actors interacting on common issues. On

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

the other hand, Ellis (2000) defined the concept as the conscious process of enlarging the range of economic and social choices available to the people living in rural areas. Deininger (2003) added that it includes initiatives that are feasible and effective in improving the livelihoods of rural people and aim at reducing rural poverty as well as establishing favourable environments for the growth of productive rural agriculture agents. Insightfully, Moseley (2003) viewed rural development simply as the process of improving the quality of life and economic well-being of people living in rural areas.

Miller and Luloff (1980) defined the rural areas as societies that are characterized by small size, low population density, and relatively remote, where Ellis and Biggs (2001) suggested that agriculture is the mainstay of the economy, with people relatively similar in their values, attitudes, and behaviour. In this respect, Maxwell, Urey and Ashley (2001) argued that most poverty in the world is rural, and reaching the international development targets means giving high priority to rural development. The above views suggest that one of the major aims of rural development is to reduce poverty among the rural people, whose major source of livelihood is agriculture.

Several rural development experts shared similar views on what should be the goals of rural development. Chambers (1997) shared a view that the main aim of rural development must be to put the last first by eradicating rural poverty and its real causes that are prioritised by the rural poor, whose intensity of poverty is rarely observed by rural development experts. According to Chambers, this is achieved via the elimination of spatial, project, personal, seasonal, diplomatic, and professional biases. This is consistent with the view of Hebinck, Schneider and van der Ploeg (2014) that rural development is not a meta-account that is

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

deciphered from policy into practice, but it is designed by a large number of heterogeneous practices that are started and created in response to market failures. Therefore, Katundu (2019) upholds that the main aim is to decipher and respond to the unique realities of the rural poor.

The discussions further suggest that rural development encompasses a multidimensional process involving several approaches that aim at reorganizing the entire rural economic and social systems. Ellis and Biggs (2001) cited that rural development themes evolved across approaches such as modernisation (1950s), transformational (1960s), redistribution (mid-1960s) as well as structural adjustment (1980s), microcredit (1990s), and sustainable livelihoods (2000s). Torre and Wallet (2016) explained that the modernization approach in rural development deals with the dual economy model that conveys the notions of backward agriculture, lazy peasants, and community development, while Datta (2019) pointed out that the transformational idea talks about improved technology usage, agriculture extension, rational peasants and green revolution for reduction of rural poverty.

The views shared by Carter and Michuda (2019) revealed that the distribution idea calls for the hand of the government in the provision of basic needs and integration of all sectors of the rural economy for rural development. In contrast to the distribution idea, Donkor (2019) exposed that the structural adjustment approach considers retreat of the state for free market operations, food security and famine analysis, and the rise of civil societies for rapid rural appraisal. Madhavi (2020) also explained that the microcredit idea deals with participatory rural appraisal, stakeholder analysis, rural safety nets, gender and development, environmental sustainability, and poverty reduction.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Finally, Scoones (2015) noted that the sustainable livelihoods approach mostly incorporates issues related to good governance, decentralisation, critique of participation, sector-wide approaches, social protection as well as poverty eradication. Irrespective of these evolving approaches that aim at rural development, Food and Agriculture Organization [FAO] (2015) reported that poverty remains a dominant phenomenon in rural areas, and about 75 percent of the world's poor are rural farm households. Hence, the World Bank (2017) proposed that it remains a major aim of rural development to help reduce rural poverty, a condition of life so characterised by malnutrition, illiteracy, and low life expectancy as to be beneath any reasonable definition of human decency.

Thus, rural development ought to aim at reducing rural poverty and its causes among the rural farm households particularly. From the transformational point of view, Schultz (1964) established that in rural societies, usage of improved input technologies for advancing agriculture productivity is essential to improve farm profits and catalyse progress of non-agriculture economy. The main tenet is that rural poverty reduction would remain much difficult to attain and the rural economy as a whole would remain stagnant unless productivity progress ensues from agriculture (Marsden, 2017). Pasa (2017) cited that this idea is exemplified by the ancient Green Revolution in Southern Asian communities, which was spearheaded by the usage of improved input technologies in agriculture activities (Porteous, 2020). Thus, this study operationalized rural development as reduction in poverty emanating from an increase in farm yield, income and food security.

Technology

Schumpeter (1934), a founder of innovation studies defined technology as the new products, new process, new market, new resource, and new organisations

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

that bring about changes in society once accessed and used. Similarly, Mesthene (1970) refer to technology as an organisation of knowledge for achievement of practical drives. Ferré (1995) opined that the word technology is a mix of two Greek words, 'techne and logos', while techne implies workmanship, specialty, expertise, and logos signifies practical application. Thus, Metcalfe, Fonseca and Ramlogan (2001) viewed technology as bid of arts, skills, or crafts while, Hughes and Hughes (2004) defined it as a creative process involving human ingenuity.

The understanding at this point is that the concept of technology is not limited solely to tools or knowledge but a blend of both tools and knowledge to achieve an aim. Rennkamp and Boyd (2015) proposed that technology is the usage of scientific tools and knowledge in the functional points of human life to change and control human conditions. Alston and Pardey (2016) shared similar view that technology integrates utilization of materials, instruments, strategies, and sources of capacity to make life simpler or increasingly wonderful and work progressively gainful. Chan and Holosko (2016) also opined that technology is an effort to reshape the problem of the world with a goal that products and enterprises can be imagined, created, delivered, and utilized. Thus, in literature, technologies are more often than not used simultaneously with innovations.

Nevertheless, Sadovnikova, Pujari and Mikhailitchenko (2016) upheld that it is dedicated technology to a particular work that leads to innovation in that field of work, and Goldkind, Wolf and Jones (2016) added that this is regarding the functions of the technology in initiating changes for economic growth. Therefore, in contextualizing the concept of technology in agriculture, Otsuka and Larson (2016) proposed that agricultural technology may be defined as the application of any new means of production that promotes the green revolution.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Pasa (2017) supported the view that technology in agriculture is the blend of energy, input apparatuses, knowledge, and skills that is used to advance farm productivity. Hence, Singla, Sethi and Ahuja (2018) concluded that being a stimulant for change, technology is the vast area of persistent application of dimensions to real life.

It follows that input technology in farming may be referred to as a new combination of tools and knowledge to change farming process and the outputs. In accordance, Otsuka and Muraoka (2015) cited improved maize varieties and associated inorganic fertilizers as improved input technologies in maize farming, which may change the production process and yields of maize. The World Soil Charter by Food and Agriculture Organization (2015) pointed out that hybrid and open-pollinated varieties (OPVs) are improved maize varieties that have improved qualities over the local maize varieties. Cavane (2016) explained that the improved maize varieties have their characteristics improved for selected attributes such as dry season resilience, disease impediment, short development rate, increased yield per unit of land, and enhanced quality of protein.

In the same way, Brooker et al. (2015) cited that inorganic fertilizers have qualities that can replenish soil fertility loss, enhance soil biodiversity, and sustain crop production. Manda et al. (2016) explained that the cultivation of improved maize varieties requires application of their associated inorganic fertilizers for a maximum output to be realised. Bold et al. (2017) supplemented that this is achievable since inorganic fertilizer can adapt to the heterogeneous conditions in most farming areas and overcome the problems of low outputs that are associated with vagaries of the weather. Ketema and Kebede (2017) further added that the inorganic fertiliser can build-up nitrogen and other corresponding minerals that

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

nourish maize production to flourish. Hence, ultimately the usage of improved maize seed and its associated inorganic fertilizers in farming, would increase maize yield and food security for poverty reduction.

Extending the discussion, Osuta and Muraoka (2015) explained that access to and usage of these technologies in maize farming has been met with numerous challenges. Bold, Kaizzi, Svensson and Yanagizawa-Drott (2017) revealed that the prices of the improved maize seeds and associated inorganic fertilizers are above the affordance level of most farmers. In this respect, Ariga, Mabaya, Waithaka and Wanzala-Mlobela (2019) have suggested that in order to promote the usage of these improved input technologies in maize farming for increased maize yield, income food security, and rural poverty reduction for rural development, farmers need to be facilitated.

Facilitating Factors

Several factors facilitate access to and usage of agriculture technologies. Yet, factors considered in this study are farmers' supportive institutions, human capital, and ICT-based extension. Institutions captured were extension services, financial credit (Akumbole et al., 2018), farm-based associations as well as government policy interventions (Manda et al., 2016). Human capital considered was schooling and years of experience in farming (Mmbando & Baiyegunhi, 2016). Information communication technologies ICTs include radio, television, and mobile phones (Chhachhar et al., 2014). Mostly, farmers who have access to these factors are more likely to discard the traditional input technologies and use the improved input technologies in maize farming (Kassie et al., 2014).

Veblen (1934) viewed institutions as responses to changing situations of humans such that the growth of institutions, is the development of society, while

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

North (1990) defined institutions as the rules of the game of a society, or humanly-devised constraints that shape human interaction. Alston and Pardey (2017) also contributed that these institutions generate economic value for the rural poor farmers to transform traditional agriculture and overcome poverty. Consistently, Barrett et al. (2017) cited extension services as one of the institutions, which are relevant in exposing farmers to improved technologies in agriculture. Mwalupaso et al. (2019) explained that traditional farmers depend on their farms for survival such that they would avert the risk of using new input technologies that are not pre-experimented and confirmed for profitability.

In this respect, farmers who have regular close contact with agriculture extension officers are more likely to use the improved input technologies in maize farming than farmers who have limited access to extension services. Equally, Abdallah (2016) argued that though few farmers may earn enough income to afford the cost of the extended improved input technologies, majority of them may have to fall on agricultural credits for similar purposes. Therefore, Akudugu (2016) defined agricultural credit as the present and impermanent exchange of procuring power from an individual who claims it to a farmer who needs it, giving the farmer the chance to have access to factors of production for farming purpose, but with trust in the farmer's readiness and capacity to reimburse at a predetermined future date. Mariyono (2019) added that this institution ought to be made readily available.

Even with the availability of agriculture financial credit, Floro (2019) argued that some farmers may be limited by repayment conditions due to their low collateral accumulation. Watson (2019) reinforced that without physical assets to serve as collateral; farmers may not have access to the credit, even if it

Digitized by Sam Jonah Library

© University of Cape Coast   https://ir.ucc.edu.gh/xmlui

is readily available. Calomiris, Larrain, Liberti and Sturgess (2017) had verified that collateral is significant for the borrowers and loan specialists, banks and other credit organizations to reinforce the credit market because these institutions use the collateral to clear borrowers' defaulted credits.

For the aforementioned reasons, Twumasi, Jiang, Danquah, Chandio and Agbenyo (2019) suggested that it would be in the best interest of the farmers to unionize so that they can pull their resources together as collateral. Gupta, Ponticelli and Tesei (2019) added that this farm-based organization would ensure that farmers have access to agricultural financial credit at highly subsidized terms, which may promote high take-up of improved input technologies in agriculture. In this respect, Lowitt et al. (2020) maintain that membership of farmers' unions increases the farmers' chances of acquiring agricultural financial credit as well as relevant extension information, which is relevant for the adoption of the improved technologies in farming.

In a similar way, Mathenge, Smale and Tschirley (2015) showed that belief in governmental policy interventions equally promotes usage of improved input technologies. According to Fang and Meiyan (2017), the interventions could be in the form of either subsidy on the purchase of the technologies, or as a pro-poor policy for the provision of the improved technologies to farmers. Danquah, Ahiadzo, Appiah, Roberts and Pappinen (2019) cited 'Planting for Food and Jobs, a Campaign for Rapid Growth' as one of such farmer pro-poor policies in Ghana. Thus, farmers who believe in this government policy interventions are more likely to use the improved maize varieties and the associated inorganic fertilizers.

Deductively, farmers who have access to institutions of extension service, agricultural credits, farm-based associations, and government policy are more

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

likely to use improved input technologies in maize farming. A related relevance factor is a human capital, which Smith (1776) had defined as the useful abilities acquired through education of members of a society and the state of the skill, dexterity, and judgment with which labour is applied. Schultz (1981) suggested that this includes both formal and on the job pieces of training that create economic values for the individuals and society at large. Thus, Sweetland (1996) revealed that human capital is more often measured empirically as the number of years of formal education and years of experience in undertaking an activity.

Westley et al. (2013) revealed that applying human capital to traditional agricultural research, Schultz (1964) upheld that seldomly are highly educated and well-trained farmers associated with low agriculture productivity, because they respond quickly to agricultural innovations. Cavicchi and Vagnoni (2018) clarified that the applications of modern agronomic technologies require farmers to undergo some form of education that would enable them to read at least the instructions on the usage of those technologies. Similarly, Abdulai, Nkegbe and Donkoh (2018) observed that the schooling prepares the farmers with the aids to contact extension services and to process the extension information for efficient application. In the transformation of traditional agriculture, Pardey and Alston (2019) also cited education as the most crucial human capital factor that was considered by Schultz (1970).

In this context, it is insightful that farmers with higher years of formal schooling are more likely to use the improved maize varieties and the associated inorganic fertilizers in their farming activities than farmers who have limited education. Furthermore, Danquah et al. (2019) cited years of experience in farming as an equally important human capital factor. Gupta, Ponticelli and Tesei.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

(2019) continued that this is because the education of farmers becomes most beneficial to the usage of the modern agricultural technologies if the farmers remain in farming during and after their education. Shaner (2019) also suggested that farmers who remained in farming for several years are likely to know about the technology that would favour particular farming seasons, while Mariyono (2019) maintains that due to several years of experiences in farming, some farmers may equally resist the usage of new technologies in agriculture.

Concerning the information communication technologies (ICTs)-based extensions, Bandira and Rasul (2006) pointed out that usually television, radio, and information vans serve that purpose in the usage of improved technologies in agriculture. Grabowski et al. (2015) explained that though access to these sources is expected to ease the usage of new input technologies in farming, those sources do not allow for information flow from the farmers to researchers and the extension officers. Nonetheless, Otte et al. (2018) cited mobile phones as the emerging two-way information communication technologies, which ensure that the farmers' detailed knowledge about their problems is combined with scientific problem-solving skills from different academic disciplines.

It further follows that access to mobile phone-based extensions enhances accurate uptake of agriculture extensions, while access to ICT-based extensions facilitates the usage of new agricultural technologies in general. In this respect, this study learnt from the literature review that farmers who have access to these ICT-based extensions are more likely to perceive ease of using the improved input technologies in farming. Ultimately, it is unravelled from the review that, farmers who have access to institutions, human capital, and ICT-based extensions are more likely to use improved maize varieties and associated inorganic fertilizers

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

in their maize farming activities than their counterparts who have limited access. The next sections present some empirical studies in that regard and the effects of the improved input technologies on rural poverty reduction for rural development.

Empirical Review: Usage of Improved Input Technologies in Farming

Several related empirical studies have shown that the usage of improved input technologies such as improved crop varieties and associated inorganic fertilizers in farming is the desired pathway for rural development. Kassie, Jaleta and Mattei (2014) evaluated the impact of improved maize varieties on food security in rural Tanzania. The study was supported by Schultz's Theory of Traditional Agriculture that argues that traditional farmers are poor but rational in the choice of agriculture technologies. A quantitative approach was followed and a quasi-experimental design was used to classify 680 multistage randomly sampled farmers into adopters and nonadopters of the improved maize varieties. Food insecurity was measured as chronic food insecurity (food shortage throughout the year), transitory food insecurity (occasional food shortage), breakeven refers to no food shortage but no surplus, and food surplus.

Interview schedule was used to obtain the data that were analysed using generalised propensity score matching procedure and parametric econometric method to check for the robustness of the result. The result from the analysis revealed that improved maize varieties adoption has a significant positive impact on food security. The authors reported that an acre increase in the land area allocated to the improved maize varieties reduced the tendency of chronic food insecurity by between 0.7 and 1.2, and that of transitory food insecurity by a factor between 1.1 and 1.7 respectively. It was concluded that the rural households' food security can be enhanced by initiating policy interventions that facilitate usage of

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

improved technologies. Yet, the study failed to consider factors that facilitate the adoption of improved maize varieties.

In a similar study, Zeng, Alwang, Norton, Shiferaw, Jaleta and Yirga (2015) carried out an ex-post impact of improved maize varieties on poverty reduction as a pathway for rural development in Ethiopia. The study was underpinned by theories of traditional agriculture, technological determinism, and technology acceptance. A quantitative approach and a quasi-experimental design were used. A stratified random sampling technique was employed to capture 1396 rural farm households from 30 districts in the country. However, 1359 were engaging in maize farming on 2496 plots of land and were used for the study. Farmers who planted either hybrid or improved open-pollinated maize varieties were labelled adopters (503) while the farmers who sowed the local maize variety were labelled non-adopters (583), and those who mixed both the local and the improved varieties were labelled partial adopters (273).

Interview schedules served as the data collection instruments. The explanatory variables at per hectare production were the price of the maize seed and fertilizer applied, human capital, distance to the agriculture extension office, access to credits, membership of farmer cooperative. Maize yield and cost of production were the explainable variables, which were estimated with the use of a Cobb-Douglas production function. A possible heterogeneity effect was estimated with the use of instrumental variable marginal treatment effect technique on plot level yield and cost changes due to the adoption. A regressive induction system was created to connect treatment impact estimates with an economic surplus model to distinguish the counterfactual family unit income that would have existed without improved maize assortments.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

The impacts of the adoption of the improved maize on poverty reduction were estimated by exploiting the differences between observed income and the counterfactual income distributions. The results of the analysis showed that improved maize varieties led to about 0.8 to 1.3 percentage point reduction in poverty headcount ratio and relative reduction of poverty depth and severity. According to the researchers, about 63.7 to 103.6 thousand rural households in the country have escaped poverty due to the adoption of the improved maize varieties. The study concluded that though smallest landholding farmers benefited the least from the improved maize cultivation, the adoption reduces poverty and promotes rural development. Still, the stated explainable variables that played significant roles in the adoption of the improved maize seeds were not disclosed.

In response to that gap in literature, Mmbando and Baiyegunhi (2016) focused on socio-economic and institutional factors that influence the adoption of improved maize varieties in rural Tanzania. This study followed the tenets of Schultz's traditional agriculture theory and technology acceptance model. A cross-sectional design that followed a quantitative approach was used and a multistage proportionate random sampling technique was employed to capture 160 rural maize farming households in the Hai District of the country. Interview schedules were used to collect the data that were analysed with a logistic regression model.

The result showed that the improved maize varieties' usage decision was explained by the farmers' years of education and experience in maize farming, access to extension and credit, membership of farm-based organizations. It was concluded that these factors should be considered in any attempt to promote the adoption of improved technologies in farming. However, the effects of the usage

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

of the improved maize varieties on poverty reduction for rural development were omitted. Moreover, it is not known if the farmers adopted the associated inorganic fertilizers of the improved maize varieties. Thus, this study intends to narrow those gaps by considering the factors and the effect of the usage of improved maize varieties and the associated inorganic fertilizers on poverty reduction for rural development.

A similar study was conducted by Manda, Alene, Gardebroek, Kassie and Tembo (2016), which enlarged the scope to include the adoption of improved maize varieties and associated inorganic fertilizers coupled with other farm practices such as residue retention and maize-legume rotation. Theories of traditional agriculture, technological determinism and technology acceptance fortified the study. The survey design was used and technology adopters were farmers who used either one of, or a combination of the technologies and other practices while nonadopters were farmers who used neither of the improved input technologies. The multinomial endogenous treatment impacts model that was built on data from 800 multistage randomly sampled rural farm households and 3,000 plots were used to conduct factor and impact analysis of the technologies on maize yields and family income in rural Zambia.

Wald test from a multinomial logit model revealed that the appropriation choices were driven by education, farm credit, government support, extension contacts, membership of farm-based associations, price, distance to fertilizer market, and access to market. The treatment effect also revealed that the adoption of a mix of the improved input technologies raised both maize yields and income of the farmers. Sowing of improved maize alone had a greater impact on maize income. It was concluded that the high price of inorganic fertilizer required for

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

the improved maize reduced the benefit of the improved maize such that greater household incomes were related to combining maize-legume rotation and residue retention. Yet, the impacts of the technology adoption on poverty reduction for rural development were omitted.

Verkaart, Munyua, Mausch and Michler (2017) carried out a related study on the welfare impacts of improved chickpea adoption as pathway for rural development in Ethiopia. Schultz's Traditional Agriculture theory and Schumpeterian theory of Technological Determinism constituted the theoretical framework. A quantitative approach and a survey design were methods used to segregate farmers into adopters and nonadopters of the improved seed. A multistage sampling technique was employed to capture a total of 700 farm households, while a standardized survey instrument was used for the collection of the data. A double hurdle model was used to identify determinants of the adoption while the control function approach with a random correlated effect was used for the endogeneity and a fixed variable instrumental approach was employed.

The authors reported that farmers with higher years of experience in farming and low level of education have allocated smaller farm sizes to the improved seed varieties, which suggested risk aversion. It was also reported that the adoption of improved cowpea varieties increased household income, while reducing household poverty to ensure rural development in the crop production areas of Ethiopia. The authors also revealed that a 10 percent increase in the area planted with the improved seed varieties resulted in a 3.9 percent reduction in the probability of the farmer falling below the median poverty line. Yet, a holistic analysis could have been done by considering the usage of associated inorganic

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

fertilizers, because improved crop varieties are usually introduced together with their associated inorganic fertilizers.

Similarly, Abdoulaye, Wossen and Awotide (2018) conducted an ex-post assessment of the impacts of improved maize varieties on maize yield and welfare outcomes in rural Nigeria. This study was based on Schultz's traditional agriculture theory that argues traditional farmers are poor but rational, and that farmers can adopt technologies that are profitable provided they are facilitated. A quasi-experimental design was used to classify 1907 multistage stratified random sampled rural maize farmers into 1070 adopters and 837 nonadopters. Interview schedules were used to capture plot level and household data while endogenous switching regression was employed to analyse the observed and the unobserved differences between the adopters and the nonadopters of the improved maize. The welfare outcomes were measured in terms of the incidence of poverty and per-capita total expenditure.

Endogenous switching regression that catered for the observed and the unobserved variations was used to analyse the data. The researchers reported that the adoption of the improved maize varieties increased the quantity of maize yield by 574kg/ha. It was also reported that the adoption of the improved input technologies reduced the incidence of poverty by six percent and increased the per-capita total expenditure by US$ 77 or US$0.21 per day. The researchers concluded that investments and policy measures need to be sustained for adoption of the improved maize varieties for improving yield and reducing poverty. However, the factors that play significant roles in the adoption of the improved maize varieties were not revealed to serve as policy guidance.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Another study by Akumbole, Zakaria and Adam (2018) explored the determinants of adopting improved maize varieties among smallholder maize farmers in the rural areas of Bawku Municipal District of Upper East in Ghana. The theories of technological determinism and technology acceptance informed the study. A mixed method approach was used and exploratory survey design was employed while multistage sampling techniques were adopted in the selection of 400 maize farmers. The data were gathered through interviews, focus group discussions, observations, and administration of the semi-structured questionnaire. The data were analysed with the use of framework analysis and a Probit regression model.

The report of the study revealed that farmers' annual income, extension contact, access to credit as well as labour are the factors that influence the adoption of the improved maize variety in the study area. It was also reported that the recurrent issues from the qualitative framework were consistent with the results from the Probit regression model. The conclusion was that financial institutions should make credit available for farmers to adopt the improved maize varieties. However, the author failed to explore the impact of adopting improved maize varieties. Neither was it known if similar factors play a significant role in the usage of the associated inorganic fertilizers. In addition, the study did not consider the roles of information communication technologies-based extensions in the improved maize seed adoption process.

Uduji and Okolo-Obasi (2018) attempted that research gap investigating the determinants of accepting improved seed by rural farmers and the effects of the acceptance on food security for rural development in Nigeria. Schultz's traditional agriculture theory and the technology acceptance model informed the

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

study. The objectives were addressed utilizing a bivariate probit model on an aggregate of 1200 rural farmers who were either part or not part of the federal government's e-wallet programme across six intranational zones of the country.

The outcome established that farmers' years of education, ownership and use of mobile phone as well as versatile inclusion of television extension, power for charging telephone batteries and contact with augmentation operators were the positive determinants of farmer support in the e-wallet programme, while the cultural experiences of farmers were the negative determinants. The researchers also reported that the e-wallet programme facilitated by ICT expanded the appropriation of improved seed in Nigeria to help food security in sub-Saharan Africa. It was concluded that information communication technologies are relevant for enhancing enlistment and information assortment with a focus on rural farmers for rural development. Yet, poverty reduction, which is the main concern of rural development was omitted.

Finally, Houeninvo, Célestin Quenum and Nonvide (2019) analysed the impact of improved maize adoption on farmers' welfare in rural Benin. Technological determinism, traditional agriculture, and technology acceptance model informed the study. A quantitative research approach and a survey design were used on data from a total of 356 rural maize farmers who were captured through stratified random sampling based on location. The data were captured using farm household survey and interview schedules. The researchers addressed issues of selection bias and endogeneity through the usage of a double-hurdle model to identify the factors that determine the improved maize adoption.

Secondly, the instrumental variable model was employed to assess the impact of the improved maize adoption on the farmers' income and poverty status

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

as well as the poverty gap. The area of land planted with the improved maize varieties was the instrumental variable while farm-based organisation membership, extension contacts, participation in training were the expected endogenous variables. Using a predicted area under improved maize production from the double-hurdle model as the observed area under the improved maize farming, the study found out that the decision to adopt the improved maize technology was influenced by extension services, training in improved seed farming, farm size, input price, and location of the farmer within the study area.

The researchers also reported that the adoption of improved maize reduced rural poverty through increased maize yield and farm income, and that the improved maize did not have a heterogeneous impact among both poor and nonpoor farmers. The overall conclusion from the study was that improved maize variety is important for rural development. Yet, the qualitative aspects of those issues which could overly reflect the features of rural development were omitted. The views shared by rural development experts such as Chambers (1997), and Schneider and van der Ploeg (2014), suggest that the integration of a qualitative aspect of those issues into the analysis is imperative for the study of rural development.

From the summarised empirical review in Table 1, some of the studies were limited exclusively to impact analysis (Abdoulaye et al., 2018; Kassie et al., 2014; Verkaart et al., 2017; Zeng et al., 2015), while some were also limited exclusively to facilitating factor for the adoption of the improved maize varieties (Akumbole et al., 2018; Mmbando & Baiyegunhi 2016). This does not provide a holistic overview. Even though Manda et al. (2016) and Houeninvo et al (2019)

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

combined both facilitating factors and impact in their studies, the roles of ICT-based extensions were not featured in their analysis.

Moreover, except Manda et al. (2016), all the other studies failed to consider the usage of the associated inorganic fertilizers that are usually introduced together with the improved maize varieties. Again, even though extension contacts were analysed by majority of the studies reviewed and ICT-based extension by Uduji and Okolo-Obasi (2018), none of them considered dimensions of extension service quality such as relevance, timeliness, and credibility to the farmers. Thus, this study intends to consider those gaps identified and also consider improved maize varieties together with the associated inorganic fertilizer as improved input technologies in maize farming and rural development.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Table 1: Summary of the Empirical Studies and the Gaps Identified

Author (year)	Goal of study	Theory (ies)	Approach /design	Sampling procedure	Indicators/ instrument	Analytical procedure	Key findings	Remarks /Gaps
Kassie et al (2014)	Impact of the improved maize varieties on food security in rural Tanzania.	Schultz's Traditional Agriculture	Quantitative / Survey	Multistage random sample of 680 farmers	Insecurities chronic, transitory breakeven, Surplus	Propensity score matching	Significant reduction in food insecurity	Impact on poverty reduction for rural dev. was omitted
Zeng et al (2015)	ex post impact of improved maize seeds on poverty reduction for rural devpt in Ethiopia	Schultz's Traditional Agriculture, Technological Determinism, Technology Acceptance.	Quantitative / quasi-experimental	Stratified random sample of 1359 farmers & 2496 plots of land	Yield/ha, cost, income, Poverty: incidence, depth, severity	Regressive induction model	63.7 to 103.6 thousand rural households escaped poverty	Improved maize Adoption facilitating factors were omitted
Mmba-ndo et al (2016)	socio-economic institutions that facilitate usage of improved maize seeds in rural Tanzania	Schultz's Traditional Agriculture, & Technology Acceptance.	Quantitative / Cross-sectional design	multistage random sample 160 rural maize farmers	education, experience, access to extension, credit, farm-based union	logistic regression model.	Education, experience extensions credit, farm-based union play roles	Improved maize seed's associated inorganic fertilizer was omitted
Manda et al (2016)	adoption of improved maize seeds, inorganic fertilizers, and other farm practices in Zambia	Schultz's Traditional Agriculture, Technological Determinism, Technology Acceptance.	Quantitative Survey design	multistage random sample 800 rural farm households & 3,000 plots	Quantity of maize yield	Wald test from a multinomial logit model	Intuitions, education, price, play roles/ Maize yield increased significantly	effects on poverty reduction for rural development were omitted

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Table 1 continued

Author (year)	Goal of study	Theory (ies)	Approach /design	Sampling procedure	Indicators/ instrument	Analytical procedure	Key findings	Remarks /Gaps
Verka-art et al (2017)	Welfare impact of improved chickpea as the means of rural development in Ethiopia.	Schultz's Traditional Agriculture, Technological Determinism	Quantitative / quasi experimental design	multistage sample of 700 farm household	Income and poverty incident	double hurdle model/ variable instrumentation	experience & education play roles. Increased income/ & reduction in poverty	Associated inorganic fertilizers were omitted
Abdou-laye et al (2018)	impacts of improved maize varieties on maize yield and welfare outcomes in rural Nigeria	Schultz's Traditional Agriculture	Quantitative / Survey design	Multistage random sample of 1907	incidence of poverty and per-capita total expenditure.	endogenous switching regression	Yield increased by 574kg/ha, Poverty reduced 6%, expenditure increased by $0.21/day	Rural development is not only about quantitative measurements
Akum-bole et al (2018)	determinants of adopting improved maize varieties among smallholder maize farmers of Bawku in Ghana	Technological Determinism and Technology Acceptance	Mixed method/ exploratory survey design	Multistage random sample of 400	annual income, extension contact, access to credit and access to labour	Probit regression model.	annual income, extension contact, access to credit and to labour affect the adoption	Extension credibility, relevance and timeliness were omitted
Houe-ninvo et al (2019)	impact of improved maize adoption on farmers' welfare in rural Benin	Traditional Agriculture, Technological Determinism, Technology Acceptance.	Quantitative / Survey design	stratified random sample of 356 farmers	Income, poverty status, & poverty gap.	double hurdle model & variable instrumental approach	Extensions, experience, farm size play roles/ reduced poverty	ICT-based extensions were omitted

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Lessons Learnt from the Reviews

A review of the relevant theories, concepts, and the empirical studies revealed that Schultz's Traditional Agriculture Theory (STAT) dwells on the institutional factors and human capital as the facilitating factors for farmers to use improved input technologies, which have potentials to transform traditional (rural) agriculture for the growth of the entire rural economy. It also became clear that Schultz's traditional agriculture is built on the tenets of Schumpeterian Technological Determinism (STD), which fundamentally explains the roles of technology in initiating societal growth. Technology Acceptance Model further explains how output enhancement qualities of technologies and the ease of using such technologies attract people to accept to use them in the production activities.

On issues of operationalization, it was learnt that improved maize varieties and the associated inorganic fertilizers may be referred to as improved input technologies in maize farming (Manda et al., 2016). Rural development has been operationalized as a reduction in rural poverty through an increase in farm output and income (Houeninvo et al., 2019; Verkaart et al., 2017; Zeng et al., 2015), welfare in terms of increase in per-capita total expenditure and reduction in the incidence of poverty (Abdoulaye et al., 2018), and food security (Kassie et al., 2014).

In terms of methodological lessons, except Mmbando and Baiyegunhi (2016) who used a cross-sectional design and Akumbole et al (2018) who used a mixed-method approach, the preferred design was survey. The multistage random sampling procedure was mostly used to get the farmers from whom primary data were collected with the instrumentation of interview schedules. Rural development indicators such as income, food security, aggregate consumption

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

expenditure, poverty gap, incidence, and severity were measured on the interval scale of measurement.

Analytical procedures include a double-hurdle model coupled with variable instrumentation, multinomial logit model, Probit regression model. Empirical studies have shown that institutional factors such as farmers' extension contacts, financial credit services (Akumbole et al., 2018), governmental policies and membership of farmer organizations, human capital such as years of schooling and experience in farming (Manda et al., 2016), as well as extension contacts (Houeninvo et al., 2019) facilitate the usage of the improved input technologies. These lessons inform a conceptual framework (Figure 1) for this current study.

Conceptual Framework of Usage of Improved Input Technologies

The conceptual framework generates interaction among the foremost variables sustaining the study such as usage of improved input technologies in maize farming and rural development. Figure 1 illustrates the connection between improved input technologies usage in maize farming and rural development. An existing traditional maize farming is dominated by poverty and indigenous technologies usage in farming. Technological determinism theory informs that altering such traditional agriculture for rural development requires that the farmers renew the traditional technologies. However, apart from cost and farms size issues, the usage of the improved input technologies such as improved maize varieties and associated fertilizers is influenced by the rural farmers' access to the facilitating factors such as institutions, human capital, and ICT-based extensions.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

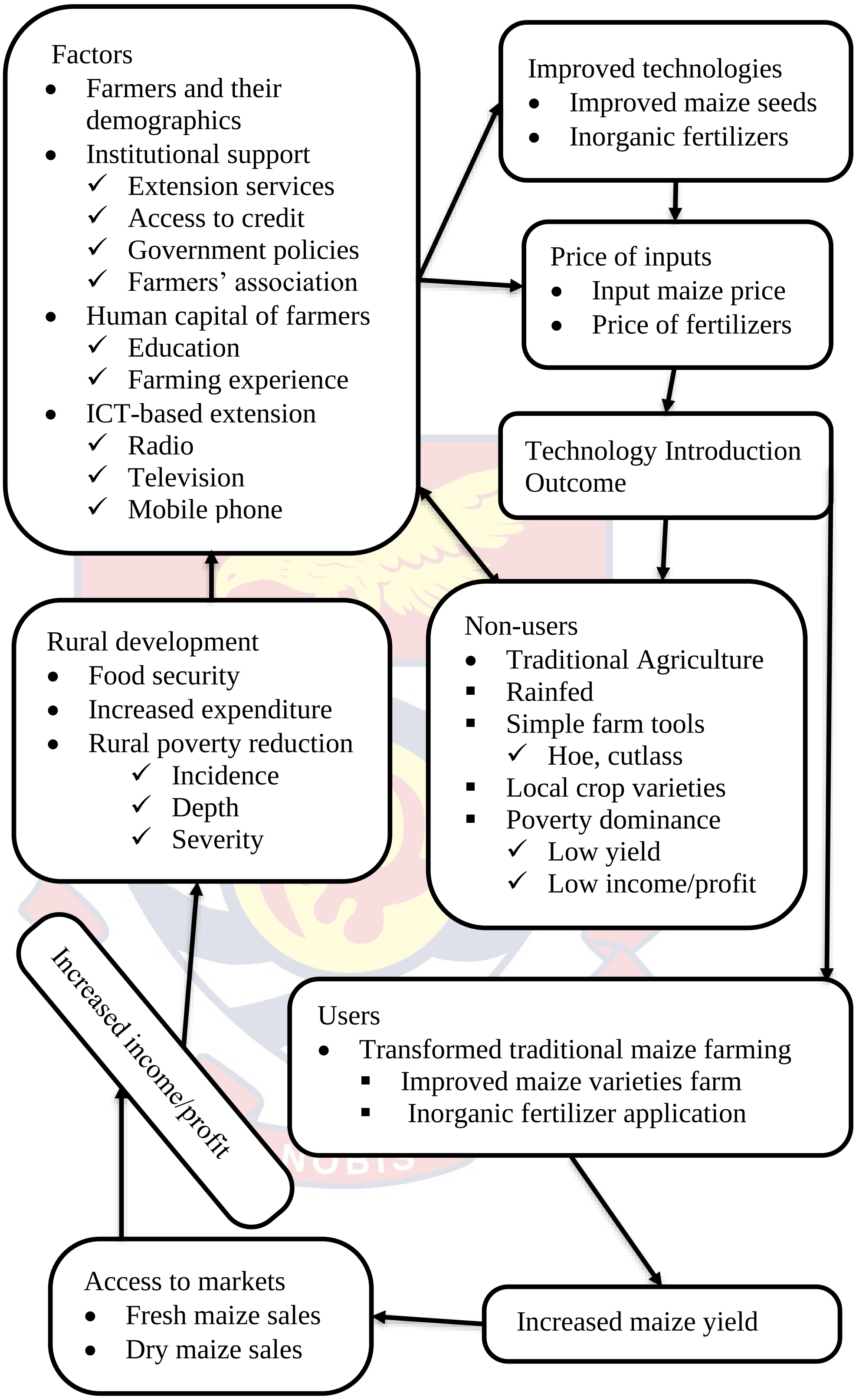

Figure 1: **Conceptual Framework of Usage of Improved Input Technologies in Maize Farming and Rural Development**

Source: Author's construct based on views from relevant literature reviewed.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Rural farmers who have limited access to the aforementioned factors are less likely to use the improved input technologies in maize farming and those farmers are more likely to remain in the traditional agriculture, and continue to sow local maize varieties. However, rural farmers who have access to the factors are more likely to use the improved input technologies to transform traditional maize farming as captured as sowing of improved maize varieties and application of associated inorganic fertilizers. Sowing of improved maize varieties and application of associated fertilizers is expected to result in an increased maize yield, and if given access to market, would increase income and food security. The increased income is expected to lead to increased expenditure and reduction in rural poverty for rural development. Rural development would then result in the provision of more of the facilitating factors that would sustain the process.

Chapter Summary

This chapter reviewed some relevant literature on the usage of improved technologies and rural development. The main theory reviewed was Schultz's Traditional Agriculture Theory (Schultz, 1964). This was supported by Schumpeterian Technological Determinism (Schumpeter, 1934) and Technology Acceptance Model (Davis, 1989). The concepts of traditional agriculture, technology, and rural development were reviewed in conjunction with empirical studies. In general, the review showed that institutional factors, human capital and ICT-based extensions affect usage of improved input technologies. Outcomes of the usage includes increased yield, income, food security and poverty reduction as pathway for rural development. Finally, lessons from the review of literature informed the conceptual framework (Figure 1) for the study. The subsequent chapter discusses the methodology of the thesis.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

CHAPTER THREE

METHODOLOGY

Introduction

Humphries (2017) defined research methodology as the particular procedures used to select, process, analyse, and present information about a topic. Kumar (2019) suggested that in a research study, the methodology chapter permits the readers to essentially assess the universal validity and reliability of the study. Willmott (2020) also explained that the research methodology provides the philosophical bases for the claims that are made in the orderly creation of information and the utilization of specific techniques. Thus, this chapter discusses the research methodology adopted for the study, which begins with the research design and followed by a description of the study area. These are followed by the discussion of the target populations, and sampling procedure, data collection instruments, ethics and data collection procedure, data processing and analysis as well as chapter summary.

Research Design

Bryman (2003) defined research design as an overall strategy that is chosen to incorporate various segments of a study reasonably and legitimately for successful data collection, measurement, and analysis in addressing a research problem. Kruger and Neuman (2006) explained that research designs are guided by research approaches, which endorse what good social research includes, legitimize why one ought to do research, relate qualities to research, and guide moral conduct. Sarantakos (2005) also suggested that social research is the purposive and thorough examination that is expected to create information as social researchers enter into the context of phenomena to look for answers to

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

inquiries. According to Sarantakos (2012), quantitative, qualitative, and mixed-method are the three main approaches in social research, which are in turn built on distinctive ontological and epistemological assumptions.

In this respect, a mixed-method approach was adopted. The choice of this research design was guided by the nature of the research objectives as well as the gaps that were identified in related studies on the usage of improved input technologies in maize farming and rural development. Creswell and Creswell (2017) opined that the mixed-method follows the idea of pragmatists' basic principles of applications, what works, and solutions to problems such that there is no one way of arriving at the truth about the usage of the improved input technologies. Similarly, as proposed by Queirós, Faria and Almeida (2017), the data collected on farmers' access to facilitating factors lend themselves to both qualitative and quantitative approaches. Snelson (2016) had explained that this ensures that the final twofold data complement each other for a holistic analysis on the effect of the improved maize varieties on rural development.

The qualitative aspect as explained by Leavy (2014), was to help unpack the reasons behind the observed proportion of the improved input technologies usage among the farmers by explaining why some farmers used the improved input technologies in maize farming and some did not use them. In this respect, an in-depth interview was held with the crop officer and the extension officers of the Ketu North Municipal Assembly. As indicated by Akumbole et al, (2018), the farmers were also asked about why they choose to use or not to use the improved input technologies. Hence, the proportions of the farmers who used the technologies were measured with the usage of quantitative data while these qualitative responses were thematically used to explain them.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

As explained by Sarantakos (2005), the quantitative aspect in this study aimed at providing a predictive understanding of the usage of improved input technologies in maize farming and rural development based on generalizations that are time and context-free. Therefore, the farmers were considered as rational beings that are controlled by social laws such that this aspect of the mixed method design was deductive (Sarantakos, 2012). As described by Leavy (2017), this aspect involves measuring variables and testing relationships between access to facilitating factors such as institutions, human capital, ICT-based extensions, and the usage of the improved technologies as well as their outcomes as pathway for rural development.

The strength of the mixed-method research design is that it gave a voice to the farmers, the crop officer, and the extension officers and ensured that the study findings were grounded in the experiences of improved input technology users. It also helped in understanding the contradictions between quantitative results and the qualitative findings concerning the usage of the improved input technologies in maize farming. Access to the facilitation factors and the reasons behind the proportion of improved input technology usage among farmers, could not have been evaluated and discussed holistically with the use of only a quantitative approach or solely qualitative approach. Thus, as explained by Morse (2016), the mixed method helped the study to overcome the weakness of the quantitative design with the strength of the qualitative aspect and vice versa.

Study Design

Correlational survey study design was adopted, which Zeng et al. (2015) opined that it provides greater insight into social science study. The choice of the survey design was informed by the lessons learnt from empirical review of similar

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

technological intervention studies. The lessons suggest that correlational survey study design guarantees an increasingly representative sample, precise data (Manda et al., 2016), and accurate results for drawing useful conclusions (Verkaart et al., 2017) as well as for making important decisions (Houeninvo et al., 2019). Creswell and Hirose (2019) explained that features of a correlational survey study design include the administration of an instrument to a sample, or the whole populace to depict the perspectives, assessments, practices, or qualities of the populace.

In this respect, at 96. 77 percent response rate, proportionate systematic random sampling procedure was used to get 300 rural maize farmers from whom information was obtained through the usage of interview schedules. In order to evaluate the proportion of the sampled rural maize farmers who used the improved input technologies in the Ketu North Municipality, the study considered improved maize varieties and associated inorganic fertilizers as a bundle of improved input technologies in the maize farming. 'Improved input technologies users' were farmers who used either one or a combination of the bundled technologies in the previous maize farming season. On the other hand, 'non-users of improved input technologies' were farmers who used neither of the input technologies in the previous maize major farm season. Thus, the users and non-users were identified based on the response of each maize farmer.

Similarly, in order to examine the role that institutions, human capital and ICT-based extensions play in the usage of the improved input technologies in the maize farming, the corresponding items on the survey instrument were utilized. Regarding the institutional factors, access to extension services was measured in terms of number of extension contacts and quality of the extension service, while

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

access to financial credit was measured in terms of the amount of money that was loaned to a farmer concerning farming in that particular farming season. Access to farm-based organizations was measured as the number of farm unions to which a farmer belonged, while believe in government policy intervention was measured at binary level of yes or no.

The human capital factor such as education was measured in terms of the number of years the farmer used in formal education, while the experience was measured in terms of the number of years that the farmer engaged in the maize farming. Access to ICT-based extension was also measured in terms of how often a farmer used radio, television, mobile phone for accessing extension within a season. Hence, variables such as institutions, human capital, ICT-based extensions as predictors and the improved input technologies usage as the dependent variable were measured quantitatively whereas qualitative responses were integrated to explain reasons behind each of the observed measurements.

The next objective was to examine the outcome of the improved input technologies in maize farming for rural development of the study area. The predictor variable was the usage of improved input technologies in maize farming, while the independent variables were quantity of maize yield, income, food security and poverty reduction as the pathway for rural development. The technology users and nonusers were compared based on these indicators. Thus, the design of the study was planned in a manner that was ideal for the researcher to complete the study within the stipulated time frame.

Typical of the weakness is that even though there might be other issues concerning improved input technologies usage in maize farming and rural development, the questions itemised in the interview schedule were designed in

Digitized by Sam Jonah Library

© University of Cape Coast   https://ir.ucc.edu.gh/xmlui

ways that focused on the specific objectives of the study, which were to: determine the proportion of the sampled rural maize farmers who used the improved input technologies in the Ketu North Municipality; examine the role that institutions, human capital and ICT-based extension play in the usage of the improved input technologies; and estimate the outcomes of the usage of improved input technologies in maize for rural development. This made the researcher's study less monotonous and tedious. Similarly, the study was limited to maize farmers who were introduced to the improved technologies in maize farming at Ketu North Municipality.

Study Area

The Ketu North Municipal Assembly lies in the South-Eastern part of the Volta Region of Ghana. The District was known as the Ketu District until the year 2008 when the Ketu North District was carved out with its capital being Dzodze, while in 2019, the District assumed a Municipal status. It is located between latitude 6◦03'N and 6◦20'N and longitude 0◦49'E and 1◦05'E. It shares boundaries with Keta Municipality to the South, Ketu South Municipality to the South East, Akatsi South to the South West, Akatsi North to the North West, and Togo to North (Figure 2).

Oppong-Anane (2006) revealed that the study area encounters a normal yearly temperature of about 30°C with a mean yearly precipitation of roughly 1270 mm. The mean annual rainfall for the area is around 1,270mm. The rainfall is bimodal type occurring from April to July and September to October. The dry season, which is mainly dominated by the dry harmattan winds, extends from December to February. Acquah and Annor-Frempong (2011) added that the vegetation of the communities is Savannah woodland, which constitutes short

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

grassland with small clumps of bush and trees, especially at the South-Eastern part of the Municipality. Similarly, Agjei (2012) discovered that the soils in the area are predominately savannah ochrosols and sprinkled with lithosols. These spatial qualities contain a crate of possibilities that can be tapped for socio-economic development.

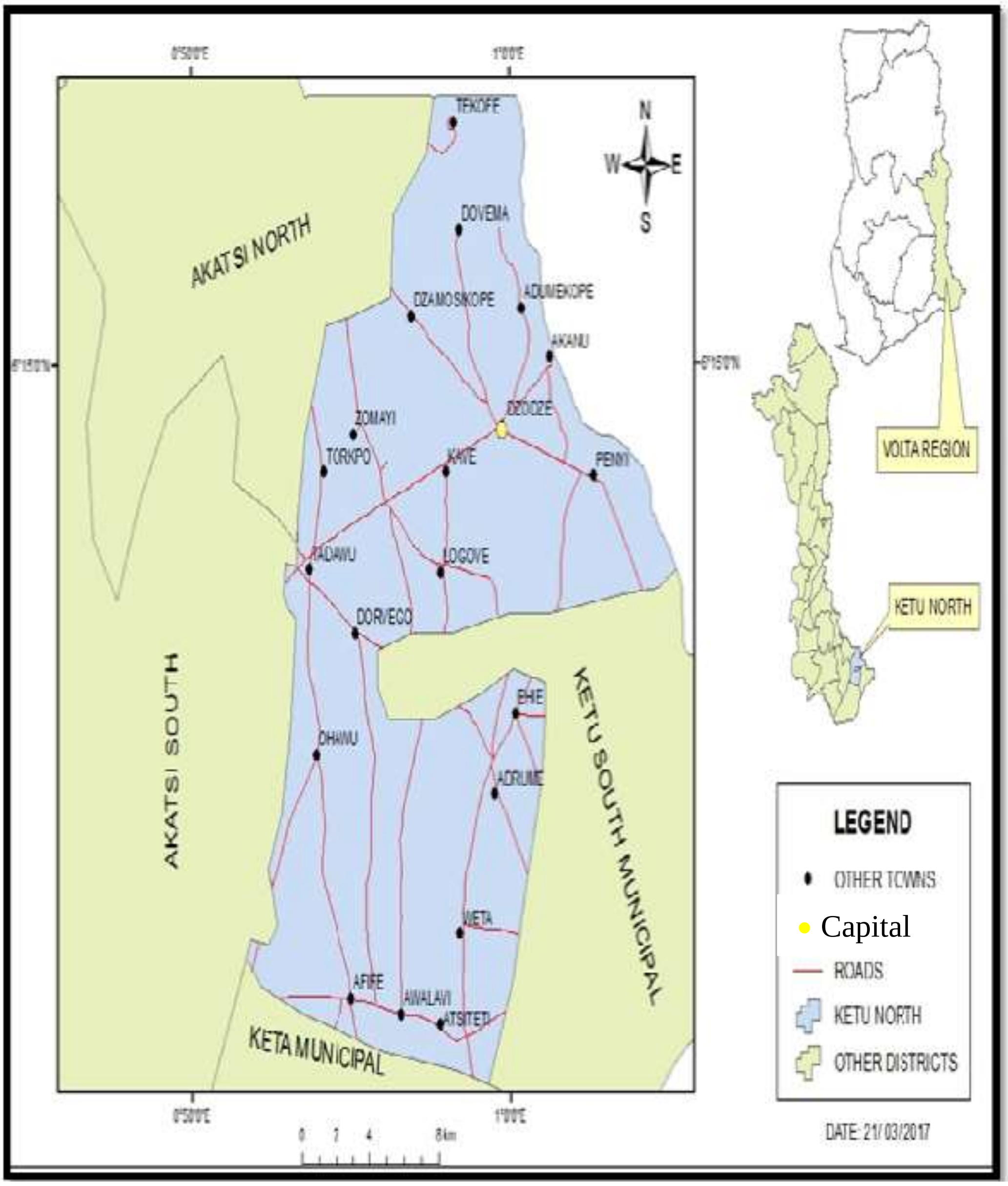

Figure 2: **Map of Ketu North Municipality of Ghana Showing the Study Areas**

Source: GIS Office (2017), Department of Geography and Regional Planning

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

In relation to the drainage and the relief, the tremendous field of level land is a potential for huge scope of commercial farming. The high power of the sun in the territory gives plenteous solar energy, which is as of now being utilized by farmers for the preservation and storage of the farm produce. The soil, vegetation and atmosphere of the area comprise reasonable environmental conditions for both arable cultivation and animal raising. Accordingly, almost every household in the area engages in farming or agricultural related activity. The normal land developed ranges between 4-6 acres of land for all crops, and major crops include maize, cassava, sweet potato, cowpea, rice. Be that as it may, these frequently lead to overexploitation of the vegetation, which without the usage of improved input technologies, subsequently brings about loss of soil fertility and food insecurity.

Population

The Ghana Statistical Survey (GSS, 2010) revealed that the study area has a population of 99, 913, and approximately 70.5 percent is rural, of which 75.8 percent are farm households. The survey also cited that the population has female dominance of 53.7 percent and 69.7 percent of the entire population are literates in at least one language. According to the Ghana Statistical Survey (GSS, 2014) the area has a labour force of 52.5 percent, and out of the total population who are 15 years and above, 70.2 percent are economically active. The Ketu North Ministry of Food and Agriculture (KN-MoFA, 2017) has cited that the major economic activity of the entire population is farming, which contributes to more than 60% of the household incomes.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Subsequently, ministry (KN-MoFA, 2019) has revealed that farming is done at the subsistent level at the mercy of the vagaries of the weather and maize as one of the major food crops grown in the area, is cultivated in virtually every part of the Municipality. Essentially, the maize serves as a source of cornflour that is used to prepare 'akple', the staple food of the people. The Ewe constitutes the predominant (98.2 percent) tribe in the Municipality, while the other ethnic groups are the Akans, Ga-Adangbe, and the Guans.

The study population was made up of maize farmers in the rural areas of the Municipality. The target population was the rural maize farmers who were introduced to improved maize varieties and the associated inorganic fertilizers. From the Crop Office of the Municipality, the lists of maize farmers indicated that a total of 1364 maize farmers were within that category across Dzodze, Penyi, Afife, and Weta operational zones. Table 2 shows that majority of the maize farmers were within the Dzodze and Weta extension operation zone (64%), while the least number of them were within Penyi extension operational zone. According to the Municipal Agricultural Crop Officer, the maize farmers were proportionally selected based on their numbers within the apportioned extension operational zones. Across the four operational zones, the males were dominant (65%) as against their female counterparts in maize farming.

The Ketu North Municipality has a collaboration with a Crop Research Institute trial station at Ohawu community of the Municipality, where modern agronomic practices are tested and transferred to farmers through the Municipal extension officers. Maize is one of the main crops that have been prioritised and the first set of farmers were introduced to improved maize varieties such as Mamaba and Obatanpa and their related inorganic fertilizers. In order to introduce

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

a new set of technologies, farmers are selected based on the major crop that they cultivate. A sample of the improved technology is sold to the selected farmers at a subsidized price, and or on credit. Later, depending on the nature of the improved technology, the farmers either buy at non-subsided price or fall on reserves from the previous farming season for sowing subsequently.

Table 2: Distribution of the Study Population by Operational Zones

Zone	Population	Percent	Male	Percent	Female	Percent
Dzodze	518	38	337	25	181	13
Weta	355	26	231	17	124	9
Afife	259	19	168	12	91	7
Penyi	232	17	151	11	81	6
Total	1364	100	887	65	477	35

Source: Ketu North District Agriculture Development Unit

Sampling Procedures

Apart from the Municipal Crop Officer and one extension officer from each of the four operational zones who were purposively selected for key informant interviews, a multistage random sampling technique was applied to generate a sample size of the farmers. Following Krejcie and Morgan's (1970) table, a sample size of 310 rural maize farmers was obtained from the total population of 1364 rural maize farmers across the four operational zones of the Municipality. The four lists of maize farmers based on extension zones were made up of both rural and urban maize farmers. Based on their house codes, farmers from the rural areas of the Municipality were purposively sorted out of each of the four lists of maize farmers. The assorted lists of rural maize farmers were the

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

four stratified sampling frames (Table 2) from which the farmers were proportionately sampled (Table 3).

Table 3: Sample Distribution of Farmers by Operational Zones

Operational Zone	Number	Male	Female
Dzodze	116	78	38
Weta	80	52	28
Afife	59	40	19
Penyi	55	33	22
Total	310	203	107

A systematic random sampling technique was employed to capture the farmers from each of the four Stratum. This technique was employed because it ensued equal representation of farmers from each of the rural areas. The sampling factor for each of the four strata was obtained by dividing the population by the sample size (1364/310= 4.4) that was approximated to five to serve the purpose. The researcher numbered pieces of papers from one to five, which were folded into ballot boxes. A field assistant was asked to pick at random, one ballot paper from each of the four ballot boxes concerning Dzodze, Weta, Afife and Penyi operational zones. The numbers picked were two for Dzodze, five for Weta, one for Afife, and four for Penyi. The sampling factor, five was added to each of the balloted numbers and the corresponding house codes were recorded up to the point the sample sizes were exhausted for each of the four zones (Table 3).

Data Collection

Data were needed to address the specified objectives of the study, which were to: determine the proportion of the sampled rural maize farmers who used

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

the improved input technologies in the study area; examine the role that institutions, human capital and ICT-based extension play in the usage of the technologies; and estimate the outcomes of the usage for rural development. Generally, primary types of data were obtained from the Municipal crop officer, extensions officers and maize farmers in their natural settings. In relation to the proportion of the farmers who used the improved input technologies, and roles of institutions, human capital and ICT-based extension, quantitative data types were obtained from the farmers and the details were captured in Table 4. Interviews were used for the data collection and out of the total target sample size of 310 farmers, 300 of them took part in the interview, which represents 96.77 response rate.

Quantitative data types in the forms of quantity of maize yield, income, total consumption expenditure per day and food security on a four-level scale of chronic and transitory food insecurity as well as breakeven and food surplus after the farm year, which relate to poverty status were obtained from the farmers. The survey method was used for the data collection through the administration of interview schedules to the farmers and interview guides to the Municipal crop officer and an extension officer of each of the four operational zones. A reconnaissance survey revealed that most of the farmers were less likely to be able to read and write, which suggested that interview schedules are the most appropriate for collecting data from the farmers. The interview guides were deemed fit for the crop officer and the extension officers who were the key informants. Qualitative data types were obtained from extension officers and crop officers to cater for how and why the disparity in the usage of the technologies.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Table 4: Variable Measurement and Data Capture

Variables	Measurement
Sex	Male = 0, Female =1
Experience	Years in maize farming
Education	Years in schooling
Quality of extension contacts	Average of number of contacts, perceive timeliness (no = 0, yes =1), relevance (no = 0, yes =1), credibility (no = 0, yes =1)
Phone-based extensions	Number of times mobile phone is used to communicate extension information
TV-based extensions	Watch extension programs; no = 0, yes = 1
Membership of FBU	Member of FBU; no = 0, yes = 1
Access to credit	Obtained credit for farm; no = 0, yes = 1
Belief in gov policy on uncertainty	Belief that government would aid in case of uncertainties in farm; no = 0, yes = 1
Access to market	Have people ready to buy maize at the prevailing market price; no = 0, yes = 1
Input maize price	Amount in GHc
Household size	Number of household members
User of improved input technologies	Used improved maize seed and or fertilizer; no = 0, yes = 1
Maize yield	Number of 2.5gk-bowls of maize harvested
Income	Amount of GHc earned from fresh maize and dry maize sold
Consumption expenditure	GHc value of corn milled/correspondences own and used, or bought and savings
Food insecurity/ security per year	Chronic food insecurity; no = 0, yes = 1, Transitory food insecurity; no = 0, yes = 1 Breakeven; no = 0, yes = 1 Food surplus: no = 0, yes = 1

Source: Field Survey, Ahiadzo (2020)

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Instrument Design

As explained earlier, interview schedules were needed to collect data from the maize farmers. In order to ensure that the views of the maize farmers informed the contents of the data collection instruments, a recognisance survey was steered, in which in-depth interviews were carried out to gather views from natural leader maize farmers. The interview schedules were designed into four sections, such as A, B, C, and D. Section A focused on the background characteristics of respondents. Issues captured under this section include the farmers' sex, age, level of education in years, marital status, household size, number of household members who help in the farming activities, and years of experience in maize farming. Except the sex item which was close ended, all the other items were open ended in this section. Sex and marital status were measured at a nominal scale, while the rests were measured numerically.

Section B was meant to determine the proportion of the sampled rural maize farmers who used the improved input technologies. Items captured in this section were variety of maize cultivated by each farmer during the previous major farm season, reasons for cultivating that particular variety of maize, the amount of land allocated for the maize, the quantity of the maize seed cultivated as well as the unit cost of the maize seed. These items were followed by how often the farmers apply inorganic fertilizer to the maize cultivated, type and quantity of the fertilizer applied as well as the price of the fertilizer applied. The varieties of maize were measured at a nominal scale and the item was close-ended with both local and improved maize seeds that are cultivated, which via the reconnaissance survey, the researcher became privy to. On the other hand, fertilizer application was measured in terms of the quantity and number of times it was applied.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

In Section C, the items were about access to facilitating factors such as institutions, human capital and ICT-based extensions that affect the usage of the improved input technologies. Access to institutions was measured in both quantitative and qualitative terms. In relation to the quantitative aspect, items were captured in terms of number of extension contacts per year, amount of financial credit obtained for maize farming per-season, number of farm-based associations that the farmers had membership status. These items were open-ended and were measured at the ratio scale of measurement, while belief in government policy against uncertainty was measured at the nominal scale with a binary close ended item.

Human capital issues were captured within the background characteristics and were integrated into the final data analysis. Access to ICT-based extensions were measured as ownership of radio, television, mobile phone and how aften these information communication technologies were used to access extensions related to the maize farming. The ownership was itemised with a yes or a no binary close-ended option, while the frequency of usage was measured on a ratio scale.

Finally, Section D focused on estimating the outcome of the improved input technologies for rural development of the study area. Issues captured in this section include quantity of maize yield, amount of fresh maize sold, access to market, seasonal income from dry maize sold, quantity of maize consumed per week, maize food security, consumption expenditure as well as food security within a year, which related to poverty and rural development. Maize yield, income, and daily expenditure were measured at the ratio scale of measurement, while food security per year were measured at an ordinal scale of measurement.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

In conclusion, out of a total of fifty-one items on the interview schedules, a total of thirteen items were close ended, while thirty-six items were open-ended.

Interview guides were needed to solicit information from the Municipal crop officer and extension officers who served as the key informants. In order to ensure the correspondence of data from both instruments for integration of results, the thematic areas captured on the interview guide were similar to that of the interview schedule. Probing issues captured under the technology usage theme included the procedure used to introduce the improved input technologies to the farmers, types of the technologies introduced as well as the guideline on their application and the reasons for the observed proportion of the usage. The basic intent of the content under this theme was to explore why some farmers use the improved technologies in the maize farming, while other farmers did not use them. This was meant to help the researcher know whether the technologies users comply with the usage guidelines or not.

In relation to the factors that affect usage of improved input technologies in the municipality, probing issues included nature of institutional factors such as extension, agricultural credit accessibility, farm-based association issues as well as governmental policy interventions in relation to farming in the municipality. These were followed by human capital and crop insurance issues, ICT-based extension, and market opportunities for the maize products. Besides, outcomes of the technologies usage for rural development were probed with issues such as yield of each maize variety, best storage strategies for each maize variety, food security issues and average household daily expenditure as well as poverty incident, gap, and severity issues.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Pre-test of Instrument

Prior to the data collection exercise, the interview schedule was pre-tried on 20 conveniently sampled rural maize farmers at Akatsi South District to guarantee consistency and clearness of the instrument. Akatsi South District was chosen for the pre-test since it has comparable attributes with the study area. The pre-test empowered the study to update a few inquiries that were hard to be deciphered in the local Ewe language. Additionally, some close-ended items were changed into open-ended questions due to the varied nature of the responses observed. The response rate from the pre-test was 95%, which prompted the researcher to contact the Ketu North Agric Officer to let the extension agents pre-inform the farmers of the main data collection for increased response rate.

Ethical Considerations

The methodology was exposed to authentic moral contemplation, and the researcher guaranteed that the methodological approaches of the study did not disregard research ethics. All conventions concerning field work like ethical clearance letter was obtained from the Institutional Review Board of the University of Cape Coast and served to the Ketu North Municipal Assembly. In order to achieve the ethics of informed consent, farmers who took part in the study were duly informed about the purpose of the study and their assent sought. Anonymity was established by not disclosing the identity of the respondents or associating any response with any particular respondent. Under no circumstance was any respondent pressured to take part in the study and the privacy of the data the respondents gave was adhered to.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Data Collection Procedure

The four sample frames per the four extension operational zones contained the farmers' zonal codes and house numbers, which were used for the data collection. The researcher and the field assistants visited the house numbers that were gotten via the systematic random sampling. The researcher's identification was shown and the purpose of the visit was explained to the farmers who were told to take part in the interview voluntarily. One-on-one interviews were held with the use of the interview schedules. The interviews were done from one extension operation zone to the next operational area from 8th August, 2020 to 25th August, 2020. Each interview lasted about 40 minutes, while key informant interviews with crop officer and the extension officers lasted about 50 minutes each. With the consent of these informants, the discussions were recorded on a recorder device for further transcription and perusal.

Data Processing and Analysis

The quantitative data from the field were coded and processed, utilizing Version 23 of the Statistical Product and Services Solutions (SPSS) and Stata version 14 software. The objectives and the conceptual framework informed the nature of the data processed. An analytical approach, which comprised both quantitative and qualitative methods was used to address the objectives. The first objective dealt with proportion of the sampled farmers who used improved input technologies in maize farming and descriptive statistics were used to determine the proportion of users and none users of the technologies. The responses from the farmers were compared with that of the key informant as the benchmark, while the qualitative data from the interviews were analysed thematically to explain why some farmers use the improved technologies and others did not use them.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Farmers who used either improved maize varieties and, or inorganic fertilizer in the previous major farming season were labelled as the users while those farmers who used neither of the two technologies were the nonusers. The second objective concerned access to institutions, human capital, and ICT based extension as facilitating factors for usage of the improved input technologies. This objective was addressed by the use of binary Logistic regression analysis. The technology users were coded as 1, while the none users were coded as 0. Binary logistics was used because the dependent variables was in non-ranked two categories such as usage and non-usage (Harrell, 2015). The aforesaid facilitating factors were used as the covariates upon which the usage of the technologies depended. Thus, the alternate hypothesis was that access to the facilitating factors significantly facilitate usage of improved input technologies in maize farming.

Various methods were used to address the third objective, which was outcome of the improved input technologies for rural development. Wilcoxon rank sum test was used to perform treatment effect on quantity of maize yield per hectare and maize income per hectare because the yield and the income were skewed. Chi-square and ordered logit were used to conduct treatment effect on food insecurity. Thus far, as the food insecurity was measured in ordered sets such as transitory, chronic, break-even, and surplus, ordered logit was deemed the most appropriate analytical technique (Pierola, Epifanio & Alemany, 2016). Finally, early aggregate consumption expenditures were utilized together with the Foster-Greer-Throbecke (FGT) poverty index and binary logit to perform treatment effect of the improved technologies on poverty reduction for rural development.

Foster-Greer-Throbecke (FGT) poverty is given as $P_\alpha = \frac{1}{n}\sum_{i=1}^{q}[\frac{Z-Y_i}{Z}]^\alpha$, whereby Y_i are the aggregate yearly consumption expenditures of the farmers, and

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

n represents the number of the farmers studied. The q is the sum of poor farmers in the sample, while α is the parameter of poverty aversion, while Z represents the poverty line value of $ 1.90, The poverty incidence is when $\alpha=0$, and $P_0 = q/n$. On the other hand, the poverty gap, which measures the depth of the poverty is when $\alpha=1$ such that $P_1 = 1/n \sum_{i=1}^{q}[Z - Y_i /Z]$. Furthermore, severity of the poverty is the square of poverty gap, which is stated as when $\alpha=2$, $P_2 = 1/n \sum_{i=1}^{q}[Z - Y /Z]^2$.

Foster-Greer-Throbecke (FGT) poverty index was utilized to measure poverty because as explained by Henri-Ukoha (2017), it helps identify the poorest among the poor and to detect non-users and users of improved input technologies that live below the generally accepted standard of living. Thematic interpretative analytical method was used to analyse the qualitative data because it helps with familiarization with data for content analysis and generating initial codes, probing for themes, reviewing themes, defining and naming themes and producing a report based on the specified objectives of the study (Braun & Clarke, 2006).

Chapter Summary

The study adopted a mixed method approach, comprising a survey of 300 farmers and six key informants who were interviewed. Proportionate systematic random sampling technique was used to get to rural maize farmers across Dzodze, Penyi, Weta, Afife extension operational zones in the Ketu North Municipality of Ghana. Interview schedules were used to collect data from the farmers, while interview guides were used for the key informant interviews. Analytical tools such as descriptive statistics, Chi-Square, binary and ordered logit, Wilcoxon Rank-Sum Test were used in Stata and SPSS to analyse the quantitative data, while the key informant interviews were transcribed and interpreted thematically. The next chapter presents the results and discussion.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter covers the results and discussion of the survey data collected on the usage of improved input technologies in maize farming and rural development in Ketu North Municipality of Ghana. At the response rate of 96.77 percent, a sum of 300 proportionate random sampled rural maize farmers were interviewed across Dzodze, Weta, Afife and Penyi extension operational zones of the study area. The chapter presents the results in three sections. Due to the nature of the objectives of the study, the first section integrates the demographic characteristics of the respondents into the first objective, which is to determine the proportion of the farmers who used improved input technologies. The second section examines factors that affect the usage of the technologies, while the last section estimates outcome of the usage related to maize yield, income, food security, and poverty reduction as a pathway for rural development.

Usage of Improved Input Technologies

This section determines proportion of the sampled rural farmers who used improved input technologies in maize farming in the Ketu North Municipality of Ghana. Schumpeter (1934) suggested that usage of improved input technologies is promoted via demonstrations that enable farmers to make informed decisions. Schultz's (1964) traditional agriculture theory added that institutions and human capital further influence that usage/non-usage of the improved input technologies. Similarly, Davis (1989) concluded that these institutional factors, human capital and other correspondences influence perception about ease of use and usefulness, which determines usage/non-usage of the improved input technologies.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Based on insights from these theories that form the basis of the conceptual framework (Figure 1), the proportion of the farmers who used improved input technologies was determined and disaggregated with respect to their demographic characteristics, access to institutions and ICT-based extensions. Mixed method, dominated by the quantitative approach was used. Qualitative responses from key informants were subsequently integrated with the quantitative outcomes to help explain the quantitative issues. In order to determine the proportion of the farmers who used the improved input technologies, the farmers were asked to state the maize variety propagated during the previous major farming season as well as the quantity and the number of times that inorganic fertilizer that was applied.

All the 300 farmers interviewed provided details in relation to that and the farmers who used either improved maize varieties and/or inorganic fertilizer in the previous major farming season were labelled as the users while those who used neither of the two technologies were nonusers. Then, with the usage of Stata version 14, descriptive statistics were applied to determine the proportion of the sampled rural maize farmers who qualified as users/nonusers of improved input technologies. The analysis showed that majority (61%) of the farmers used improved input technologies in their maize farming activities.

Table 5 shows that majority (66%) of the farmers surveyed were males; 35 percent of users of improved technologies were females, while 33.33 percent of nonusers of improved technologies were females. Kassie, Jaleta and Mattei (2014) indicated that males have access to factors of farm production compared to their female counterparts in Africa and thus more males than females engage in farming. Katundu (2019 also suggested that females in Africa are less likely to use improved technologies compared to their male counterparts.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Table 5: Sex, TV-based extension, FBU, Credit, Market, Belief in Government Policy by usage/non-usage of Improved Technologies

	Improved Input Technologies		
	Non-users	Users	Total
Sex of Respondents	No (%)	No (%)	No (%)
Male	76(64.96)	122(66.67)	198(66)
Female	41(35.04)	61(33.33)	102(34)
Total	117(100)	183(100)	300(100)
Access to credit			
No	113(96.58)	105(57.38)	218(72.67)
Yes	4(3.42)	78(42.62)	82(27.33)
Total	117(100)	183(100)	300(100)
Membership of FBU			
No	89(76.07)	0(0.00)	89(29.67)
Yes	28(23.93)	183(100)	211(70.33)
Total	117(100)	183(100)	300(100)
Belief in government policy			
No	85(72.65)	90(49.18)	175(58.33)
Yes	32(27.35)	93(50.82)	125(41.67)
Total	117(100)	183(100)	300(100)
Access to market			
No	26(22.22)	56(30.60)	82(27.33)
Yes	91(77.78)	127(69.40)	218(72.67)
Total	105(100)	78(100)	183(100)
Access TV-based extensions			
No	66(56.41)	85(46.45)	151(50.33)
Yes	51(43.59)	98(53.55)	149(49.67)
	Total	117(100)	183(100)

Source: Field survey, Ahiadzo (2020)

In relation to credits, majority (72.67%) of the farmers did not have access to credit. A little over 42 percent of the users of improved input technologies had

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

access to credit, while only 3.42 percent of nonusers had access to credit for farming within the season. In Ghana, farm credit gives farmers the chance to have access to factors of production, but with trust in the farmer's readiness and capacity to reimburse at a predetermined future date (Akudugu, 2016). Floro (2019) added that such trust is built on the farmer's collateral accumulation capacity, but most farmers in Sub-Sahara Africa have low collateral accumulation capacity.

All users of improved input technologies were members of farm-based unions, while majority (76.07%) of nonusers did not belong to any farm-based union. On the whole, majority (70.33%) of the farmers belonged to at least a farm-based union. Literature suggests that membership of farm-based unions increases the members' chances of acquiring and managing vital extension information for usage of improved technologies (Watson, 2019). Lowitt et al. (2020) added that membership of farm-based unions enables farmers to pool their resources together to serve as collateral for farm credit access, which is relevant for usage of improved input technologies. The conceptual framework (Figure 1) described that farmers who form farm-based unions and/or have access to credit are more likely to use improved input technologies than those with limited access.

In general, many (58.33%) of the rural farmers did not have belief in government policy interventions against uncertainties in farming. Specifically, 72.65 percent of nonusers of improved input technologies did not have belief in government policy interventions against uncertainties in farming, while a little over 50 percent of users of improved input technologies had belief in government policy interventions. Mathenge, Smale and Tschirley (2015) showed that belief in governmental policy intervention is relevant for encouraging farmers to use

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

improved input technologies. Fang and Meiyan (2017) explained that such belief serves as the basis upon which most rural farmers take innovative risks.

Majority (69.4%) of users of improved input technologies had access to market, while 77.78 percent of nonusers had access to market. On the whole, 72.67 percent of the farmers had access to market. Verkaart et al (2017) indicated that farmers sort out their work to optimize utility over consumption products in an economic and institutional environment that is compelled by the commonness of market disappointments in developing nations of Africa. Thus, access to market is expected to increase the likelihood of usage of improved input technologies for increased yield, income, and food security for rural development as illustrated in the conceptual framework (Figure 1).

On the whole, a little over 50 percent of the farmers did not have access to television-based extensions. Majority (53.55%) of the users of improved input technologies had access to television-based extensions, while majority (56.41%) of nonusers did not have access to television-based extensions. Relatedly, the median number of mobile phone-based extensions by users was four (skewness = -0.65, mean= 3.07) with a quartile deviation of 1.5, while the median number of mobile phone-based extensions by nonusers was three (skewness = -0.65, mean= 2.47) with a quartile deviation of two (Table 6). Opoku and Enu-Kwesi (2020) suggested that mobile phones and televisions as information technologies ease extension information delivery and management. The conceptual framework showed that farmers who have access to ICT-based extensions are expected to use improved technologies than those with limited access (Figure 1).

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Table 6: Household size, Experience, Education, Quality of extension contacts, Phone-based extensions, Input maize price

	Users					Nonusers				
Variables	Mean	Median	SK	SD	QD	Mean	Median	SK	SD	QD
Household size	6.87	6.00	1.12	2.95	1.50	6.30	6.00	0.15	2.34	2.00
Years of Experience	20.13	18.0	0.47	11.46	10.0	25.44	24.00	0.63	10.86	8.00
Years of Education	9.98	9.00	0.41	2.85	1.50	6.00	6.00	-0.11	3.92	3.00
Quality of extension contacts	1.30	1.33	0.37	1.02	0.88	0.76	0.33	1.48	0.86	0.54
Phone-based extensions	3.07	4.00	-0.65	1.69	1.50	2.47	3.00	-0.65	2.68	2.00
Input maize price	10.09	15.00	-0.71	6.21	4.5	2.81	0.00	0.59	3.56	3.50

Source: Field survey, Ahiadzo (2020)

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Quality of extension contacts is an index computed as an average of highly correlated variables such as number of extension contacts, and their perceived timeliness (no = 0, yes = 1), relevance (no = 0, yes = 1) and credibility (no = 0, yes = 1). The users had mean quality of extension contacts of 1.30 (skewness = 0.37, median = 1.33) with a standard deviation of 0.88. On the other hand, non-users had median quality of extension contacts of 0.33 (skewness = 1.48, mean = 0.76) with a quartile deviation of 0.54. As explained by Barrett et al. (2017) extension services are one of the most relevant institutions for exposing farmers to improved technologies in Africa and Ghana. Most rural farmers depend on their farms for survival such that they would avert the risk of using improved input technologies that are not pre-experimented and confirmed for profitability (Mwalupaso et al., 2019).

The median household size of the users was six (skewness = 1.12, mean = 6.87) with a quartile deviation of 1.5. On the other hand, the mean household size of non-users was six (skewness = 0.15, median = 6) with a standard deviation of 2.23. On the whole, the lowest household size was two, while the highest household size was 17. The argument in literature is that farmers with large household size are usually faced with problems of food insecurity due to high dependency (Kassie, Jaleta & Mattei, 2014). Yahya (2020) explained that though most farm households turn to have large household size to serve as farm labour, observations have shown that the large household size weakens food security motives of farming.

The users had 20.13 mean years of experience in maize farming (skewness = 0.47, median = 18 years) with a standard deviation of 11.46. On the other hand, nonusers had 24 median years of experience in maize farming (skewness = 0.63,

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

mean = 25.44 years) with a quartile deviation of eight. On the whole, the least years of experience in maize farming was three, while the most experienced farmer had been in maize farming for 55 years. There is inconsistency in literature concerning the role that years of experience play in usage of improved input technologies. Shaner (2019) argued that farmers who remained in farming for several years are more likely to know about the technology that favours particular farming seasons and use them, whereas Mariyono (2019) maintains that due to several years of experiences, some farmers may equally resist the usage of new technologies.

The mean years of education of users was 9.98 (skewness = 0.41, median = 9 years) with a standard deviation of 2.85, while the mean years of education of non-users was six (skewness = -0.11, median = 6 years) with a standard deviation of three. In total, seven percent of the farmers never had formal education, while the highest years of education was 20. Danquah, Ahiadzo, Appiah, Roberts and Pappinen (2019) upheld that seldomly are highly educated and well-trained farmers in Ghana associated with low agriculture productivity, because they respond quickly to modern agronomic practices than their counterpart farmers who have little or no schooling. Gupta, Ponticelli and Tesei (2019) observed that the schooling prepares the farmers with the aids to have participative extension contacts for effective application.

The median input maize price for users of improved maize varieties was GHc15.00 per 2.5kg (skewness = -0.71, mean = GHc10.09). On the other hand, the median input maize price for nonusers of improved maize varieties was GHc0.00 per 2.5kg (skewness = 0.59, mean = GHc2.81). This means that majority of nonusers re-cultivated the maize yield from previous season, or did not buy

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

input maize. Precisely, 59.83 percent of nonusers did not buy input maize, while 21.86 percent of users of improved maize varieties did not buy input maize. High input maize price adversely corresponds with the decision to use improved input technologies in the maize farming in West Africa (Houeninvo et al., 2019).

It became necessary to find out why some farmers used the improved input technologies, while others did not use them. Each of the 300 farmers provided reasons for their choice of inputs in maize farming. About 39 percent of nonusers revealed that they cultivated local maize varieties without fertilizer application due to their age long experience in such production practice, while 32.5 percent of them used similar farm inputs because they believe that the local maize varieties last longer in storage in maize granary (ebli-va) compared to the improved maize varieties. The key informants confirmed this belief and explained that the improved maize seed contains more protein so if it is not harvested immediately after maturity, army worms attack them right on the farm, which suggests that it is advisable to harvest improved maize in time.

Twenty eight percent (28.2%) of the nonusers were ready to use improved technologies, but they cited credit as the constraints due to absence of collateral and soft-term credits. Yet, majority (61.7%) of the users accepted the improved technologies because they observed that it increased income for their fellow union members who used them, while the rest (38.3%) of the users claimed that they were convinced because demonstrations showed that improved maize varieties and inorganic fertilizers enhanced growth and yield. The procedure used in the demonstration includes information of the farmers on the type of improved technologies to be introduced and the selection of a farmer whose site is to be used for the demonstration (Extension Officers at KNMA; August, 2020).

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

The first key informant explained that:

> *We* [extension agents] *prepare the site together with the farmers and the sowing of the improved maize variety is done alongside the local variety that the farmers had been sowing. This is to enable the farmers to compare the outputs from the introduced improved maize variety and the local variety so that they can choose for themselves which one to use. We cultivate both the traditional maize and the improved maize variety in line at similar intervals on the same site but on different plots. Our municipal crop office supplies the farmers with the improved maize varieties and the associated inorganic fertilizers such as the NPK and the urea (*Extension Officer at Dzodze; August, 2020).

The implication of the above statement is that as explained by traditional agriculture theory (Alston, 2018), demonstrations on the usage of improved technologies encourage first-time usage among farmers. In addition, Drew (2016) opined that inferring from technological determinism theory, demonstrations convince nonusers to also use the improved input technologies in their farming activities. As the technology acceptance theory highlighted, the usage of the improved technologies was attainable due to the fact that the demonstrations promote perception about ease of use and usefulness of the improved technologies (Syiem & Raj, 2015). The conceptual framework (Figure 1) also captured that the usage of improved input technologies is enhanced when farmers become conversant with improved technologies through such practical extensions.

Disaggregation of the data revealed that 57.4 percent of the users sowed open pollinated variety (OPV), while the rest of them sowed hybrid maize varieties. The responses from a key informant interview suggest that the OPV is

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

developed under open environment and it can be sowed for three consecutive farming seasons before going for a fresh seed. On the other hand, the hybrid maize variety is a cross-breed between two progenies developed under a very closed environment such that if maximum output is desired, a fresh maize seed ought to be bought for each farm season (Crop Officer at Dzodze; August, 2020).

In order to establish whether the users applied inorganic fertilizer at the prescribed ratio of 50kg per hectare for a maximum of three times, the responses of the users were further disaggregated in relation to the quantity and the number of times that inorganic fertilizer was applied (Table 7). All the users of improved input technologies who sowed the hybrid seed applied fertilizer at least once, while a little over 31 percent of the open pollinated variety users did not apply any fertilizer during the previous major farm season. Comparing the outcomes to the key informants' prescription of 50 kg of fertilizer per/ha for a maximum of three times, only 13.7 percent of users did the right thing. These observations where significant ($\chi2 = 30.72$, df = 3: P = 000), which suggest that there were significant associations between type of improved maize varieties cultivated and the extent of fertilizer application.

Table 7: Improved Maize Varieties by Fertilizer Application

	Types of Improved Maize Variety		
	OPV	Hybrid	Total
No of times of fertilization	No (%)	No (%)	No (%)
0	33(31.4)	0(0.0)	33(18.0)
1	25(23.8)	28(35.9)	53(29.0)
2	33(31.4)	39(50.0)	72(39.3)
3	14(13.3)	11(14.1)	25(13.7)
Total	105(100)	78(100)	183(100)

($\chi2 = 30.72$, df = 3: P = 000).
Source: Field survey, Ahiadzo (2020)

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Factors that Affect Usage of Improved Input Technologies

In objective two, I examined the factors that affect the usage of improved input technologies. The conceptual framework (Figure 1) shows that rural farmers make production and consumption decisions so concurrently that unless they are facilitated, they may remain in traditional farming, which is dominated by rural poverty. Technological determinism theory informs that altering such traditional farming requires renewal of traditional input technologies (McCurry, 2016), while traditional agriculture theory maintains that usage of the improved technologies is affected by institutional and human capital factors (Pasa, 2017). In examining relevance of technology acceptance in contemporary research, Opoku and Enu-Kwesi (2020) opined that access to information technologies improves extension information delivery and management, which may affect usage of improved input technologies in farming.

Institutional issues captured were extension contacts and quality, financial credit (Akumbole et al., 2018), farm-based associations, and belief in government policy interventions (Manda et al., 2016). Human capital considered was schooling and years of experience in farming (Mmbando & Baiyegunhi, 2016). The information communication technologies ICTs include television, and mobile phones-based extension (Chhachhar et al., 2014). Generally, farmers who have access to these factors were hypothesised to be more likely to discard the traditional technologies and use improved input technologies in maize farming compared to the farmers who had limited access to the proposed factors. At the response rate of 96.77 percent, 183 users of improved input technologies and 117 non-users were used for the analysis.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Binary logistic regression was performed to examine the role of access to institutions, human capital and ICT-based extension in the usage of improved input technologies in maize farming activities of Ketu North Municipality of Ghana. Lan, Chiang and Studer (2018) opined that the binary logistic regression takes into consideration simple testing of models to foretell results with two classes. Pallant (2020) demonstrated that the independent variables can be either categorical or noncategorical or a blend of both in one model. Contextualized in this study, the dependent variable, which was the usage of improved input technologies in maize farming was coded as 1 for users and 0 for nonusers.

The model was underpinned by Schultz's traditional agriculture theory, technological determinism theory and technology acceptance model, and was built with 11 independent variables. These include sex, quality of extension contacts, access to mobile phone-based extensions, access to television-based extensions, years of experience, years of education, membership of farm-based associations, access to credit, belief in government policy interventions, access to market and price of maize seed cultivated.

The Logit model is illustrated as:

P = $\frac{e\,x\,p(z)}{1+e(z)}$, whereby P is the proportion of occurrence

Z $= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} +$ $\beta_{11} X_{11}$, which represents the equation for usage/non-usage of improved input technologies.

Whereby X_1, X_1……. X_n are the explanatory variables. The inverse relation of the equation is now: Z = In $\frac{p}{1-p}$, which represents the natural logarithm of the odds, which is known as the logit. The logit transforms P, which is limited to the range [0,1] to a range [-∞, ∞].

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

The independent variables are:

X_1= Sex (male = 0, female = 1)

X_2 = Experience (years)

X_3 = Education (years)

X_4 = Quality of extension contacts (timeliness, relevance, and credibility)

X_5= Phone-based extensions (number of times per season)

X_6 = TV-based extensions (No = 0, Yes = 1)

X_7 = Membership of farm-based unions FBU (No = 0, Yes = 1)

X_8 = Access to credit (No = 0, Yes = 1)

X_9 = Belief in government policy interventions (No = 0, Yes = 1)

X_{10} = Access to market (No = 0, Yes = 1)

X_{11} = Input maize price (GHc)

In order to put the logistic regression to use, as Pallant (2005) opined, multicollinearity, sample size and normality assumptions were checked. The multicollinearity test was performed on the independent variables as a method of dispensing with any relationship between at least two independent variables which may distort the results. Multicollinearity exists where at least two autonomous factors are profoundly related with one another to such an extent that they measure something very similar, yet in an alternate manner (Daoud, 2017). If this happens, as pointed out by Kim (2019), the assessed regression coefficients can equivocate broadly, making it unstable to decipher the coefficients as a pointer of the explanatory variable.

As per Wilson et al. (2009), if the tolerance value is below 0.1, it demonstrates a genuine collinearity issue. Field additionally showed that when the Variance Inflation Factor (VIF) for the independent variables surpass 10, then

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

there is a reason for concern. From Table 8, it tends to be seen that all the tolerance values are higher than the satisfactory 0.1, and all the VIF values are below 10. This gives a sign that the data were liberated from the issue of multicollinearity.

Table 8: Text of Collinearity of Independent Variables

Independent variables	Collinearity Statistics	
Model	Tolerance	VIF
Sex: female (1)	0.905	1.10
Years of Experience	0.924	1.08
Years of Education	0.721	1.39
Extension contacts and quality index	0.928	1.08
Phone-based extensions	0.910	1.10
TV-based extensions (1)	0.920	1.09
Membership of FBU (1)	0.574	1.74
Access to credit (1)	0.859	1.16
Belief in government policy on uncertainty (1)	0.933	1.07
Access to market (1)	0.903	1.11
Input maize price	0.691	1.45

Source: Field Survey, Ahiadzo (2020)

According to Cargnelutti Filho and Toebe (2020), the suggested sample size for a regression analysis should be N> 50+ 8m where m= number of independent variables. In this study, the independent factors are 11 in number. By computation N = 50 + 8 (11) = 138. This demonstrates that the sample size of 139 would have been adequate for executing a regression in this study. Hence, the sample size of 300 utilized for this study is more than enough to avoid any infringement of the assumption of sample size for binary regression analysis.

Apart from the multicollinearity and the sample size tests, as Pallant (2005) suggested, normality check is conducted. Simmons (2016) showed that

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

the normality can be checked by observing the pattern of the histogram within the probability normality plot. Cargnelutti Filho and Toebe (2020) illustrated that for normality to be assumed, the histogram is expected to align itself in reasonable bell shape within the bell shape of the normal probability plot. As demonstrated in Figure 3, there was no major deviation in the data from normality.

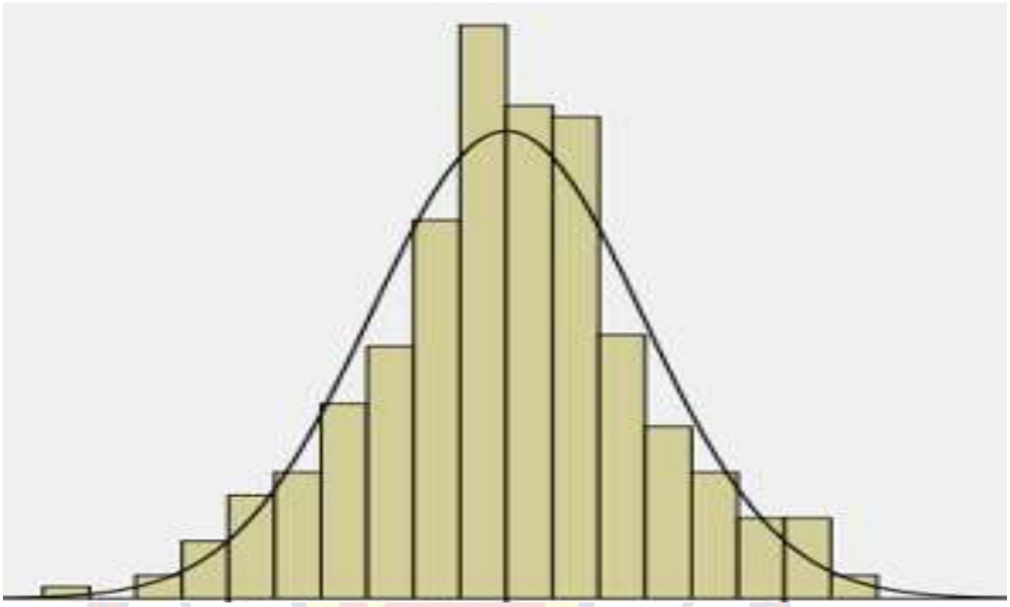

Figure 3: **Histogram and Normal Probability Plot**
Source: Field Survey, Ahiadzo (2020)

The model was better than Stata's unique speculation, which expected that each rural maize farmer will not use the improved input technologies in maize farming activities. This was established by Log likelihood -21. 49, Wald Chi-square LRχ2 (11) estimation of 358.27 with a sample size of 300 farmers, and a P-value (P> χ2) of 0.000. In addition to the model fitness, the Pseudo R^2 value was 0.893. This means that about 89 percent of the variation in the usage of improved input technologies is jointly explained by the explanatory variables in the model.

The results show that seven out of the 11 variables significantly explain the usage/non-usage of improved input technologies (Table 9). Precisely, years of

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

education (X_3), quality of extension contacts (X_4), access to phone-based extensions (X_5), membership of farm-based unions (X_7), access to credit (X_8), and input maize price (X_{11}) significantly explain the usage of improved input technologies. These findings are similar to that of Mmbando and Baiyegunhi (2016) that the decision to use improved maize varieties was explained by farmers' years of education and access to extension and credit as well as membership of farm-based unions in Tanzania.

Table 9: Variables in Usage of Improved Input Technologies Equation

						95% C.I. for EXP(B)	
Model	B	SEE	Z	Sig.	Exp(B)	Lower	Upper
X_1	-0.528	1.01	-0.52	0.601	0.590	0.081	4.272
X_2	- 0.113	0.05	-2.40	**0.016**	0.893	0.814	0.979
X_3	0.315	0.15	2.03	**0.042**	1.371	1.012	1.857
X_4	0.839	0.39	2.13	**0.033**	2.314	1.071	5.001
X_5	0.710	0.35	2.04	**0.042**	2.033	1.027	4.024
X_6	0.784	0.91	0.86	0.390	2.191	0.367	13.084
X_7	4.630	0.93	4.96	**0.000**	102.485	16.457	638. 22
X_8	0.004	0.00	2.60	**0.009**	1.004	1.001	1.006
X_9	1.619	1.00	1.62	0.105	5.048	0.715	35.644
X_{10}	-1.328	1.02	-1.30	0.193	0.265	0.036	1.955
X_{11}	0.333	0.10	3.21	**0.001**	1.396	1.138	1.711
Con	-9.375	2.65	-3.53	0.000	0.000	0.000	0.015
Number of observations 300					LRχ2 (11)	358.27	
Pseudo R^2		0.893			P> χ2	0.000	

Source: Field Survey, Ahiadzo (2020)

The results are also consistent with that of Manda, Alene, Gardebroek, Kassie and Tembo (2016) that the usage of improved maize seeds and inorganic fertilizer was driven by education, farm credit, government support, extension contacts, membership of farm-based associations and input maize price in Zambia. Similarly, in Nigeria, Uduji and Okolo-Obasi (2018) found that e-wallet programme facilitated by mobile phone expanded the appropriation of improved

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

seed in Nigeria. However, the previous studies considered extension contacts solely, while this study used quality of extension contacts, which was composed of extension contact and its timeliness, relevance and credibility to farmers. From the perspective of technology acceptance model, Opoku and Enu-Kwesi (2020) alluded that these insights remain relevant in extension information management, which affects the usage of improved input technologies.

The coefficient of quality of extension contacts (X_4) was positive (p-value = 0.033). This means that a unit increase in the quality of extension contacts increases the usage of improved input technologies by a factor of 0.839, ceteris paribus. The odds of using improved input technologies in maize farming (Exp (B) = 2.314), implies that farmers who had quality of extension contacts were 2.314 times more likely to use improved input technologies in maize farming than those without quality of extension contacts. Considering the components of the quality of extension contacts, farmers who had timely, relevance and credible extension contacts were more likely to use improved maize varieties and inorganic fertilizer in maize farming than those without timely, relevance and credible extension contacts.

Similarly, access to phone-based extension (X_5) facilitates the usage of improved input technologies in maize farming activities of the study area by a factor of 0.710, all other things being equal (p-value = 0.042). The odds (Exp (B) =2.033) indicates that farmers who had access to mobile extensions were 2.033 times more likely to use improved input technologies compared to the farmers who had no access to mobile phone-based extensions. Uduji and Okolo-Obasi (2018) also reported a similar result that mobile phone as well as the versatile

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

inclusion of television-based extensions were the positive determinants of farmers' usage of improved maize varieties in Nigeria.

However, quantitative approach was used in their study while this study used mixed method approach to integrate the unique facilitation role of mobile phone in the usage of improved input technologies in the study area. During the key informant interviews, an extension officer stated that:

> *As for mobile phone-based extension communication, our rural farmers cannot be underrated and some of them even know how to make conference call. The last time a farmer wanted to seek a clarification from me on extension information that he heard on radio, I clicked on the answer button of the incoming call and I was notified that conference call, something that I thought that a rural farmer cannot do, the farmer knows* (Extension Officer at Ketu North Municipality; August, 2020).

This statement means that before the farmers apply extension information gotten from ICTs such as radio, mobile phone and television, they first confirmed from extension officers. Dafoe (2015) opined from the viewpoint of technological determinism theory that this information flow is relevant because the usage of improved inputs production is enhanced when information about the improved technologies is of common knowledge to everyone. It further implies that though traditional agriculture theory maintains that extension services demand a close contact between farmers and the extension agents (Alston & Pardey (2017), the mobile phones allow the farmers to sit in the comfort of their homes or farms and access extension services as shown in the conceptual framework (Figure 1).

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

In addition to extension issues, membership of farm-based unions (X_7) positively affect the usage of improved input technologies (p-value = 0.000). The inference of this result is that membership of a farm-based union increases usage of improved input technologies by a factor of 4.630, all other things being equal. The odds of using improved input technologies in the maize farming (Exp (B) = 102.485) implies that farmers who belong to farm-based unions were 102.485 times more likely to use improved maize varieties and their associated inorganic fertilizer than their counterparts who did not belong to any farm-based union. The result is consistent with that of Manda, Alene, Gardebroek, Kassie and Tembo (2016) that membership of farm-based unions promotes information flow and collective decision to use improved maize varieties and inorganic fertilizer in farming activities of rural Zambia.

As captured in the conceptual framework (Figure 1), which was explained by insights from Schultz's traditional agriculture (Fang & Meiyan, 2017), farm-based union as a social institution, provides mutual support for the members in time of need and encourages social learning via the interactions among members. In accordance with the technology acceptance model, improved social learning on the improved input technologies promotes ease of use and usefulness among the farmers (Asongu & Boateng, 2018), which facilitated the usage of improved input technologies in the study area. Based on technological determinism, Burrell (2018) explained that this results into constant renewals as non-users learn how to use the improved input technologies from the early adopters.

Another factor that facilitates the usage of improved input technologies was access to credit (X_8, p-value = 0.009), by a factor of 0.004, ceteris paribus. The odds of using improved technologies in maize farming was (Exp (B) = 1.004).

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

This odd indicates that farmers who had access to credit were1.004 times more likely to use improved input technologies in maize farming as compared to their counterparts who did not have access to credit.

The conceptual framework (Figure 1) describes that though few farmers may earn enough income to afford the cost of improved input technologies, majority of them may have to fall on agricultural credits for similar purposes. As opined in the traditional agriculture theory (Mariyono, 2019), rural farmers are poor but efficient, which means that once they have access to credit, they would be willing to buy and use improved input technologies. This result is consistent with that of Akumbole, Zakaria and Adam (2018) that credit access directly influenced adoption of improved maize varieties by smallholder maize farmers in the rural areas of Bawku Municipal District of Upper East in Ghana.

In addition to those institutional facilitators, human capital component such as farmer's years of education (X_3) directly affects the usage of improved input technologies (p-value = 0.042). The insight from this result is that a unit increase in the farmer's years of education, increases usage of improved input technologies by a factor of 0.315, ceteris paribus. Precisely, farmers who had formal education were 1.371 times more likely to use the improved input technologies than their counterpart farmers who had no formal education (Exp (B) = 1. 371). Similar finding was reported by Manda et al. (2016) in Tanzania as well as by Verkaart, Munyua, Mausch and Michler (2017) in Ethiopia that higher formal education encouraged usage of improved input technologies among farmers.

The finding reaffirms a proposition by Schultz's traditional agriculture theory (Schultz, 1964) that it is more likely that farmers who have higher levels of education would be in the best position to capitalize on that human capital and

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

use improved input technologies that are highly profitable to farming. Technology acceptance theory (Davis (1989) proposed that perceived usefulness of the improved technologies and perceived ease of using them form the basis of predicting the user's willingness to use those improved technologies, while the review by Opoku and Enu-Kwesi (2020) suggests that the perceived ease of use and usefulness are in turn affected by other factors, including education.

The results also show that the input maize price (X_{11}) directly affects the usage of improved input technologies (p-value = 0.001). This result implies that the farmers need improved maize varieties so much that irrespective of a unit increase in their prices, the willingness to buy and cultivate is still high by a factor of 0.333, all other things being equal. The odds of using improved input technologies (Exp (B) = 1.396) means that farmers who bought the maize varieties at higher prices were 1.396 times more likely to use improved input technologies in maize farming than their counterparts who did not buy or buy at lower prices. This result differs from that of Houeninvo et al. (2019) that the price of improved maize seed negatively affects adoption of improved maize seed in Benin. The discrepancy could be due to the fact that the farmers in this study had been locked up into usage of improved input technologies and thus had no choice.

Schultz's traditional agriculture theory (Schultz, 1964) argues that rural farmers are poor but efficient. Dandekar (2017) explained that though the theory assumes that the relative price of all factors of production remains unchanged, it is equally assumed that the farmers have perfect knowledge about the returns to various factors of production. The conceptual framework, Figure 1, draws on insights from technological determinism theory that improved maize varieties increase output compared to the local varieties. The result suggests that the price

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

of improved maize varieties for sowing is higher than that of the local variety for similar purpose. Thus, irrespective of the increased input maize prices, farmers were willing to buy and cultivate to sell at relatively higher prices to other farmers who wish to buy the improved maize from their colleague farmers.

On the other hand, years of experience (X_2) in farming explain non-usage of improved input technologies (p-value = 0.016). The meaning of this result is that a unit increase in the farmers' years of experience in maize farming decreases their usage of improved input technologies by a factor of 0.113, all other things being equal. The odds of using the improved input technologies (Exp (B) = 0.893) implies that farmers with higher years of experience in maize cultivation were 0.893 less likely to use improved input technologies than the farmers with low years of experience. Verkaart et al. (2017) reported a similar result that farmers with higher years of experience in farming averted the risk of using improved input technologies in Ethiopia. Yet, unlike their study, this thesis further explores the unique challenge associated with highly experienced farmers in relation to the usage of improved input technologies.

During a key informant interview, an extension agent expressed that:

> *The challenge we face in relation to highly experienced farmers is that it takes a longer time for them to accept improved* [new] *technologies, but we also learn a lot from them as they mostly understand the business aspect of the maize farming* (Extension Agent at Afife zone; August, 2020)

Explaining the result and this statement in view of technology acceptance theory, Grabowski, Kerr, Donovan and Mouzinho (2015) pointed out that usage of improved technologies is affected by the level to which the farmer believes that

Digitized by Sam Jonah Library

using that particular improved input technology augments work performance and the level to which the farmer has confidence that using the improved technology would demand less effort. It could be that highly experienced farmers perceived the ease of using the local maize varieties than the improved input technologies. As explained by the traditional agriculture theory (Yahya, 2020), this could be due to the fear of risking their survival on unknown technologies. The conceptual framework described that highly experienced farmers are likely to remain in traditional agriculture, and continue to sow local maize varieties because they had been locked up into the usage of local technologies (Figure 1).

In summary, among the variables that significantly explain the usage of improved input technologies in maize farming activities of the study area, membership of farm-based unions (X_7, Exp (B) = 102.485) was the strongest predictor. This was followed by quality of extension contacts (X_4, Exp (B) = 2.314), phone-based extensions (X_5, Exp (B) = 2.033), input maize price (X_{11}, Exp (B) = 1.396), years of education (X_3, Exp (B) = 1.371), and access to credit (X_3, Exp (B) = 1.004). On the other hand, years of experience in maize farming (X_2, Exp (B) = 0.893) was the only significant predictor of non-usage of improved input technologies. However, sex of the farmers (X_1), access to television-based extensions (X_6), belief in government policy interventions (X_9), and access to market (X_{10}) did not significantly explain usage or non-usage of improved input technologies (Table 9).

Outcomes of Usage of Improved Input Technologies

In the final objective, I evaluated the outcomes of the usage of improved input technologies in maize farming for rural development in the Ketu North Municipality of Ghana. The estimations were carried out with the usage of

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

treatment effects analyses to compare users of improved input technologies and nonusers based on maize yields per hectare, income as well as food security per year. Finally, with the aid of aggregate yearly consumption expenditure, Foster-Greer-Throbecke (FGT) poverty index was used to compare poverty incidence, gap, and severity between users and nonusers of improved input technologies in maize farming. At the response rate of 96.77 percent, 183 users of improved input technologies and 117 non-users were used for the yields per hectare analysis.

In order to obtain the yield of maize per hectare, the farmers were asked to state the total number of maize farms cultivated in the previous major farm season as well as the total yield of maize, which were mostly obtained at a 2.5kg-bowl measurement unit. With the rationale to make the data collection easy and precise, the yield of maize data collection was broken down into numbers of bowl of maize sold, given to relatives, consumed per week, stored and the period that the maize got finished. The total number of 2.5kg-bowls of maize realized from the computations were multiplied by 2.5kg as unit to obtain the output in kilograms, while the products were divided by the total number of hectares of maize farm cultivated by each farmer. Finally, the quotients, which were the yields of maize in kilograms per hectare, were further divided by 1000 to convert the yields into metric ton per hectare for each farmer.

In general, the median yield of maize was 1.688 metric tons per hectare in the rural areas of the Ketu North Municipality of Ghana (skewness = 1.209, mean = 1.958 metric tons/ha) with a quartile deviation of 0.8222. This output implied that from the year 2015 to 2020, the Municipal's average yield of maize increased from 1.6 metric tons per hectare (MoFA, 2015) by 5.5 percent in rural areas. A key informant stated that: '*Generally, the emergence of Planting for Foods and*

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Jobs policy in 2017, is being associated with increased usage of improved maize varieties and associated inorganic fertilizers, which are translating into increasing yield of maize in the Municipality' (A crop officer, KNMA, 2020).

The conceptual framework (Figure 1) illustrates that sowing of improved maize and application of associated fertilizers is expected to result in an increased maize yield, and given access to market, is expected to increase income, food security and consumption expenditure for poverty reduction as pathway to rural development. Insights were drawn from technological determinism theory (Nagy & Neff, 2015), which argues that the rewards of usage of improved technologies is that the users' returns are altered into tangible income growth. Traditional agriculture theory added that this income growth is inevitable for poverty reduction (Mathenge et al., 2015), while technology acceptance model explains that this usefulness attracts people to use improved input technologies (Aker et al., 2016).

The overall minimum yield of maize was 1.125 metric tons per hectare, which was obtained by a nonuser, whereas the maximum yield of maize was 3.906 metric tons per hectare by a user of improved input technologies. The highest yield of maize among nonusers was 1.875 metric tons/ha while the median yield for them was 1.400 metric tons per hectare (skewness = 0.540, mean = 1.434 metric tons/ha) with a quartile deviation of 0.3325. This result suggests that the average yield of maize for the nonusers was less than the Municipality's average yield of 1.6 metric tons/ha reported by MoFA (2015). Further disaggregation of the data revealed that majority (75.2%) of the nonusers were producing at an output level less than the Municipality's yield of 1.6 metric tons per hectare.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

On the other hand, the median yield among users of improved input technologies was 2.083 metric tons per hectare (skewness = 0.719, mean = 2.293 metric tons/ha) with a quartile deviation of 1.2375, which is higher than the Municipality's 1.6 metric tons per hectare as reported by MoFA (2015). The least yield of maize by the users was 1.389 metric tons per hectare. The data were disaggregated to estimate the yields that were associated with the varying levels of improved technologies usage among the users. As stated earlier, the ratio and the optimum number of fertilizer application is 50kg of fertilizer per hectare for three times. The result showed that 18 percent of the users who sowed improved maize seeds without application of fertilizer had a median yield of 2.031 metric tons per hectare (skewness = 1.209, mean = 2.152 metric tons/ha) with the least of 1.339 metric tons per hectare and maximum yield of 3.700 metric tons/ha

During that major farm season in 2019, the 29 percent of the users who applied inorganic fertilizer once to the improved maize varieties, had a median yield of 1.880 metric tons per hectare (skewness = 0.828, mean = 2.194 metric tons/ha). The lowest and the highest yield for this class of users of improved input technologies were 1.389 metric tons per hectare and 3.875 metric tons per hectare respectively. In addition, the 39.3 percent of the users who applied inorganic fertilizer twice to the improved maize varieties obtained the median maize yield of 1.956 metric tons per hectare (skewness = 0.759, mean = 2.302 metric tons/ha), with the lowest and the highest maize yield of 1.407 metric tons per hectare and 3.906 metric tons per hectare congruently.

Finally, the 13.7 percent of the users who applied the inorganic fertilizers at the prescribed ratio and at the maximum three times, had the mean yield of 2.662 metric tons per hectare (skewness = 0.249, median = 2.500 metric tons/ha).

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

This result falls a little short of the 2.7 metric tons per hectare that was reported from a demonstration farm in the study area by the Ketu North Municipal Agriculture Department [KNMAD] (2019). The least yield of maize for these class of users was 1.562 while the maximum yield was 3.906 metric tons per hectare during the same farm season in 2019. Yet, this maximum output still falls short of the potential 5.5 metric tons per hectare reported from a trial farm in the year 2017 by the MoFA (2017). Subsequently, treatment effects of the improved input technologies were estimated on quantity of maize yield.

The preliminary analysis revealed that the assumption of normality was violated (Levene's F= 140.88, p = 0.000). Under this condition, Pallant (2005) indicated that it is most appropriate to use a nonparametric procedure such as Wilcoxon rank sum test, which is equivalent to the independent sample t-test. Creswell and Creswell (2017) explained that this test is based on assumption of symmetry and thus a test of median difference. The outcome of the Wilcoxon test revealed that users of improved input technologies in maize farming had a higher significant yield (median = 2.083 metric tons/ha, QD =1.2375) than nonusers (median = 1.400 metric tons/ha, QD= 0.3325; Z (300) = -11.599, p-value = 0.000 < 0.05 (two-tailed). The magnitude of the median difference (-0.683 metric ton/ha) was large ($Z/\sqrt{N}$ = -0.6697) in accordance with Rosenthal, Cooper and Hedges' (1994) classification.

As captured in Table 10, even without application of inorganic fertilizer, users who sowed improved maize seeds had a higher yield (median 2.031 =, QD = 0.156) than nonusers (median = 1.400, QD = 0.791; Z (150) = -7.021, p-value = 0.000 < 0.05 (two-tailed). The effect size (-0.631 metric ton/ha) was large ($Z/\sqrt{N}$ = -0.57) per the classification by Rosenthal et al. (1994). This outcome is

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

consistent with that of Abdoulaye, Wossen and Awotide (2018) that the adoption of the improved maize varieties increased the quantity of maize yield by 574kg/ha in the rural areas of Nigeria. It further agrees with Manda, Alene, Gardebroek, Kassie and Tembo's (2016) finding that adoption of a mix of improved input technologies raised maize yields in the rural areas of Zambia. Houeninvo, Célestin Quenum and Nonvide (2019) also came out with similar finding in the rural areas of Benin.

Table 10: Wilcoxon Test of Median Maize Yield per/ha by Usage of Improved Input Technologies

	Maize yield in metric tons per hectare					
Group	Obs	Median	z-value	p-value	Rank sum	Expected
Nonusers	117	1.400	-11.599	**0.000**	9111	17609
Users	183	2.083			36040	27542
Combine	300	1.688			45150	45150
Nonusers	117	1.400	-7.021	**0.000**	7287	8834
Seed only	33	2.031			4039	2492
Combine	150	1.458			1133	1133

i. Obs (300) unav =537059, Adjustment = -274 av = 536785
ii. Obs (150) unav=48584, Adjustment = -41, av = 48542
Source: Field Survey, Ahiadzo (2020)

As Schultz's (1964) traditional agriculture theory opined, output from farming is mostly increased by transforming traditional farming through the usage of improved input technologies. Similarly, technological determinism theory added that input technologies are responsible for the nature of the outputs in production activities and once the input technologies are improved, output is bound to increase (Schumpeter, 1934). In addition to the insights from technology acceptance model (Davis (1989), the conceptual framework (Figure 1) shows that

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

some users may use only improved maize seeds, while others may further apply fertilizer, which may cause variations in the outputs and needs to be verified.

Table 11 represents the comparison of maize output per hectare by rate of inorganic fertilizer application to improved maize varieties among the 183 users of improved technologies. As the yield per hectare distributions were skewed, it became most appropriate to use Kruskal Wallis test of equality of yield per hectare, which is a nonparametric equivalent of the ANOVA parametric test (Pallant, 2005). The Kruskal Wallis test of equality showed that application of inorganic fertilizer had a significant positive impact on yield per hectare $\chi 2$ (183, df=3) = 9.758, p-value= 0.0207. This result means that at the ratio of 50kg per/ha, the more fertilizer is applied to improved maize varieties for 3 optimum times, the higher the yield per hectare.

Table 11: Kruskal Wallis Equality of Maize Yield by Fertilizer Application

Groups	Observations	Median	Rank Sum
None	33	2.031	2837
Once	53	1.880	4376
Twice	72	1.956	6592
Thrice	25	2.500	3032

$\chi 2$ (183, df=3) = 9.758, p-value= 0.0207; $\chi 2$ with ties = 9.768, p-value = 0.0206
Source: Field Survey, Ahiadzo (2020)

The data were further disaggregated and Wilcoxon rank sum tests were run to find out if each level of fertilizer application to improved maize varieties had significant impact on maize yield (Table 12). The Wilcoxon rank sum tests showed that application of fertilizer at the ratio of 50kg per hectare for once, or twice does not significantly increase the quantity of yield per hectare in the study

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

area (p-values>0.1). On the hand, application of fertilizer at the prescribed ratio for the optimum number of three times significantly increases maize yield per hectare (p-values<0.05).

Table 12: Wilcoxon test of Equality of Yield by Fertilization

	Median by fertilization frequency		
Frequency	None Z(P-value)	Once Z(P-value)	Twice Z(P-value)
Once	0.369(0.712)		
Twice	-0.411(0.681)	-0.992(0.321)	
Thrice	-2.851(**0.004**)	-2.790(**0.005**)	-2.395(**0.017**)

Source: Field Survey, Ahiadzo (2020).

Similar results were reported by Zeng, Alwang, Norton, Shiferaw, Jaleta and Yirga (2015), that the adoptions of improved input technologies at different levels have significant effects on the quantity of maize yield in Ethiopia. Manda, Alene, Gardebroek, Kassie and Tembo (2016) also reported that application of fertilizer increased maize yield in Zambia. However, those studies did not identify the specific ratio and frequency at which fertilizer application had significant impacts on maize yield. As captured in the conceptual framework (Figure 1), the increase in the quantity of maize yield is expected to translate into increased income, given that the farmers had access to market for the sale of the maize.

Based on access to market, net income per hectare for users of improved input technologies were compared with that of nonusers of improved input technologies. Access to market was measured in terms of willingness of the farmers to sell the maize produced at the prevailing market price of GHc5.00 per a 2.5kg bowl and the readiness of customers to purchase. There was no significant difference in access to market between users and nonusers ($\chi 2$ = 2.523, df =1: p-

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

value = 0.112> 0.05). The net income per hectare was obtained by subtracting from the total seasonal income, the total cost of maize seed cultivated as well as that of the fertilizer applied, and the answer divided by total maize farm sizes in hectare. Exactly 154 users of improved input technologies had net incomes, while 88 nonusers also had net incomes. The rest of the farmers did not respond to the item on income and thus the sample size for the net income analysis was 242.

In general, the median net income/ha was GHc483.30 (skewness =1.181, mean = GHc604.81) with a quartile deviation of 158.35, while the lowest was GHc11.25, and the maximum was 2328.75 among the farmers. Specifically, the median net income/ha of users was GHc578.32 (skewness =1.00, mean = GHc 691.38) with a quartile deviation of 207.40. On the other hand, the median net income/ha of nonusers was GHc310.22 (skewness =1.21, mean = GHc 453.31) with a quartile deviation of 168.22. These descriptive statistics suggest that normality assumption was not met (skewness values > 0.5). Thus, the Wilcoxon rank sum test was used to compare the median net incomes per hectare between users and nonusers of improved technologies. The analysis suggests that users had a rank sum of 24197 with expected sum of 18711, while the nonusers had a rank sum of 5206 with expected sum of 10692.

The result showed that users of improved maize varieties and associated inorganic fertilizer in maize farming had a significant higher net income/ha (median = GHc578.32, QD = 207.40) than nonusers (median = GHc310.22, QD = 168.22); Z (242) = -10.475, p-value = 0.000 (two-tailed). The magnitude of the median difference (-268) was large ($Z/\sqrt{N}$ = -0.6734) per the classification by Rosenthal et al. (1994). Given that both users and nonusers of improved input technologies had equal access to market, the meaning of this result is that usage

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

of improved input technologies increases yield per hectare, which in turn increased net maize income per hectare as can be inferred from the conceptual framework (Figure 1).

A further disaggregation of the data showed that 29 out of the users of improved maize varieties who did not apply any fertilizer, had net incomes. The Wilcoxon rank sum test between this group of users and nonusers of improved maize varieties showed that users had a rank sum of 2738 with expected sum of 1711, while the nonusers had a rank sum of 4165 with expected sum of 5192. The result (Z (117) = -6.485, p-value = 0.000) revealed that even without application of inorganic fertilizer, the users who sowed improved maize varieties had a higher net income per hectare (median = 652.08, QD = 280.20) than nonusers (median = GHc310.22, QD = 168.22). The effect size (-341.86) was large ($Z/\sqrt{N} = -0.5995$) per Rosenthal et al.'s (1994) classification.

The result replicates that of Manda, Alene, Gardebroek, Kassie and Tembo (2016). They utilized a treatment effect and found out that adoption of a mix of the improved input technologies raised both quantity of maize yields and income as well as promoted welfare of rural farmers in Zambia. Similarly, Houeninvo, Célestin Quenum and Nonvide (2019) found that the adoption of improved maize varieties alone increased farm income and promoted rural development in Benin. Therefore, as depicted in the conceptual framework, the usage of improved input technologies in maize farming increase farm income and presents potentials for rural development in the study area (Figure 1).

It is discernible from the conceptual framework (Figure 1), that in addition to increasing farm income for rural development, food security is equally relevant for advancing the aims of rural development (Datta, 2019). Therefore, in the

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

ensuing paragraphs, I compared perceived food insecurity by 183 users of improved technologies and 117 nonusers. In accordance with Kassie, Jaleta and Mattei's (2014) approach, food insecurity was measured on a four-level scale such as chronic food insecurity, which means food shortage throughout the year, transitory food insecurity to mean occasional food shortage, as well as breakeven to refer to no food shortage but no food surplus, and finally food surplus after the year.

In order to carry out this task, the farmers were asked to state their methods of storage and the number of months that the harvested maize was consumed. Majority (82.9%) of nonusers of improved input technologies revealed that their harvested maize in the husk, was stored in granary called *'Ebli-Va'* and at a median 10kg weekly maize consumption per nonuser household, the harvested maize was consumed by a median household size of six persons for 8.47 mean months (skewness = 0.312, median = 8 months). Similarly, majority (53%) of the users of improved input technologies utilized the granary storage method and at a median 12.5kg weekly maize consumption per a user household, the harvested maize was consumed by median household size of six persons for 8.84 mean months (skewness = 0.316, median = 8 months). Other storage methods include keeping grains in either sack, gallons, or special bags with ash.

However, maize is not the only food that is consumed by the farmers. Thus, the farmers were asked to express the realities related to food insecurity, which Woertz (2017) described as disruptions of food eating patterns within the year as a result of absence of money and other resources. As captured in Table 13, analysis of responses from the farmers indicates that majority (66.8%) of nonusers of improved technologies had either transitory or occasional food

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

insecurity after the 2019 major maize farm season. Within the same period, 37.2 percent and 43.2 percent of the users of improved input technologies in maize farming broke even and had food surplus respectively. The statistics (N = 300, $\chi2$ = 93.117, df = 3: p-value 0.000) show that these observations were significant.

Table 13: Technologies Usage by Food Insecurity/Security

	Improved input technologies		
	Nonuser	User	Total
Food insecurity/Security	No (%)	No (%)	No (%)
Chronic food insecurity	8(6.8)	1(0.5)	9(3.0)
Transitory food insecurity	78(66.7)	35(19.1)	157(52.3)
Breakeven	24(20.5)	68(37.2)	92(30.7)
Food surplus	7(6.0)	79(43.2)	42(14)
Total	117(100)	183(100)	300(100)

(N = 300, $\chi2$ = 93.117, df = 3: p-value 0.000).
Source: Field survey, Ahiadzo (2020)

Based on these results, ordered logit regression was conducted in which the ordinal food insecurities depend on the usage of improved input technologies and other factors such as access to institutions, human capital as well as access to ICT-based extensions (Figure 1). The food insecurity/security as the dependent variable was inputted in descending order of severity as: chronic food insecurity (No = 0, Yes = 1), transitory food insecurity (No = 0, Yes = 1), breakeven food security (No = 0, Yes = 1), and food surplus food security (No = 0, Yes = 1). Traditional agriculture theory (Schultz, 1964), technological determinism theory (Schumpeter, 1934) and technology acceptance model (Davis, 1989) underpinned the model.

Digitized by Sam Jonah Library

The independent variables were:

X_1= Sex (male = 0, female = 1)

X_2 = Experience (years)

X_3 = Education (years)

X_4 = Quality of extension contacts

X_5= Phone-based extensions (number of times per season)

X_6 = TV-based extensions (No = 0, Yes = 1)

X_7 = Membership of farm-based unions FBU (No = 0, Yes = 1)

X_8 = Access to credit (No = 0, Yes = 1)

X_9 = Belief in government policy interventions (No = 0, Yes = 1)

X_{10} = Access to market (No = 0, Yes = 1)

X_{11} = Input maize price

X_{12} = Household size

X_{13} = User of improved input technologies (No = 0, Yes = 1)

Pallant (2005) suggested that even though ordered logit does not assume normality, multicollinearity and sample size conditions must be met to ensure that the independent variables have sovereign odds. As shown earlier, the sample size of 300 utilized in this study, is far higher than the baseline sample size of 155 from N> 50+ 8m where m represents the number of independent variables (Cargnelutti Filho & Toebe, 2020). As shown in Table 14, there were no recognized issues of multicollinearity per the conditions by Wilson et al. (2009) that the tolerance value should be above 0.1, while the Variance Inflated Factors (VIF) are less than 10.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Table 14: Text of Collinearity of Independent Variables

	Collinearity Statistics	
Independent Variables in the model	Tolerance	VIF
Sex: female (1)	0.895	1.12
Years of Experience	0.854	1.17
Years of Education	0.693	1.44
Quality of extension contacts	0.821	1.22
Phone-based extensions	0.862	1.16
TV-based extensions (1)	0.902	1.11
Membership of FBU (1)	0.310	3.22
Access to credit (1)	0.818	1.22
Belief in government policy on uncertainty (1)	0.914	1.09
Access to market (1)	0.900	1.12
Input maize price	0.615	1.63
Household size	0.901	1.11
User of improved input technologies (1)	0.210	4.79

Source: Field survey, Ahiadzo (2020)

The model was better than Stata's unique speculation, which expected that the explanatory variables did not contribute significantly to food insecurity and or food security. This was established by Log likelihood -272.308, Wald Chi-square LRχ2 (39) estimation of 166.37 with a sample size of 300 farmers, and a P-value (P> χ2) of 0.000. In addition to the model fitness, the Pseudo R^2 value was 0.234, which means that about 23.4 percent of the variation in food insecurity/security is jointly explained by the explanatory variables in the model. The results show that significantly, two out of the 13 variables, two variables explain chronic food insecurity, and three variables each contribute to transitory food insecurity and breakeven food security, while four variables explain food surplus food security (Table 15).

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Table 15: Ordered Logistic Regression of Factors that Affect Food Insecurity/Security

	Chronic food insecurity			Transitory food insecurity			Breakeven food security			Food surplus food security		
Variables	B	Exp (B)	Sig	B	Exp(B)	Sig	B	Exp(B)	Sig	B	Exp(B)	Sig
X_1	1.684	5.388	.144	.460	1.583	.212	-.460	.632	.212	-.385	.680	.334
X_2	-.068	.934	.189	-.020	.980	.178	.020	1.021	.178	.015	1.016	.352
X_3	-.272	.762	**.049**	.008	1.001	.871	-.008	.992	.871	-.040	.961	.491
X_4	-6.713	.001	.095	2.058	7.832	.114	-2.058	.127	.114	-1.130	.323	.441
X_5	.126	1.135	.676	.069	1.071	.500	-.069	.934	.500	-033	.967	.769
X_6	.829	2.290	.410	-.128	.880	.706	.128	1.137	.706	-.799	.500	**.034**
X_7	.666	1.946	.533	-.317	.729	.282	.317	1.373	.282	.182	1.199	.578
X_8	-.007	.993	.991	-.001	.999	.064	.001	1.000	.064	.000	1.000	.488
X_9	-2.057	.128	.125	.376	1.457	.274	-.376	.686	.274	-.658	.518	.078
X_{10}	-2.402	.091	**0.022**	1.175	3.237	**.003**	-1.175	.309	**.003**	-.951	.386	**.031**
X_{11}	-.012	.988	.987	.075	1.077	**.047**	-.075	.928	**.047**	-.108	.878	**.005**
X_{12}	.015	1.015	940	.063	1.066	.307	-.063	.939	.307	.022	1.022	.740
X_{13}	-13.990	.001	.987	-2.271	.103	**.002**	2.271	9.686	**.002**	4.44	85.033	**.000**
Constant	1.806	6.087	.408	-.415	.660	.608	.415	1.515	.608	-918	.399	.313

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

The usage of improved input technologies X_{13} consistently explain non-transitory food insecurity (p-value = 0.002), breakeven food security (p-value = 0.002), and food surplus food security (p-value = 0.000), while input maize price X_{11}, consistently explain transitory food insecurity (p-value = 0.047), non-breakeven food security (p-value = 0.047), and non-food surplus food security (p-value = 0.005) respectively. On the other hand, years of education (X_3), access to television-based extension X_6 and access to market X_{10} behaved inconsistently across the four levels of food insecurity/security. The rests are all insignificant across the four levels of food insecurity/security (Table 15).

Kassie, Jaleta and Mattei (2014) came out with similar results that household size explained chronic food insecurity and transitory food insecurity, while education and usage of improved maize varieties explained non-chronic food insecurity, non-transitory food insecurity, breakeven food security and food surplus food security in rural Tanzania. However, their study did not consider the effects of the improved maize price on food insecurity/security. The conceptual frame work shows that increased input maize price is associated with non-usage of improved input technologies, which results in food insecurity (Figure 1).

A unit increase in input maize price increases transitory food insecurity by a factor of 0.075 (p-value = 0.047), and decreases breakeven food security as well as food surplus food security by factors of 0.075 (p-value = 0.047) and 0.108 (p-value = 0.005) respectively. Farmers who bought input maize at higher prices were 1.077 more likely to experience transitory food insecurity than their counterpart farmers who did not buy the input maize (Exp (B) = 1.077) with (CI 95% Exp(B) 1.001, 1.160). They were also 0.928 less likely to breakeven (Exp (B) = 0.928) with (CI 95% Exp(B)= 0.862 0.999), and 0.878 less likely to obtain

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

food surplus than the farmers who did not buy the input maize (Exp (B) = 0.878) with (CI 95% Exp(B)= 0.163, 0.919).

Though access to market X_{11} was relevant for escaping chronic food insecurity (p-value = 0.022), it also accounted for transitory food insecurity, non-breakeven food security and non-food surplus food security. Table 15 shows that access to market increases transitory food insecurity by a factor of 1.175 (p-value = 0.003). It also decreases breakeven food security, and food surplus food security by factor of 1.175, and 0.951 respectively. The odds (Exp (B) = 3.237) shows that farmers who had access to market for the sale of maize were 3.237 more likely to experience transitory food insecurity compared to farmers who did not have access to market (CI 95% Exp(B) = 1.476, 7.103). Those with access to market were also 0.309 less likely to breakeven (Exp (B) = 0.309), and they were also 0.386 less likely to have food surplus (Exp (B) = 0.386) than the farmers who had no access or limited access to market to sell maize.

A key informant explained that maize is always in high demand in the Ketu North Municipality, while most farmers depend on maize outputs as source of staple food and for income concurrently. Thus, with this ready market, most of them sell the maize and use the income to take care of their immediate needs. However, this results into food shortage problems especially getting to the start of new farm season and most farmers turn to buy maize for consumption at the time of limited income. The key informant revealed that as a solution to these challenges, the farmers are advised to cultivate improved maize seeds and apply fertilizers for improved yield that can sustain household consumption and income.

Usage of improved input technologies X_{13} explains non-transitory food insecurity, breakeven food security, and food surplus food security. Usage of

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

improved input technologies reduces transitory food insecurity by a factor of 2.271 (p-value = 0.002), and increases breakeven food security and food surplus food security by a factor of 2.271 (p-value = 0.002) and a factor 4.44 (p-value = 0.000) respectively. Furthermore, users of improved input technologies in maize farming were 0.103 less likely to experience transitory food insecurity than nonusers of improved input technologies (Exp (B) = 0.103) with (CI 95% Exp(B) = 0.025, 0.428). Similarly, the users were 9.686 more likely to breakeven (Exp (B) = 9.686) with (CI 95% Exp(B) = 2.336, 40.153), and 85.033 more likely to have food surplus than the nonusers (Exp (B) = 85.033) with (CI 95% Exp(B) = 16.637, 434.608).

The results indicate that though farmers are locked up into the usage of improved maize varieties such that no matter the increment in price, they had no other choice than to buy, such prices push them into food insecurity, while the usage of the improved technologies reduces food insecurity and increases food security. These results replicate the argument by Schultz’s traditional agriculture theory that by using improved input technologies, farmers can produce enough food to feed themselves and to feed their neighbours at a cheaper cost (Fang & Meiyan, 2017). The conceptual framework shows that the usage of improved technologies is expected to increased food security, which presents potentials for rural poverty reduction as a pathway for rural development (Figure 1).

Finally, aggregate yearly consumption expenditure was used to measure the treatment effect of the improved input technologies on poverty reduction for rural development. Several rural development researchers including Akumbole, Zakaria and Adam (2018) as well as Houeninvo, Célestin Quenum and Nonvide (2019) acknowledged that consumption expenditure is a more suitable measure

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

of rural poverty reduction for rural development. It was difficult to obtain a daily consumption record, because most farmers had their consumption expenditures on market days at 5-days intervals for non-maize commodities and at varying days for maize consumptions relating to cornflour. The quantity of maize milled into corn flour, stored and other correspondences that were owned and utilized by the farmers were valued at the prevailing market prices and effected into the daily consumption expenditure estimate at the household level.

The daily household consumption expenditures were divided by their respective household sizes to obtain average daily consumption expenditure per household. These quotients were each multiplied by 365 days to convert them into aggregate yearly consumption expenditure per household. Employing the Foster-Greer-Throbecke [FGT] (1984), the poverty index is stated as:

$$P_{\alpha} = \frac{1}{n}\sum_{i=1}^{q}[\frac{Z-Y_i}{Z}]^{\alpha},$$

Y_i is the consumption expenditure of the farmers, and n represents the number of the farmers studied. The q is the sum of the farmers in the sample who lived below the poverty line, while α is the parameter of poverty aversion, which is generally given as 0 where poverty incidence = q/n. Pasa (2017) indicated that the poverty aversion α becomes 1 where poverty gap is determined as $1/n \sum_{i=1}^{q}[(Z - Y_i)/Z]$. As the aversion parameter is 2, the poverty severity/squared poverty gap index is computed as $1/n \sum_{i=1}^{q}[(Z - Y_i)/Z]^2$. The Z is the poverty line $ 1.90 per day given by the World Bank (2019). Using the prevailing exchange rate of GHc5.77 to $1.00; the Z was converted into Ghana currency as GHc10.95 pay day. Osuji and Henri-Ukoha (2017) explained the poverty line (Z) as the threshold level of expenditure considered vital for an individual to realize a sufficient way of life in a given society.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Multiplying the GHc10.95 per day by 365 days, the resulting poverty line per year was GHc3996.75 within the period. In general, the 300 farmers had an annual median consumption expenditure of GHc4015.00 (skewness = 2.728, mean = GHc 3998.61) with a quartile deviation of 234.33. The median annual consumption expenditure of users of improved technologies was GHc4043.10 (skewness = 3.636, mean = GHc 4068.00) with a quartile deviation of 236.90. On the other hand, the median yearly consumption expenditure of the nonusers of improved input technologies was GHc3962.86 (skewness = 0.941 mean = GHc 3890.12) with a quartile deviation of 234.64. On the whole, the least consumption expenditure per year was GHc1642.50 by a nonuser, whereas the highest yearly consumption expenditure was GHc15289.44 by a user of improved technologies.

In order to determine the poverty incidence, the yearly consumption expenditure data were re-coded as 1 for farmers whose expenditure was below GHc3996.75 poverty line, and 0 for those farmers whose aggregate consumption expenditure was higher than GHc3996.75. Using the poverty aversion 'α' $=0$, which assumes that none of the farmers lived below the GHc3996.75 aggregate consumption expenditure poverty line, the poverty incidence $P_0 = q/n$. A cross tabulation was run on the recoded consumption expenditure variable by usage of improved input technologies (Table 16).

Out of a total of 300 rural maize farmers studied, 47 percent of them lived below the GHc3996.75 poverty line per year. This shows a percentage higher than the 30 percent poverty incidence reported about the municipality by the Ghana Statistical Service [GSS] (2015). This discrepancy could be due to the difficulties in relation to obtaining a precise consumption expenditure data among rural folks. The results also show that the poverty incidence among the 117 nonusers was

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

52.14 percent, whereas the 183 users of improved input technologies had a poverty incidence rate of 43.72 percent during the period. Zeng, Alwang, Norton, Shiferaw, Jaleta and Yirga (2015) reported a similar result that poverty incidence was 55.4 percent among nonadopters of improved maize varieties, while adopters had poverty incidence rate of 47.11 percent in Ethiopia.

Table 16: Poverty Incidence by Usage of Improved Input Technologies

	Improved input technologies		
	Nonuser	User	Total
Poverty Status	No (%)	No (%)	No (%)
Nonpoor farmers (0)	56(47.86)	103(56.28)	159(53.0)
Poor Farmers (1)	61(52.14)	80(43.72)	141(47.0)
Total	117(100)	183(100)	300(100)

(N = 300, $\chi 2$ = 2.0317, df = 1: p-value 0.154).
Source: Field survey, Ahiadzo (2020)

Even though poverty incidence was lower among users of improved input technologies than nonusers, the association between usage/non-usage and poverty incidence was not insignificant (N = 300, $\chi 2$ = 2.0317, df = 1: p-value 0.154). As Creswell and Creswell (2017) suggested, once this association is insignificant, there is no need to advance the analysis to determine the effect of usage of improved input technologies on poverty incidence because it will as well be insignificant. However, in order to determine the effects of all the independent variables on poverty incidence, a binary logit regression analysis was conducted in which poverty incidence was the dependent variable.

Using the 300 interviewed farmers, the results of the binary regression in Appendix A at page (143) shows that only belief in government policy interventions X_9 significantly explained poverty incidence among the farmers (p-

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

value = 0.046). Belief in government policy interventions X_9 had marginal effect of 0.503 on poverty incidence. The odd of the poverty incidence was (Exp (B) = 1.653), which implies that farmers who had belief in government policy interventions were 1.653 more likely to live below the GHc3996.75 aggregate yearly consumption expenditure poverty line than their counterpart farmer did not have belief in government policy interventions. Thus, belief in government policy interventions directly affects poverty incidence, while usage of improved input technologiesX_{13} does not significantly reduce poverty incidence.

The result has implications for usage of improved input technologies. Mathenge, Smale and Tschirley (2015) explained that belief in governmental policies promotes usage of improved technologies in farming activities, which is expected to reduce poverty incidence. According to Fang and Meiyan (2017) though such belief serves as guarantee for farmers to use new technologies without fear of uncertainty, yet most governments usually fail to compensate farmers in times of loss due to drought, flood and other correspondences. It could be that most farmers who had belief in government had loss of yield due to uncertainties, but they were not compensated and thus lived below the poverty line. For instance, though the government's policy on Planting for Food and Jobs does not have a compensation scheme (PFJ, 2017), the key informants revealed that it is highly embraced by most farmers in the study area.

On the other hand, the poverty gap, which measures the depth of poverty is when the inequality avoidance parameter $\alpha=1$ and $P_1 = 1/n \sum_{i=1}^{q}[(Z - Y_i)/Z]$. The depth of poverty is a measure of inequality among the poor farmers and thus keep if command was used to retain the observations of only the poor farmers and (Z – Y)/Z was generated as a variable. The summation of (Z – Y)/Z by usage/non-

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

usage, produced $\sum_{i=1}^{q}[(Z - Y_i)/Z]$ for all the poor farmers in general as well as for users, and nonusers respectively. Finally, these sums were divided by their respective sample sizes such as 300 for entire sample farmers, 183 sampled users, and 117 sampled nonusers of improved technologies.

Based on the quotients, the average poverty depth was 0.1082 among the entire sampled farmers, 0.0951 among users of improved input technologies, whereas it was 0.1286 among nonusers who live below the poverty line. These gaps indicate the proportion of consumption expenditures needed for the poorest farmer within each group to escape extreme poverty. The severity of poverty/ squared poverty gap index is stated as when $\alpha=2$, $P_2 = 1/n \sum_{i=1}^{q}[(Z - Y_i)/Z]^2$. The computations based on this revealed that the average poverty severities were 0.0117 among the entire sampled poor farmers, 0.009 among users, while it was 0.0165 among nonusers who live below the poverty line.

These results are similar to that of Houeninvo et al. (2019) that adopters of improved maize varieties had lower poverty severity (0.10) than nonadopters (0.12) and that generally improved maize varieties reduced rural poverty through increased maize yield and farm income for rural development in Benin. However, even though the researchers acknowledged that consumption expenditure is better for poverty measurement than income, they utilised income as a proxy for the consumption expenditure, while this study used consumption expenditure for the poverty measurement. The conceptual framework shows that users of improved input technologies are less likely to experience severer poverty than nonusers and that usage of improved input technologies promote poverty reduction as pathway for rural development (Figure).

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Chapter Summary

This chapter discussed results of usage of improved input technologies in maize farming by rural farmers in Ketu North Municipality of Ghana. The chapter revealed that majority (61%) of the farmers used improved maize varieties at varying ratios of inorganic fertilizer application. Both users and nonusers of the technologies offered unique reasons for why they used or did not use improved technologies. It was established that years of education, quality of extension contacts, access to phone-based extensions, membership of farm-based unions, access to credit, and input maize price explain usage of improved input technologies, while years of experience in maize farming explain non-usage of the technologies. The usage of the technologies led into increased maize yield and income per hectare, food security, and relative reduction of poverty. The next chapter presents the summary, conclusions and recommendations.

VERITAS NOBIS LUMEN

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter contains the summary of the thesis and key findings of the study. The first section of the chapter recaps the entire study and also presents the key findings. It also captures the conclusions and recommendations. This is followed by the conclusion and the recommendations that were drawn from the key findings. Finally, limitations and suggestions for further studies are outlined for consideration.

Summary

The general purpose of the study was to examine usage of improved input technologies in maize farming by rural farmers in Ketu North Municipality of Ghana. Specifically, the study determined the proportion of the farmers who used improved input technologies, and examined the factors that affect usage of the improved input technologies. Finally, the study evaluated the outcomes of usage of improved input technologies in maize farming for rural development, and made recommendations for intensification of improved technologies in maize farming.

I used a mixed method approach, comprising a survey of 300 farmers and key informant interviews. Proportionate systematic random sampling method was used to get to rural maize farmers across Dzodze, Penyi, Weta, Afife zones in the study area. Interview schedules were used to collect data from farmers, while interview guides were used for the key informant interviews. Tools such as descriptive statistics, Chi-Square, Wilcoxon rank-sum test, Kruskal Wallis test, binary and ordered logit were used in Stata and SPSS to analysis the quantitative data, while the key informant interviews were transcribed and interpreted.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

The first objective of the study focused on proportion of farmers who used improved input technologies. The key findings were as follows:

1. Majority (61%) of the farmers used improved maize input technologies and 57.4 percent of the users cultivated open pollinated variety while the rest sowed the hybrid seeds and inorganic fertilizer was applied at varying ratios to both categories of improved maize varieties.
2. Users of hybrid improved maize seeds were more likely to apply fertilizer than users of open pollinated variety (N= 183, $\chi 2 = 30.72$, df = 3: P = 000) and in general, only 13.7 percent of the users of improved maize varieties applied fertilizer at the prescribed ratio of 50kg/ha for three optimum times suggested by the key informants.
3. The extension officers used demonstrations to introduce farmers to the improved input technologies, while the Municipal crop office supplied the farmers with the improved maize varieties and the associated inorganic fertilizers.
4. The most cited reason for usage of improved input technologies was the observation that it increased income fellow farm-based union members who used them (61.7%), whereas the more suggested reason for the non-usage was rich experience in local maize variety sowing without fertilizer application (39.3%).
5. Relatively, users of improved input technologies had relatively higher years of education, quality of extension contacts, and access to mobile phone-based extension, farm-based unions, farm credits, and bought input maize at higher prices than nonusers, while nonusers had higher years of experience in maize farming than users.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

The key findings that emerged for objective two, which addressed factors that affect usage of improved input technologies were that:

1. Membership of farm-based unions (B= 4.630, p-value = 0.000), quality of extension contacts (B= 0.839, p-value = 0.033), access to phone-based extensions (B= 0.710, p-value = 0.042), input maize price (B =1.396, p-value = 0.001), years of education (B= 0.315, p-value = 0.042), and access to credit (B= 1.619, p-value = 0.009) explained usage of improved input technologies.
2. The strongest predictor of usage of improved input technologies was membership of farm-based unions (Exp (B) = 102.485).
3. Years of experience in farming (-0.113, p-value = 0.016) significantly explained non-usage of improved input technologies and even though highly experienced farmers had in-depth knowledge in the business aspect of maize farming, it takes longer time for them to accept improved input technologies.
4. Sex of farmers with 0 for males and 1 for females (B= -0.528, p-value = 0.601), access to television-based extensions (B= 0.784, p-value = 0.390), access to market (B= -1.328, p-value = 0.193), and belief in government policy interventions (B= 1.619, p-value = 0.105) did not significantly affect usage/non-usage of improved input technologies.

The final objective focused on the outcome of usage of improved input technologies for rural development. The key findings were as follows:

1. The median maize yield among users of improved input technologies was 2.083 metric tons/ha (skewness = 0.719, mean = 2.293 metric tons/ha)

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

with a quartile deviation of 1.2375, while the median maize yield by nonusers was 1.400 metric tons/ha (skewness = 0.540, mean = 1.434 metric tons/ha) with a quartile deviation of 0.3325 and usage of improved technologies significantly increased maize yield by 0.683 metric ton/ha (Z (300) = -11.599, p-value = 0.000 (two-tailed).

2. The median net income of users was GHc578.32/ha (skewness =1.00, mean = GHc 691.38) with a quartile deviation of 207.40, while the median net income of nonusers was GHc310.22/ha (skewness =1.21, mean = GHc 453.31) with a quartile deviation of 168.22 and usage of improved input technologies significantly increased net income by GHc268/ha (Z (242) = -10.475, p-value = 0.000 (two-tailed).
3. Even without application of inorganic fertilizer, usage of improved maize seeds increased yield by 0.631 metric ton/ha (Z (150) = -7.021, p-value = 0.000 < 0.05 (two-tailed) and increased net income by GHc341.86/ha (Z(117) = -6.485, p-value = 0.000), while application of fertilizer at the prescribed ratio of 50kg/ha for three optimum times significantly increased maize yield/ha $\chi 2$ (183, df=3) = 9.758, p-value= 0.0207).
4. Consistently, usage of improved technologies facilitated food security (transitory food insecurity =-2.271, p-value = 0.002), (breakeven = 9.686, p-value = 0.002), and (food surplus = 4.44, p-value = 0.000), while input maize price predicted food insecurity (transitory food insecurity = 0.075, p-value = 0.047), (breakeven = -0.075, p-value = 0.047), and (food surplus = -0.108, p-value = 0.005).
5. Yeas of education explained only non-chronic food insecurity (B= -0.272, p-value = 0.049), while access to market did not behave consistently

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

across the four levels of food insecurity/security (chronic food insecurity = -2.402, p-value = 0.022), (transitory food insecurity = 1.175, p-value = 0.003), (breakeven = -1.75, p-value = 0.003), and (food surplus = -0.951, p-value = 0.031).

6. Users of improved input technologies had lower poverty incidence rate (43.72%), gap (0.0951) and severity (0.009) than nonusers (incidence rate = 52.14%), (gap = 0.1286), and (severity = 0.0165), while belief in government policy interventions had marginal effect of 0.503 on poverty incidence (p-value = 0.046).

Conclusions

Greater proportion of the sampled rural maize farmers used improved input technologies at varying levels of intensification. Most of the users of improved maize seed preferred open pollinated variety (OPV) maize to the hybrid varieties. However, only a handful of the users applied fertilizer at the prescribed ratio. Reasons for usage of improved maize varieties and associated fertilizers included collective decision by farm-based unions to use them for increased income and increase yield from the technologies shown in demonstrations by extension officers. On the other hand, reasons for non-usage of improved input technologies included credit constraints, rich experience in the cultivation of local maize varieties without fertilizer application, and belief that local maize varieties last longer in storage relative to improved varieties.

The factors that facilitated usage of improved input technologies in maize farming were membership of farm-based unions, quality of extension contacts, access to phone-based extensions, input maize price, years of education, and

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

access to credit. On one hand, farmers who were members of farm-based unions were most likely to use improved input technologies, followed by farmers who had quality of extension contacts, access to phone-based extensions, and those who bought input maize at higher price. The trend was ended by farmers with higher years of education, and those who had access to credit. On the other hand, years of experience in maize farming explained non-usage of improved input technologies, but highly experienced farmers had rich knowledge in the business aspect of maize farming. Sex of farmers, belief in government policies, access to TV-based extensions and market did not influence usage/non-usage of improved input technologies.

The outcomes of usage of improved input technologies in maize farming for rural development were that users had higher maize yield per hectare, income per hectare, and escaped food insecurity with relatively lower poverty incidence, gap, and severity than nonusers. Increased usage of the technologies coincided with emergence of government policy on Planting for Food and Jobs and even without fertilizer application, improved maize seeds increased yield and income, while application of fertilizer at the prescribed ratio also increased maize yield. Education was relevant for escaping the severest form of food insecurity/ chronic food insecurity while access to market did not consistently ensure food security. High input maize price pushed farmers into all forms of food insecurity, while, belief in government policy was debilitative in escaping poverty incidence.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Recommendations

From the findings and the conclusions, the following recommendations have been put forward for intensification of improved input technologies in maize farming.

Farmers

1. On the basis that usage of improved maize varieties and/or inorganic fertilizer increased yield, income, food security, and reduced poverty incidence, gap and severity, farmers who did not use these improved input technologies are advised to use them in their farm activities within the next farming season in 2021. Farmers are encouraged to cultivate the improved maize for sale and consumption in the short run, while they cultivate the local variety for storage and consumption in the long run. The farmers are to be encouraged by the extension the agents via the provision of timely, relevance and credible extension services to use the improved input technologies. This will ensure that the farmers obtain increased yield, income, and food security throughout the year.
2. As membership of farm-based unions largely facilitate usage of improved input technologies in maize farming, farmers are to be advised by farm-based union members to form or join the existing unions to provide mutual support in their efforts to use improved input technologies. This could be done by discussing the benefits of being a farm-based union member on radio and community communication vans so that the farmers can be attracted to the farm-based unions. This would enhance quality extension information sharing and management and also enable the farmers to either

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

pull their resources together to serve as collateral for accessing farm credit or to buy improved maize at lower price from the union members.

3. Farmers are advised to collaborate with the crop officer and extension agents to encourage the existing agricultural credit institutions and rural banks to launch branches in the rural agriculture communities so as to make credit access much easier. This will help the farmers to access the credit needed for usage of improved input technologies, which would result into increased yield, income, food security and poverty reduction as a pathway for rural development.
4. The farmers are encouraged to undertake adult education and encourage their wards to acquire formal education. The adult education could be championed by the farm-based unions as part of their activities and the farmers should encourage their wards to make a good use of the free basic and secondary education in the country. This would ensure that human capital is enhanced for farmers and their wards to engage in participatory extension delivery and management for effective application in their farm activities.

Crop officer and extension agents

1. Owing to the fact that quality of extension contacts and mobile phone-based extension facilitated usage of improved input technologies, they should be given priority in the extension issues of the municipality for increased usage of improved technologies. The crop officer is encouraged to ensure timely provision of improved maize varieties and associated inorganic fertilizer to the farmers, while the extension agents are advised

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

to champion the provision of timely, relevant and credible extension services to farmers.

2. Since application of fertilizer at the prescribed ratio of 50kg/ha for three optimum times, increased yield and income but only a harmful of the users complied, the extension officers are encouraged to find out why majority of the users did not apply the fertilizer at the prescribed ratio. This would enable the extension agents to obtain the necessary feedbacks for the Ketu North Municipality of Ghana to use for policy making and budgetary consideration in the 2022 mid-year budget.
3. Maize farming remains a major source of staple food security, income and a potential for poverty reduction in Ketu North Municipality of Ghana. The municipal crop officer who doubled as the implementer of the Government's policy on Planting for Food and Jobs ought to deepen the support for improved input technologies usage in maize farming. This aid may be offered by allotting higher quotas in the budgets for rural areas to intensify improved technologies. Exposing farmers to markets as well as offering more subsidy on the price of improved maize varieties and associated fertilizers will increase their usage. The outcome will manifest as increased maize yield, income, food security and consumption for escaping rural poverty as a pathway for rural development.

Digitized by Sam Jonah Library

© University of Cape Coast   https://ir.ucc.edu.gh/xmlui

Limitations and Suggestions for Further Study

The limitation related to the scope of this thesis is that though there were other maize farmers in the study area who were not introduced to improved maize varieties and associated fertilizer, this study focused on farmers who were introduced to improved maize seeds and associated fertilizer via demonstrations. A methodological limitation is that the data were mostly based on mental records of the farmers as most of them did not have farm diaries. Food insecurity/security measurement was merely based on perceptions of farmers related to their desired quantity and quality of food for a length of time within the year. Finally, though contemporary poverty measurement embraces multidimensional and complex indicators, aggregate annual consumption expenditure was used as a proxy.

In the course of the study, the aforementioned issues were identified for further research. Such studies should be large in scope and consider farmers in general, irrespective of being introduced to the improved input technologies via demonstrations, or not. This will clarify the role that demonstrations play in usage of improved input technologies, because even though all the sampled farmers were taken through the demonstrations, not all of them used the technologies. In order to enhance accuracy of the data, usage of farm diaries could be encouraged among farmers prior to such study. The contemporary multidimensional and complex dimensions of poverty and food insecurity/security would have to be considered in such further study. Once these complex dimensions are clarified, farmers would have firmer basis for usage/non-usage of improved technologies.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

REFERENCES

Abdallah, A. H. (2016). Does credit market inefficiency affect technology adoption? Evidence from Sub-Saharan Africa. *Agricultural Finance Review*, *76*(4), 494-511.

Abdoulaye, T., Wossen, T., & Awotide, B. (2018). Impacts of improved maize varieties in Nigeria: ex-post assessment of productivity and welfare outcomes. *Food Security*, *10*(2), 369-379.

Abdulai, S., Nkegbe, P. K., & Donkoh, S. A. (2018). Assessing the technical efficiency of maize production in northern Ghana: The data envelopment analysis approach. *Cogent Food & Agriculture*, *4*(1), 151-239.

Acquah, H., & Annor-Frempong, F. (2011, November). Farmers perception of impact climate change on food crop production in Ketu North district in the Volta Region of Ghana. In *1st World Sustain. Forum* (Vol. 1). MDPI.

Adam, R. I., Kandiwa, V., David, S., & Muindi, P. (2019). Gender-responsive approaches for enhancing the adoption of improved maize seed in Africa: A training manual for plant breeders and technicians. Repository of Cimmyt Organization.

Adjei, C. O. (2012). Citizen action, power relations and wetland management in the tampa bay urban socio-ecosystem.

Ahmed, H., Martey, E., & Anang, B. T. (2019). Impact of improved variety adoption on farm income in Tolon district of Ghana. *Agricultural Socio-Economics Journal*, *19*(2), 105-115.

Aker, J. C., Ghosh, I., & Burrell, J. (2016). The promise (and pitfalls) of ICT for agriculture initiatives. *Agricultural Economics*, *47*(S1), 35-48.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Akudugu, M. A. (2016). Agricultural productivity, credit and farm size nexus in Africa: A case study of Ghana. *Agricultural Finance Review*, *76*(2), 288-308.

Akumbole, J. A., Zakaria, H., & Adam, H. (2018). Determinants of Adoption of Improved Maize Technology among Smallholder Maize Farmers in the Bawku West District of the Upper East Region of Ghana. *Journal of Development*, *3*, 6.

Alston, J. M. (2018). Reflections on agricultural R&D, productivity, and the data constraint: unfinished business, unsettled issues. *American Journal of Agricultural Economics*, *100*(2), 392-413.

Alston, J. M., & Pardey, P. G. (2014). Agriculture in the global economy. *Journal of Economic Perspectives*, *28*(1), 121-46.

Alston, J. M., & Pardey, P. G. (2016). Antipodean agricultural and resource economics at 60: agricultural innovation. *Australian Journal of Agricultural and Resource Economics*, *60*(4), 554-568.

Alston, J., & Pardey, P. (2017). *Working Paper 260-Transforming Traditional Agriculture Redux*. African Development Bank.

Amankwah-Amoah, J. (2015). Solar energy in sub-Saharan Africa: The challenges and opportunities of technological leapfrogging. *Thunderbird International Business Review*, *57*(1), 15-31.

Amankwah-Amoah, J. (2019). Technological revolution, sustainability, and development in Africa: Overview, emerging issues, and challenges. *Sustainable Development*.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Anang, B. T. (2018). Farm technology adoption by smallholder farmers in Ghana. *Review of Agricultural and Applied Economics (RAAE)*, *21*(1340-2018-5179), 41-47.

Anderson, E. N. (2014). *Food and environment in early and medieval China*. University of Pennsylvania Press.

Ariga, J., Mabaya, E., Waithaka, M., & Wanzala-Mlobela, M. (2019). Can improved agricultural technologies spur a green revolution in Africa? A multicountry analysis of seed and fertilizer delivery systems. *Agricultural Economics*, *50*, 63-74.

Asongu, S. A., & Le Roux, S. (2017). Enhancing ICT for inclusive human development in Sub-Saharan Africa. *Technological Forecasting and Social Change*, *118*, 44-54.

Asongu, S. A., & Odhiambo, N. M. (2019). How enhancing information and communication technology has affected inequality in Africa for sustainable development: An empirical investigation. *Sustainable Development*, *27*(4), 647-656.

Asongu, S. A., Nwachukwu, J. C., & Pyke, C. (2019). The comparative economics of ICT, environmental degradation and inclusive human development in Sub-Saharan Africa. *Social Indicators Research*, *143*(3), 1271-1297.

Asongu, S., & Boateng, A. (2018). Introduction to special issue: mobile technologies and inclusive development in Africa. *Sustainable Development*, *1* (5) 297-301.

Aworawo, F. (2020). Regional integration and development in Africa: Between the rock and a hard place. *Journal of International Studies*, *12*, 19-30.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Ayoola, G. B. (1997). Toward a theory of food and agriculture policy intervention for a developing economy with particular reference to Nigeria. CARD *Working Papers*167. Iwota State University

Azadnia, M., Zahedi, S., & Pourabedy, M. R. (2017). Analysis of the impact of ICT on sustainable development using sustainability indicators. *International Journal of Computer Applications*, *169*(6), 975-8887.

Baffoe-Asare, R., Danquah, J. A., & Annor-Frempong, F. (2013). Socioeconomic factors influencing adoption of CODAPEC and cocoa high-tech technologies among small holder farmers in Central Region of Ghana. *American Journal of Experimental Agriculture*, *3*(2), 277-292.

Bandiera, O., & Rasul, I. (2006). Social networks and technology adoption in Northern Mozambique. *The Economic Journal*, *116*(514), 869-902.

Barrett, C. B., Christiaensen, L., Sheahan, M., & Shimeles, A. (2017). On the structural transformation of rural Africa. The World Bank. *Journal of African Economies*, *26* (1), 11-35

Bear, C., & Holloway, L. (2015). Country life: Agricultural technologies and the emergence of new rural subjectivities. *Geography Compass*, *9*(6), 303-315.

Bernstein, H. (2014). Food sovereignty via the 'peasant way': a sceptical view. *Journal of Peasant Studies*, *41*(6), 1031-1063.

Bierschenk, T (1997). Institutions and technologies for rural development in West Africa. In Bierschenk (Ed.). Proceedings of the International Symposium *(pp 16-22). Cotonou, Benin*. Margraf.

Bijker, W. E. (2009). How is technology made? That is the question. *Cambridge Journal of Economics*, *34*(1), 63-76.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Bold, T., Kaizzi, K. C., Svensson, J., & Yanagizawa-Drott, D. (2017). Lemon technologies and adoption: measurement, theory and evidence from agricultural markets in Uganda. *The Quarterly Journal of Economics, 132*(3), 1055-1100.

Boogaard, B. K. (2019). The relevance of connecting sustainable agricultural development with African philosophy. *South African Journal of Philosophy*, *38*(3), 273-286.

Botchwey, S. A (2019, April). *The headquarters agreement signed between the government of Ghana (GOG) and the forum for agricultural research in Africa (FARA).* Cabinet memorandum presented at the parliament of Ghana, Accra. Retrieved from http://www.ir.parliarment.gh

Brooker, R. W., Bennett, A. E., Cong, W. F., Daniell, T. J., George, T. S., Hallett, P. D., ... & Li, L. (2015). Improving intercropping: A synthesis of research in agronomy, plant physiology and ecology. *New Phytologist*, *206*(1), 107-117.

Bryman, A. (2003). *Research methods and organization studies* (Vol. 20). Routledge.

Burrell, D. N., Nobles, C., Dawson, M., McDowell, T., & Hines, A. M. (2018). A public policy discussion of food security and emerging food production management technologies that include drones, robots, and new technologies. *Perspectives of Innovations, Economics and Business*, *18*(2), 71-87.

Calomiris, C. W., Larrain, M., Liberti, J., & Sturgess, J. (2017). How collateral laws shape lending and sectoral activity. *Journal of Financial Economics*, *123*(1), 163-188.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Cargnelutti Filho, A., & Toebe, M. (2020). Reference sample size for multiple regression in corn. *Pesquisa Agropecuária Brasileira*, *55*.

Carter, M. R., & Michuda, A. (2019). The Distribution of Productive Assets and the Economics of Rural Development and Poverty Reduction. In *The Palgrave Handbook of Development Economics* (pp. 377-408). Palgrave Macmillan, Cham.

Cavane, E. (2016). Farmers' attitude and adoption of improved maize varieties and chemical fertilizers in Mozambique. *Indian Research Journal of Extension Education*, *11*(21), 1-6.

Cavicchi, C., & Vagnoni, E. (2018). Intellectual capital in support of farm businesses' strategic management: A case study. *Journal of Intellectual Capital*, *19*(5), 1469-1930

Chambers, R. (1997). *Whose reality counts* (Vol. 25). London: Intermediate technology publications.

Chan, C., & Holosko, M. (2016). Technology for social work interventions. *Journal of Technology in Human Services*, *35* (1), 1-7.

Chandler, D. (2002). Technological or media determinism: Introduction. *The Media and Communications Studies Site*.

Chhachhar, A. R., Qureshi, B., Khushk, G. M., & Ahmed, S. (2014). Impact of information and communication technologies in agriculture development. *Journal of Basic and Applied Scientific Research*, *4*(1), 281-288.

Corbridge, S. (2017). Urban-Rural relations and the counter-revolution in development theory and policy. In *The geography of urban-rural interaction in developing countries* (pp. 233-256). Routledge.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Creswell, J. W., & Hirose, M. (2019). Mixed methods and survey research in family medicine and community health. *Family Medicine and Community Health*, *7*(2), e000-086.

Dafoe, A. (2015). On technological determinism: A typology, scope conditions, and a mechanism. *Science, Technology, & Human Values*, *40*(6), 1047-1076.

Dandekar, V. M. (2017). Questions of economic analysis and the consequences of population growth: Comment. *In Subsistence Agriculture and Economic Development* (pp. 366-375). Routledge.

Danquah, J. A., Ahiadzo, R. K., Appiah, M., Roberts, C. O., & Pappinen, A. (2019). Assessing smallholder farmers' understanding of environmental effects of modern agronomic practices in Ghana. *Journal of Experimental Agriculture International*, 1-16.

Daoud, J. I. (2017). Multicollinearity and regression analysis. *Journal of Physics: Conference Series*, 949 (1), 012-009

Datta, A. (2019). Rural development. In *Handbook of Social Policy and Development*. Edward Elgar Publishing.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Deere, C. D., & De Leal, M. L. (2014). *Empowering women: Land and property rights in Latin America*. University of Pittsburgh Pre.

Deininger, K. W. (2003). *Land policies for growth and poverty reduction*. World Bank Publications. Retrieved from http://www.books.google.com

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Dercon, S., & Gollin, D. (2014). Agriculture in African development: theories and strategies. *Annu. Rev. Resour. Econ.*, *6*(1), 471-492.

Donkoh, S. A., Azumah, S. B., & Awuni, J. A. (2019). Adoption of improved agricultural technologies among rice farmers in Ghana: A multivariate probit approach. *Ghana Journal of Development Studies*, *16*(1), 46-67.

Donkor, K. (2019). *Structural adjustment and mass poverty in Ghana*. Routledge.

Dotson, T. (2015). Technological determinism and permissionless innovation as technocratic governing mentalities: psychocultural barriers to the democratization of technology. *Engaging Science, Technology, and Society*, *1*, 98-120.

Drew, R. (2016). Technological determinism. *A Companion to Popular Culture*, *38*(1), 1-67.

Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford university press.

Ellis, F., & Biggs, S. (2001). Evolving themes in rural development 1950s-2000s. *Development policy review*, *19*(4), 437-448.

Enu-Kwesi, F., Koomson, F., & Baah-Mintah, R. (2013). The contribution of the Kakum Rural Bank to poverty reduction in the Komenda-Edina-Eguafo-Abrem Municipality in the central region, Ghana. *Economic Annals*, *58*(197), 121-139.

Fang, C., & Yu, D. (2017). Urban agglomeration: An evolving concept of an emerging phenomenon. *Landscape and Urban Planning*, *162*, 126-136.

FAO, I. (2015). Status of the world's soil resources (SWSR)–main report. *Food and agriculture organization of the United Nations and intergovernmental technical panel on soils, Rome, Italy*, *650*.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

FAO, I., WFP, W., & UNICEF. (2019). *Safeguarding against economic slowdowns and downturns.* FAO, Rome, Italy

FAO. (2017). *The state of food security and nutrition in Africa: Building resilience for peace and food security.* FOA, Rome.

Feliciano, D. (2019). A review on the contribution of crop diversification to Sustainable Development Goal 1 “No poverty” in different world regions. *Sustainable Development*, *27*(4), 795-808.

Floro, S. L. (2019). *Informal credit markets and the new institutional economics: The case of Philippine agriculture*. Routledge.

Foster, J., Greer, J., & Throbeckee, E. (1984). A class of decomposable poverty measures. *Econometrica: journal of the econometric society*, 761-766.

Geng, Y., Cao, G., Wang, L., & Wang, S. (2019). Effects of equal chemical fertilizer substitutions with organic manure on yield, dry matter, and nitrogen uptake of spring maize and soil nitrogen distribution. *PloS one*, *14*(7).

Ghana Statistical Service. (2015). Ghana poverty mapping report. Retrieved from http://www.gss.gov.gh

Goldkind, L., Wolf, L., & Jones, J. (2016). Late adapters? How social workers acquire knowledge and skills about technology tools. *Journal of Technology in Human Services*, *34*(4), 338-358.

Gollin, D. (2014). The Lewis model: A 60-year retrospective. *Journal of Economic Perspectives*, *28*(3), 71-88.

Gomulka, S. (2006). *The theory of technological change and economic growth*. Routledge.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Grabowski, P., Kerr, J., Donovan, C., & Mouzinho, B. (2015). *A* prospective analysis of participatory research on conservation agriculture in Mozambique. Retrieved from http//www.ageconsearch.umn.edu

Gupta, A., Ponticelli, J., & Tesei, A. (2019). Technology adoption and access to credit via mobile phones. Working Paper, No. 892, Queen Mary University of London, School of Economics and Finance, London

Haggblade, S., Me-Nsope, N. M., & Staatz, J. M. (2017). Food security implications of staple food substitution in Sahelian West Africa. *Food Policy*, *71*, 27-38.

Hamad, M. A., Eltahir, M. E. S., Ali, A. E. M., & Hamdan, A. M. (2018). Efficiency of using smart-mobile phones in accessing agricultural information by smallholder farmers in North Kordofan Sudan. University of Kordofan, Sudan.

Hamilton, S. (2014). Agribusiness, the family farm, and the politics of technological determinism in the post–World War II United States. *Technology and culture*, 560-590.

Harrell, F. E. (2015). Binary logistic regression. In *Regression modeling strategies* (pp. 219-274). Springer, Cham.

HE, W. H., & ZOU, K. (2006). Demand Analysis of Farmer Information Service [J]. *Technology Economics*, *12*.

Hebinck, P., Schneider, S., & van der Ploeg, J. D. (Eds.). (2014). *Rural development and the construction of new markets*. Routledge.

Houeninvo, G. H., Célestin Quenum, C. V., & Nonvide, G. M. A. (2019). Impact of improved maize variety adoption on smallholder farmers' welfare in Benin. *Economics of Innovation and New Technology*, 1-16.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Hughes, T. P., & Hughes, T. P. (2004). *Human-built world: How to think about technology and culture*. University of Chicago Press.

Humphries, B. (2017). *Re-thinking social research: Anti-discriminatory approaches in research methodology*. Taylor & Francis.

Kamilaris, A., & Prenafeta-Boldú, F. X. (2018). Deep learning in agriculture: A survey. *Computers and electronics in agriculture*, *147*, 70-90.

Kansanga, M. M. (2017). Who you know and when you plough? Social capital and agricultural mechanization under the new green revolution in Ghana. *International Journal of Agricultural Sustainability*, *15*(6), 708-723.

Kassie, M., Jaleta, M., & Mattei, A. (2014). Evaluating the impact of improved maize varieties on food security in Rural Tanzania: Evidence from a continuous treatment approach. *Food Security*, *6*(2), 217-230.

Katundu, M. A. (Eds). (2019). Rural development in perspective of putting the last first. *The East African Journal of Social Sciences and Humanities (Eajssh)*, *1*(1), 103-106.

Katz, M. L., & Shapiro, C. (1985). Network externalities, competition, and compatibility. *American economic review*, *75*(3), 424-440.

Ketema, M., & Kebede, D. (2017). Adoption intensity of inorganic fertilizers in maize production: empirical evidence from smallholder farmers in eastern Ethiopia. *Journal of Agricultural Science*, *9*(5), 124-132.

Kim, J. H. (2019). Multicollinearity and misleading statistical results. *Korean journal of anesthesiology*, *72*(6), 558.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Kreuger, L., & Neuman, W. L. (2006). *Social work research methods: qualitative and quantitative approaches: with Research Navigator*. Pearson/Allyn and Bacon.

Kruger, L. W., & Neuman, W. L. (2006). Social Work Research Metods. Qualitative and quantitative application.

Kumar, R. (2019). *Research methodology: A step-by-step guide for beginners*. Sage Publications Limited.

Kwan, L. Y. Y., & Chiu, C. Y. (2015). Country variations in different innovation outputs: The interactive effect of institutional support and human capital. *Journal of Organizational Behavior*, *36*(7), 1050-1070.

Lan, A. S., Chiang, M., & Studer, C. (2018, March). Linearized binary regression. In *2018 52nd Annual Conference on Information Sciences and Systems (CISS)* (pp. 1-6). IEEE.

Larson, D. F., Muraoka, R., & Otsuka, K. (2016). Why African rural development strategies must depend on small farms. *Global Food Security*, *10*, 39-51.

Leavy, P. (2017). Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches.

Leavy, P. (Ed.). (2014). *The Oxford handbook of qualitative research*. Oxford University Press, USA.

Lin, H., Yip, G., Yang, J., & Fu, X. (2019). Collaborative innovation for more value: how to make it work. *Journal of Business Strategy*.

Lowitt, K., Hickey, G. M., Saint Ville, A., Raeburn, K., Thompson-Colón, T., Laszlo, S., & Phillip, L. E. (2020). Knowledge, markets and finance: factors affecting the innovation potential of smallholder farmers in the

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

caribbean community. *Food Security in Small Island States* (pp. 179-197). Springer, Singapore.

Lundahl, M. (1987). 'Efficient but Poor',schultz', theory of traditional agriculture. *Scandinavian Economic History Review*, *35*(1), 108-129.

Mabe, L. K., & Oladele, I. (2015). E-readiness among male and female extension officers in north-west province, South Africa. *Journal of agricultural & food information*, *16*(4), 315-325.

Madhavi, N. R. (2020). Microfinance: An innovation in rural credit system. *Studies in Indian Place Names*, *40*(4), 653-659.

Manda, J., Alene, A. D., Gardebroek, C., Kassie, M., & Tembo, G. (2016). Adoption and impacts of sustainable agricultural practices on maize yields and incomes: Evidence from rural Zambia. *Journal of Agricultural Economics*, *67*(1), 130-153.

Mariyono, J. (2019). Micro-credit as catalyst for improving rural livelihoods through agribusiness sector in Indonesia. *Journal of Entrepreneurship in Emerging Economies*, *11*(1), 98-121.

Marsden, T. (2017). *Transforming the rural: Global processes and local futures*. Emerald Group Publishing.

Marx, M. R. S. L. (1994). *Does technology drive history?: The dilemma of technological determinism*. Mit Press.

Masuka, B., Matenda, T., Chipomho, J., Mapope, N., Mupeti, S., Tatsvarei, S., & Ngezimana, W. (2016). Mobile phone use by small-scale farmers: A potential to transform production and marketing in Zimbabwe. *South African Journal of Agricultural Extension*, *44*(2), 121-135.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Mathenge, M. K., Smale, M., & Tschirley, D. (2015). Off-farm employment and input intensification among smallholder maize farmers in Kenya. *Journal of Agricultural Economics*, *66*(2), 519-536.

Mavhunduse, F., & Holmner, M. (2019). Utilisation of mobile phones in accessing agricultural information by smallholder farmers in dzindi irrigation scheme in South Africa. *African Journal of Library, Archives & Information Science*, *29*(1), 93-101.

Maxwell, S., Urey, I., & Ashley, C. (2001). *Emerging issues in rural development: Overseas development institute.* London Press

McCarthy, D. R. (2015). *Power, information technology, and international relations theory: The power and politics of US Foreign policy and internet*. Palgrave Macmillan.

McCurry, J. (2016). Japanese firm to open world's first robot-run farm. *The Guardian*, *2*.

McGaw, J. A. (Ed.). (2014). *Early American Technology: Making and Doing Things from the Colonial Era to 1850*. UNC Press Books.

Mesthene, E. G. (1970). Technological change: Its impact on man and society.

Metcalfe, J. S., Fonseca, M. D., & Ramlogan, R. (2001). *Innovation, growth and competition: evolving complexity or complex evolution*. Centre for Research on Innovation and Competition, University of Manchester.

Miller, M. K., & Luloff, A. E. (1980). Who Is Rural? A Typological Approach to the Examination of Rurality.

Ministry of Food and Agriculture (2015). http://www.MoFA.gov.gh.

Ministry of Food and Agriculture (2017). http://www.MoFA.gov.gh.

Ministry of Food and Agriculture (2019). http://www.MoFA.gov.gh

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Mmbando, F. E., & Baiyegunhi, L. J. (2016). Socio-economic and institutional factors influencing adoption of improved maize varieties in Hai District, Tanzania. *Journal of Human Ecology*, *53*(1), 49-56.

Morse, J. M. (2016). *Mixed method design: Principles and procedures* (Vol. 4). Routledge.

Moseley, M. J. (Ed.). (2003). *Local partnerships for rural development: The European experience*. CABI.

Moyo, S. (2003). *The land question in Africa: research perspectives and questions*. Codesria.

Murphie, A., & Potts, J. (2017). *Culture and technology*. Macmillan International Higher Education.

Musson, R. M. W. (2014). UK seismic hazard assessments for strategic facilities: a short history. *Bollettino di Geofisica Teorica e Applicata*, *55*(1), 165-173.

Muthinja, M. M., & Chipeta, C. (2018). What drives financial innovations in Kenya's commercial banks? An empirical study on firm and macro-level drivers of branchless banking. *Journal of African Business*, *19*(3), 385-408.

Muzari, W., Gatsi, W., & Muvhunzi, S. (2012). The impacts of technology adoption on smallholder agricultural productivity in sub-Saharan Africa: A review. *Journal of Sustainable Development*, *5*(8), 69.

Nagy, P., & Neff, G. (2015). Imagined affordance: Reconstructing a keyword for communication theory. *Social Media plus Society*, *1*(2), 603-385.

Nelson, G. K. (1986). Book Reviews. *Sociology*, *20*(4), 627–628.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Nkegbe, P. K. (2018). Credit access and technical efficiency of smallholder farmers in Northern Ghana. *Agricultural Finance Review*. 78(5), 0002-1466

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge university press.

Ogada, M. J., & Nyangena, W. (2019). Complementarity of inorganic fertilizers and improved maize varieties and farmer efficiency in maize production in Kenya. *African Review of Economics and Finance*, *11*(1), 76-100.

Olagunju, K. O., Ogunniyi, A. I., Awotide, B. A., Adenuga, A. H., & Ashagidigbi, W. M. (2019). Evaluating the distributional impacts of drought-tolerant maize varieties on productivity and welfare outcomes: an instrumental variable quantile treatment effects approach. *Climate and Development*, 1-11.

Opoku, M. S., & Enu-Kwesi F. (2020). Relevance of the technological acceptance model (TAM) in information management research: A review of selected empirical evidence. *Research Journal of Business and management*, 7(1), 34-44. DOI:

Osuji, E. E., & Henri-Ukoha, A. (2017). Determinants of poverty among arable crop farmers using sustainable soil management techniques in Imo State, Nigeria. *International Journal of Biosciences, Agriculture and Technology*, *8*(8), 55-63.

Otsuka, K. (2016). Transforming African agriculture by promoting improved technology and management practices. *Background paper for ACET's Transforming Africa's Agriculture; ACET: Accra, Ghana*.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Otsuka, K., & Larson, D. F. (Eds.). (2015). *In Pursuit of an African Green Revolution: Views from Rice and Maize Farmers' Fields* (Vol. 48). Springer.

Otte, P. P., Bernardo, R., Phinney, R., Davidsson, H., & Tivana, L. D. (2018). Facilitating integrated agricultural technology development through participatory research. *The Journal of Agricultural Education and Extension*, *24*(3), 285-299.

Pallant, J. (2005). SPSS survival manual: A step by step guide to using SPSS for windows (version 12). *New South Wales, Australia: Allen & Unwin*.

Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. Routledge.

Pardey, P. G., & Alston, J. M. (2019). Transforming traditional agriculture redux. *In The Oxford Handbook of Structural Transformation*. Retrieved from http//www.oxfordhamdbooks.com

Pasa, R. B. (2017). Technological intervention in agriculture development. *Nepalese Journal of Development and Rural Studies*, *14*(1-2), 86-97.

PFJ. (2017). Planting for food and jobs strategic plan for implementation (2017–2020) ministry of food and agriculture. Ghana: Republic of Ghana.

Pierola, A., Epifanio, I., & Alemany, S. (2016). An ensemble of ordered logistic regression and random forest for child garment size matching. *Computers & Industrial Engineering*, *101*, 455-465.

Porteous, O. (2020). Trade and agricultural technology adoption: Evidence from Africa. *Journal of Development Economics*, 144(1), 102-440.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Queirós, A., Faria, D., & Almeida, F. (2017). Strengths and limitations of qualitative and quantitative research methods. *European Journal of Education Studies*, 3(9), 2501 - 1111

Rahmanian, M., Batello, C., & Calles, T. (2018). *Pulse crops for sustainable farms in Sub-Saharan Africa*. Food and Agriculture Organization of the United Nations.

Rennkamp, B., & Boyd, A. (2015). Technological capability and transfer for achieving South Africa's development goals. *Climate Policy*, *15*(1), 12-29.

Rosenthal, R., Cooper, H., & Hedges, L. (1994). Parametric measures of effect size. *The handbook of research synthesis*, *621*(2), 231-244.

Rostow, W. W. (1960). *The process of economic growth* (No. HB199 R65 1960).

Sadovnikova, A., Pujari, A., & Mikhailitchenko, A. (2016). Radical innovation in strategic partnerships: A framework for analysis. *Journal of Business Research*, *69*(5), 1829-1833.

Salam, A. (2020). Internet of things in agricultural innovation and security. *Internet of Things for Sustainable Community Development* (pp. 71-112). Springer, Cham.

Sarantakos, S. (2005). *Social Research*. (3. Baskı).

Sarantakos, S. (2012). *Social research*. Macmillan International Higher Education.

Schewe, R. L., & Stuart, D. (2015). Diversity in agricultural technology adoption: How are automatic milking systems used and to what end?. *Agriculture and human values*, *32*(2), 199-213.

Digitized by Sam Jonah Library

Schultz, T. W. (1964). *Transforming traditional agriculture.* Retried from http//www.cabdirect.org

Schumpeter, J. A. (2013). *Capitalism, socialism and democracy*. Routledge.

Schumpeter, J.A. (1934). *The theory of economic development: An inquiry into profits, capital, credits, interest, and the business cycle*. Transaction Publishers, Piscataway.

Scoones, I. (2015). *Sustainable livelihoods and rural development*. Practical Action Publishing.

Shaner, W. W. (2019). *Farming systems research and development: Guidelines for developing countries*. Routledge.

Simmons, G. F. (Ed). (2016). Some ideas from the theory of probability: The normal distribution curve and its differential equation. In *Differential Equations with Applications and Historical Notes, Third Edition* (pp. 73-86). Chapman and Hall/CRC.

Sims, B., & Kienzle, J. (2017). Sustainable agricultural mechanization for smallholders: What is it and how can we implement it?. *Agriculture*, *7*(6), 50.

Singla, A., Sethi, A. P. S., & Ahuja, I. S. (2018). An empirical examination of critical barriers in transitions between technology push and demand-pull strategies in manufacturing organizations. *World Journal of Science, Technology and Sustainable Development*, *15*(3), 257-277.

Smith, A. (1776). An inquiry into the wealth of nations. *Strahan and Cadell, London*, 1-11.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Snelson, C. L. (2016). Qualitative and mixed methods social media research: A review of literature. *International Journal of Qualitative Methods*, *15*(1), 624-574.

Surry, D. W., & Baker III, F. W. (2016). The co-dependent relationship of technology and communities. *British Journal of Educational Technology*, *47*(1), 13-28.

Sweetland, S. R. (1996). Human capital theory: Foundations of a field of inquiry. *Review of educational research*, *66*(3), 341-359.

Syiem, R., & Raj, S. (2015). Access and usage of ICTs for agriculture and rural development by the tribal farmers in Meghalaya state of north-east India. *Journal of Agricultural Informatics*, *6*(3), 24-41.

Tanko, M., Ismaila, S., & Sadiq, S. A. (2019). Planting for Food and Jobs (PFJ): A panacea for productivity and welfare of rice farmers in Northern Ghana. *Cogent Economics & Finance*, *7*(1), 1693-121.

Tetteh, E. K., Akon-Yamga, G., Jumpah, E., & Omari, R. (2020). Scientific human resource for national development in Ghana: Issues and challenges. *African Journal of Science, Technology, Innovation and Development*, *12*(1), 57-68.

Torre, A., & Wallet, F. (2016). In search of rural development. In *Regional Development in Rural Areas* (pp. 51-65). Springer, Cham.

Twumasi, M. A., Jiang, Y., Danquah, F. O., Chandio, A. A., & Agbenyo, W. (2019). The role of savings mobilization on access to credit: A case study of smallholder farmers in Ghana. *Agricultural Finance Review*, *60* (1) 275-289

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Udemezue, J. C., & Osegbue, E. G. (2018). Theories and models of agricultural development. *Annals of Reviews and Research*, *1*(5), 1-4.

Uduji, J. I., & Okolo-Obasi, E. N. (2018). Adoption of improved crop varieties by involving farmers in the e-wallet program in Nigeria. *Journal of Crop Improvement*, *32*(5), 717-737.

Veblen, T. (1934). *The theory of the leisure class: An economic study of institutions.* The Modern Library. New York

Verkaart, S., Munyua, B. G., Mausch, K., & Michler, J. D. (2017). Welfare impacts of improved chickpea adoption: A pathway for rural development in Ethiopia?. *Food Policy*, *66* (1), 50-61.

Watson, A. (2019). *Australian drought policy: Notes on collateral damage and other issues*. A mini-symposium on drought held at the 63rd annual conference of the Australasian Agricultural and Resource Economics Society, Melbourne, Australia, 12-15 February 2019.

Westley, F. R., Tjornbo, O., Schultz, L., Olsson, P., Folke, C., Crona, B., & Bodin, Ö. (2013). A theory of transformative agency in linked social-ecological systems. *Ecology and Society*, *18*(3).

Willmott, H. (2020). On Research Methodology. *The Journal of Organization and Discourse*, *1*(1), 1-4.

Wilson, P. B., Estavillo, G. M., Field, K. J., Pornsiriwong, W., Carroll, A. J., Howell, K. A., ... & Pogson, B. J. (2009). The nucleotidase/phosphatase SAL1 is a negative regulator of drought tolerance in Arabidopsis. *The Plant Journal*, *58*(2), 299-317.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Woertz, E. (2017). Food security in Iraq: results from quantitative and qualitative surveys. *Food Security*, *9*(3), 511-522.

World Bank Group. (2016). *World development report 2016: digital dividends*. World Bank Publications.

World Bank Group. (2017). *World development indicators 2017*. World Bank.

Yahya, A. (2020). Agriculture: Wireless sensor network theory. In *Emerging Technologies in Agriculture, Livestock, and Climate* (pp. 1-44). Springer, Cham.

Zaremohzzabieh, Z., Samah, B., Omar, S., Bolong, J., & Shaffril, H. (2014). A systematic review of qualitative research on the role of ICTs in sustainable livelihood. *The Social Sciences*, *9*(6), 386-401.

Zeng, D., Alwang, J., Norton, G. W., Shiferaw, B., Jaleta, M., & Yirga, C. (2015). Ex post impacts of improved maize varieties on poverty in rural Ethiopia. *Agricultural Economics*, *46*(4), 515-526.

Zheng, P., Liang, X., Huang, G., & Liu, X. (2016). Mapping the field of communication technology research in Asia: Content analysis and text mining of SSCI journal articles 1995–2014. *Asian Journal of Communication*, *26*(6), 511-531.

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

APPENDICES

Appendices A: Binary Regression of Poverty Incidence

Model	B	SEE	Z	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
X_1	-0.321	0.27	-1.21	0.225	0.725	0432	1.219
X_2	- 0.020	0.01	-1.76	0.079	0.980	0.959	1.002
X_3	0.010	0.04	0.27	0.786	1.010	0.939	1.087
X_4	0.884	0.95	0.93	0.354	2.420	0.373	15.717
X_5	-0.030	0.08	-0.40	0.692	0.970	0.837	1.126
X_6	-.0.041	0.25	-0.17	0.868	0.960	0.590	1.560
X_7	0.020	0.23	0.09	0.927	1.021	0.657	1.587
X_8	-0.000	0.00	-0.67	0.504	0.999	0.999	1.000
X_9	0.503	0.25	1.99	**0.046**	1.653	1.008	2.711
X_{10}	0.113	0.28	0.40	0.688	1.119	0. 647	1.937
X_{11}	0.006	0.02	0.26	0.798	1.006	0.961	1.053
X_{12}	-0.065	0.05	-1.41	0.159	0.937	0.856	1.026
X_{13}	-0.625	0.50	-1.26	0.208	0.535	0.202	1.416
Con	0.751	0.56	1.33	0.183	2.112	0.701	6.399
Number of observations 300					LRχ2 (13)	14.44	
Pseudo R^2		0.0348			P> χ2	0.3434	

Log likelihood = -200.29572

Source: Field Survey, Ahiadzo (2020)

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

APPENDIX B

INTERVIEW GUIDE FOR CROP AND EXTENSION OFFICERS AS KEY INFORMANTS IN THE KETU NORTH MUNICIPALITY OF GHANA

Sections 1: Usage of improved input technologies in maize farming

1. The procedure used to introduce improved maize varieties to farmers
    - Selection of farmers
    - Any training
    - Cost of the improved maize seeds
2. Types of improved maize varieties introduced to the farmers
3. Duration of maturity for each variety of maize
4. The proportion of farmers who used the improved maize varieties
5. Types of inorganic fertilizers to be applied to each type of the improved maize varieties
6. Price of each type of the inorganic fertilizer
7. Ratio for fertilizer application to a hectare of an improved maize variety farm
8. Number of times that the fertilizer should be applied to an improved maize variety farm
9. Reasons for why some farmers used the technologies while others did not use them

Section 2: Factors that affect usage of improved input technologies

10. Institutional factors for facilitating the usage of the technologies
    - Extension (number of contacts per year, accuracy, timeliness, relevance, credibility innovativeness, accessibility)
    - Agricultural credit services (amount, repayment conditions, penalty for deferment of payment
    - Farm-based association

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

- Governmental policy interventions (aids, insurance premium)
- Nature of relationship between farmers and those institutional agents

11. Human capital issues
    - Education and training of farmers
    - Farmers experience in maize farming
12. ICT-based extensions
    - Mobile phone usage
    - Radio
    - Television
13. Weather adaptation strategies for maize farming in the municipality
14. Nature of road network in the municipality
15. Market opportunities for maize in the municipality

SECTION 3: Outcome of Usage of Improved Input Technologies

16. Average yield of maize of each variety of maize grown in the municipality
17. Best storage strategies for each maize variety
18. Food security issues in rural areas of the municipality
19. Average household daily expenditure in the municipality
20. Poverty incident, gap, severity issues

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

APPENDIX C

INTERVIEW SCHEDULE FOR MAIZE FARMERS IN RURAL AREAS OF KETU NORTH MUNICIPALITY OF GHANA

Dear participant, my name is Robert Kwame Ahiadzo. I am researching on the topic '*Usage of Improved Input Technologies in Maize Farming and Rural Development in the Ketu North Municipality of Ghana'* as part of my MPhil in Development Studies at the University of Cape Coast. Please kindly assist by answering as many questions as you deem convenient as this study is for academic purposes. Answering all the questions will require a maximum of 45 minutes and all responses would be handled with the utmost confidentiality. Thank you

Serial No/House Number of respondents____________________

SECTIION A: **Demographic Characteristics**

1. Sex: i. Male [ ] ii. Female [ ]
2. Age________
3. Years of education _______________
4. Marital status ____________________________
5. Household size __________
6. Number of household members who help in the farming activities_______
7. Years of experience in maize farming ____________

SECTION B: **Usage of Improved Input technologies in Maize Farming**

8. Which of the following varieties of maize did you cultivate last season?

   i. Obatanpa [ ] ii. Mamaba [ ] iii. Gbowunefa [ ]

   iv. Ablivi [ ] v. Aditsibli [ ] vi. Other, specify__

9. Why have you chosen to cultivate the type of maize seed stated in q8?

   ____

10. What is the total size of your maize farm land in hectares? __________

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

11. What is the number of plots per a farm? ________________

12. What is the total quantity of maize seed cultivated? ______________

13. How much was a unit cost of the maize seed cultivated? ______________

14. Number of times that inorganic fertilizer is applied___________________

15. Number plots of maize that fertilizer is applied ______________________

16. How many kilograms of inorganic fertilizer is applied? ___________

17. How much is the cost of bag of the fertilizer that you applied? GHc _____

18. What is the name of the fertilizer that you have applied? ____________

SECTION C: <u>Factors that Affect Usage of Improved Input Technologies</u>

19. How long does it take for the maize to mature? ______________________

20. How is the weather condition for the cultivation the maize in your farm?

____

21. What weather adaptation strategies do you mostly use?

____

22. How often do you have extension contacts with extension officers per year?

____

23. The extension services have quality in relation to the following dimensions

Dimensions of the extension services quality	No	Yes
23a. Accuracy		
23b. Relevance		
23c. Credibility		
23d. Timeliness		
23e. Innovativeness		
23f. Accessibility		

24. Amount of financial credit obtained for maize farming per-season GHc __

25. What is the term of condition for the credit accessed? ________________

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

26. Have you repaired the credit that you have received? i. Yes [ ] ii. No [ ]

27. How many farm-based associations do you belong to? ______________

28. Are you aware of any crop insurance premium in Ghana?

i. Yes [ ] ii. No [ ]

29. Which crop insurance policy have you subscribed to ? i. None [ ]

ii. Drought index insurance [ ] ii. Area yield index insurance [ ]

iii. indemnity-based crop insurance [ ] iv. Other, specify___

30. Belief in government policy interventions including Planting for Food and Jobs policy as protection against uncertainty for farmers?

i. No [ ] ii. Yes [ ]

31. Which form of governmental aid did you obtain for maize farming?

____

32. How would you describe the nature of the relationship between you and the and institutional agents for;

i. Extension services? ____

ii. Financial credit? ____

iii. Farm-based unions? _______________________________________

iv. Government policy implementation? __________________________

33. Do you own a mobile phone? i. No [ ] ii. Yes [ ]

34. How often do you use the mobile phone for extension purposes per year?

____

35. Does your household own a radio? i. No [ ] ii. Yes [ ]

36. How often do you listen to extension information on the radio per year?

____

37. Does your household own a television? i. No [ ] ii. Yes [ ]

Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

38. How often do you watch extension shows on television? ___________

SECTION D: <u>Outcome of Usage of Improved Input Technologies</u>

39. Amount of fresh maize sold in the previous major farming season GHc___

40. Quantity of dry maize produced from the previous major farming season

Quantity____________________ ii. Unit __________

41. Storage method to wait for market and, or for preservation ___________

42. Do you have a ready market for the sale of the maize?

i. Yes [ ] ii. No [ ]

43. Challenges faced in meeting the maize market demands ______________

44. Type of road network between the farm and the market centers

i. Foot path [ ] ii. Untarred road [ ] iii. Tarred road [ ]

45. Distance covered in meters to access the market center for sale of maize

____

46. Total seasonal income from the sale of dry maize GHc ____________

47. Quantity of maize consumed per week i. Quantity_______ ii. Unit ______

48. Quality of protein in the maize variety used i. very high [ ] ii. High [ ]

iii. Midway [ ] iv. Low [ ] v. Very low [ ]

49. Duration of household food security by the harvested maize _________

50. Household daily expenditure without maize consumption expenses GHc__

51. Within the year, how was food issues for you and your household?

i. Food shortage throughout the year [ ] ii. Occasional food shortage [ ]

iii. No food shortage and no food surplus [ ] iv. Food surplus [ ]

Digitized by Sam Jonah Library