RELATIONSHIP BETWEEN USE OF EXTENSION INFORMATION SERVICES AND AGRICULTURAL PRODUCTIVITY AMONG SMALLHOLDER FARMERS IN TANA RIVER COUNTY, KENYA

BY

GOUDIAN KILEMBA GWADEMBA

E83/31011/2015

A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (LIBRARY AND INFORMATION SCIENCE) IN THE SCHOOL OF EDUCATION, KENYATTA UNIVERSITY

FEBRUARY, 2021

DECLARATION

I declare that this research thesis is my original work and has not been presented in any other university/institution for consideration of any certification. This research thesis has been complemented by referenced sources duly acknowledged. Where text, data (including spoken words), graphics, pictures or tables have been borrowed from other sources, including the internet, these are specifically accredited and references cited using current APA system and in accordance with anti-plagiarism regulations.

Signature………………………………… Date………………………………

Gwademba Goudian Kilemba
Department of Library and Information Science

Supervisors' Declaration

We confirm that the work reported in this thesis was carried out by the candidate under our supervision as University supervisors.

Signature…………………………………Date………………………………

Dr. Daniel Wambiri Muthee
Senior Lecturer, Department of Library and Information Science,
Kenyatta University

Signature………………………………… Date………………………………

Dr. Peter Wamae Wahome
Lecturer, Department of Library and Information Science
Kenyatta University

DEDICATION

This work is dedicated to my wife Gladys Malika, my daughter Arlene Alivitsa, my Son Nathaniel Baraka, my Brothers Stanley Angaya, Graham Adika, Douglas Atsyanji and Alexander Abwao, my sister Consolata Vuhya, and my late parents, Mr. Mondest Buyusi and Mama Dinah Alivitsa, who offered great support, inspiration and encouragement.

ACKNOWLEDGEMENT

The successful completion of this research thesis would not have been possible without the help and support from my supervisors, Dr. Daniel Wambiri Muthee and Dr. Peter Wamae Wahome. Their contributions were immense especially in terms of continuous support, encouragement and constant guidance which were invaluable and instrumental to the completion of this research thesis.

Also worth acknowledging is the support from Dr. Joshua R. Njuguna and Dr. Michael M. Mukuvi who supervised me until approval of the research proposal and I appreciate the guidance given by Dr. Peter Mwathi during concept paper development and Dr. Kamau Maina for the support during final thesis corrections. Similarly I'm indebted to the Department of Library and Information Science, the current chairperson Dr. Peter Wamae and the former Chairperson Dr. Zipporah Gichuhi, and the secretary Ms. Isabella Mbugua.

Furthermore my sincere gratitude goes to the staff at the Department of Agriculture, County Government of Tana River and the County Commissioner Tana River County. Their support, hospitality and readiness to voluntarily provide needed data, greatly touched my heart. Our interactions will forever be treasured.

I'm equally most grateful to my family members, colleagues at work and friends for their prayers, support and encouragement during the most challenging moments of my study and finally I acknowledging with humility and gratitude the Almighty God for sustaining me throughout my life and in particular during the period I have been working on this thesis. I have experienced His continued presence in my life and that of my family.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

AAK	:Agro Chemical Association of Kenya
AfDB	: African Development Bank
AFRRI	: African Farm Radio Research Initiative
AIRC	: Agricultural Information Resource Centre
ALMRP	: Arid Lands Resource Management Project
ASALs	: Arid and Semi-arid Lands
ASDS	: Agricultural sector Development Strategy
ASDSP	: Agricultural sector Development Support Program
ATC	: Agricultural Training Centre
CIGs	: Common Interest Groups
DSSs	: Decision Support Systems
ESPs	: Extension Service Providers
FACs	: Farmer Advisory Committees
FAO	: Food and Agricultural Organization
FRI	: Farm Radio International
FFS	: Farmer Field Schools
FMISs	: Farm Management Information Systems
GDP	: Gross Domestic Product
GIS	: Geographical information systems
GoK	: Government of Kenya
ICT	: Information Communication and Technology
IFAD	: International Fund for Agricultural Development
IMWIC	: The International Maize and Wheat Improvement Centre
I-PSP	: Interim Poverty Strategy Paper
ISP	: Information Search Process
IUCN	: International Union for Conservation of Nature
KACCAL	: Kenya Adaptation to Climate Change in Arid Lands
KALRO	: Kenya Agricultural and Livestock Research Organization

KAPP	: Kenya Agribusiness and Productivity Program
KEMFRI	: Kenya Marine and Fisheries Institute
KIPPRA	: Kenya Institute of Policy, Research and Analysis
MAAIF	: Ministry of Agriculture, Animal Industry and Fisheries (Republic of Uganda)
MAFSC	: Ministry of Agriculture Food Security and Cooperatives (Republic of Tanzania)
MoALF	: Ministry of Agriculture Livestock and Fisheries (Kenya)
MDGs	: Millennium Development Goals
NARDTC	: National Aquaculture Research Development Training Centre
NASEP	: National Agricultural Sector Extension Policy
NGOs	: Non-Governmental Organization
PRCs	: Participatory Radio Campaigns
RFID	: Radio frequency identification
SDGs	: Sustainable Development Goals
WBG	: World Bank Group
WDR	: World Development Report

ABSTRACT

Food security assessments reports have demonstrated that, most food insecure people stay in remote areas, with limited access to information and technology geared towards enhancing agricultural productivity. This foregoing suggests that agricultural information is relevant to agricultural productivity, particularly for smallholder farmers, who remain the foundation of agricultural production in emerging economies. Literature review of the study established that agricultural information is prerequisite to farming as it enables proper utilization of limited production resources and therefore regarded as a significant factor in enhancing productivity, but disclosed that while considerable efforts have been made by the Kenyan government to improve agricultural extension information services for smallholder farmers, low agricultural productivity has continued to be experienced in Tana River County, Kenya. It was in recognition of this value that this research was carried out with a purpose of evaluating the relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya. The main objective of the study was to ascertain whether increased use of extension information services correlated with increased agricultural productivity. The study adopted the Information Search Process (ISP) theory by Caroline Kuhlthau. The location of the study was Tana River County where a sample of 382 farming households was chosen from a population of 68,242 and 79 public extension information service providers selected from a total population of 85 through stratified sampling. Data was collected using questionnaires and interview schedules and both qualitative and quantitative data was captured. The research took a correlational study design and through statistical analysis using the Pearson Correlation Coefficient, Simple Linear Regression and Paired Samples T-Test, evaluated the relationship between the use of extension information services and agricultural productivity among smallholder farmers in Tana River County. A piloting of data collection instruments was undertaken in Kilifi County to test their reliability and validity. Data analysis focused on responding to research hypothesis and considering appropriate level of interpretation for each situation. The research findings revealed that, there was a moderately strong correlation coefficient averaging r=0.6 between use of extension information services and agricultural productivity in Tana River County. The study also underscored the role of ICT in improving the usefulness of agricultural extension information services and recommended the need to streamline extension information service delivery in order to ensure smallholder farmers had seamless access to agricultural information. The study was significant in that its findings are expected to benefit all agricultural stakeholders by enabling them appreciate the role of extension information services in enhancing agricultural productivity. It is expected that this study will add credibility to the agricultural extension information policy agenda for smallholder farmers all over the world.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

This chapter provides a comprehensive background to the study and gives a full statement of the problem in order to point out the core purpose of the research. The objectives of the study and research hypothesis have been provided with the aim of finding out the relationship between the use of extension information services and agricultural productivity among smallholder farmers in Tana River County. Justification as to why the study was significant as well as the scope and assumptions of the study are presented and through the theoretical and conceptual frameworks, great insight is given into the relationship between the use of extension information services and agricultural productivity. At the end of the chapter, operational definitions of terms as used in the text are given.

1.2 Background to the Study

Agricultural Extension describes the dissemination of information on farming in order to help farmers enhance agricultural productivity. A premise exists that if the dissemination of information to farmers is well planned and farmers are enabled to use the information then farming output will improve.

To achieve an effective agricultural extension information system, there is need to meaningfully improve the quality of public extension information services that support agriculture through increasing farmer access to relevant and timely farming information, that will contribute to improving the effectiveness of decision making among smallholder farmers (Rao N.H., 2007).

Transformation of public agricultural extension information services has become an essential part of strategic development agendas, with the role of agricultural extension information service providers being regarded as essential in food security endeavors. It is for this reason that the United Nations Sustainable Development Goals (SDGs) agenda aim to achieve food security by promoting sustainable agriculture for smallholder farmers by the year 2030, (UN General Assembly, 2015). Nevertheless, this endeavor can only be achieved through ensuring that farmers have access to agricultural extension information services.

The focus on information as a tool to enhances agricultural productivity has also been illustrated by the World Development Indicators (World Bank, 2016). Through this report, The world Bank demonstrates the fact that in the year 2012, 13% of the world's population subsisted below the international poverty line of two dollars a day, down from 37% in 1990. This implies that for sustainable improvement in the economy, there is an overriding need to drastically reduce poverty globally, but while the SDGs proposes ending poverty in all forms by the year 2030, however this can only be achieved if farmers have access to agricultural information especially on climate smart agriculture is paramount in addressing salient issues that affect agricultural productivity.

In analyzing the extent to which poverty has affected the world population, The World Development Report (2016), acknowledged that, a majority of the world's population live in poverty. This status has raised concerns regarding the probability of policies intended to improve the lives of the society failing to bring desired outcomes and poor access to information on agricultural production has been identified as one of the reasons behind the declining food production.

Land productivity has been on the decline and this calls for a need to investigate whether the world agriculture information extension system is functioning effectively to ensure that smallholder farmers access and use modern agricultural technology. It is a fact that efforts to end starvation by the year 2030 will not be successful if the world does not focus on enhancing smallholder farmers' access to agricultural information.

A report on food systems for inclusive rural transformation by Food and Agricultural Organization (FAO, 2017), stated that, sustainable farming in low income countries has been a challenge in comparison to developed economies, where agricultural productivity had increased significantly over the past 20 to 30 years. A worldwide compromise therefore has emerged suggesting that, investment in agriculture can no longer be ignored, owing to the fact that food security cannot be achieved at the expense of the smallholder farmers who produce most of the food consumed in both rural and urban areas.

Food security assessments by the International Fund for Agriculture and Development (IFAD, 2012) and FAO, (2017), demonstrated that, between two thirds and three quarters of the food insecure people live in pastoral areas, with limited access to technology and information geared towards enhancing agricultural productivity. In Kenya smallholder famers depend on maize as the main food crop, but its production has been on the decline with an estimation of 0.5 to 1.5mt per hectare per year (Ouma et al., 2002) in contradiction of a production potential of 4mt per hectare per year. The major cause of this could be ascribed to insufficient agricultural information to maintain the maize farming practice.

In the same reports IFAD and FAO goes further to advance that, in order to be able to offer sustainable livelihoods for everyone, sub-Saharan Africa countries need to increase food production five-times by the year 2050, so as to handle the food requirements of the predicted population growth. This requires a complete transformation though improving the agriculture extension information system besides working on every aspect of the agricultural production chain from restoring exhausted soil, adhering to safe use of pesticides, using better and certified propagation materials and breeding stock, besides observing crop and livestock nutrition through use of fertilizers and feeds.

This foregoing therefore suggests that to achieve viable agricultural production, timely extension information services are needed to support agriculture. It is by tackling all these aspects at once and involving all the stakeholders both in the public and private sectors, that agricultural productivity can be improved in a sustainable way.

Conferring credence to assertions by Bachhav (2012), it is accepted that, well planned agricultural extension information systems enhances farming productivity by providing information on good farming practices, that will supports farmers know where to buy inputs or to sell their products. Zarmai [et al,] (2014) affirms this fact by declaring that, in any agricultural environs, appropriate and well-timed information helps farmers make right decisions to sustain growth of agriculture.

According to McLeod (2018), naturally humans beings desire to increase their intelligence and thereby giving rise to the cognitive needs to gain more information and knowledge through learning, exploring and discovering new knowledge. It is for this reason that access to well-structured and appropriate agriculture extension information and proper application of the same by farmers is considered as having the ability to enhanced agricultural production.

Bachhav (2015), Kemp (2005) and Ganpat (2015), gives credibility to the need for knowledge by asserting that, information is an important aspect of economic development, because it reduced doubt and broadened the scope of options to be taken in solving problems thus in the present knowledge society. When people are informed, they are able to take control of their lives by taking necessary and timely actions; hence, information is an important element for progress. There is therefore the need to investigate whether the decreased agricultural productivity characterized all over the world could be attributed to limited access to agricultural information delivered to farmers through extension services.

According to the Economic Review of Agriculture (Republic of Kenya, 2015), creating an enabling environment for marketing of agricultural produce is critical to the economic empowerment of the smallholder farmers. The review goes further to note that, the impediment to smallholder agricultural produce marketing is directly linked to the inability to access timely marketing information that renders the whole marketing process disorderly and unresponsive to smallholder farmer's needs.

The importance of agriculture to the economy of Kenya is further substantiated by the Kenya Agricultural Sector Development Strategy 2010–2020 (ASDS, GoK, 2010), which confirmed that agriculture supported up to 75% of Kenya's budget, supports the labor force and brings about 70% of the export earnings. Besides producing almost all of the country's food supplies as well as providing a substantial proportion of raw materials for the agro-based industries.

According to FAO (2017) report on Information and Communication Technology (ICT) in Agriculture, the world population is projected to exceed 9 billion by the year 2050, and to feed the increasing population there will be a need to increase food production by 60 percent from its 2005/2007 in order to meet this additional food demand. The reports therefore advocates for the application of ICT in agricultural extension information services. When properly applied ICTs can help in assembling and disseminating agricultural information. This information can be incorporated into research and development initiatives and ultimately support in disseminating knowledge to farmers besides connecting producers to consumers.

Olaniyi (2013) echoes the importance of ICTs by emphasized the significance of e-extension in complementing and modernizing existing extension approaches and methods. He additionally points out that, smallholder farmers' ability to produce substantially, is subdued by available agriculture policies that do not adequately address smallholder farmer agriculture information needs and suggests that investment in the intensified use of ICTs can offer more advantages in ensuring seamless access to agricultural information resources.

While the prominence given to agriculture productivity has been paramount, the Kenya Economic Outlook 2016 and 2017 by Deloitte declared that the agriculture industry in Kenya had shown some form of decline. This may have been the reason why in the financial year 2019/2020 budget, the Kenyan government allocated Ksh.59.1 billion to the agricultural sector. (KNT, 2019/2020). The foregoing may suggested the need to investigate whether an ineffective agricultural extension information system may have contributed to the diminishing performance.

In giving credence to the importance of agricultural extension information the Kenya National Agricultural Sector Extension Policy (NASEP) concedes that, effective agricultural extension information services are important for improved agricultural productivity (NASEP, 2012). It is noteworthy being certain that agricultural extension information services are sufficiently financed, and planned.

Successful connections between extension service providers (ESPs) and other participants involved in technology development and delivery of agricultural information are also very essential.

The importance of agricultural information is acknowledged by The Agricultural Sector Transformation and Growth Strategy, (GoK, 2019), the strategy acknowledges that agricultural information is pertinent to agricultural output especially for smallholder farmers, who remain the foundation of food production in developing economies, however, while considerable efforts have been made by the government to change the agricultural extension information systems for smallholder farmers, low agricultural productivity has continued to be experienced in Tana River County.

A report on 'Increasing Agricultural Productivity and Incomes of Smallholder Farmers in Kenya' by the Kenya Agribusiness and Productivity Program (KAPP, 2015) also recognized the central role of agricultural information for economic growth in Tana River County, but acknowledged that, production in the various value chains had trailed far behind those in other counties.

The KAPP report further noted that farming in Tana River County is characterized by small farms extending from half an acre to three acres and is mostly on subsistence model in the productive areas that received adequate rainfall or are closer to the river, has good soils and suitable temperatures, with the major sources of agricultural information being the Ministry of Agriculture Livestock and

Fisheries (MoALF), Kenya agricultural livestock and research organization (KALRO), local and national radio and television stations and international NGOs. These organizations play a unique and indispensable role in the dissemination of agricultural information to farmers.

A household baseline survey report carried out in Tana River County (ASDSP, 2019), revealed that commercialization of agricultural enterprises in Tana River County was still at nascent stages and marketing of agricultural produce was a major hindrance to optimal production. The report further pointed out that, lack of knowledge in business skills was the major impediment to smallholder farmers fully exploiting the county's agricultural potential and recommended that extension information service providers should give prominence to agribusiness development in order to empower smallholder farmers in the county to develop prerequisite skills in agricultural marketing, value addition and agro-processing.

The Tana River County Integrated Development Plan (CIDP, 2013-2017, 2018-2022) also emphasized the importance of smallholder farming in the county where it was noted that 75% of the entire agricultural harvest and 70% of traded agricultural yield was produced by smallholder farmers, nevertheless the CIDP goes further to reiterate the importance of extension information services in enhancing agricultural productivity in Tana River County.

A report by Arid Lands Resource Management Project (ALMRP) as conveyed by the Kenya Interim Poverty Strategy Paper (I-PSP, 2000–2003) also revealed that the county was 79% food uncertain and with an prevalence of poverty at 62%. This was also affirmed by a report by the International Union for Conservation of Nature (IUCN, 2003) that attested to the fact that efforts at food security in the county had always failed. This therefore pointed to the need to investigate the relationship between use of extension services information and agricultural productivity among smallholder farmers in the county.

1.3. Statement of the Problem

Food security assessments reports, (IFAD, 2012) and (FAO, 2017) have demonstrated that, most food insecure people reside in the countryside, with limited access to technology and information geared towards enhancing agricultural productivity. This foregoing therefore suggests that to achieve viable agricultural production, extension information services that support agriculture must be improved.

The Kenya National Agricultural Sector Extension Policy (NASEP, 2012) also underlines the importance of agricultural extension information in enhancing farming output through provision of information on best practices in farming and reinforces the importance of agricultural information in improving agricultural productivity, especially for smallholder farmers, who remain the foundation of food production in developing countries. However in spite of the endeavors to enhance public agricultural extension information services, low agricultural productivity has continued to be experienced in Tana River County (IUCN, 2003).

The decline in productivity is of great concern considering that smallholder farmers are supposed to account for more than 75% of the total agricultural output and 70% of marketed agricultural produce in order to sustain the food requirements of Tana River County (CIDP, 2018-2022).

Whereas the role of smallholder farmers in food security, and environmental protection is acknowledged, the Kenya Interim Poverty Strategy Paper (I-PSP, 2000–2003) reveals that even though Tana River County has good soils, suitable climate, adequate rainfall and is endowed with the largest river in Kenya, food security has continued to be a challenge with an incidence of poverty at 62%, it is therefore not known whether this deprivation and scarcity can be attributed to the non-utilization of agricultural extension information.

This foregoing serves to show that, in spite of decades of investment in agricultural production endeavors, Tana River County is yet to achieve sustainable production. The essence of this research was therefore to investigate the relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County in Kenya.

1.4 Purpose of the Study

The purpose of this study was to evaluate the relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya.

1.5 Objectives of the Study

The Specific Objectives of the Study were to:

i. Ascertain whether there was a relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya.

ii. Find out if there was a relationship between use of extension information services and marketing of agricultural produce among smallholder farmers in Tana River County.

iii. Evaluate the relationship between use of ICT in the dissemination of extension information and agricultural productivity among smallholder farmers in Tana River County.

iv. Establish if there was a relationship between constraints in accessing extension information services and agricultural productivity among smallholder farmers in Tana River County

v. Determine if there was a relationship between methods used in the dissemination of extension information services and agricultural productivity among smallholder farmers in Tana River County.

1.6 Research Hypotheses

This study was based on the following hypotheses;

a) Alternative Hypothesis (H1)

There is a relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya.

b) Null Hypothesis (H0)

There is no relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya.

1.7 Significance of the Study

The findings of this study are expected to benefit agricultural stakeholders who will be enabled to appreciate the role of information in enhancing agricultural productivity. The study will also empower policy makers and extension information service providers formulate and implement sound agricultural and rural development policies that will targeted rural smallholder farmers and test their effectiveness in improving agricultural productivity.

Through the study findings, agricultural organizations, research and training institutions will gain an understanding of the importance of agricultural information in enhancing productivity as they will be able to test extension service delivery methodologies, suggest best ways for improvement and share research findings with relevant agricultural stakeholders for decision making.

1.8 Scope, Limitations and Delimitations of the Study

1.8.1 Scope of the Study

This study focused on farming households, agricultural, veterinary, livestock and fisheries extension service providers in Tana River County because they were considered to be the key agricultural stakeholders in the county and their relationship and interactions were perceived to directly impact on agricultural productivity.

The study was only concerned with obtaining information pertaining to extension services and agricultural productivity and solely concentrated on gathering information on the accessibility and utilization of agricultural extension information in relation to enhancing productivity by drawing a correlation between the two variables.

1.8.2 Limitations of the Study

Tana River County was selected as the best location for the study because of its ability to show case an agro-pastoral farming system where the combination of crop and livestock production, is practiced among established and pastoral, communities. However the study only focused on drawing a correlation between use of extension information services and agricultural productivity among smallholder farmers in Tana River County. Large scale commercial farming, livestock ranches, and irrigation schemes were not assessed. However, the findings can have wide application in other counties in Kenya and other developing countries in general where agricultural production is dependent on smallholder farmers.

1.8.3 Delimitations of the study

The study was only interested in establishing whether a relationship existed between the use of extension information services and agricultural productivity among smallholder farmers in Tana River County but because correlation *is not causation* it therefore follows that the results of the study only showed the existence or nonexistence of a relationship, and not what caused the relationship.

1.9 Theoretical Framework

The study adopted the Information Search Process (ISP) theory by Caroline Kuhlthau. This theory enumerates six relevant stages that can be applied in information seeking, acquisition and use. The ISP was suggested by Carol Kuhlthau in 1991 and proposes different but appropriate information seeking methods from the user's perspective using six simple steps starting with task initiation, selection, exploration, focus formulation, collection and presentation.

The ISP articulates that, at the beginning of the search the information seeker has feelings of doubt and uncertainty but as the search progresses the thoughts become clearer, feelings of apprehension and uncertainty change to confidence and belief.

The relevance of this theory to this study is exemplified by the fact, smallholder farmers in Tana River County were found to be deficient in agricultural information, but on realizing that they lack knowledge or understanding of some principles in agricultural production, feelings of indecision and anxiety arise which provides a short-lived feeling of optimism and a eagerness to start the quest for information.

In the process of searching for information relevant to farming needs, mismatched information is gathered and reluctance, confusion, and doubt increases. Farmers therefore find themselves lacking confidence but through the guidance and support from extension service providers, they are enabled to form a concentrated standpoint and therefore indecision reduces and self-assurance increases.

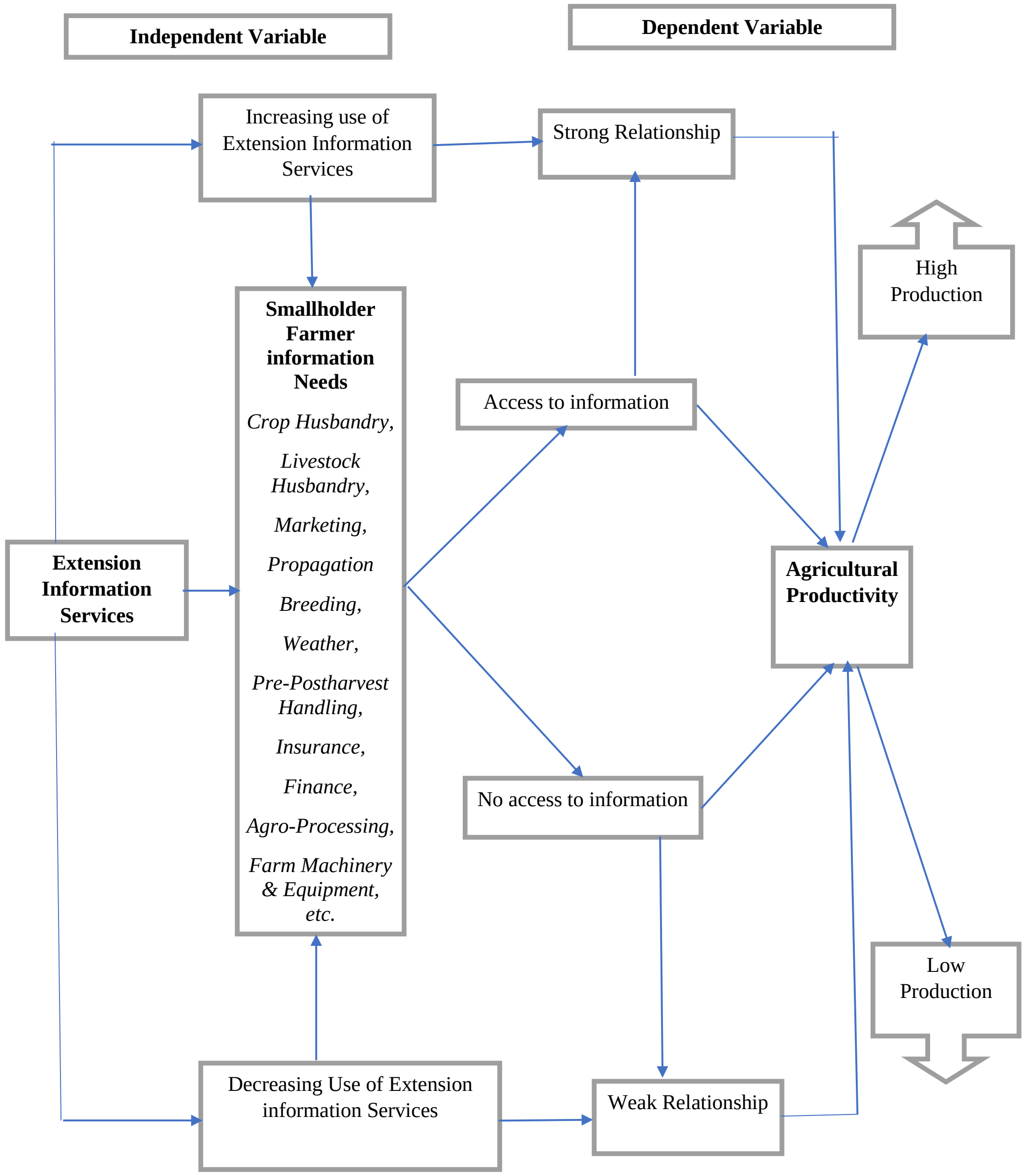
When farmers assemble relevant information, doubt reduces and interest develops. Through the support from agricultural extension services providers farmers are enabled to apply knowledge and skills gained through innovation, adoption and application of good agricultural practices that eventually enhances productivity.

When the search for agricultural information is completed, farmers are equipped with a new understanding, that enables them to articulate, explain and share the knowledge attained with other farmers and eventually all are able to apply the information in making timely decisions and solving farming problems, ultimately productivity increases hence substantiating that a relationship exists between use of extension services information and agricultural productivity.

1.10 Conceptual Framework

This research was founded on the premise that agricultural productivity is affected by numerous influences. Some of these aspects are the various inputs incorporated into farming activities including information on land preparation, choice of plant propagation materials or livestock breeds, and time of planting or breeding, weather changes, use of farm inputs or the type of animal feeds and the mode of harvesting and postharvest handling of the produce.

Figure 1.1 below presents a clear insight into the relationship between the use of extension information services and agricultural productivity among smallholder farmers in Tana River County.



Source: Researcher, 2019

Figure 1.1: Relationship Between Use Of Extension Information Services And Agricultural Productivity Model

From figure 1.1 above, agricultural productivity is the dependent variable that could be affected by the independent variable indicated as extension information services.

Interventions to counter low agricultural productivity would include among others: creating an efficient agricultural extension information system, that will ensure seamless access to information, formulating appropriate agricultural extension information policies that will increase agricultural budgetary allocations therefore permitting employment, incorporation of research and development into agricultural extension therefore facilitating translation of research results into real farming and improving the relationship between farmers and agricultural extension information service providers, besides allowing for the strengthening of monitoring and evaluation of extension information services.

This conceptual framework model considers the life cycle of farming activities and takes cognizance of the fact that for these activities to be carried out successfully, relevant agricultural information is necessary. From the model it is considered that increased access to information improves agricultural productivity and vice versa.

The continuous access to agricultural extension information services ensures that farmers are empowered with knowledge on good agricultural practices throughout the farming life-cycle and therefore able to identify and address any possible causes of low agricultural productivity. Such an approach will improve agricultural productivity especially for smallholders farmers such as those in Tana River County which is the core area of study.

The fundamental principle of this conceptual framework model is the need to increase access to agricultural information through the interaction between smallholder farmers and agricultural extension information service providers, the overall expected effect being increased agricultural productivity that will result in improved livelihoods, food security and increased on farm incomes for the smallholder farmers in Tana River County. The hypothesis here is that increased use of agricultural extension information by smallholder farmers will consequence corresponding to increased agricultural productivity.

1.11 Operational Definition of Terms

Accessibility: The frequency of receiving agricultural information

Extension Information Service: Provision of agricultural information to support smallholder farmers improve agricultural productivity

Productivity: The proportion of agricultural output in relation to agricultural inputs also referred to as yields

Extension Service Provider: Individuals providing agricultural information to farmers.

Agricultural information: Sets of information and messages that are relevant to agricultural production activities.

Agricultural information needs: individual or group's desire to locate and obtain information to satisfy an agricultural need.

On farm income: Profits or losses generated from farming activities

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter appraisals literature associated with the use of extension information and agricultural productivity. It assesses the relationship between use extension information services and marketing of agricultural produce, and evaluates how ICT had been applied in transforming agricultural extension information dissemination. The chapter also highlights constraints to ease of access and application of agricultural extension information and finally reviews the effectiveness of the extension information dissemination methods. At the end of the chapter, a summary of the literature reviewed and research gaps identified are given.

2.2 Relationship between use of extension information services and agricultural productivity.

Agricultural information plays a significant role in enhancing smallholder farming activities. This therefore imply that knowledge of acceptable quality is essential for enhancing all fields of agriculture and is needed throughout the Farming life-cycle. A research on agricultural information sources and their effect on farm productivity in Kenya by Wanyama, Mathenge and Mbaka, (2015), found that agricultural extension was a significant tool for disseminating agriculture information to farmers, and emphasized that information was a critical tool in transforming subsistence farming into commercial agriculture that would promote household food security, improve income and reduce poverty. However, the report acknowledged that access to agricultural information was still limited in most parts of the country especially in areas where agricultural productivity was dependent on smallholder farmers.

In evaluating the Agricultural Sector Development Strategy (ASDS, 2010–2020), it is also acknowledged that agriculture in Kenya is largely practiced by smallholder farmers in the productive areas that receive adequate rainfall, have good soils and suitable temperatures. This farming is characterized by small farms ranging from half an acre to three acres and is mostly on subsistence model. However, with the increase in population and urbanization, commercial farming is now being encouraged and adopted.

Through the ASDS, smallholder farmer are said to be accounting for 75 per cent of the total agricultural yield and 70% of traded agricultural harvest by confirming that between 2002 and 2007, smallholder farmers accounted for over 70% of Kenya's food production. However, the capacity of these farmers to implement decent agricultural practices such as the use of certified seeds and other propagation materials, rearing of improved livestock breeds, use of concentrate feeds, fertilizers, pesticides, farm mechanization and adoption of climate smart farming and technology besides embracing demand driven access to agricultural extension information has relatively been low.

Tadele (2017) in the report on agricultural productivity in Africa asserts that, though there is a huge potential for improved output for smallholder farmers in Africa, the low productivity is mainly related to poor crop and livestock nutrition, unaffordable inputs by smallholder farmers and lack of an effective extension system. This potential is affirmed by The World Bank report on smallholder farming, but emphasizes that agricultural founded economic progress entails a productivity insurgency in smallholder farming (WBG, 2008), because over 68% of the total produced and sold agricultural products are dominated by smallholder farmers in Kenya.

A report from the Ministry of Agriculture, Animal Industry and Fisheries, Republic of Uganda (MAAIF, 2011) reckoned the important input by smallholder farmers in the development of the economy as a whole, but reckoned that notwithstanding this contribution, they continue to suffer from inadequate access to essential facilities such as agricultural information extension services, finance and limited market information.

A similar analysis from the government of Kenya by the Ministry of Agriculture, Livestock and Fisheries, Strategic plan 2013-2017 (MoALF, 2015), recounted that, the inability of smallholder farmers to access timely agricultural extension and the ever increasing transport costs render smallholder producers susceptible to outward shocks beyond their control.

Salami, Kamara and Brixiova (2010), in a research on smallholder agricultural productivity by The African Development Bank (AfDB) notes that, smallholder farmers in Kenya, account for 75% of agricultural maize production, yet current maize yields stand at 1.8 tons per hectare or about eight bags an acre compared to the estimated optimal yields of 30 bags per acre. These assertions were corroborated by Olwande (2012), of The Tegemeo Institute of Policy and Development, Egerton University whose findings showed that over 75% of the total maize yield is produced by smallholder farmers.

The policy report further states that, in 2012 the estimated average Kenyan farm yield was at 1,934kgs of maize per hectare and since the crop in Kenya is usually packed in 90kg bags, this translates to 21.5 bags per hectare or 8.6 bags per acre. This deviation from the ideal yields is great and requires an investigation to ascertain whether the inability to access agricultural extension information could be one of the causes.

Figures sourced from FAO (2015), by the International Maize and Wheat Improvement Centre (IMWIC) clearly illustrated the deviation in the current maize production, by showing that productivity stagnated between the year 2000 and 2013 and the average yield was at 1,622kgs/ha or 7.3 bags per acre. This report acknowledged that maize yields had reduced significantly considering that Kenya's current production potential ranged from 27-30 bags per acre as verified by the Kenya Seed Company, a state corporation that noted that, while it has developed maize varieties that could yield up to 60 bags an acre, this reality could only be achieved if farmers practiced good crop husbandry, used the right inputs and had access to relevant agricultural information.

FAO, IFAD and WFP (2015), in a report on *The State of Food Insecurity in the World* acknowledges that, no smallholder farmer has been able to achieve optimal maize yields and confirms that productivity has been on the decline all over the world. This status has led to the argument that maize production may have declined due to the weakening of extension information dissemination support to smallholder farmers who account for over two thirds of the total maize production in Kenya. While this evidence may suggest that the declining agricultural productivity among smallholder farmers may have been as a result of an ineffective extension information system, it is necessary to holistically investigate the attributes of the weakening agricultural productivity among different agricultural value chains and draw a correlation to extension information service provision.

In Tana River County, Kenya, though the important role of agriculture for economic growth has long been recognized, production in the various value chains have trailed far behind those in other counties (KAPP, 2015). It is this revelation regarding the slow growth in yields that pointed to the need to carry out this study in order to ascertain whether the use of extension information services correlates with agricultural productivity for smallholder farmers in the Tana River County.

2.3 Relationship between use of extension information services and marketing of agricultural produce.

Agricultural marketing encompasses the facilities and skills involved in moving an agricultural product from the farm to the consumer sometimes referred to as *'from* *field to fork'*. These activities involve the preparation, establishing, leading and management of agricultural produce so as to satisfy all actors involved in the value chain.

According to Kiruthiga, et al., (2015), agricultural marketing is a procedure that commences with a choice to produce a marketable farm commodity, and it entails all the facets of market structures comprising of pre- and post-harvest operations such as agro-processing, assembling, grading, storage, transportation and distribution. This therefore imply that farmers require information to be able to undertake this important function.

Crawford (1997), defined agricultural marketing as all activities from the start of agricultural production until the produce reaches the consumers i.e. *"from the farm to the fork."* This suggests that farmers need extension services not only with regard to production but also throughout all the other stages of the entire value chain including agribusiness, in order to enable them apply scientific research and knowledge to agricultural practices.

In a Research on Agricultural Marketing by Smallholders in Kenya, Olwande, et. al., (2015), established that marketing of smallholder agricultural produce is one of the effective ways to increase farmer revenues, and create employment in Sub-Saharan Africa, but pointed out that marketing of agricultural produce was still a challenge by virtue of the fact that smallholder farmers were deficient in relevant and timely agricultural information. The report pointed out the need for intercessions that would increase smallholder production of quality and quantity produce through raising farming output, besides implementing approaches to enhancing market entry. Effective agricultural marketing therefore requires information that will enable complex market data analysis , identifying changes in demand, and sound decision making with regard to supply.

In a report on a strategy for agricultural transformation in Africa (AfDB, 2016), agriculture was found to be a chief source of income to smallholder farmers in Africa. However, due to poor agricultural practices, the report noted that, the continent had continued to experience persistent food scarcity, resulting in a projected growth of a malnourished population from around 240 million in 2015 to above 320 million by 2025. Besides the inefficiencies in production, pitiable marketing structures were also found to be hindering commercialization of smallholder agricultural enterprises in Africa. This therefore requires the need to examine the role of extension information services in the marketing of agricultural produce, considering that most smallholder farmers may not be conversant with the global marketing standards, due to them being deficient in knowledge on certification, skills and facilities for post-harvest handling technology, besides agro processing so as to add value and increase shelf life.

Salami, et al., (2010), in a Working Paper on Smallholder Agriculture in East Africa, noted that while smallholder agriculture remains key in African agriculture, the region's recent rapid growth has remained limited due to restricted access to markets and finance. The paper further noted that these factors, coupled with poor infrastructure and lack of timely market information, affected commercialization of smallholder farming enterprises. This therefore infer that there is need for measures to be put in place to ensure ease of access to agricultural marketing information.

According to the Economic Review of Agriculture (Republic of Kenya, 2015), creating an enabling environment for marketing of agricultural produce and products is critical to the economic empowerment of the smallholder farmers; this is because commercialization of agricultural enterprises will indisputably create incomes for the farmers. Generally, the impediment to smallholder produce marketing is the lack of marketing information that renders, chains for the different commodities difficult to understand, thus making the whole marketing process disorderly and unresponsive to smallholder farmer's needs.

A household baseline survey report carried out in Tana River County (ASDSP, 2014), revealed that while significant efforts have been made to commercialize agriculture in the county, marketing has remained a major hindrance and suggested that, to solve these problem, there was need for timely information and proper guidance and capacity building in agribusiness and entrepreneurial skills for all practicing farmers. It is this foregoing that necessitated the need to find out if use of extension information services has a relationship with the marketing of agricultural produce for improved incomes among smallholder farmers in Tana River County in Kenya.

2.4 Relationship between use of ICT in Extension Information Services and Agricultural Productivity

Digital transformation of public service has become an essential part of the strategic agendas, both in the public and the private sector. In principle it is expected that use of extension information services enhances farming output because farmers are enabled to utilize their limited production resources.

The adoption of ICTs in agriculture, has largely been low, particularly in contrast to other industrial sectors (Teye et al., 2012). It's use has predominantly come from technology advances in the fields, such as GIS for land use planning, hydroponic greenhouse automatized technology, Radio frequency identification (RFID) devices for livestock traceability sensors, weather monitoring stations and various internet banking applications.

As Nikkilä et al., (2010) has pointed out that, the use of sensing and monitoring technology has resulted in precision farming. Other areas have been in demonstrating biological procedures such as in the Decision Support Systems (DSSs) for pests and diseases or nutrient management besides the drone technology for application of agricultural pest and diseases control sprays. There has also been the introduction of programmed milking and crop harvesting machines. Though the argument against technology has been that technology application deprives human being of jobs and therefore adversely affecting the social and economic status of developing nations.

In giving credence to precision farming and related DSSs, Keating and McCown, (2001); Wolfert, (2002) says that this kind of farming systems focuses on precise facets of farm management and usually involves farm data on fields. This has resulted into inventions in DSSs that has created Farm Management Information Systems (FMISs). However, the incorporation of ICTs into agricultural information extension systems has been slow in adoption.

A report by IFAD (2013), on food security, and the environment, indicated that a majority of smallholder farmers continue to practice agriculture mainly at subsistence level, and while their role in agricultural production is well defined, their inability to access timely agricultural extension information inhibits their potential. This therefore points to the need to incorporate ICTs in agricultural information dissemination.

Olaniyi (2013) additionally has pointed out that smallholder farmers' ability to produce substantially, is subdued by available agriculture policies that do not address smallholder farmer agriculture information needs adequately and its acknowledged that investment in the intensified use of ICTs can offer more advantages in ensuring seamless access to agricultural information resources.

Studies in East Africa have also indicated that while the region has an elaborate extension system, its impact on changing the livelihoods of rural populations who continue to depend on the unprofitable subsistent farming is yet to be felt (Moris, 1991; Kyaruzi, Mlozi, & Busindi, 2010; Kasie et al., 2012; Wambura, Acker and

Mwasyete, 2012). This therefore means that there is need to innovatively use ICTs in enhancing the dissemination of information to farmers.

According to a report by FAO (2017), use of ICTs in agriculture has the potential to bring significant benefits through better information on markets, prices signal opportunities to producers, consumers, and with increased access to mobile phones, farmers can better plan production and investments, based on supply-and-demand fundamentals, thus increasing market efficiency. The report goes further to justify that, using e-agriculture can lead to greater efficiencies in agricultural extension, disaster risk management and early warning systems, enhanced market access and financial inclusion, as well as capacity development among rural communities, resulting in better market information for producers.

From the foregoing, it is clear that ICTs can increase smallholder’s access to timely extension information while addressing other challenges such as reducing the cost of extension visits, enabling more frequent two-way communication between farmers and agents, and improving agents’ accountability. By increasing communication linkages between farmers, extension agents, and research centers, ICTs can improve the flow of relevant information among all these agents.

The Nairobi Declaration (2011), gave credence to commitment for increasing investment in agriculture by providing an opportunity for offering extension information services that are farmer-centered, and participatory. This new impetus recognized the importance of incorporating ICTs in extension programs considering the indispensable and vital role ICTs can play in disseminating agricultural information to a large population of farmers fishers and pastoralists.

While information dissemination media such as the radio and television play a key role in the advancement of agricultural extension and communication programs, Ward, (2013), acknowledges that evolution in the internet and the increased access to and use of mobile technology are seen as game-changing. This therefore calls for the need to integrate traditional media and new ICTs in order to expand extension coverage, but to attain a high acceptance, farmers need to be involved in choice and developing relevant content. This therefore calls for interactions with information service providers and ICT soft and hardware developers in restructuring the infrastructure and building capacity of stakeholders to take advantage of the new ICTs.

Outreach programs, such as through the radio, which has massive rural listeners has been improved with application of ICTs. Farm Radio International (FRI) has been mixing the use of mobile technologies with radio to provide collaborative, 2-way participatory radio programs for farming communities. Through the African Farm Radio Research Initiative (AFRRI), farmers have been guided to make informed choices on farming.

Participatory Radio Campaigns (PRCs) have also been tried and appraised different countries such as Ghana, Malawi, Mali, Tanzania and Uganda with results showing where interactions with the farmers through visits and phone calls, farmers who participated adopted the practices (Ward, 2013).

According to Bolo and Makini, (2012), policy changes and economic austerity programs have however obstructed extension services, in developing countries. This is particularized the case in Kenya, where policy changes between 1965 – 2007 led to deviations in extension information service delivery from being a public service to demand driven.

The Kenyan constitution (2010) also devolved agriculture therefore making it a fully devolve function thus reducing state control and expenditure on agricultural programs. This has slowed down agricultural extension policy formulation and implementation in all the 47 counties in Kenya. The new constitution allows counties in Kenya to work as autonomous states capable of formulating their own policies without reference to each other.

This foregoing in policy changes brought into focus the significance of ICT in transforming agricultural extension information services to ensuring wider coverage with the expectation that its application would help public extension information service providers connect farmers with other stakeholders. However the low budget has affected the effectiveness of the programs. In view of the foregoing, it was therefore important to examine the relationship between the use of ICT in extension information services and agricultural productivity among smallholder farmers in Tana River County.

2.5 Constraints in Accessing Extension Information Services

For many years, agricultural extension has been used as an essential tool for disseminating agricultural information in Kenya. This importance is further underscored in the Agriculture Sector Development Strategy (ASDS, 2010-2020) as a critical agent needed to transform subsistence farming into commercial agriculture (Republic of Kenya, 2010). However, poor investment in extension information services has affected accessibility and utilization by smallholder farmers.

In Kenya constraints to accessing agricultural information has to a larger extent been attributed to the decline in staffing and facilitation due to freeze employment. For example, the proportion of public extension worker to farmers is about 1:1000 as equated to the wanted level 1:640 in an agro-pastoral farming system (NASEP, 2012, MoALF, 2017), making it difficult to reach many farmers.

In giving credence to the importance of agricultural information, Munyua, (2000) and Obidike (2011) point out that in order to better agricultural growth, seamless access to information resources is indispensable, particularly in spheres of new agricultural skills, early warning systems on drought, pests, diseases and weather changes, improved propagation materials and or breeding stock, fertilizer, credit, market prices etc.

It is in recognition of the pronounced challenges to agricultural information dissemination that Van and Fortier (2000) reckons that these challenges most often surround the dissemination of agricultural information illiterate. Aina (2007) also, opines that farmers would profit from information, if access was improved and the interactions were more often,.

With reference to Wambura, Acker, and Mwasyete (2012), agricultural extension is said to be spread all over the world. However, its ability to help smallholder farmers' increase their farming output and thus advance their living standard has not been good enough. It is in view of these assertions that, Davis et al., (2010), Baig and Aldosari, (2013), noted that, while extension was said to be supporting over one billion smallholder farmers all over the world there was a need to advance on information distribution so as to reach out to more farmers.

It is from the realization that agricultural production has been on the decline that Hellin (2012), acknowledged that, while concerted efforts have been put in place to transform the agricultural sector in developing countries, desirable results are yet to be felt due to the inefficient financing needed for setting up demonstration plots where farmers can learn essential agricultural concepts. There is also the tendency for under provision of activity facilitation funds such as transportation and provision materials needed for efficiency in extension activities, furthermore the official structure characteristic of all government funded projects as extension officers lack the freedom to alter the description of their responsibilities.

In analyzing constraints to use of agricultural extension information, Tanko, Adeniji and Nwachukwu, (2012), were of the opinion that among the factors that lead to low adoption by farmers are the perceptions farmers have regarding the training methodologies employed by service providers. This implied that there is need refresher trainings on dissemination methods and rural sociology bearing in mind that, a majority of the farmers are uneducated and have no background in modern agriculture.

Furthermore, Gautam (2000), suggested that the primary importance of the extension training should mainly focus on empowering farmers to become better farmers through improved quality and quantity as this will enable them realize that, the training gained will help them identify problems that need to be solved, derive benefit from attending training and therefore make the services be demand driven through cost sharing and thus in the long run be sustainable.

Mattee (1994), also raised a disturbing fact by asserting that in most cases, farmers have inadequate access to extension information because of the disconnected nature of the agents and therefore uninterrupted interaction is curtailed. This coupled with the consideration that, a single extension service provider maybe accountable for over 1,000 farming households and therefore difficult to attend to all of them. The number of extension service providers therefore does not compare with the requirement (Mvuna, 2010) and this, coupled with the absence of a clear value chain approach, has impacted negatively on extension information service provider's efficiency.

Gender issues affecting agricultural extension have also been exposed in studies by Obidike (2011) who revealed that, gender disparities similarly affected the quality of extension services. This imply that the prevailing information sources and systems are affected by factors such as the inability to read the available information, language barrier, poverty, inability to set aside time for research and availability of untrustworthy information. There also exists great disparity between the number of male and female extension service providers, with the number of females being too low. This inequality in extension personnel affects extension delivery in that, sometimes female farmers are not comfortable under the guidance of a male extension officer. These factors therefore have an influence on the usefulness of extension information services in enhancing agricultural productivity and hence the need to establish whether these pronounced constraints were widespread to include smallholder farmers in Tana River County.

2.6 Extension Information Dissemination Methods

Agricultural extension delivery is an casual training method focused on farmers, as pointed out in a report on extension approaches (FAO, 1988), the extension information procedure provides guidance and instructions to help farmers find answers to farming difficulties. Extension also purposes to intensify the effectiveness of the farming, rise output and largely rise the standard of living of the farming community.

In reference to NASEP, (2012), information is an indispensable agriculture production factor prerequisite to advancing new farming systems. However it has been noted that farmers only need agricultural information to the degree that it can afford them with appropriate and sensible information and consider it as a public service or good which they will only pay for if the information is not available for free and if they perceive the marginal benefits to be greater than the marginal costs.

According to Moris, (1991), East Africa is amongst the regions with an intricate extension system in Africa. However, Moris, (1991) goes ahead to point out that, in spite of this, agricultural productivity has continued to decline thus necessitating an investigation into the causes among smallholder farmers. It is from this revelation that Kassie, Ndiritu and Shiferaw, (2012); Kyaruzi, Mlozi, and Busindi, (2010); and Wambura et al., (2015) proposed that there is need to define the main role of extension services in ensuring research results are transmitted to farms where farmers are enabled to test results in real farming. Through extension information services farmers should be guided in decision making and prediction of farming outcomes.

Conferring credence to the importance of agricultural extension information, Byerlee, Diao and Jackson (2009), disclosed that some of the information from extension agents that farmers can benefit from includes; information on weather, prevailing prices of farm produce, pest and disease control, appropriate farm technology, market information, certified propagation materials, livestock breeds, access to finance and bookkeeping. They asserted that farmers can also be guided on how to apply current or unacquainted inputs and use farm technologies.

Extension services can therefore help to lessen technology breaches by hastening technology transmission and effectiveness by way of supporting farmers become better producers. Extension information service providers are therefore important because they offer guidance to farmers necessary for appropriate and timely decision making and thus bridge communication networks between researchers and farmers.

In supporting the role of extension in agricultural productivity, Anderson and Feder (2007), pointed out that, adaptation of new farming ideas can only be through understanding farmers' challenges and articulating them to researchers. This imply that extension information service providers can only create an impact if farmers learned through participation.

According to Mvuna (2010), the most common methodologies in extension training include farm visits, contract farming, lead farmer training, and participatory approaches through demonstration farms and farmers field schools (FFSs).

In demonstrating the importance of mass media in extension, Churi et al. (2012), says that in Kenya, the mass media has been at the forefront in disseminating agricultural information. Radio and television programs such as 'Shamba Shape Up' on Citizen Radio and Television, 'Seeds of Gold', a weekly farming magazine published by the Nation Media Group, and the 'Smart Harvest', farmer magazine published weekly by the Standard Media Group have been useful in disseminating agricultural information. The recently launched KTN Farmer TV by the standard media group, that basically highlights agricultural innovations has also seed widespread dissemination of agricultural information. The MoA-INFO and WeFarm, which are free text message service have also gained application as farmers are accorded a platform for sharing of agricultural information.

In Kenya, dissemination of agricultural research information is mainly done through Kenya Agricultural and Livestock Research Organization (KALRO), farmers' agricultural training centers (ATCs) in many counties, chiefs' barazas and through the Agricultural Information Resource Centre (AIRC). Through extension meetings, farmers are enabled to share experiences which form a pool of knowledge. Churi et al., (2012), acknowledged that extension agents serve an imperative role in supporting farmers make focused perspectives of the different agricultural concepts.

The use of cell phones has also had a wide application where farmers are allowed to share their indigenous knowledge of agricultural production (Lwoga, Ngulube, and Stilwell, 2010). However, Churi et al. (2012), notes that, low literacy levels have been a key barrier to transfer of information to smallholder farmers. This foregoing therefore necessitated the need for an investigation into whether there was a relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County.

2.7 Summary and Research Gap

From the literature reviewed, agricultural extension information services are essential in enhancing agricultural productivity and marketing. While over a billion smallholder farmers all over the world depend on extension information services, there is a need to scrutinize the usefulness of the information disseminated especially with regard to how they relate to smallholder farmers' agricultural productivity. Such a position will inspire desirable changes that will bring about better farming methods and increased yields.

Prominent gaps in access to agricultural extension information services continue to be experienced by smallholder farmers, characterized by the cyclic global food insecurity resulting from decreased productivity, raising cases of malnutrition and increased wastage. There is therefore a need to investigate the relationship between the use of extension information services and agricultural productivity and qualify whether access to agricultural information increases agricultural productivity.

While the overall assumption has been that an ideal agricultural extension information system will enhance productivity, achieving a demand driven extension information system among smallholder farmers has been elusive due to gaps in flexibility, participation and sustainability in extension information services. This infers the need to investigate the gaps in extension information service policy formulation and implementation. There is also a need to define the stakeholders and consider the capacities of both the extension agents and the smallholder farmers while at the same time taking cognizance of the policy shifts.

Prominent gaps exist in the dissemination of agricultural information to smallholder farmers, this hampers continuous exchange of information and therefore a need to enhance the skills and practices of extension information service providers. Fostering linkages between sector stakeholders important in order to promote agricultural productivity among smallholder farmers. For an efficient agricultural extension information system there is the superseding need to understand the training of extension information service providers so as to empower them with skills on information dissemination and knowledge management.

While smallholder farmers perform a significant role in improving agricultural productivity, Obidike, (2011), highlights problems these farmers' encounter in retrieving Agricultural Information and opines that, in most cases the methods they use to seek for information are not effective to assist them access worthy information. There is therefore the need to examine agricultural information needs of rural people and the methods they use to seek for information considering that smallholder farmers’ information needs continue to go unsatisfied.

A well-functioning agricultural extension information system requires investment in research and the eventual transfer of results to farmers. Prominent gaps exist in the allocation of resources to enhance agricultural information research and development. There is therefore the superseding need to examine whether comprehensive policies have been put in place to address salient issues that directly affect access and use of agricultural information.

While it is evident that ICTs can enhance smallholder’s access to timely extension information by increasing communication connections between farmers, extension agents, and research centers, major gaps exist in exploiting ICTs. Seamless flow of information has been elusive and there is need to evaluate the infrastructure in place for the development of an effective e-extension system.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter highlights the methodology used in the study, justifies the chosen design and describes the study variables. The chapter also explains how the location and target population of the study is identified besides giving an in-depth explanation of how the sample size was determined. Details as to how data collection instruments were constructed and pre-tested for reliability and validity are discussed. The chapter comprehensively describes how data was collected by drawing attention to the data collection techniques, and methods applied in analyzing the collected data. Finally, the chapter considers the logical and ethical issues relating to the research.

3.2 Research Design

The research applied a correlation study design and measured the relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County. According to Mugenda and Mugenda (2003), a Correlational investigation is a type of non-experimental research method, in which a researcher measures two variables and assess the statistical relationship between them with no influence from any extraneous variable. The correlation strategy enabled the determination of the strength of the direct relationship between use of extension information services and agricultural productivity. The results from the correlational research were used to determine occurrence of associations, forecast occurrence of relationship among the variables and make predictions using the data and knowledge gathered.

3.2.1 Variables

The dependent variable was agricultural productivity because this is what was measured in the study and it was the variable that was affected by use of extension information services. The independent variable was the extension information services because agricultural productivity was presumed to respond to the use of extension information services. To enhance agricultural productivity, smallholder farmers were assumed to depend on the utilization of extension information services. The investigation was therefore looking for some kind of relationship between the two variables by establishing whether use of agricultural extension information services caused some kind of change in the agricultural productivity among smallholder farmers in Tana River County.

3.2.2 Research Methodology

During the enquiry, both quantitative and qualitative data was gathered and evaluated. According to Mugenda and Mugenda (2003), quantitative approaches underscore unbiased measurements of the statistical, analysis of data collected through questionnaires, and interviews. While Kothari (2009) refers to qualitative data as the information gathered in a narrative form through questionnaires or interviews. Quantitative research focused on gathering numerical data while qualitative data which was non-numerical in nature was gathered in a narrative form. The data collected was restricted to the relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya.

3.3 Location of the Study

The study was carried out in Tana River County, Kenya. The choice was based on a number of issues prominent among them being the need to select an area with the ability to show case an agro-pastoral farming system where the combination of crop and livestock production, is practiced among established and pastoral communities. Most of the 47 counties in Kenya had either an intensive mixed farming system or a complete Pastoral farming system.

The choice of the location was also based on the fact that, available literature had revealed that the county was 79% food uncertainty with an prevalence of poverty at 62% (I-PSP), 2000–2003, Kenya). Notwithstanding the pronounced food scarcity, the International Union for the Conservation of Nature categorized Tana River County as having vast land, good soils, suitable temperatures, sufficient water (IUCN, 2003) and with an elaborate extension system (Household Baseline Survey Report–Tana River County, ASDSP 2014). While the county had been acknowledged as suitable for agricultural production efforts at food security had always failed (Interim Poverty Strategy Paper (I-PSP), 2000–2003, Kenya).

3.4 Target Population

The target population for this study were farming households and public extension service providers in Tana River County. The county's total population was 315,943 based on the 2019 National Population and Housing Census (GOK, 2019), distributed on 68,242 households averaging five family members. The County had 85 extension service providers (Household baseline survey report – Tana River County, ASDSP 2019) as shown in table 3.1 below

Table 3.1:Tana River County Farming Population Distribution

Sub-County	Agricultural Ward	No. of Extension Service Providers	Approximate Farming Population	Approximate Farming Households
Tana Delta (Garsen)	Garsen South	5	26,113	6223
	Garsen Central	12	25,449	5090
	Garsen West	4	17,438	3488
	Garsen North	3	18,158	3632
	Kipini East	2	13,852	2784
	Kipini West	3	15,747	3149
Tana River (Galole)	Kinakomba	6	23,414	5683
	Chewani	15	25,657	6131
	Wayu	5	25,165	5033
	Mikinduni	3	14,310	2862
Tana North (Bura)	Chewele	4	24,362	4872
	Hirimani	9	23,706	5741
	Madogo	8	25,508	6102
	Sala	3	15,777	3155
	Bangale	3	21,287	4297
Total		Σ=85	Σ=315,943	Σ=68,242

Source: Household baseline survey report – Tana River County, ASDSP II 2019 and The National Population and Housing Census (GOK, 2019).

From table 3.1 above, Tana River County had a total of 85 public agricultural extension information agents serving 68,242 farming households.

3.5 Sampling Technique and Sample Size

3.5.1 Sampling Technique

The selection technique used was stratified random sampling where the entire population was divided into 15 different agricultural administrative wards or strata as shown in Table 3.1 above, then randomly the final subjects were proportionately selected from the different strata. For this research only public agricultural extension service providers and smallholder farming households engaged in commercially viable agricultural value chains were selected.

To check the overlap and control double responds from the same respondents on different agricultural enterprises all targeted farming households were only allowed to respond to questions on a specific enterprise. This was to ensure that a farming household only responded to a single questionnaire on a specific farming enterprise and only 382 questionnaires were administered.

3.5.2 Sample size

To make it simpler the method of determining the sample size for a finite population, the researcher used the Krejcie & Morgan (1970), Table For Determining Sample Size From a Given Population as shown in Table 3.2

Table 3.2: Krejcie & Morgan (1970), Table For Determining Sample Size From a Given Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	373
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	225	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	***75000***	***382***
95	76	270	159	750	256	2600	335	100000	384
	NOTE:	"N" is the population size							
		"S" is the sample size							
Source: Krejcie, Robert V., Morgan, Daryle W., 'Determining Sample Size for Research Activities' Educational and Psychological Measurement, 1970.									

Based on the target population as given in section 3.4, the projected farming population of Tana River County in the year 2019 was 315,943 distributed on 68,242 households of an average five family members. Using the Krejcie & Morgan

(1970), Table for determining sample size, the desired sample size for smallholder farming households will be 382 and the sample size for extension service providers will be 79 as shown in Table 3.2.

Table 3.3 below provides an analysis of Tana River County Population and Sample Size for Agricultural Extension Service Providers

Table 3.3:Population and Sample Size for Agricultural Extension Information Service Providers

Public Extension Service Providers Sampling Matrix		
Department	Population size ('N')	Sample Size ('S')
Agriculture	45	40
Livestock	20	19
Fisheries	10	10
Veterinary	10	10
Total	**85**	**79**

Source: Research Data, 2019

As analyzed in table 3.3, above the sample size for Agricultural extension information service providers was calculated to be 79. The sample size for this study was further distributed within the agricultural administrative wards as shown in the table 3.4 below.

Table 3.4: Study Planned Sample Size

Sub-County	Agricultural Ward	Targeted No. of Farming Households	Targeted No. of Extension Service Providers	Planned Sample Size
Tana Delta (Garsen)	Garsen South	38	5	43
	Garsen Central	37	10	47
	Garsen West	21	4	25
	Garsen North	19	3	22
	Kipini East	19	2	21
	Kipini West	22	3	25
Tana River (Galole)	Kinakomba	27	6	33
	Chewani	42	13	55
	Wayu	17	5	22
	Mikinduni	21	3	24
Tana North (Bura)	Chewele	23	4	27
	Hirimani	21	7	28
	Madogo	47	8	55
	Sala	11	3	14
	Bangale	17	3	20
Total	**Σ=15**	**Σ=382**	**Σ=79**	**Σ=461**

Source: Research Data, 2019

From table 3.4, the study sample size was therefore taken as 382 farming households and 79 extension service providers, all totaling to 461, however considering that there was a possibility of one farming household engaging in more than two enterprises, to check and control this occurrence the study only considered one household for one enterprise and therefore questionnaires were only administered once per household per specific agricultural enterprise this avoided the likelihood of one responded replying to two questionnaires on different agricultural enterprises.

3.6 Research Instruments

Data was collected by use of questionnaires and interview schedules since these two instruments are suitable for collecting data from a large number of respondents. The methods are also cost effective and the information obtained is more accurate as the instruments enable face to face interaction during data collection which helps to check and avoid false information.

3.6.1 Questionnaires

Due to the nature of the population distribution and the high number of respondents, questionnaires were found to be suitable for collecting data from smallholder farming households. The responses questionnaires gather are also standardized and more objective than in interviews and observation methods, besides it also being relatively quick to collect information using a questionnaire as it saves on time. Questionnaires also help in upholding confidentiality and can be used to collect information from a large portion of a group. Questions in the questionnaire were both structured and unstructured. A Likert scale - where participants were given a range of options, such as agree, strongly agree etc. were used. The questionnaires were circulated to the respondents by the researcher and the respondents were allowed to complete after which they were collected after the given response time was over. While faming households were likely to be found engaging in more than one farming enterprises and the time of the research, before distribution of questionnaires all targeted farming households were evaluated and allocated specific agricultural enterprises. This was to check the overlap and control double responds from the same respondents on different enterprises. This therefore implied that a farming household only responded to a questionnaire on one farming enterprise and only 382 questionnaires were distributed.

3.6.2 Interview Schedules

Structured interview schedules were used for collecting data from extension information service providers due to the fact that they usually yield a high percentage of returns as compared to questionnaires because practically everyone can be reached for response through this approach.

The information obtained through interviews is also more reliable as it has an improved response rate as compared to questionnaires, and the evaluator can also assess the non-verbal behavior of the respondent. The interviewer also can also order the sequence of the question, unlike in the questionnaire, and can anticipate the impulsiveness of the response.

The interviewer engaged the respondents in questions that were beneficial to compare and contrast participant’s responses in order to get essential data to meet the specific objectives of the study. A semi-structured interview schedule was developed where structured questions were asked together with open-ended ones. This increased the reliability and credibility of the research data. Every respondent was subjected to similar questions to test consistencies.

3.7 Piloting

According Creswell (2009) piloting is testing the data collection instruments to determine whether or not the study will produce expected results. This phase was central in the research process because it allowed the researcher pretest the reliability and validity of the instruments and notice difficulties or flaws that could be confronted during the main research.

Piloting was undertaken with a group of smallholder farmers in Kilifi County. According to Yogesh (2006) for piloting results to be effective, it should comprise of respondents equal to 10% of the sample size. For this study, 39 smallholder farmers and 8 public extension information service providers were arbitrarily chosen and involved in piloting the questionnaire and interview schedules respectively.

A triangulation of the study was carried out through the use of a combination of several methods of data collection on the same topic. According to O'Donoghue and Punch (2003), triangulation method helps in cross-checking data from different sources to search for consistencies in the research data in order to overcome the weakness or inherent preconceptions and the complications that come from using a single method to collect data.

Questionnaires and interview schedules on the same topics were prepared and administered to eight agriculture extension information service providers and thirty nine farming households and both qualitative and quantitative data was collected. Thereafter, the piloting data was analyzed and appropriate revision was done to the data collection instruments before the actual data collection to ensure they captured all the necessary information.

3.7.1 Validity

Validity is the degree to which the outcomes of the study can be correctly construed and generalized to the populations (Mugenda and Mugenda, 2003). The questionnaire was verified to check its content, construct and face validity. Content validity was done to guarantee that contents of the instrument contained acceptable sample of the field of content it was intended to represent. Face validity relates to the set-up of the tool and comprised of characteristics such as lucidity of printing, font size and type, appropriateness of workplace, and relevance of language among others. Construct validity assesses the type of emotional concepts or features measured by the tool. Validity was guaranteed through the use of research professionals who were study supervisors at Kenyatta University. The questionnaire and the interview schedule were given to the supervisors to appraise and rate each entry in relation to the objectives based on the relevant or irrelevant on an even likert scale of 1-4 scale. Validity index was calculated from the ratio n3/4/N as 0.83.25, where n3/4 was the number of items marked 3 or 4 by both supervisors, and N was the total number of items evaluated. The score was above the recommended minimum validity index of 0.70 (Oso & Onen, 2011). The questionnaire was therefore valid.

3.7.2 Reliability

Reliability is the level to which research findings are reliable and replicable (Kothari, 2011). Reliability is also the evenness of scores when the research instrument is ordered from one set of items to another, and also from one point in time to another (Frankel & Wallen, 2006). The data collection instruments were pre-tested for reliability using Cronbach alpha (α) with a sample of 10% of smallholder farmers and extension information service providers arbitrarily chosen from the Kilifi County. Ten percent was preferred for the pre-test because it is the least number that produces expressive results in data analysis of a survey research, (Yogesh, 2006). The reliability index of 0. 839 was calculated and since it was greater than 0.7 the lowest suggested value, the data collection instruments were therefore acknowledged as consistent.

3.8 Data Collection Techniques

Research questions were used to gather data from farming households and all questionnaires were distributed to respondents by the investigator with the help of

12 competent research assistants. Due to the fact that the research was Cross-cultural the investigator worked with twelve research assistants, four in each of the three sub counties as shown in Table 3.4 above. The target was for each assistant to reach out to at least thirty respondents besides performing a wide range of different functions, from translating to guiding, and their participation in the research ensured quality of the study design, its process and outcomes.

However in the case of structured interview schedules, every extension service provider was subjected to the same questions as all the others by the researcher. Primary data was gathered directly from respondents through questionnaires and interview schedules whereby all variables of interest were identified.

3.9 Data Analysis and Presentation

Data was examined for descriptive and inferential statistics using Microsoft excel and Statistical Package for the Social Sciences (SPSS for Windows Version 22). Descriptive statistics were used to represent the sets of groups molded from the data, while inferential statistics were used to make prediction that impacts the conclusion on a large population. Descriptive statistics allowed the investigator to implicitly define a distribution of measurements (Mugenda & Mugenda, 1999) and also to label, organize and summarize data (Fain, 1999).

The data gathered in the study was evaluated using descriptive statistics where the measure of central tendency using frequencies, percentages, means, standard deviations and distribution tables were calculated. Inferential statistics used in the study included the use of Correlational analysis, independent sample t-test, paired t-test and simple regression analysis. This enabled the determination of relation between the independent and dependent variables.

The nominal and ordinal data collected using questionnaires and interview schedules was computed from the qualitative data and exposed to quantitative analysis applying descriptive and inferential statistics in line with the five research objectives. Descriptive statistics was used to describe the population characteristics numerically and hence more precisely in accordance with Saunders et al. (2007). The Inferential statistical analysis of the results were done to determine whether or not there is a statistical relationship established between Extension Information Services (the independent variable) and Agricultural Productivity (the dependent variable) on the basis of the research hypothesis.

The data was read through and segments within it established. To permit quantitative analysis, data was converted into numerical codes that suggested how associated data segments informed the research objectives. The report was then prepared by deliberating on the similarities and differences in relation codes across discrete original sources and backgrounds, and comparing the relationship between one or more codes. Data cleaning also known as data cleansing followed where collected data was inspected for inaccuracies in order to guarantee that it is free of irrelevant and incorrect information. This entailed detecting incorrect, inappropriate, partial parts of a dataset of the data collected. After data cleaning, sorting of data followed in order to make analysis more effective and easy for tabulation using Microsoft word, excel and other statistical packages. All the quantitative data was analyzed in Micro Soft Excel and the SPSS (Version 22) computer package.

The correlation technique was applied to measure the strength of relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya. The Pearson correlation coefficient (PCC) formula shown below was applied on the data collected on the 23 major agricultural enterprises, to measure the linear correlation between variable X (number of extension visits) and variable Y (household agricultural productivity or yield marketed).

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

Where;-
n = the sample size,
Σx = sum of x scores,
Σy = sum of y scores,
Σxy = sum of the products of paired scores,
Σx^2 = sum of squared x scores,
Σy^2 = sum of squared y scores

According to Kothari (2004:141), and Mugenda and Mugenda (2012:133), the computation of a correlation coefficient (r) produce a digit that ranges from **-1 to +1**. The value of ***'r'*** is **± 1**. A positive value of ***r*** shows positive relationship between the two variables i.e. agricultural productivity or marketed produce and use of extension services, whereas a negative value of ***'r'*** signifies negative association. A zero value of ***'r'*** showed that there was no relationship between the two variables.

Where ***'r' = (+) 1***, it showed perfect positive relationship and when it was ***'r' = (–) 1***, it showed perfect negative association, meaning that variations in independent variable 'use of extension services' (*X*) described 100% of the differences in the dependent variable 'agricultural productivity' or agricultural marketing (*Y*). In cases where the value of ***'r'*** was closer to +1 or –1, it was an indicator of great degree of relationship between the two variables.

Data was analyzed with the use of an MS Excel, by calculating relationships. In Excel, three columns were set up: Variable 1 'number of extension visit and Variable 2 productivity or yield in kilograms, bags or liters of produce. Graphs and scatter plots were prepared using Excel program to represent data and Statistical Package for Social Sciences (SPSS) was used to create tables and charts required for data presentation. Other presentations were in the form of text, figures and percentages.

A Significance test was undertaken to test whether the association was merely apparent, and might have arisen by chance, the study used the t-test to understand the significance of the correlation coefficient calculated. The t-test formula below was used to calculate a test statistic in order to test the hypothesis of correlation coefficient and Scatter graphs were drawn to indicate the direction of the relationship.

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

A paired t-test was used to relate the on farm income means from the registered household income from the sale of agricultural produce. The t test carried out was essentially to test the study hypothesis by comparing the household on farm income mean for the year 2017 and 2018.

The sum of incomes for the two years under study was calculated and the differences determined between year 2017 and year 2018. The sum of the differences was calculated and squared and the t-test formula below was applied to compare the mean on farm income for the agricultural enterprise evaluated over the years under review.

$$t = \frac{(\sum D)/N}{\sqrt{\frac{\sum D^2 - \left(\frac{(\sum D)^2}{N}\right)}{(N-1)(N)}}}$$

Where;-
ΣD: Sum of the differences (Sum of x-y)
ΣD^2: Sum of the squared differences (Sum of $(x\text{-}y)^2$)
$(\Sigma D)^2$: Sum of the differences squared. (Sum of x-y squared)

The study used Simple Linear Regression to assesses the relationship between independent variable x (use of extension information services) and dependent variable y (Agricultural productivity). The simple linear model was expressed using the equation:

$$y = mx + b$$

Where;-

y – Dependent variable
x – Independent variable
m – Intercept
b – Slope

From the data analyzed, extension information visits and agricultural production values were summed up and squared and the mean production calculated to solve for ***m*** and ***b*** using the function;

$$m = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x^2) - (\Sigma x)^2} \qquad b = \frac{\Sigma y - m(\Sigma x)}{n}$$

From the calculations, predictions of ***y*** (production) were made from the given values of ***x*** (Extension information use***)*** using the simple regression equation **y = mx + b**

3.10 Logistical and Ethical Considerations

In conducting the research, expertise, carefulness and integrity was required. This was done to safeguard the rights of the respondents. To guarantee the study was moral, the rights to self-determination, anonymity, confidentiality, and informed consent were observed. Written permission for the grant of a research license to conduct the study was obtained from The National Commission for Science, Technology and Innovation (NACOSTI) and additional authorization sought from the County Government of Tana River, county commissioner, ministry of education science and technology and the Ministry of Agriculture, Irrigation, Lands, Livestock and Fisheries. Respondents were briefed about the purpose of the study and the measures to be employed in data collection.

Anonymity and confidentiality was maintained throughout the study by not disclosing the respondents' names on questionnaires and reports and detaching the written consent from the questionnaires. Adherence to the legal and ethical issues in the entire research process was guaranteed through obtaining legal authority from the relevant government agency to carry out the research, obtaining voluntary and informed consent of the respondents in participating in the research, and disclosure to the respondents that the information given was to be used for no other purpose but for research only.

CHAPTER FOUR

PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION

4.1 Introduction

This chapter presents the findings, interpretations and discussion according to the study objectives and hypotheses. It covers an analysis of findings based on a study carried out to establish the relationship between use of extension information services information and agricultural productivity among smallholder farmers in Tana River County. The chapter discusses the relationship between agricultural productivity and access to information, constraints smallholder farmers face in accessing agricultural information and delves into how ICTs have been applied in transforming agricultural information dissemination in the County.

4.2 General and Demographic Information

4.2.1 General Information and Research Problems

The General information included data on the number of deployed public extension information service providers, number of faming households, Tana River County administrative units and the major agricultural enterprises with economic relevance to the inhabitants of Tana River County. This information was important in laying the basis for an enquiry into the relationship between the use of extension information services and agricultural productivity

Quantitative and qualitative data was primarily gathered using questionnaires and structured interviews, the purpose of such an inquiry was to generate results through analysis, interpretations and presentation of findings through data collection instruments. Questionnaires were administered to farming households heads and scheduled interviews directed to agricultural, veterinary, fisheries and livestock extension officers.

Data on major agricultural enterprises with economic relevance were profiled, analyzed and selected based on the number of farmers engaged in the farming enterprise on fulltime basis, acreage under crop, quantity of yield produced and marketed and number of livestock reared, this was to guarantee that the data collected was substantial to the study objectives.

The findings' presentations, analysis, and interpretations were finally grouped into five broad themes in respect to the objectives of the study. The study was only concerned with obtaining useful information pertaining to use of extension service information and agricultural productivity by drawing a correlation between the two variables.

4.2.2 Return Rate

In calculating the response rate (RR), the study adopted the calculations as defined by The American Association for Public Opinion Research, (AAPOR, 2016) and Shapiro, (2011). The response rate was considered by dividing the number of respondents by the sampled number of respondents and converting into a percentage.

The questionnaires for farming households were Completed by 382 sampled respondents, while interviews were supposed to be administered to 79 sampled agriculture extension information service providers selected from the departments of Agriculture, veterinary, fisheries and livestock. The study sample size was 461 respondents as stated in Section 3.5.2.

a) Response Rate to Farming Household Heads Questionnaire

Out of the 382 distributed farming households questionnaires, a total of 365 (95.55%) questionnaires were administered and 17 (4.45%) were returned unused. This return rate was acceptable in reference to The American Association for Public Opinion Research (AAPOR, 2016), which considers 60% as the acceptable minimum response rate for published research.

To guarantee that the data gathered was substantial to the study objectives, data on major agricultural enterprises with economic relevance were profiled, analyzed and selected based on the number of farmers involved in the farming enterprise on fulltime basis. The 382 respondents were therefore selected based on the 23 major agricultural enterprises in Tana River County and each respondent was allocated to specific enterprises.

To check overlap and control double responds from the same respondents on different enterprises all targeted farming households were only allowed to respond to questions on a specific agricultural enterprise. This was to ensure that a farming household only responded to a single questionnaire on one farming enterprise and only 382 questionnaires were distributed. Apart from respondents in enterprises such as camel milk, cabbages and chicken eggs for which response rate was between 80% and 87%, respondents in the other enterprises had a response rate of above 90% as indicated in table 4.1 below:

Table 4.1: Response Rate to Farming Household Heads Questionnaire

Response Rate				
S/R	Agricultural Enterprise	Sampled No. of Respondents	Actual No. of Respondents	Response Rate (%)
1	Maize	30	28	93.3
2	Green grams	30	28	93.3
3	Mangoes	30	29	96.7
4	Cow Milk	29	28	96.6
5	Chilies	20	19	95
6	Water melon	20	20	100
7	Tomatoes	20	19	95
8	Goat milk	19	18	94.7
9	Citrus fruits (Oranges)	19	18	94.7
10	Kales	19	19	100
11	Coconuts	19	19	100
12	Cashew nuts	18	18	100
13	Chicken Eggs	15	13	86.7
14	Cabbages	12	10	83.3
15	Camel milk	10	8	80
16	Honey	10	9	90
17	Fish	10	10	100
18	Butternuts	10	10	100
19	Bananas	9	9	100
20	Cassava	9	9	100
21	Onions	8	8	100
22	Cotton	8	8	100
23	Sesame Seed (Simsim)	8	8	100
Total		**382**	**365**	**95.55%**

Source: Research Data, 2019

b) Response Rate to Extension Information Service Providers Interviews

Out of the targeted 79 agriculture extension information service providers, 75 (94.94%) participated in the study. This return rate was acceptable in reference to The American Association for Public Opinion Research (AAPOR, 2016), which considers 60% as the acceptable minimum response rate for published research.

The 79 respondents were selected from agriculture, livestock, fisheries and veterinary departments under the ministry of agriculture livestock and fisheries departments in Tana River County and the responses are summarized in table 4.2 below:-

Table 4.2: Response Rate to Extension Information Service Providers Interviews

Extension Service Providers Category	Sampled No. of Respondents	Actual No. of Respondents	Response Rate (%)
Agriculture Extension officers	40	38	95
Livestock Extension officers	19	18	94.7
Fisheries Extension officers	10	9	90
Veterinary extension officers	10	10	100
Totals	**79**	**75**	**94.94%**

Source: Research Data, 2019

The full participation by the extension agents provided valuable data on the relationship between the use of extension information services and agricultural productivity in Tana River County.

4.2.3 Demographic Data

Demographic data was collected by considering the characteristics of the respondents in terms of age, gender, and literacy levels. Information on village name and agricultural ward as also captured.

The demographic information helped in appreciating the background respondents and aided in developing the strategy on how to reach out to the respondents.

From the data collected Tana River County was found to be administratively divided into three sub-counties, with a farming population of 315,943 distributed on 68,242 households of an average five family members, and was divided into 8 divisions with 15 different agricultural wards forming 42 administrative location (GOK, 2019). The County had a total of 85 public agricultural extension information service providers each serving over 800 farming households. The demographic profile is as given in table 4.3 below.

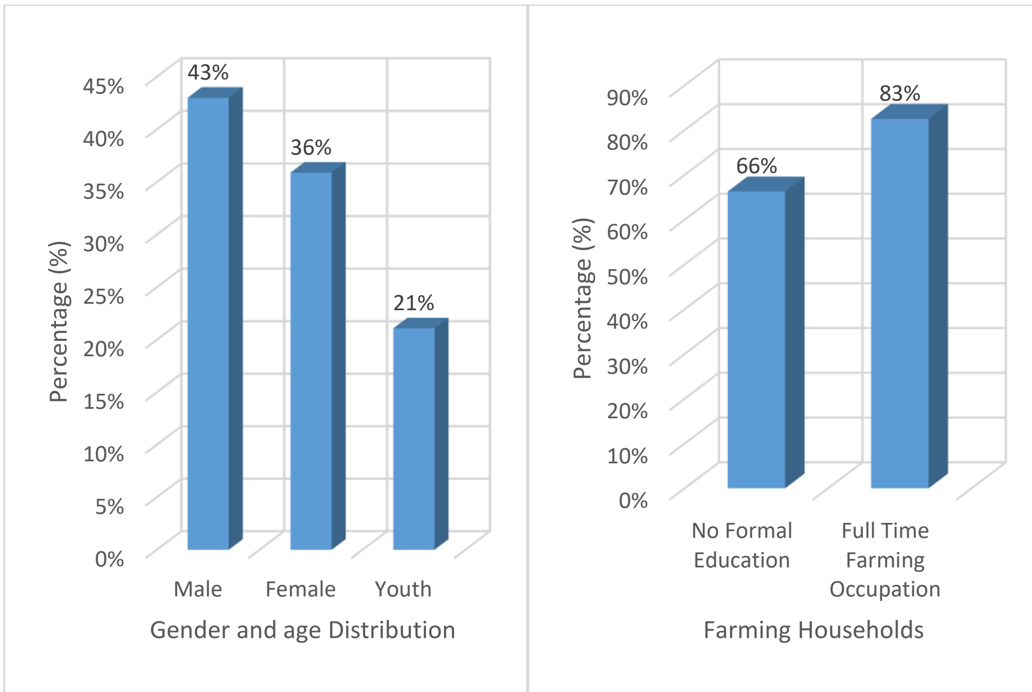
Table 4.3: Tana River County Farming Households by Administrative Unit

Administrative Characteristics	Sub-Counties			Total
	Tana River (Galole)	Tana Delta (Garsen)	Tana North (Bura)	
Number of Agricultural Wards	4	6	5	15
Number of Extension Officers	29	29	27	85
Approximate Farming Population	88,546	116,757	110,640	315,943
Approximate Farming Households	19,709	24,366	24,167	68,242

Source: Household baseline Survey (ASDSP, 2019)

Demographic data was also gathered on gender, age, literacy level and occupation of the faming households. Data gathered revealed that a high number of the farming households were led by male farmers at 43% (153 out of the sampled 365 households), followed by the female led households at 36% (131 out of the sampled 365 households) and youth lead households were the least at 21% (77 out of the sampled 365 households).

Most farmers also had low literacy level with 242 (66%) of the sampled 365 households being with only led by farmers having no formal education. Regarding occupation the data gathered reveled that most households in Tana river county were full time farmers with only 17% (64 households out of the 365 sampled) of being partly engaged in non-farming occupations. The data is provided in the bar chart in figure 4.1 below.



Source: Research Data, 2019

Figure 4.1: Farming Households Demographic Profile

This data was effectively collected through questionnaires administered to farming household heads and interviews with public agricultural, veterinary, fisheries and livestock extension officers from Tana River County because they were the key agricultural stakeholders and their relationship and interactions were perceived to directly impact on agricultural productivity.

4.3 Findings for Objectives

4.3.1 Relationship Between Use Of Extension Information Services And Agricultural Productivity.

In order to evaluate the relationship between use of extension information services and agricultural productivity, the study analyzed all the major agricultural value chains based on their importance to the livelihoods and economic activities of the inhabitants of Tana River County. The enquiry considered twenty three major economically viable agricultural value chains and an examination of each was undertaken by requesting the practicing smallholder farmers to provide data on the number of extension visits made by extension service providers during the year 2018 and the corresponding yield.

The extension visits were considered to be agricultural information dissemination sessions. This was followed by capturing the corresponding production for each agricultural enterprise in order to assess any form of relationship that existed between the information provided by the extension agents and farm yield. The data collected was analyzed and a correlation coefficient calculated to determine the degree of the relationship between the information and productivity variables. This data was considered necessary in analyzing the relationship between the use of extension information services and agricultural productivity. The data collected on the twenty three agricultural enterprises in Tana River County was analyzed per every agricultural enterprises selected as below.

i) Relationship between use of Extension Information Services and Maize Productivity

In analyzing the relationship between the use of extension information services and maize productivity among smallholder farmers in Tana River County, a sample of 28 maize farming households with an average of three acres of land under the crop was chosen for the research.

The sampled farmers were requested to offer information on the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018, the unit of study being household head. The extension service information was measured in terms extension training and visits made to farming households and the visits were considered as information dissemination sessions.

To ensure that the extension visits were equated to the use of information disseminated, farmers were requested to only provide the number of times when they received and applied the useful information on maize production, the number of visits where information not relevant to maize farming was disseminated were disregarded. From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***.

Out of the 28 maize farming households sampled, extension information visits per household ranged between 10 and 79 times per year with a corresponding mean maize yield of 11.8 bags per acre. However farmers who received more than 70 extension information dissemination visits during the year produced over 30 bags per acre signifying that use of extension information correlated with increased maize productivity.

This information was corroborated by Figures sourced from FAO (2015), by the International Maize and Wheat Improvement Centre (IMWIC) report which acknowledged that Kenya's smallholder maize production potential ranged between 27-30 bags per acre, but could yield up to 40 bags an acre, if farmers practiced good crop husbandry, used the right inputs and had access to relevant agricultural information.

To lay the basis for calculating the relationship between the two variables; use of extension information and maize productivity, the sum of the scores of ***x*** (extension visits) and ***y*** (maize yield) were computed. The sum of products and squares of the two variables were then calculated and based on the acreage captured per household the average maize production per acres was then calculated. More details on the relationship between the use of extension information services and maize productivity are shown in table 4.4 below;

Table 4.4: Relationship between use of Extension Information Services and Maize Productivity

Maize Enterprise				n=28		
Extension Visits in days per Year (*x*)	Maize Yield in 90kg bags per year (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Mean Maize Production per acre in 90kg bags (y/a)
79	72	5688	6241	5184	2	36.0
75	47	3525	5625	2209	1.5	31.3
75	76	5700	5625	5776	2.5	30.4
65	41	2665	4225	1681	2	20.5
59	108	6372	3481	11664	4.5	24.0
47	39	1833	2209	1521	2	19.5
47	77	3619	2209	5929	4.5	17.1
37	65	2405	1369	4225	5.5	11.8
33	24	792	1089	576	3.5	6.9
27	30	810	729	900	2.5	12.0
25	21	525	625	441	5	4.2
25	23	575	625	529	2	11.5
24	21	504	576	441	3.5	6.0
22	19	418	484	361	2.5	7.6
22	23	506	484	529	3	7.7
21	28	588	441	784	4	7.0
21	15	315	441	225	2	7.5
21	16	336	441	256	3	5.3
19	19	361	361	361	2.5	7.6
19	15	285	361	225	2.5	6.0
17	13	221	289	169	2.5	5.2
17	41	697	289	1681	5	8.2
16	55	880	256	3025	5	11.0
13	17	221	169	289	4.5	3.8
13	41	533	169	1681	5	8.2
11	13	143	121	169	3	4.3
11	13	143	121	169	4.5	2.9
10	15	150	100	225	2.5	6.0
$\Sigma x=871$	$\Sigma y=987$	$\Sigma xy=40810$	$\Sigma x^2=39155$	$\Sigma y^2=51225$	$\bar{x}=3.3$	$\bar{x}=11.8$

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables; use of extension information (x) and maize productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.4 above in order

to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 28(40810) - (871 \times 987) / [\surd \{[28(39155) - (871^2)] \times [28(51225) - 987^2]\}$$

$$r = 1{,}142{,}680 - 859{,}677 / \surd \{[1{,}096{,}340 - 758{,}641] \times [1{,}434{,}300 - 974{,}169]\}$$

$$r = 283{,}003 / \surd (337{,}699 \times 460{,}131)$$

$$r = 283{,}003 / \surd 155{,}385{,}778{,}569$$

$$r = 283{,}003 / 394{,}190.03$$

$$r = 0.71794$$

$$r = 0.718$$

From the calculation, the numerical value of the correlation coefficient was 0.718 and on a scale of −1 to +1 this figure was closer to 1.0, therefore suggesting the presence of a strong positive relationship between the use of extension information services and maize productivity. The sign of the correlation coefficient being positive also suggested that increased use of agricultural information strongly increased maize production and vice versa.

The effect of the size of the correlation called the coefficient of determination defined as r^2 showed that the percentage maize production could be predicted from the relationship between the two variables. For $r = 0.718$ the r^2 is 0.516, which predestined that 51.6% of the variation in maize productivity could be credited to the utilization of extension information services. Conversely, 48.4% of the variation in maize production could not be explained as resulting from utilization of extension services.

ii) Relationship Between Use Of Extension Information Services And Green Grams Productivity

In analyzing the relationship between green Grams productivity and the utilization of extension information services. A total of 28 farmers with an average 2.5 acres were sampled for the research and with the support from trained research assistants, requested to fill questionnaires, the unit of the study being household heads. This was to minimize extreme cases and to ensure that the chosen farmers were smallholders and therefore land size was a prominent factor in the selection.

The sampled farmers were requested to provide the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018. The extension information was measured in terms extension training and visits made to farming households as the visits were considered as information dissemination sessions.

To ensure that the extension visits were equated to the use of information disseminated, farmers were requested to only provide the number of times when they received and applied the useful information on green grams production, the number of visits where information not relevant to the green grams farming was disseminated were disregarded.

To ensure that the extension visits were equated to the use of information disseminated, farmers were requested to only provide the number of times when they received and applied the useful information on Green Grams production, the number of visits where information not relevant to maize farming was disseminated were disregarded.

Out of the 28 Green Grams farming households sampled, extension information visits per household ranged between 2 and 23 times per production season with a corresponding mean green grams yield of 2.7 bags per acre. However a majority of farmers who received more than 15 extension information dissemination visits during the year produced over 3 bags per acre signifying that use of extension information correlated with increased green grams productivity.

This information was corroborated by figures sourced from KALRO (2018), by the Kenya climate smart agriculture project (KCSAP) report which informed that green grams average yields in Kenya range from 1 to 2 bags (90 -180 kg) per acre but could yield up to up to 4 bags (360 kg) per acre, if farmers practiced good crop husbandry, used the right inputs and had access to relevant agricultural information.

From the data collected the value of extension visits was the independent variable denoted as $\boldsymbol{x}$ while the yield or production was the dependent variable denoted as $\boldsymbol{y}$.

To lay the basis for calculating the correlation between the two variables; use of extension information and green grams production, the sum of the scores of ***x*** (extension visits) and ***y*** (green grams yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average green grams production per acres was then calculated as shown in table 4.5 below;

Table 4.5: Relationship between use of Extension Information Services and Green Grams Productivity

Green Grams Enterprise				n=28		
No of Extension Visits per farmer (x)	Green Grams yield in 90kg bags (y)	(xy)	(x^2)	(y^2)	Acreage (a)	Mean Green Grams Production in 90kg Bags per Acre (y/a)
23	15	345	529	225	4.0	3.8
21	8	168	441	64	2.0	4.0
19	5	95	361	25	1.5	3.3
19	7	133	361	49	2.0	3.5
19	13	247	361	169	3.5	3.7
18	6	108	324	36	1.5	4.0
17	3	51	289	9	1.0	3.0
17	5	85	289	25	1.5	3.3
17	9	153	289	81	2.5	3.6
17	9	153	289	81	2.5	3.6
17	13	221	289	169	3.5	3.7
16	7	112	256	49	2.0	3.5
15	6	90	225	36	2.0	3.0
15	9	135	225	81	2.5	3.6
14	11	154	196	121	4.0	2.8
13	5	65	169	25	3.0	1.7
13	4	52	169	16	1.5	2.7
13	5	65	169	25	2.5	2.0
13	6	78	169	36	3.5	1.7
13	4	52	169	16	1.5	2.7
13	6	78	169	36	2.5	2.4
12	4	48	144	16	2.0	2.0
12	17	204	144	289	6.0	2.8
11	2	22	121	4	1.5	1.3
11	3	33	121	9	2.0	1.5
11	5	55	121	25	3.0	1.7
9	4	36	81	16	3.0	1.3
2	1	2	4	1	1.5	0.7
$\Sigma x=410$	$\Sigma y=192$	$\Sigma xy=3040$	$\Sigma x^2=6474$	$\Sigma y^2=1734$	$\bar{x}=2.5$	$\bar{x}=2.7$

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (***x***) and green grams productivity (***y***), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.5 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =28(3040) – (410 × 192) / [√ {[28(6474) – (410^2)] × [28(1734) – 192^2]}

r = 85,120 – 78,720/√ {[181,272 – 168,100] × [48,552– 36,864]}

r = 6,400/√ (13,172× 11,688)

r = 6,400 /√153,954,336

r = 6,400/12407.83365459096

r = 0.5158031611319107

r = 0.516

From the calculation, the numerical value of the correlation coefficient was 0.516 this figure being positive and closer to 1.0, signified the presence of a moderately stronger linear relationship between use of extension information services and green grams productivity. This also suggested that increased use of agricultural extension information moderately increased green grams production in Tana River County.

The effect size of the correlation called the coefficient of determination defined as r^2 indicated that Green Grams production could be projected from the calculated relationship between the two variables. For r = 0.516, r^2 is 0.27, this inferred that

27% of the green grams productivity could be credited to the use of extension information, services. Conversely, 73% of the variation in green grams production could not be explained as resulting from access to and utilization of agricultural extension information services.

iii) Relationship between use of Extension Information Services and Cashewnuts Productivity

In analyzing the relationship between Cashewnuts productivity and the utilization of extension services information a sample of 18 smallholder farmers with either an average of 15 mature trees or half an acres of land under a mature crop were chosen and requested to fill questionnaires. This was to ensure the sampled farmers were smallholder farmers and owned trees that were at prime production.

The sampled farmers were then asked to provide data on the number of extension training and visits made to their farms by extension service providers and the corresponding yield during the year 2018. The extension information was measured in terms extension training and visits made to farming households as the visits were considered as information dissemination sessions.

To ensure that the extension visits were equated to the use of information disseminated, farmers were requested to only provide the number of times when they received and applied the useful information on Cashewnuts production, the number of visits where information not relevant to the Cashewnuts farming was disseminated were disregarded.

Out of the 18 Cashewnuts farming households sampled, extension information visits per household ranged between 2 and 18 times per year with a corresponding mean Cashewnuts yield of 8kgs per tree. However farmers who received more than 10 extension information dissemination visits during the year averaged 10 bags per tree signifying that use of extension information correlated with increased Cashewnuts productivity.

This information was corroborated by figures sourced from a report on Cashewnuts production, FAO (2004), which reported that with the use of elite planting material coupled with a package of improved agronomic practices, a yield of 8-10 kg per tree could be achieved.

From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield or production was the dependent variable denoted as ***y***. To lay the basis for calculating the correlation between the two variables; use of extension information and Cashewnuts production, the sum of the scores of ***x*** (extension visits) and ***y*** (Cashewnuts yield) was calculated and the sum of their products and squares calculated. More details on the relationship between the use of extension information services and Cashewnuts productivity are shown in table 4.6 below;

Table 4.6: Relationship between use of Extension Information Services and Cashewnuts Productivity

Cashew nuts Enterprise				n=18		
Extension Visits (*x*)	Cashew nuts Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	No of trees (t)	Mean Cashew nuts Production per tree in Kgs (y/t)
18	110	1980	324	12100	11	10.0
15	71	1065	225	5041	7	10.1
13	107	1391	169	11449	10	10.7
13	30	390	169	900	3	10.0
12	112	1344	144	12544	11	10.2
11	125	1375	121	15625	13	9.6
10	98	980	100	9604	11	8.9
9	195	1755	81	38025	23	8.5
9	52	468	81	2704	6	8.7
7	123	861	49	15129	15	8.2
7	217	1519	49	47089	27	8.0
7	221	1547	49	48841	27	8.2
5	162	810	25	26244	23	7.0
4	52	208	16	2704	7	7.4
3	212	636	9	44944	27	7.9
3	112	336	9	12544	17	6.6
2	93	186	4	8649	17	5.5
2	39	78	4	1521	7	5.6
$\Sigma x=150$	$\Sigma y=2131$	$\Sigma xy=16929$	$\Sigma x^2=1628$	$\Sigma y^2=315657$	$\bar{x}=15$	$\bar{x}=8.4$

Source: Research Data, 2019

In order to measure how strong or weak a relationship is between the two variables; use of extension information (x) and Cashewnuts productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.6 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =18(16929) – (150 × 2131) / [√ {[18(1628) – (1502)] × [18(315657) – 21312]}

r =304722 – 319650/ √ [(29,304 – 22500) × (5,681,826– 4,541,161)]

r = -14,928 / √ (6804×1,140,665)

r = -14928 / √7,761,084,660

r = -14,928/ 88,097.01845125066

r = -0.1694495484913644

r = -0.169

From the calculation, the numerical value of the correlation coefficient was -0.169, this figure being negative and not closer to -1.0, signified the presence of a very weak negative relationship between use of extension information services and Cashew Nuts productivity. The negative sign of the correlation coefficient meant that as use of extension information services increased agricultural productivity decreased and vice versa.

The effect size of the correlation called the coefficient of determination defined as r2 indicated that Cashew Nuts productivity could be predicted from the relationship between the two variables. For r = -0.169, r^2 is 0.03, which explained that only 3% of the variation in mean Cashew nuts productivity could be attributed to the utilization of extension information services. Conversely, 97% of the variation in cashew nuts production could not be explained as resulting from access to and utilization of extension services.

iv) Relationship between use of Extension Information Services and Coconuts Productivity

In analyzing the relationship between use of extension information services and coconut productivity among smallholder farmers in Tana River County, Kenya, 19 farmers with an average of 25 mature coconut palm tree were chosen. This was to minimize extreme cases and to ensure that the chosen farmers were smallholders and therefore number of trees was a prominent factor in the selection.

The sampled farming households were asked to provide the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018. The extension service information was measured in terms extension training and visits made to farming households as the visits were considered as information dissemination sessions.

To ensure that the extension visits were equated to the use of information disseminated, farmers were requested to only provide the number of times when they received and applied the useful information on coconut production. The number of visits where information not relevant to the coconut farming was disseminated were disregarded.

Out of the 19 coconut farming households sampled, extension information visits per household ranged between 2 and 19 times per year with a corresponding mean coconut yield of 18 nuts per tree per year. However farmers who received more than 10 extension information dissemination visits during the year were able to produce more than 20 nuts per tree per year, signifying that use of extension information correlated with increased Coconut productivity.

This information was corroborated by figures sourced from a national Coconut survey, report by the Kenya Coconut Development Authority (2013)., which reported that 150 nuts per tree per year was the estimated optimal productivity but this seemed idealistic compared to the current productivity of 27 nuts per tree per year in Kenya, however a productivity of 70 nuts per tree per year was achievable with proper production practices. The current productivity was therefore far below potential, and less than half of what would be achieved under average circumstances.

From the data collected the values of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (Coconut yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average Coconut production per tree was then calculated. More details on the relationship between the use of extension information services and coconut productivity are shown in table 4.7 below;-

Table 4.7: Relationship between use of Extension Information Services and Coconut Productivity

Coconut Enterprise				n=19		
Extension Visits (*x*)	Coconut Copra Yield in pcs (*y*)	(*xy*)	(x^2)	(y^2)	No. of Trees (t)	Mean Coconuts Copra Production per tree in Pcs (y/t)
19	589	11191	361	346921	18	33
18	210	3780	324	44100	8	26
15	110	1650	225	12100	5	22
13	607	7891	169	368449	30	20
13	430	5590	169	184900	20	22
12	190	2280	144	36100	9	21
11	325	3575	121	105625	16	20
10	666	6660	100	443556	33	20
9	298	2682	81	88804	18	17
9	252	2268	81	63504	16	16
7	564	3948	49	318096	38	15
7	284	1988	49	80656	20	14
7	211	1477	49	44521	15	14
5	568	2840	25	322624	41	14
4	552	2208	16	304704	40	14
3	232	696	9	53824	17	14
3	512	1536	9	262144	40	13
2	773	1546	4	597529	60	13
2	338	676	4	114244	29	12
$\Sigma y=169$	$\Sigma y=7711$	$\Sigma xy=64482$	$\Sigma x^2=1989$	$\Sigma y^2 = 3,792,401$	$\bar{x}=25$	$\bar{x}=18$

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and Coconut productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.7 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 19(64482) - (169 \times 7711) / [\sqrt{\{[19(1989) - (169^2)] \times [19(3792401) - 7711^2]\}}$$

$$r = 1225158 - 1303159 / \sqrt{[(37791 - 28561) \times (72055619 - 59459521)]}$$

$$r = -78001 / \sqrt{(9230 \times 12{,}596{,}098)}$$

$$r = -78001 / \sqrt{116{,}261{,}984{,}540}$$

$$r = -78001 / 340{,}972.1169538647$$

$$r = -0.2287606408900407$$

$$r = -0.229$$

From the calculation, the numerical value of the correlation coefficient was -0.229, this figure being negative and not closer to -1.0, signified the presence of a weak negative relationship between extension information services and coconut productivity. This negative sign of the correlation coefficient also suggested that as the use of extension information services increased, coconut productivity decreased and vice versa.

The effect size of the correlation called the coefficient of determination defined as r^2 indicated that Coconut productivity could be predicted from the relationship between the two variables. For $r = -0.229$, r^2 is 0.052, which implied that only 5.24% of mean Coconuts productivity could be credited to the utilization of extension information services. Conversely, 94.76% of the variation in coconuts production could not be explained as resulting from use of extension information services.

v) Relationship between use of Extension Information Services and Watermelon Productivity

The study also evaluated the relationship between use of extension information services and water melon productivity. For proper analysis, 20 water melon farmers who had an average of 0.2 acres of Watermelon crop during the year 2018 were selected and through questionnaires requested to provide data on the number of extension information dissemination Visits and the corresponding yields.

To ensure that the extension visits were equated to the use of information disseminated, farmers were requested to only provide the number of times when they received and applied the useful information on Watermelon production, the number of visits where information not relevant to the Watermelon farming was disseminated were disregarded.

Out of the 20 Watermelon farming households sampled, extension information visits per household ranged between 11 and 43 times per season with a corresponding mean coconut yield of 12,690 kgs per acre per season. However farmers who received more than 40 extension information dissemination visits during the season were able to produce more than 20,000kgs per acre per season, signifying that use of extension information correlated with increased Watermelon productivity.

This information was corroborated by figures sourced from a Watermelon production report by SHEP PLUS, (2017) which informed that the estimated optimal productivity per acre ranged between 25,000 – 50,000kgs per acre.

Further quantitative as evaluated in table 4.8 also disclosed that on average, an extension service providers only made 28 information dissemination visits to Water melon farms in a year which was considered too low bearing in mind that the average lifecycle of Watermelon transcended to over 60 days. This implied that pertinent agricultural information was missed as a result of the infrequent visit but the extension service providers attested to tight farm visit schedules owing to the reduced number of crop extension officers in the county.

From the data collected the value of extension visits was the independent variable denoted as x while the yield was the dependent variable denoted as y. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (Watermelon yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average Watermelon production per acres was then calculated. More details on the relationship between the use of extension information services and Watermelon productivity are shown in table 4.8 below.

Table 4.8: Relationship between use of Extension Information Services and Watermelon Productivity.

Water Melon Enterprise				n=20		
Extension Visits (*x*)	Water Melon Yield in kgs (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Water Melon Production in Kgs per acre (y/a)
43	2500	107500	1849	6250000	0.1	25,000
43	2100	90300	1849	4410000	0.1	21,000
43	2700	116100	1849	7290000	0.13	20,769
39	2300	89700	1521	5290000	0.15	15,333
38	2200	83600	1444	4840000	0.15	14,667
37	2800	103600	1369	7840000	0.2	14,000
35	2400	84000	1225	5760000	0.2	12,000
33	2500	82500	1089	6250000	0.2	12,500
29	1900	55100	841	3610000	0.16	11,875
27	2300	62100	729	5290000	0.2	11,500
25	1400	35000	625	1960000	0.12	11,667
24	2330	55920	576	5428900	0.2	11,650
23	2522	58006	529	6360484	0.25	10,088
22	2700	59400	484	7290000	0.25	10,800
22	2600	57200	484	6760000	0.25	10,400
21	2100	44100	441	4410000	0.2	10,500
19	2800	53200	361	7840000	0.3	9,333
17	1200	20400	289	1440000	0.16	7,500
13	1300	16900	169	1690000	0.18	7,222
11	1800	19800	121	3240000	0.3	6,000
Σx=564	Σy=44,452	Σxy=1,294,426	Σx^2=17,844	Σy^2=103,249,384	$\bar{x}$=0.2	$\bar{x}$=12,690

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and Watermelon productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.8 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 20(1,294,426) - (564 \times 44,452) / [\sqrt{ \{[20(17,844) - (564^2)] \times [20(103,249,384) - 44,452^2] \}}$$

$$r = 25,888,520 - 25,070,928 / \sqrt{ \{[356,880 - 318,096] \times [2,064,987,680 - 1,975,980,304]\} }$$

$$r = 817,592 / \sqrt{(38,784 \times 89,007,376)}$$

$$r = 817,592 / \sqrt{3,452,062,070,784}$$

$$r = 817,592 / 1,857,972.569976209$$

$$r = 0.440045247821107$$

$$r = 0.440$$

From the calculation, the numerical value of the correlation coefficient was 0.440. This figure being positive but not closer to 1.0 suggested that increased access and utilization of extension information moderately increased Watermelon production in Tana River County.

The effect of size of the correlation called the coefficient of determination defined as r^2 also indicated that Watermelon productivity could be predicted from the relationship between the two variables. For r =0.440, r^2 is 0.194, which explained that only 19.36% of water melon productivity could be could be credited to the utilization of extension information services. Conversely, 80.64% of the variation in Watermelon production could not be explained as resulting from use of extension services.

vi) Relationship between use of Extension Information Services and Mango Productivity

The study also evaluated the relationship between use of extension information services and Mango Productivity in Tana River County. Twenty nine farming households, each with an average of twenty mature trees or with a minimum half acre of mature mango orchard were selected for the study. This was to ensure only small holder farmers with commercial mango farming potential were selected and through questionnaires data on extension visits

The sampled farmers were asked to provide data on the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018. The extension service information was measured in terms extension training and visits made to farming households as the visits were considered as information dissemination sessions.

To ensure that the extension visits were equated to the use of information disseminated, farmers were requested to only provide the number of times when they received and applied the useful information on Mango production, the number of visits where information not relevant to the mango farming was disseminated were disregarded.

Out of the 29 mango farming households sampled, extension information visits per household ranged between 11 and 77 times per season with a corresponding mean mango yield of 146kgs per tree per season. However farmers who received more than 70 extension information dissemination visits during the season were able to produce more than 200kgs per tree per season, signifying that use of extension information correlated with increased mango productivity.

This information was corroborated by figures sourced from a mango production report by SHEP PLUS, (2017) which informed that the estimated optimal productivity per acre ranged between 10,000 – 15,000kgs acre. Considering that at a spacing of 12m by 12m an acre would have 40 trees, this translates to 250 – 375kgs per tree per season.

From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating the correlation between the variables, the sum of the scores of ***x*** (extension visits) and ***y*** (mango yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average mango production per tree was then calculated. More details on the relationship between the use of extension information services and mango productivity are shown in table 4.9 below;-

Table 4.9: Relationship between use of Extension Information Services and Mango Productivity

Mango Enterprise				n=29		
Extension Visits (*x*)	Mango Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	No. of trees (t)	Average Mango Production in Kgs per tree (y/t)
77	1467	112959	5929	2152089	5	293
75	1465	109875	5625	2146225	7	209
52	5111	265772	2704	26122321	27	189
43	2282	98126	1849	5207524	13	176
43	4126	177418	1849	17023876	25	165
43	6252	268836	1849	39087504	35	179
39	3317	129363	1521	11002489	20	166
38	3131	118978	1444	9803161	20	157
37	5128	189736	1369	26296384	35	147
37	1144	42328	1369	1308736	8	143
35	2156	75460	1225	4648336	15	144
33	4130	136290	1089	17056900	30	138
33	6230	205590	1089	38812900	40	156
29	2132	61828	841	4545424	15	142
29	5126	148654	841	26275876	40	128
27	3105	83835	729	9641025	20	155
27	7110	191970	729	50552100	40	178
25	2107	52675	625	4439449	17	124
24	2011	48264	576	4044121	12	168
23	2166	49818	529	4691556	13	167
22	1221	26862	484	1490841	7	174
22	1720	37840	484	2958400	15	115
21	1456	30576	441	2119936	14	104
19	1323	25137	361	1750329	13	102
17	2120	36040	289	4494400	20	106
16	1173	18768	256	1375929	13	90
13	1195	15535	169	1428025	15	80
13	1197	15561	169	1432809	17	70
11	1191	13101	121	1418481	17	70
Σx=923	Σy=82,292	Σxy=2,787,195	Σx^2=36,555	Σy^2=323,327,146	x̄=20	x̄=146

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and mango productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.9 above in order

to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2 * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}}$$

$$r = 29(2{,}787{,}195) - (923 \times 82{,}292) / [\sqrt{\{[29(36{,}555) - (923^2)] \times [29(323{,}327{,}146) - 82{,}292^2]\}}$$

$$r = 80{,}828{,}655 - 75{,}955{,}516 / \sqrt{\{[1{,}060{,}095 - 851{,}929] \times [9{,}376{,}487{,}234 - 6{,}771{,}973{,}264]\}}$$

$$r = 4{,}873{,}139 / \sqrt{(208{,}166 \times 2{,}604{,}513{,}970)}$$

$$r = 4{,}873{,}139 / \sqrt{542{,}171{,}255{,}079{,}020}$$

$$r = 4{,}873{,}139 / 23{,}284{,}571.18091334$$

$$r = 0.2092861817442444$$

$$r = 0.209$$

From the calculation, the value of the correlation coefficient was 0.209. According to the correlation scale this value was considered weak, therefore signifying the presence of a weak positive relationship between extension information services and mango productivity.

The effect size of the correlation called the coefficient of determination defined as r^2 also indicated that mango productivity could be predicted from the relationship between the two variables. For $r=0.209$, r^2 is 0.044, which implied that only 4.4% of the variation in mean mango productivity scores could be credited as resulting from the utilization of extension information services. Conversely, 95.6% of the variation in mango production could not be explained as resulting from utilization of extension services.

vii) Relationship between use of Extension Information Services and Bananas Productivity

The study also analyzing the banana value chain where nine smallholder farmers with an average of 10 banana plantain stools or an eighth of an acre of land under bananas were engaged through questionnaires. This was to minimize extreme cases and to ensure that the chosen farmers were smallholders and therefore the number of banana was a prominent factor in the selection.

The chosen farmers were requested to fill questionnaires distributed by a team of trained research assistants who guided illiterate farmers, the unit of study being household head. Respondents were asked to provide the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018. The extension service information was measured in terms extension training and visits made to farming households as the visits were considered as information dissemination sessions.

To ensure that the extension visits were equated to the use of information disseminated, farmers were requested to only provide the number of times when they received and applied the useful information on Banana production, the number of visits where information not relevant to the Banana farming was disseminated were disregarded.

Out of the nine banana farming households sampled, extension information visits per household ranged between 8 and 42 times per season with a corresponding mean banana yield of 2,400kgs per acre per year. However farmers who received more than 30 extension information dissemination visits during the season were able to produce more than 4000kgs per acre per year signifying that, use of extension information correlated with banana productivity. This quantity was however still low in comparison to figures sourced from a banana production report by SHEP PLUS, (2017) which informed that the estimated average yield of bananas in Kenya was 6000kgs/acre.

To lay the basis for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (banana yield) was calculated and the sum of their products and squares calculated. Based on the number of banana plantain stools captured per household the average banana production per stool was then calculated as shown in table 4.10 below.

Table 4.10: Relationship between use of Extension Information Services and Banana Productivity

Banana Value Chain				n=9		
Extension Visits (*x*)	Banana yield in kgs(*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Average Banana Production per acre in Kgs (y/a)
42	424	17808	1764	179776	0.1	4240.0
37	401	14837	1369	160801	0.1	4010.0
30	430	12900	900	184900	0.125	3440.0
29	221	6409	841	48841	0.1	2210.0
23	101	2323	529	10201	0.1	1010.0
21	325	6825	441	105625	0.125	2600.0
15	353	5295	225	124609	0.175	2017.1
11	232	2552	121	53824	0.125	1856.0
8	104	832	64	10816	0.175	594.3
Σx=216	Σy=2591	Σxy=69781	Σx^2=6254	Σy^2=879393	$\bar{x}$=0.125	$\bar{x}$=2441.9

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and banana productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.10 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 9(69{,}781) - (216 \times 2{,}591) / [\sqrt{}\ \{[9(6{,}254) - (216^2)] \times [9(879{,}393) - 2591^2]\}$$
$$r = 628{,}029 - 559{,}656/\sqrt{}\ \{[56{,}286 - 46{,}656] \times [7{,}914{,}537 - 6{,}713{,}281]\}$$
$$r = 68{,}373/\sqrt{}\ (9630 \times 1{,}201{,}256)$$
$$r = 68{,}373/\sqrt{11{,}568{,}095{,}280}$$
$$r = 68{,}373/107555.0802147439$$
$$r = 0.636$$

From the calculation, the correlation coefficient was 0.636, This figure according to the correlation scale, signified the presence of a strong positive relationship between use of extension information services and Banana productivity in Tana River County.

The effect of size of the correlation called the coefficient of determination defined as r^2 indicated that banana productivity could be projected from the relationship between the two variables. For r =0.636, r^2 is 0.4045, which indicated that 40.45% mean banana productivity could be attributed to the utilization of extension information services. Conversely, 59.55% of the variation in bananas production could not be explained as resulting from use of agricultural extension information services.

viii) Relationship between use of Extension Information Services and Citrus Fruits Productivity

An analysis of the relationship between use of extension information services and citrus fruits productivity was carried out by considering 18 smallholder farmers with an average of 0.2 acres of mature citrus trees. The farming households were carefully chosen to ensure they had been in production during the year 2018 and through use of questionnaires, they were requested to provide data on the number of extension visits and the corresponding the yields over the same year.

Out of the 18 citrus fruits farming households sampled, extension information visits per household ranged between 11 and 37 times per year with a corresponding mean citrus fruits yield of 8,300kgs per acre per year. However farmers who received more than 30 extension information dissemination visits during the season were able to produce more than 10,000kgs per acre per year signifying that, use of extension information correlated with citrus fruits productivity. This quantity was however still low in comparison to figures sourced from Oxfam, (2018), that stated that the Maximum production 15000kgs per acre per year

From the data collected the value of extension visits was the independent variable denoted as x while the yield was the dependent variable denoted as y. To lay the basis for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (citrus yield) was calculated and the sum of their products and squares calculated. The result are shown in Table 4.11 below.

Table 4.11: Relationship between use of Extension Information Services and Citrus Productivity

Citrus Fruits Enterprise				n=18		
Extension Visits (x)	Citrus Yield in Kgs (y)	(xy)	(x^2)	(y^2)	Acreage (a)	Production in kgs per acre (y/a)
37	1243	45991	1369	1545049	0.10	12,430.00
33	2232	73656	1089	4981824	0.20	11,160.00
33	1379	45507	1089	1901641	0.13	11,032.00
32	2112	67584	1024	4460544	0.20	10,560.00
31	1327	41137	961	1760929	0.13	10,616.00
31	1429	44299	961	2042041	0.13	11,432.00
29	1231	35699	841	1515361	0.13	9,848.00
29	992	28768	841	984064	0.10	9,920.00
23	1111	25553	529	1234321	0.12	9,258.33
23	2228	51244	529	4963984	0.30	7,426.67
23	1452	33396	529	2108304	0.20	7,260.00
22	2344	51568	484	5494336	0.30	7,813.33
21	1432	30072	441	2050624	0.20	7,160.00
19	2543	48317	361	6466849	0.40	6,357.50
17	957	16269	289	915849	0.20	4,785.00
17	2654	45118	289	7043716	0.50	5,308.00
13	1942	25246	169	3771364	0.40	4,855.00
11	1864	20504	121	3474496	0.50	3,728.00
$\Sigma x=444$	$\Sigma y=30472$	$\Sigma xy=729{,}928$	$\Sigma x^2=11{,}916$	$\Sigma y^2=56{,}715{,}296$	$\bar{x}=0.23$	$\bar{x}=8{,}386.10$

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and citrus productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.13 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2)-(\Sigma x)^2} * \sqrt{n(\Sigma y^2)-(\Sigma y)^2}}$$

$$r = 18(729{,}928) – (444 \times 30{,}472) / [\sqrt{} \{[18(11{,}916) – (444^2)] \times [18(56{,}715{,}296) – 30{,}472^2]\}$$

$$r = 13{,}138{,}704 – 13{,}529{,}568 / \sqrt{} \{[214{,}488 – 197{,}136] \times [1{,}020{,}875{,}328 – 927{,}933{,}444]\}$$

$$r = -390{,}864 / \sqrt{} (17352 \times 92{,}941{,}884)$$

$$r = -390{,}864 / \sqrt{1{,}612{,}727{,}571{,}168}$$

$$r = -390864 / 1{,}269{,}932.112818634$$

$$r = -0.307783381488519$$

$$r = -0.308$$

From the calculation, the correlation coefficient value was -0.308, this figure being negative and not closer to -1.0, on the correlation scale signified the presence of a weak negative relationship between use of extension information services citrus fruits productivity. This also suggested that as the use of extension information services increased, Citrus fruits productivity decreased and vice versa.

The effect size of the correlation called the coefficient of determination defined as r^2 indicated that citrus fruits productivity could be predicted from the relationship between the two variables. For r =-0.308 r^2 is 0.0949, which indicated that only 9.49% of the variation in mean citrus fruits productivity could be credited to the utilization of extension information services. Conversely, 90.51% of the variation in citrus fruits production could not be explained as resulting from utilization of extension services.

ix) Relationship between use of Extension Information Services and Kales Productivity

In analyzing the relationship between use of Extension Information Services and Kales Productivity 19 smallholder commercial farmers with an average 0.3 acres of Kales crops were selected for the study. The sampled farmers were asked to provide data on the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018.

Out of the 19 kales farming households sampled, extension information visits per household ranged between 11 and 31 times per season with a corresponding mean kales yield of 8,200kgs per acre per year. However farmers who received more than 20 extension information dissemination visits during the season were able to produce more than 10,000kgs per acre per season signifying that, use of extension information correlated with kales productivity. This quantity was however still low in comparison to figures sourced from a kales production report by SHEP PLUS, (2017) which informed that the estimated maximum average yield of kales in Kenya was 15,000kg per acre.

From the data collected the values of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (Kales yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average Kales production per acres was then calculated. The results are shown in Table 4.12 below;

Table 4.12: Relationship between use of Extension Information Services and Kales Productivity

Kales Enterprise				n=19		
Extension Visits (*x*)	Kales Yield in kgs (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Kales Production in Kgs per acre (y/a)
31	2400	74400	961	5760000	0.2	12000
31	2100	65100	961	4410000	0.2	10500
29	2300	66700	841	5290000	0.2	11500
29	1400	40600	841	1960000	0.125	11200
29	2800	81200	841	7840000	0.25	11200
28	2600	72800	784	6760000	0.25	10400
23	2500	57500	529	6250000	0.25	10000
21	2330	48930	441	5428900	0.2	11650
19	1900	36100	361	3610000	0.2	9500
19	2300	43700	361	5290000	0.25	9200
19	2800	53200	361	7840000	0.3	9333
17	2100	35700	289	4410000	0.25	8400
15	1200	18000	225	1440000	0.2	6000
13	2522	32786	169	6360484	0.5	5044
13	2200	28600	169	4840000	0.5	4400
13	2500	32500	169	6250000	0.5	5000
13	1800	23400	169	3240000	0.5	3600
12	2700	32400	144	7290000	0.5	5400
11	1300	14300	121	1690000	0.5	2600
$\Sigma x=385$	$\Sigma y=41,752$	$\Sigma xy=857,916$	$\Sigma x^2=8,737$	$\Sigma y^2=95,959,384$	$\bar{x}=0.3$	$\bar{x}=8259.3$

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information and kales productivity, a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.12 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 19(857{,}916) - (385 \times 41{,}752) / [\sqrt{\{[19(8{,}737) - (385^2)] \times [19(95{,}959{,}384) - 41{,}752^2]\}}$$

$$r = 16{,}300{,}404 - 16{,}074{,}520 / \sqrt{\{[166{,}003 - 148{,}225] \times [1{,}823{,}228{,}296 - 1{,}743{,}229{,}504]\}}$$

$$r = 225{,}884 / \sqrt{(17{,}778 \times 79{,}998{,}792)}$$

$$r = 225{,}884 / \sqrt{1{,}422{,}218{,}524{,}176}$$

$$r = 225{,}884 / 1{,}192{,}568.037545867$$

$$r = 0.18940977383867814$$

$$r = 0.189$$

From the calculation, the numerical value of the correlation coefficient was 0.189. This value according the correlation scale, signified the presence of a very weak positive relationship between utilization of extension information and kales productivity.

The effect size of the correlation called the coefficient of determination defined as r^2 also indicated that kales productivity could be predicted from the relationship between the two variables. For $r = 0.189$, r^2 is 0.0357, which indicated that only 3.57% of kales productivity could be attributed to the utilization of extension information services. Conversely, 96.43% of the variation in kales production could not be explained as resulting from utilization of extension services.

x) Relationship between use of Extension Information Services and Tomato Productivity

To appreciate the relationship between use of extension information services and tomato productivity , 19 smallholder farming households with who had an average 0.2 acres of tomato crop during the year 2018 were sampled .

The sampled farmers were asked to provide the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018. The extension service information was measured in terms extension training and visits made to farming households as the visits were considered as information dissemination sessions.

Out of the 19 tomato farming households sampled, extension information visits per household ranged between 9 and 76 times per season with a corresponding mean kales yield of 8,100kgs per acre per year. However farmers who received more than 40 extension information dissemination visits during the season were able to produce more than 10,000kgs per acre per season signifying that, use of extension information correlated with tomato productivity. This quantity corroborated with figures sourced from a tomatoes production report by SHEP PLUS, (2017) which informed that tomato yields vary from 12,000 – 40,000kg per acre depending on the variety and crop husbandry

From the data collected the values of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of ***x*** (extension visits) and ***y*** (tomato yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average tomato production per acres was then calculated. The results are shown in table 4.13 below.

Table 4.13: Relationship between use of Extension Information Services and Tomatoes Productivity

Tomatoes Enterprise			n=19			
Extension Visits (*x*)	Tomatoes Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Average Tomato Production in Kgs Per Acre (y/a)
76	3330	253080	5776	11088900	0.2	16650
76	5673	431148	5776	32182929	0.3	18910
51	2979	151929	2601	8874441	0.2	14895
49	1700	83300	2401	2890000	0.125	13600
41	1510	61910	1681	2280100	0.125	12080
39	982	38298	1521	964324	0.1	9820
33	1522	50226	1089	2316484	0.2	7610
31	783	24273	961	613089	0.1	7830
29	1411	40919	841	1990921	0.2	7055
27	1900	51300	729	3610000	0.25	7600
19	811	15409	361	657721	0.125	6488
17	937	15929	289	877969	0.125	7496
17	1433	24361	289	2053489	0.2	7165
17	753	12801	289	567009	0.125	6024
16	1255	20080	256	1575025	0.25	5020
13	1733	22529	169	3003289	0.5	3466
13	180	2340	169	32400	0.125	1440
11	115	1265	121	13225	0.125	920
9	153	1377	81	23409	0.2	765
Σx=584	Σy=29,160	Σxy=1,302,474	Σx^2=25,400	Σy^2=75,614,724	x̄=0.2	x̄=8149.2

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and tomato productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.13 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below; -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 19(1{,}302{,}474) – (584 \times 29{,}160) / [\surd \{[19(25400) – (584^2)] \times [19(75{,}614{,}724) – 29{,}160^2]\}$$

$$r = 24{,}747{,}006 – 17{,}029{,}440 / \surd \{[482{,}600 – 341{,}056] \times [1{,}436{,}679{,}756 – 850{,}305{,}600]\}$$

$$r = 7{,}717{,}566 / \surd (141{,}544 \times 586{,}374{,}156)$$

$$r = 7{,}717{,}566 / \surd 82{,}997{,}743{,}536{,}864$$

$$r = 7{,}717{,}566 / 9{,}110{,}309.738799444$$

$$r = 0.8471244360805915$$

$$r = 0.847$$

From the calculation, the numerical value of the correlation coefficient was 0.847 this figure according to the correlation scale, signified the presence of a very stronger relationship between utilization of extension information services and tomatoes productivity in Tana River County.

The effect size of the correlation called the coefficient of determination defined as r^2 indicated that tomato production could be predicted from the relationship between the two variables. For r =0.847, r^2 is 0.7174, which indicates that 71.74% of the mean tomato productivity could be credited to the utilization of extension information services. Conversely, 28.26% of the variation in tomato production could not be explained as resulting from access to and utilization of extension services.

xi) Relationship between use of Extension Information Services and Chilies Productivity

An analysis of the relationship between use of extension information services and chilies productivity the study considered 19 sampled farmers with an average of 0.2 acres of chilies crop.

Through the use of questionnaires the selected farmers were requested to provide data on the number of times they had interacted with extension service provide during the year 2018 and their corresponding production for the same year was captured for the computation of a correlation coefficient.

Out of the 19 chilies farming households sampled, extension information visits per household ranged between11 and 49 times per season with a corresponding mean chilies yield of 1,200kgs per acre per year. However farmers who received more than 30 extension information dissemination visits during the season were able to produce more than 1500kgs per acre per year signifying that, use of extension information correlated with chilies productivity. This quantity corroborated with figures sourced from a report on Profitable chili farming in Kenya by SHEP PLUS, (2017) which informed that with good practices, harvests of 1,000 kg to 3,000 kg per acre can be achieved.

From the data collected the values of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (chilies yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average chilies production per acres was then calculated. The results are shown in Table 4.14 below.

Table 4.14: Relationship between use of Extension Information Services and Chilies productivity

Chilies Enterprise				n=19		
Extension Visits (*x*)	ABE Chilies Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Chilies Production in Kgs per Acre (y/a)
49	3800	186200	2401	14440000	1.50	2533.3
41	1330	54530	1681	1768900	0.75	1773.3
39	1300	50700	1521	1690000	0.75	1733.3
39	400	15600	1521	160000	0.25	1600.0
33	1500	49500	1089	2250000	1.00	1500.0
31	1100	34100	961	1210000	0.75	1466.7
29	900	26100	841	810000	0.75	1200.0
28	1600	44800	784	2560000	1.50	1066.7
23	1522	35006	529	2316484	1.25	1217.6
23	1200	27600	529	1440000	1.00	1200.0
23	500	11500	529	250000	0.30	1666.7
22	1800	39600	484	3240000	1.50	1200.0
21	1400	29400	441	1960000	1.25	1120.0
19	1300	24700	361	1690000	2.00	650.0
18	200	3600	324	40000	0.50	400.0
17	1700	28900	289	2890000	3.50	485.7
15	1100	16500	225	1210000	2.50	440.0
13	300	3900	169	90000	0.75	400.0
11	800	8800	121	640000	2.00	400.0
$\Sigma x=494$	$\Sigma y=23,752$	$\Sigma xy = 691,036$	$\Sigma x^2=14800$	$\Sigma y^2=40,655,384$	$\bar{x}=0.3$	$\bar{x}=1160.7$

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and chilies productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.14 above in order

to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 19(691{,}036) - (494 \times 23{,}752) / [\sqrt{\{[19(14{,}800) - (494^2)] \times [19(40{,}655{,}384) - 23752^2]\}}$$

$$r = 13{,}129{,}684 - 11{,}733{,}488 / \sqrt{\{[281{,}200 - 244{,}036] \times [772{,}452{,}295 - 564{,}157{,}504]\}}$$

$$r = 1{,}396{,}196 / \sqrt{(37{,}164 \times 208{,}294{,}791)}$$

$$r = 1{,}396{,}196 / \sqrt{7{,}741{,}067{,}612{,}724}$$

$$r = 1{,}396{,}196 / 2{,}782{,}277.414767262$$

$$r = 0.5018176809363174$$

$$r = 0.502$$

From the calculation, the numerical value of the correlation coefficient was 0.502, this figure being positive and closer to 1.0, signified the presence of a moderately stronger relationship between chilies productivity and access to and utilization of extension services information in Tana River County.

The effect of size of the correlation called the coefficient of determination defined as r^2 indicated chilies productivity could be predicted from the relationship between the two variables. For $r = 0.502$, r^2 is 0.252, which indicates that 25.2% of chilies productivity could be credited to the utilization of extension information services. Conversely, 74.8% of the variation in chilies production could not be explained as resulting from access to and utilization of extension services.

xii) Relationship between use of Extension Information Services and Cabbages Productivity

The evaluation of the Relationship between use of extension information services and cabbages productivity in Tana River county considered 10 sampled farmers with an average of 0.1 acres of land under onion production. Through the use of questionnaires the sampled farmers were requested to provide data on the number of times they were visited be extension service providers and the corresponding yield during the year 2018.

Out of the 10 cabbages farming households sampled, extension information visits per household ranged between 11 and 33 times per season with a corresponding mean cabbage yield of 20,000 heads per acre per season. However farmers who received more than 20 extension information dissemination visits during the season were able to produce up to 25,000 heads of cabbage per acre per season signifying that, use of extension information correlated with cabbage productivity. This quantity corroborated with figures sourced from a Cabbage cultivation manual, KALRO, (2017), which informed that in Kenya, depending on good crop management, the vegetable yields range from 40- 100tons/ha. Considering that a cabbage head averaged 2kg it implies that an acre will produce between 20,000 - 50,000 heads.

From the data collected, the value of extension visits was the independent variable denoted as x while the yield was the dependent variable denoted as y. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (cabbages yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average cabbages production per acres was then calculated. The results are shown in Table 4.15 below.

Table 4.15: Relationship between use of Extension Information Services and Cabbages Productivity

Cabbage Enterprise				n=10		
Extension Visits (*x*)	Cabbages Yield in heads (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Average Production in heads per acre (y/a)
33	2400	79200	1089	5760000	0.10	24000.0
29	2700	78300	841	7290000	0.13	21600.0
29	2450	71050	841	6002500	0.10	24500.0
27	2211	59697	729	4888521	0.10	22110.0
23	2052	47196	529	4210704	0.10	20520.0
19	2600	49400	361	6760000	0.15	17333.3
17	2168	36856	289	4700224	0.13	17344.0
14	2000	28000	196	4000000	0.13	16000.0
13	2300	29900	169	5290000	0.13	18400.0
11	2224	24464	121	4946176	0.15	14826.7
$\Sigma x=215$	$\Sigma y=23{,}105$	$\Sigma xy=504{,}063$	$\Sigma x^2=5{,}165$	$\Sigma y^2=53{,}848{,}125$	$\bar{x}=0.12$	$\bar{x}=19{,}663.4$

Source: Research Data, 2019

In order to measure how strong or weak a relationship is between the two variables, use of extension information (x) and cabbage productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.15 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =10(504,063)–(215×23,105)/ [√ {[10(5,165)–(215^2)] × [10(53,848,125) – $23,105^2$]}

r = 5,040,630 – 4,967,575/√ {[51,650 – 46,225] × [538,481,250 – 533,841,025]}

r = 73,055/√ (5,425 × 4,640,225)

r = 73,055/√25,173,220,625

r = 73,055/158660.7091406061

r = 0.460447960907941

r = 0.460

From the calculation, the numerical value of the correlation coefficient was 0.460, this figure though positive was not closer to 1.0, therefore suggested the presence of a moderate positive relationship between use of extension information services cabbages productivity and access to and utilization of extension services information in Tana River County.

The effect size of the correlation called the coefficient of determination defined as r^2 indicated that cabbage production could be predicted from the relationship between the two variables. For r = 0.460, r^2 is 0.2116, which indicates that 21.16% of cabbage productivity could be credited to the utilization of extension information services. Conversely, 78.84% of the variation in cabbage production could not be explained as resulting from access to and utilization of extension services.

xiii) Relationship between use of Extension Information Services and Onions Productivity

In analyzing the relationship between use of extension information services and bulb onions productivity, eight farmers with an average 0.2 acres of land under production were sampled and through the use of questionnaires requested to provide information on the number of times they interacted with extension service providers and the corresponding onion yield during the year 2018.

Out of the eight bulb onion farming households sampled, extension information visits per household ranged between 14 and 49 times per season with a corresponding mean cabbage yield of 10,800kgs per acre per season. However farmers who received more than 30 extension information dissemination visits during the season were able to produce more than 15,000 kgs of onions per acre per season signifying that, use of extension information correlated with onion productivity. This quantity corroborated with figures sourced from Onion Farming Profit Per Acre report, Oxfam, (2018). Where it was approximated that in Kenya an acre of well managed bulb onion will produce at least between 14000-18000 kilograms of bulb onions per season.

From the data collected the values of extension visits was the independent variable denoted as $\boldsymbol{x}$ while the yield was the dependent variable denoted as $\boldsymbol{y}$. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (onion yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average onion production per acre was then calculated. The results are shown in Table 4.16 below.

Table 4.16: Relationship between use of Extension Information Services and Onion Productivity

Bulb Onion Enterprise				n=8		
Extension Visits (x)	Onion Yield in Kgs (y)	(xy)	(x^2)	(y^2)	Acreage (a)	Onion Production in Kgs per Acre (y/a)
49	1710	83790	2401	2924100	0.100	17100
39	1265	49335	1521	1600225	0.075	16867
33	1824	60192	1089	3326976	0.125	14592
27	1234	33318	729	1522756	0.125	9872
25	1423	35575	625	2024929	0.175	8131
23	1052	24196	529	1106704	0.125	8416
15	1440	21600	225	2073600	0.250	5760
14	1432	20048	196	2050624	0.250	5728
$\Sigma x=225$	$\Sigma y=11,380$	$\Sigma xy=328,054$	$\Sigma x^2=7,315$	$\Sigma y^2=16,629,914$	$\bar{x}=0.2$	$\bar{x}=10,808.3$

Source: Research Data, 2019

Considering the core objective was to measure how strong or weak a relationship is between the two variables; use of extension information (x) and onion productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.16 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 8(328{,}054) – (225 \times 11{,}380) / [\sqrt{} \{[8(7{,}315) – (225^2)] \times \sqrt{} [8(16{,}629{,}914) – 11{,}380^2]\}$$

$$r = 2{,}624{,}432 – 2{,}560{,}500 / \sqrt{} \{[58{,}520 – 50{,}625] \times [133{,}039{,}312 – 129{,}504{,}400]\}$$

$$r = 63{,}932 / \sqrt{} (7895 \times 3{,}534{,}912)$$

$$r = 63{,}932 / \sqrt{27{,}908{,}130{,}240}$$

$$r = 63{,}932 / 167{,}057.2663489978$$

$$r = 0.3826951164544992$$

$$r = 0.383$$

From the calculation, the correlation coefficient value was 0.383 which according to the scale signified the presence of a weak positive relationship between use of extension information services and onions productivity in Tana River County.

The effect size of the correlation called the coefficient of determination defined as r^2 indicated that onion productivity could be projected from the relationship. For $r = 0.383$, r^2 is 0.1467, which indicates that 14.67% of onion productivity could be credited to the utilization of extension information services. Conversely, 85.33% of the variation in onion production could not be explained as resulting from access to and utilization of extension services.

xiv) Relationship between use of Extension Information Services and Butternuts Productivity

An analysis of the Relationship between use of Extension Information Services and Butternuts Productivity was carried out by considering 10 sampled smallholder farmers with an average 0.2 acres of land under production . The sampled farmers were asked to provide data on the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018.

Out of the 10 butternut farming households sampled, extension information visits per household ranged between 1 and 22 times per season with a corresponding mean butternut yield of 1,600kgs per acre per season. However farmers who received more than 10 extension information dissemination visits during the season were able to produce more than 3,000 kgs of butternuts per acre per season signifying that, use of extension information correlated with butternut productivity. This quantity corroborated with figures sourced from Farm Africa (2018). Which reported that on average butternut squash could yield between 5000-6000kgs per acre per season.

From the data collected the values of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of ***x*** (extension visits) and ***y*** (butternuts yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average butternuts production per acres was then calculated. The results are shown in table 4.17 below.

Table 4.17: Relationship between use of Extension Information Services and Butternuts Productivity

Butternut Enterprise				n= 10		
Extension Visits (*x*)	Butternuts Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Butternut Production in Kgs per acre (y/a)
22	121	2662	484	14641	0.025	4840.0
13	89	1157	169	7921	0.025	3560.0
11	221	2431	121	48841	0.075	2946.7
9	97	873	81	9409	0.1	970.0
7	101	707	49	10201	0.125	808.0
6	215	1290	36	46225	0.2	1075.0
3	111	333	9	12321	0.2	555.0
3	152	456	9	23104	0.3	506.7
2	211	422	4	44521	0.5	422.0
1	268	268	1	71824	0.5	536.0
Σx=77	Σy=1,586	Σxy=10,452	Σx2=1,008	Σy2=289,008	x̄=0.2	x̄=1,621.9

Source: Research Data, 2019

Further the study examined how strong a relationship is between the two variables, use of extension information (x) and butternuts productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.17 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =10(10452)–(77×1586)/ [√ {[10(1008)–(77^2)] × √ [10(289,008) – 1586^2]}

r = 104,520 – 122,122/√ {[10,080 – 5929] × [2,890,080 – 2,515,396]}

r = -17,602/√ (4,151 × 374,684)

r = -17,602/√1,555,313,284

r = -17,602/39437.46051519408

r = -0.4463269073026785

r = -0.446

From the calculation, the numerical value of the correlation coefficient was -0.446, this figure being negative and not closer to -1.0, signified the presence of a moderately weak negative relationship between extension information services and butternuts productivity. This also suggested that The negative sign of the correlation coefficient meant that as use of extension services information increased, butternuts productivity decreased and vice versa.

For r = -0.446 the coefficient of determination r^2 is 0.1989, which explains that 19.89% of butternuts productivity could be credited to the utilization of extension information services. Conversely, 80.11% of the variation in butternuts production could not be explained as resulting from access to and utilization of extension services.

xv) Relationship between use of Extension Information Services and Cassava Productivity

An analysis of the Relationship between use of Extension Information Services and Cassava Productivity in Tana River County was carried out by considering nine sampled smallholder farmers who had an average 0.3 acres of cassava crop.

Through the use of questionnaires the sampled farmers were requested to provide information on the number of times they interacted with agricultural extension information service providers and the corresponding Cassava yield during the year 2018.

Out of the nine cassava farming households sampled, extension information visits per household ranged between 3 and 31 times per season with a corresponding mean cassava yield of 1,600kgs per acre per season. However farmers who received more than 10 extension information dissemination visits during the season were able to produce more than 2,000 kgs of cassava per acre per season signifying that, use of extension information correlated with butternut productivity. This quantity was however very low as compared with figures sourced from KALRO, (2008), which informed that Cassava could yield between 4 to 14 tons per acre, though high yielding varieties with a potential of 20 to 28 tons per acre had been developed.

From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (cassava yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average cassava production per acres was then calculated. The results are shown in Table 4.18 below.

Table 4.18: Relationship between use of Extension Information Services and Cassava Productivity

Cassava Enterprise				n=9		
Extension Visits (*x*)	Cassava Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Cassava Production in Kgs per Acre (y/a)
31	104	3224	961	10816	0.05	2080
29	252	7308	841	63504	0.075	3360
22	331	7282	484	109561	0.125	2648
21	137	2877	441	18769	0.05	2740
15	95	1425	225	9025	0.1	950
11	479	5269	121	229441	0.5	958
9	263	2367	81	69169	0.5	526
7	110	770	49	12100	0.5	220
3	574	1722	9	329476	0.5	1148
$\Sigma x=148$	$\Sigma y=2,345$	$\Sigma xy=32,244$	$\Sigma x^2=3,212$	$\Sigma y^2=851,861$	$\bar{x}=0.3$	$\bar{x}=1625.6$

Source: Research Data, 2019

In order to measure how strong or weak a relationship is between the two variables; use of extension information (x) and cassava productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.18 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 9(32{,}422) - (148 \times 2345) / [\sqrt{}\ \{[9(3212) - (148^2)] \times \sqrt{}\ [9(851861) - 2345^2]\}$$

$$r = 291798 - 347060/\sqrt{}\ \{[28{,}908 - 21{,}904] \times [7{,}666{,}749 - 5{,}499{,}025]\}$$

$$r = -55{,}262/\sqrt{}\ (7{,}004 \times 2{,}167{,}724)$$

$$r = -55{,}262 / \sqrt{}\ 15{,}182{,}738{,}896$$

$$r = -55262 / 123{,}218.2571537189$$

$$r = -0.4484887327294267$$

$$r = -0.448$$

From the calculation, the numerical value of the correlation coefficient was -0.448, this figure being negative and not closer to -1.0, suggested the presence of a moderately weak negative relationship between use of extension information services and cassava productivity. This negative sign of the correlation coefficient meant that as use of extension information increased cassava productivity decreased, and vice versa.

The effect size of the correlation called the coefficient of determination defined as r^2 indicated that cassava production could be predicted from the relationship between the two variables. For $r = -0.448$, r^2 is 0.2007, which explains that 20.07% of the cassava productivity could be attributed to the utilization of extension information services. Conversely, 79.93% of the variation in cassava production could not be explained as resulting from utilization of extension services.

xvi) Relationship between use of Extension Information Services and Sesame Seed (SimSim) Productivity

The study also analyzed the relationship between use of Extension Information Services and Sesame Seed (SimSim) Productivity by considering eight sampled farmers who had an average of one acre of sesame seed crop. The land factor was to ensure that only smallholder farmers who had commercial viability were considered for the study.

The sampled farmers were asked to provide data on the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018.

Out of the eight sesame seed farming households sampled, extension information visits per household ranged between 5 and 25 times per season with a corresponding mean sesame seed yield of 100kgs per acre per season. However there seemed to be no relationship between the use of extension information and sesame seed productivity. Data collected revealed that farmers who had received less extension information visits had produced more than those who had higher numbers of visits. Production per unit area was also found to be below the ideal as according to a Sesame organic cultivation guide, Naturland.(2002), with good management, yield should be between 450-550 kg/ha or 180-220kgs/acre.

From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (sesame seed yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average sesame seed production per acres was then calculated. The results are shown in Table 4.19 below;

Table 4.19: Relationship between use of Extension Information Services and Sesame Seed Productivity

Extension Visits (*x*)	Sesame Seed Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Sesame Seed Production in kgs per acre (y/a)
25	132	3300	625	17424	1.5	88
23	103	2369	529	10609	1	103
19	71	1349	361	5041	1	71
17	75	1275	289	5625	1	75
14	123	1722	196	15129	1.5	82
13	82	1066	169	6724	0.75	109
11	26	286	121	676	0.25	104
5	144	720	25	20736	0.75	192
$\Sigma x=127$	$\Sigma y=756$	$\Sigma xy=12,087$	$\Sigma x^2=2,315$	$\Sigma y^2=81,964$	$\bar{x}=1$	$\bar{x}=103.04$

Source: Research Data, 2019

The study further examined the strength of the relationship between the two variables, use of extension information (x) and sesame seed productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.19 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =8(12,087)– (127×756)/ [√ {[8(2,315)– (1272)] × √ [8(81,964) – 7562]}

r= 96,696 -96,012/ [√ {[18,520 – 16,129] × √655,712 – 571,536]}

r=684/ [√2,391× √84,176]

r=684/48.9×290.131

r=684/14,187.41

r=0.04821175

r=0.048

The calculation revealed a correlation coefficient of 0.048 which though positive was closer to zero and therefore from the correlation scale implied a near absence of a linear relationship between use of extension information services and Sesame seed productivity.

xvii) Relationship between use of Extension Information Services and Cotton Productivity

In evaluating the Relationship between use of extension information services and cotton productivity eight smallholder cotton farmers were sampled and using questionaries' data on the number of extension visits made to their farms by extension service providers and the corresponding yield during the year 2018.

Out of the eight cotton farming households sampled, extension information visits per household ranged between 31and 55 times per season with a corresponding mean cotton yield of 65kgs per acre per season. However farmers who received more than 45 extension information dissemination visits during the season were able to produce more than 70 kgs of cotton per acre per season signifying that, use of extension information correlated with butternut productivity.

The study also revealed that the extension visits were evenly distributed such that range between the highest and the lowest was so close meaning the visits were frequently made to all cotton farming households. The quantity produced per unit area didn't deviate much from the figures sourced from *The Status Report on the Cotton Industry in Kenya,* Cotton Development Authority, (CODA, 2011) and corroborated by a Policy Brief; *Enhancing Investment Attractiveness In Kenya's Cotton Sector* (Feed The Future, 2017) that reported that, cotton yields in Kenya peaked in 2006 at 303kg/ha or 121kgs/acre but declined to average at 196 kg/ha or 78kgs/acre from 2006 to 2018.

From the data collected the values of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (cotton yield) was calculated and the sum of their products and squares calculated. Based on the acreage captured per household the average cotton production per acres was then calculated. More details on the relationship between the use of extension information services and cotton productivity are shown in table 4.20 below;

Table 4.20: Relationship between use of Extension Information Services and Cotton Productivity

Cotton Enterprise				n=8		
Extension Visits (*x*)	Cotton Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	Household Acreage (a)	Cotton Production in Kgs per acre (y/a)
55	93	5115	3025	8649	1.25	74.4
55	100	5500	3025	10000	1.25	80.0
52	93	4836	2704	8649	1.25	74.4
49	91	4459	2401	8281	1.25	72.8
45	83	3735	2025	6889	1.25	66.4
43	72	3096	1849	5184	1.25	57.6
37	77	2849	1369	5929	1.5	51.3
31	66	2046	961	4356	1.5	44.0
$\Sigma x=367$	$\Sigma y=675$	$\Sigma xy=31{,}636$	$\Sigma x^2=17{,}359$	$\Sigma y^2=57{,}937$	$\bar{x}=1.3$	$\bar{x}=65.1$

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables; use of extension information (x) and cotton productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.20 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 8(31{,}636) - (367 \times 675) / [\sqrt{} \{[8(17{,}359) - (3672)] \times \sqrt{} [8(57{,}937) - 6752]\}$$

$$r = 253{,}088 - 247{,}725 / [\sqrt{} \{[138{,}872 - 134{,}689] \times \sqrt{} [463{,}496 - 455{,}625$$

$$r = 5{,}363 / [\sqrt{} \{4{,}183 \times \sqrt{7{,}871}]$$

$$r = 5{,}363 / [64.68 \times 88.72]$$

$$r = 5{,}363 / 5{,}738.41$$

$$r = 0.934579$$

$$r = 0.935$$

From the calculation, the numerical value of the correlation coefficient was 0.935, this figure was positive and very close to 1.0, therefore signifying the presence of a very strong near perfect positive relationship between use of extension information services and cotton productivity.

For $r = 0.935$, r^2 is 0.8742, which indicated that 87.42% of the variation in cotton productivity could be ascribed to the utilization of extension information services. Conversely, 12.58% of the variation in cotton production could not be explained as resulting from access to and utilization of extension services.

xviii) Relationship between use of Extension Information Services and Dairy Cattle Milk Productivity

In order to ascertain the relationship between use of extension information services and dairy cattle milk productivity in Tana River County, 28 dairy cow farmers with an average four lactating dairy cattle were sampled for the study. Through questionnaires, data on the number of engagements with agricultural extension information service providers and their corresponding milk production for the year 2018 was captured.

Out of the 28 dairy cattle farming households sampled, extension information visits per household ranged between 11 and 77 times per year with a corresponding mean milk yield of 500kgs per cow per year. However farmers who received more than 70 extension information dissemination visits during the year were able to produce above 1500kgs of milk per cow per year, signifying that, use of extension information correlated with Dairy cow milk productivity.

The quantity produced per cow in tana river county corroborated with figures sourced from the Dairy development report in Kenya (FAO. 2011)., that estimated milk production in Kenya to range between 1300 Kgs and 4000 Kgs per cow per year however . The report went further to report that his high milk production depended on the degree of intensification and good animal husbandry practices.

From the data collected the values of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (dairy cattle milk yield) was calculated and the sum of their products and squares calculated. The results are shown in Table 4.21 below;

Table 4.21: Relationship between use of Extension Information Services and Dairy Cattle Milk Productivity

Dairy Cow Enterprise				n=28		
Extension Visits (*x*)	Cow Milk Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	No. of cows (c)	Average Milk Production in Kgs/Cow/Year (y/c)
77	4671	359667	5929	21818241	3	1557.0
75	4658	349350	5625	21696964	3	1552.7
47	1109	52123	2209	1229881	2	554.5
44	1990	87560	1936	3960100	3	663.3
43	1824	78432	1849	3326976	3	608.0
43	1268	54524	1849	1607824	2	634.0
43	2520	108360	1849	6350400	4	630.0
39	1178	45942	1521	1387684	3	392.7
38	1312	49856	1444	1721344	4	328.0
37	1289	47693	1369	1661521	4	322.3
37	1448	53576	1369	2096704	4	362.0
35	1564	54740	1225	2446096	5	312.8
33	1300	42900	1089	1690000	2	650.0
33	2302	75966	1089	5299204	4	575.5
29	1325	38425	841	1755625	3	441.7
29	1265	36685	841	1600225	4	316.3
27	1052	28404	729	1106704	4	263.0
25	1077	26925	625	1159929	2	538.5
23	1666	38318	529	2775556	3	555.3
22	1211	26642	484	1466521	5	242.2
22	1200	26400	484	1440000	4	300.0
21	1568	32928	441	2458624	4	392.0
19	1230	23370	361	1512900	5	246.0
17	1200	20400	289	1440000	4	300.0
16	1738	27808	256	3020644	7	248.3
13	1952	25376	169	3810304	5	390.4
13	1970	25610	169	3880900	6	328.3
11	1910	21010	121	3648100	6	318.3
Σx=911	Σy=48,797	Σxy=1,858,990	Σx^2=36,691	Σy^2=107,368,971	$\bar{x}$=4	$\bar{x}$=500.8

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and dairy cow milk productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.21 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =28(1,858,990) – (911 × 48,797) / {[√{[28(36,691) – (911^2)] × √ [28(107,368,971) – $48{,}797^2$]}

r =52,051,720 – 44,454,067/ √ [(1,027,348 – 829,921) × (3,006,331,188 – 2,381,147,209)]

r = 7,597,653 / √ (197,427×625,183,979)

r =7,597,653 / √123,428,197,422,033

r =7,597,653 / 11,109,824.36503985

r = 0.6838679667977585

r = 0.684

From the calculation, the numerical value of the correlation coefficient was 0.684 this figure was closer to 1.0, therefore signifying the presence of a strong relationship between use of extension information services and cattle milk productivity. The sign of the correlation coefficient being positive also suggested that increased use of extension information directly increased Cattle milk production.

The coefficient of determination r^2 indicated that cow milk production could be predicted from the relationship between the two variables. For r = 0.684, r^2 is 0.47, which means that 47% of cattle milk productivity could be credited to the utilization of extension information services. Conversely, 53% of the variation in cattle milk production could not be explained as resulting from access to and utilization of extension services.

xix) Relationship between use of Extension Information Services and Dairy Goat Milk Productivity

In order to ascertain the relationship between use of extension information services and dairy goat milk productivity among smallholder farmers in Tana River County, 18 dairy goat farmers with an average ten lactating dairy goats were sampled for the study. In order to minimize extreme cases and to ensure that the chosen farmers were small holders the herd size was a prominent factor in the selection of the farmers.

Through the use of questionnaires, data on the number of agricultural extension dissemination visits and the corresponding milk production for the year 2018 was captured.

Out of the 18 dairy goat farming households sampled, extension information visits per household ranged between 5 and 65 times per year with a corresponding mean milk yield of 135kgs per goat per year. However farmers who received more than 40 extension information dissemination visits during the year were able to produce above 300kgs of milk per goat per year, signifying that, use of extension information correlated with Dairy goat milk productivity. The quantity produced per goat in Tana River County corroborated with figures sourced from the Beginner Dairy Goat Fact Sheet, (Larry, 2017).that estimated goat milk production in to range between 790-5,470lb per lactation translating to 358 -2,483 Kgs per goat per year.

From the data collected the values of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (dairy goat milk yield) was calculated and the sum of their products and squares calculated. More details on the relationship between the use of extension information services and Dairy goat milk productivity are shown in Table 4.22 below.

Table 4.22: Relationship between use of Extension Information Services and Dairy Goat milk Productivity

Dairy Goat Milk Enterprise				n= 18		
Extension Visits in a year (x)	Goat Milk Yield in Kgs (y)	(xy)	(x^2)	(y^2)	No. of Goats (g)	Average Goat Milk Production in Kgs per Goat (y/g)
65	2124	138060	4225	4511376	6	354.0
52	1901	98852	2704	3613801	6	316.8
42	2999	125958	1764	8994001	9	333.2
40	7989	319560	1600	63824121	25	319.6
38	1653	62814	1444	2732409	12	137.8
32	2930	93760	1024	8584900	24	122.1
29	1532	44428	841	2347024	13	117.8
20	1230	24600	400	1512900	11	111.8
20	1335	26700	400	1782225	12	111.3
19	1238	23522	361	1532644	12	103.2
18	1232	22176	324	1517824	12	102.7
16	1225	19600	256	1500625	13	94.2
16	221	3536	256	48841	5	44.2
12	113	1356	144	12769	3	37.7
11	157	1727	121	24649	5	31.4
9	118	1062	81	13924	4	29.5
8	114	912	64	12996	4	28.5
5	111	555	25	12321	3	37.0
$\Sigma x = 452$	$\Sigma y = 28{,}222$	$\Sigma xy = 1{,}009{,}178$	$\Sigma x^2 = 16{,}034$	$\Sigma y^2 = 102{,}579{,}350$	$\bar{x}=10$	$\bar{x}=135.1$

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and dairy goat milk productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.22 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =18(1009178) –(452 × 28222) / [√ {[18(16034)–(452^2)]×[18(102,579,350)– 28222^2]}

r =18165204 – 12756344/ √ [(288612 – 204304) × (1,846,428,300 – 796,481,284)]

r =5408860 / √ (84308×1,049,947,016)

r =5408860 / √88,518,933,024,928

r =5408860 / 9,408,450.086221853

r = 0.5748938401576867

r = 0.575

From the calculation, the numerical value of the correlation coefficient was 0.575 which according to the correlation scale signifying the presence of a moderately strong relationship between use of extension information services and goat milk productivity.

The coefficient of determination defined as r^2 indicated that dairy goat milk could be predicted from the relationship between the two variables. For r = 0.575 the r^2 is 0.33, which means that 33% of goat milk productivity could be attributed to the utilization of extension information services. Conversely, 67% of the variation in

Goat milk production could not be explained as resulting from access to and utilization of extension services.

xx) Relationship between use of Extension Information Services and Chicken eggs Productivity

In evaluating the relationship between use of extension information services and chicken eggs productivity for smallholder farmers in Tana River County, thirteen poultry farmers with an average fifteen laying hens were sampled for the study. This was to minimize extreme cases and to ensure that the chosen farmers were small holders and therefore the number of birds reared was a prominent factor in the selection.

Through a the use of questionnaire as a data collection tool, the farmers were requested to provide data on the number of hens kept, number of interactions with agricultural extension information service providers and finally the number of eggs laid during the year 2018.

Out of the 13 chicken farming households sampled, extension information visits per household ranged between 3 and 67 times per year with a corresponding mean egg production of 140 eggs per hen per year. However farmers who received more than 50 extension information dissemination visits during the year were able to produce above 200 eggs per hen per year, signifying that, use of extension information correlated with chicken eggs production.

The quantity of eggs produced per hen in Tana River County corroborated with figures sourced from the Kenya Poultry sector country review (FAO, 2007) that the typical egg production cycle lasts about 17 months (72 weeks) with hens laying 280 egg.

From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (chicken eggs laid) was calculated and the sum of their products and squares calculated. Based on the number of hens recorded per household the average chicken eggs production per hen was then calculated. The results shown in Table 4.23 below.

Table 4.23: Relationship between use of Extension Information Services and Chicken Eggs Productivity

Hen Eggs Enterprise				n=13		
Extension Visits (*x*)	Hen Eggs Yield in pcs (*y*)	(*xy*)	(x^2)	(y^2)	No. of Hens (h)	Egg Production per Hen (y/h)
67	2111	141437	4489	4456321	10	211
57	1901	108357	3249	3613801	9	211
51	1999	101949	2601	3996001	10	200
38	1653	62814	1444	2732409	10	165
29	1532	44428	841	2347024	10	153
21	1230	25830	441	1512900	10	123
20	1335	26700	400	1782225	11	121
17	1238	21046	289	1532644	11	113
15	1232	18480	225	1517824	12	103
12	1225	14700	144	1500625	11	111
10	1221	12210	100	1490841	10	122
8	1114	8912	64	1240996	10	111
3	1111	3333	9	1234321	9	74
Σx=348	Σy=18902	Σxy=590196	Σx^2=14296	Σy^2=28957932	x̄=10	x̄=140

Source: Research Data, 2019

In order to measure how strong a relationship is between two variables; use of extension information (x) and chicken eggs productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.23 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =13(590,196) – (348 × 18,902) / [√ {[13(14,296) – (348) 2] × √ [13(28,957,932) – (18,902)2]}

r=7,672,548 – 6,577,896/ [√ {[185,848 – 121,104] × √ [376,453,116 – 357,285,604]}

r=1,094,652/ [√64,744 × √ [19,167,512]}

r=1,094,652/ [254.45×4,378.072]

r=1,094,652/1,114,000.42

r=0.9826

r=0.983

From the calculation, the numerical value of the correlation coefficient was 0.983, this figure being closer to 1.0, signified the presence of a very strong near perfect relationship between use of extension information services and chicken eggs productivity. The sign of the correlation coefficient being positive also suggests that increased utilization of extension information directly increased egg production.

The coefficient of determination defined as r^2 indicated that chicken eggs production could be predicted from the relationship between the two variables.

For r = 0.983, r^2 is 0.9663, which means that 96.63% of chicken eggs productivity could be ascribed to the utilization of extension information services. Conversely, 3.37% of the variation in chicken eggs production could not be described as resulting from access to and utilization of extension services.

xxi) Relationship between use of Extension Information Services and Pond Fish Productivity

An appraisal of the Relationship between use of extension information services and pond fish productivity for smallholder farmers in Tana River County. Was carried out by analysis ten sampled Tilapia pond fish farmers with an average size of 20m by 15m fish pond.

Through questionnaires the sampled farmers were requested to provide data on the pond size, number of fish reared in the ponds, total harvest for the 2018 and the number of visit made by agricultural extension information providers.

Out of the 10 fish pond farming households sampled, extension information visits per household ranged between 19 and 62 times per year with a corresponding mean Tilapia fish production of 200kg per pond per year. However farmers who received more than 50 extension information dissemination visits during the year were able to produce above 300kgs per pond per year, signifying that, use of extension information correlated with pond fish production.

The quantity of fish produced per pond in Tana River County corroborated with figures sourced from A review of aquaculture production and health management practices of farmed fish in Kenya (Opiyo, 2018) that gave an average harvest weight about 250 grams per fish, and total production about 0.25 Kgs/sq m for a stocking rate of 1 fish/m^2. Higher stocking densities could however be employed to achieve higher production but must be combined with better management to get an expected survival is about 80 percent. A pond of 20m by 15m therefore was expected to yield a maximum of 300kgs for 1 fish/m^2 each of 0.25kgs but farmers in Tana River County were found to be stocking between 3 to 5 fish/m^2 therefore achieving higher yields.

From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (pond fish harvested) was calculated and the sum of their products and squares calculated. More details on the relationship between the use of extension information services and pond fish productivity are shown in Table 4.24 below.

Table 4.24: Relationship between use of Extension Information Services and Pond Fish Productivity

Pond Fish Enterprise				n=10		
Extension Visits (*x*)	Fish Harvested in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	No. of ponds (h)	production per Pond (y/h)
62	624	38688	3844	389376	2	312
52	724	37648	2704	524176	2	362
47	501	23547	2209	251001	2	251
45	532	23940	2025	283024	2	266
43	553	23779	1849	305809	3	184
39	421	16419	1521	177241	2	211
33	111	3663	1089	12321	1	111
31	175	5425	961	30625	2	88
28	251	7028	784	63001	2	126
18	104	1872	324	10816	1	104
Σx=398	Σy=3996	Σxy=182009	Σx^2=17310	Σy^2=2047390	x̄=2	x̄=201

Source: Research Data, 2019

In order to measure how strong a relationship is between the two variables, use of extension information (x) and pond fish productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.24 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =10(182009) – (398× 3996) / [√ {[10(17310) – (398^2)] × [10(2,047,390) – 3996^2]}

r = 1,820,090 – 1,590,408/√ {[173,100 – 158,404] × [20,473,900– 15,968,016]}

r = 229,682/√ (14,696× 4,505,884)

$$r = 229{,}682 / \sqrt{66{,}218{,}471{,}264}$$

$$r = 229{,}682 / 257329.4994049458$$

$$r = 0.892559928030016$$

$$r = 0.893$$

From the calculation, the numerical value of the correlation coefficient was 0.893, this figure according to the correlation scale, signified the presence of a strong relationship between use of extension information services and pond fish productivity. The sign of the correlation coefficient being positive also suggested that increased utilization of extension information directly increased pond fish production and vice versa.

The coefficient of determination defined as r^2 indicated that pond fish productivity could be predicted from the relationship between the two variables. For $r = 0.893$, $r^2 = 0.797$, which implied that 79.7% of pond fish productivity could be credited to the utilization of extension information services. Conversely, 20.3% of the variation in pond fish production could not be explained as resulting from access to and utilization of extension services.

xxii) Relationship between use of Extension Information Services and Camel Milk Productivity

In order to ascertain the relationship between use of extension information services and camel milk productivity for smallholder farmers in Tana River County, eight camel farmers with an average 10 adult dairy camels were sampled for the study.

This was to minimize extreme cases and to ensure that the chosen farmers were smallholder. The herd size was therefore a prominent factor in the selection.

Through a the use of questionnaire as a data collection tool, the farmers were requested to provide information on the number of camels they kept, the number of times they interacted with agricultural extension information service providers and finally the milk produced during the year 2018.

Out of the 8 dairy camel farming households sampled, extension information visits per household ranged between 7 and 23 times per year with a corresponding mean milk yield of 1000kgs per camel per year. However farmers who had received more than 20 extension information dissemination visits during the year were able to produce above 1500kgs of milk per camel per year, signifying that, use of extension information correlated with Dairy camel milk productivity. The quantity produced per camel in Tana River County corroborated with figures sourced from a report on Camel milk production and marketing in Pastoral areas (Gebremichael, 2019), which informed that the average milk production was about 1 800 kg per camel per year.

From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating the correlation between the variables, the sum of the scores of x (extension visits) and y (camel milk yield) was calculated and the sum of their products and squares calculated. Based on the number of camels captured per household the average camel milk production per camel was then calculated. More details on the relationship between the use of extension information services and camel milk productivity are shown in Table 4.25 below.

Table 4.25: Relationship between use of Extension Information Services and Camel Milk Productivity

Dairy Camel Enterprise				n=8		
Extension Visits (*x*)	Camel Milk Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	No. of Camels (c)	Mean Camel Milk Production in Kgs (y/c)
23	9666	222318	529	93431556	6	1611.0
21	9564	200844	441	91470096	6	1594.0
19	9325	177175	361	86955625	10	932.5
18	9324	167832	324	86936976	9	1036.0
11	9299	102289	121	86471401	11	845.4
10	9111	91110	100	83010321	12	759.3
9	7077	63693	81	50083929	11	643.4
7	6052	42364	49	36626704	11	550.2
$\Sigma x=118$	$\Sigma y= 69,418$	$\Sigma xy = 1,067,625$	$\Sigma x^2=2006$	$\Sigma y^2= 614,986,608$	$\bar{x}=10$	$\bar{x}=996.5$

Source: Research Data, 2019

In order to measure how strong a relationship is between two variables, use of extension information (x) and camel milk productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.25 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$r = 8(1,067,625) - (118 \times 69418) / [\sqrt{} \{[8(2006) - (118^2)] \times \sqrt{} [8(614,986,608) - 69418^2]\}$$

$$r = 8,541,000 - 8,191,324/\sqrt{} \{[16,048 - 13,924] \times [4,919,892,864 - 4,818,858,724]\}$$

$$r = 349,676/\sqrt{} (2124\times 101,034,140)$$

$$r = 349,676 /\sqrt{}214,596,513,360$$

$$r = 349,676 / 463,245.6296178087$$

$$r = 0.7548392853452131$$

$$r = 0.755$$

From the calculation, the numerical value of the correlation coefficient was 0.755, according to the correlation scale, this figure signified the presence of a strong relationship between use of extension information services and camel milk productivity. The sign of the correlation coefficient being positive also suggests that increased utilization of extension information directly increased camel milk production and vice versa.

The coefficient of determination r^2 also indicated camel milk production could be predicted from the relationship between the two variables. For $r = 0.755$, r^2 is 0.57, which suggested that 57% of the variation in camel milk productivity could be ascribed to the utilization of extension information services. Conversely, 43% of the variation in camel milk production could not be explained as resulting from access to and utilization of extension services.

xxiii) Relationship between use of Extension Information Services and Honey Productivity

An analysis of the relationship between use of extension information services and honey productivity in Tana River County was done through the evaluation of nine sampled beekeepers with an average of ten bee hives. This was to minimize extreme cases and to ensure that the chosen farmers were smallholders commercial beekeepers.

Using questionnaires data was collected on the number of beehives, and the number of times the farmers were visited by agricultural extension information service providers and the quantity of honey harvested during the year 2018.

Out of the 9 beekeeping households sampled, extension information visits per household ranged between 8 and 42 times per year with a corresponding mean honey yield of 26.8kgs per beehive per year. However farmers who had received more than 30 extension information dissemination visits during the year were able to produce above 30kgs of honey per beehive per year, signifying that, use of extension information correlated with honey productivity.

The quantity produced per beehive in Tana River County corroborated with figures sourced from a report on the Cost Benefit Analysis for Hives NAFIS, (2019), that stated that, realistically a bee hive can produce anywhere between 30 to 60 pounds (14 to 27 kilograms) of honey per year. However, better management can produce significantly more, potentially up to 100 pounds (45 kilograms) of honey per hive per year.

From the data collected the value of extension visits was the independent variable denoted as ***x*** while the yield was the dependent variable denoted as ***y***. To lay the basis for calculating for calculating the correlation between the variables, the sum of the scores of ***x*** (extension visits) and ***y*** (honey yield) was calculated and the sum of their products and squares calculated. Based on the number of bee hives captured per household the average honey production per hive was then calculated. More details on the relationship between the use of extension information services and honey productivity are shown in table 4.26 below;-

Table 4.26: Relationship between use of Extension Information Services and Honey Productivity

Apiculture Enterprise				n=9		
Extension Visits (*x*)	Honey Yield in Kgs (*y*)	(*xy*)	(x^2)	(y^2)	No. of Beehives (h)	Mean Production per hive (y/h)
42	424	17808	1764	179776	12	35.3
37	401	14837	1369	160801	12	33.4
30	430	12900	900	184900	13	33.1
29	221	6409	841	48841	9	24.6
23	101	2323	529	10201	4	25.3
21	325	6825	441	105625	14	23.2
15	353	5295	225	124609	15	23.5
11	232	2552	121	53824	9	25.8
8	104	832	64	10816	6	17.3
$\Sigma x=216$	$\Sigma y=2591$	$\Sigma xy=69781$	$\Sigma x^2=6254$	$\Sigma y^2=879393$	$\bar{x}=10$	$\bar{x}=26.8$

Source: Research Data, 2019

In order to measure how strong or weak a relationship is between the two variables, use of extension information (x) and honey productivity (y), a Pearson Correlation Coefficient (r) formula was applied on the data analyzed in table 4.26 above in order to calculate the correlation coefficient. A covariance of the two variables was calculated and then divided by the product of their standard deviations as shown below: -

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r =9(69781) – (216 × 2591) / [√ {[9(6254) – (216^2)] × √ [9(879393) – 2591^2]}

r = 628,029 – 559,659/√ {[56,286 – 46,656] × [7,914,537 – 6,713,281]}

r = 68,370/√ (9630× 1,201,256)

r = 68,370 /√ 11,568,095,280

r = 68,370 / 107,555.0802147439

r = 0.6356741800249361

r = 0.636

From the calculation, the numerical value of the correlation coefficient was 0.636 this figure according to the correlation scale signified the presence of a moderately strong relationship between use of extension information services and honey productivity. The sign of the correlation coefficient being positive also suggests that increased access and utilization of extension information directly increased honey production.

The coefficient of determination defined as r^2 indicated that honey production could be predicted from the relationship between the two variables. For r = 0.636, r^2 is 0.404, which implied that 40.4% of honey productivity could be credited to the utilization of extension information services. Conversely, 59.6% of the variation in honey production could not be explained as resulting from access to and utilization of extension services.

4.3.2 Relationship Between Use Of Extension Information Services and Marketing of Agricultural Produce

Through both descriptive and inferential statistics, the study also determined if a relationship existed between extension information service provision and agricultural marketing in Tana River County. This was considered necessary due to the fact that, literature review of the study had discovered that farmers needed extension information not only with regard to production but also throughout all the other stages of the entire value chain including agribusiness, in order to enable them apply scientific research and knowledge to agricultural practices.

The study identified agricultural enterprises that farmers preferred based on sales volumes and on farm income. Through the recall method, 365 smallholder farmers were asked to provide data on sales volume for every enterprise from baseline (2017 sales) and follow-up actual (2018 sales). The data gathered was analyzed and grouped into three main clusters based on household on farm income as shown in table 4.27 below;

Table 4.27: Agricultural Value Chain Preference

Agricultural Enterprise	Sample Size (n=365)	2017				2018				Level of Marketing Preference
		Extension Visits in days per Year	Baseline Sales	Unit Price (Kes)	On-Farm Income (Kes)	sum of Extension Visits in days per Year	Actual Sales	Unit Price (Kes)	On-Farm Income (Kes)	
Mangoes	29	559	73111kgs	20	1,462,220	923	81050kgs	25	2,026,250	High Preference
Cattle Milk	28	499	34298kgs	50	1,714,900	911	47450kgs	60	2,847,000	
Maize	28	501	77771kgs	28	2,177,588	871	85590kgs	30	2,567,700	
Citrus Fruits	18	599	25777kgs	100	2,577,700	444	29700kgs	80	2,376,000	
Tomatoes	19	679	27897kgs	80	2,231,760	584	28410kgs	100	2,841,000	
Camel Milk	8	49	55991kgs	50	2,799,550	118	68900kgs	45	3,100,500	
Totals	**130**	**2,886**	**294,845**		**12,963,718**	**3,851**	**341,100**		**15,758,450**	
Water melon	20	299	31177kgs	20	623,540	564	43485kgs	25	1,087,125	Moderate Preference
Cabbage	10	111	45385kgs	35	1,588,475	215	57250kgs	30	1,717,500	
Chilies	19	612	22417kgs	60	1,345,020	494	23040kgs	80	1,843,200	
Kales	19	481	19999kgs	50	999,950	385	20505kgs	60	1,230,300	
Goats Milk	18	573	26891kgs	50	1,344,550	452	27780kgs	60	1,666,800	
Green grams	28	111	16110kgs	80	1,288,800	410	17010kgs	100	1,701,000	
Onions	8	107	10118kgs	125	1,264,750	225	11240kgs	120	1,348,800	
Cashew nuts	18	311	1139kgs	650	740,350	150	1987kgs	750	1,490,250	
Honey	9	329	2171kgs	450	976,950	216	2565kgs	500	1,282,500	
Pond Fish	10	499	3111kgs	250	777,750	398	3965	350	1,387,750	
Totals	**159**	**3,433**	**178,518**		**10,950,135**	**3,509**	**208,827**		**14,755,225**	
Chicken Eggs	13	101	17682pcs	10	176,820	348	18798pcs	15	281,970	Low Preference
Cotton	8	499	7673kgs	60	460,380	367	6500kgs	60	390,000	
Coconuts	19	299	9101kgs	10	91,010	169	7567kgs	15	113,505	
Bananas	9	367	7999kgs	80	639,920	216	5520kgs	80	441,600	
Sesame Seed	8	231	8579kgs	55	471,845	127	7360kgs	50	368,000	
Cassava	9	239	1117kgs	45	50,265	148	2160kgs	50	108,000	
Butternuts	10	156	1097kgs	85	93,245	77	1520kgs	100	152,000	
Totals	**76**	**1,892**	**53,248**		**1,983,485**	**1,452**	**49,425**		**1,855,075**	

Source: Research Data, 2019

Applying descriptive statistics the total on farm income was calculated for all the twenty three agricultural value chains. This information offered an understanding of market preferences and as shown in table 4.27 above. From the analysis it was deducted that based on, on farm revenue, the highly preferred agricultural enterprises were Mangoes, Cattle Milk, Maize, Citrus fruits, Tomatoes and Camel Milk, while the least preferred enterprises were chicken eggs, cotton, coconuts, Banana, Sesame seeds, Cassava and butternuts.

Qualitative data gathered further revealed that extension information dissemination visits also influenced agricultural enterprise preference, sales and household income e.g. in the year 2017 a total of 2,886 visits were made for the highly preferred enterprises with a corresponding income of Kes. 12,963,718 for the year, while in the corresponding year 2018 extension visits increased to 3,851 generating an income of Kes.15,758,450. This change in on farm household income was attributed to the increased use of agricultural information considering that data was gathered from the same farmers and same enterprises.

The same positive effect on, on farm income as a result of increased extension interactions was depicted for the moderately preferred Agricultural enterprises where 3,433 visits were made in the year 2017 with a corresponding income of Kes. 10,950,135 while in the following year 2018, the visits increased to 3,509 with a corresponding income of Kes. 14,755,225.

However for the least preferred Agricultural enterprises the data analyzed confirmed that there was a reduction in extension information dissemination interactions and this was perceived to have contributed to the reduced revenues. In the year 2017 only 1,892 visits were made by the extension information service providers for the least preferred enterprises, which resulted in a household income of Kes. 1,983,485, this trend continued during the following year 2018 where the visits were further reduced to 1,452, the effect being a corresponding reduction in the on farm incomes to Kes. 1,855,075.

The data analyzed therefore enabled the study to draw an inference that there was a relationship between the two variables; use of agricultural extension information and marketing, however to qualify the study hypothesis the study carried out a paired t test (also called a correlated pairs t-test, a paired samples t test or dependent samples t test).

A paired t-test was used to compare two income means for the for the year 2017 and 2018. The registered income from the sale of agricultural produce from the 23 enterprises was collected from the farming households through questionnaires and the registered income for the year 2017 paired with the registered incomes for the year 2018. The t test carried out was essentially to test the study hypothesis by comparing the on farm income mean for the year 2017 and 2018.

The On farm income data on 23 agricultural enterprises for the year 2017 and 2018 was collected from 365 farming households and analyzed as shown in table 4.28 below;

Table 4.28: On Farm Income Mean comparison

Agricultural Enterprise	Respondents (n=365)	2017 On-Farm Income (Kes)	2018 On-Farm Income (Kes)	(x-y)	$(x-y)^2$
		Score 1 (x)	Score 2 (y)		
Mangoes	29	1,462,220	2,026,250	-564,030	318,129,840,900
Cattle Milk	28	1,714,900	2,847,000	-1,132,100	1,281,650,410,000
Maize	28	2,177,588	2,567,700	-390,112	152,187,372,544
Citrus Fruits	18	2,577,700	2,376,000	201,700	40,682,890,000
Tomatoes	19	2,231,760	2,841,000	-609,240	371,173,377,600
Camel Milk	8	2,799,550	3,100,500	-300,950	90,570,902,500
Water melon	20	623,540	1,087,125	-463,585	214,911,052,225
Cabbage	10	1,588,475	1,717,500	-129,025	16,647,450,625
Chilies	19	1,345,020	1,843,200	-498,180	248,183,312,400
Kales	19	999,950	1,230,300	-230,350	53,061,122,500
Goats Milk	18	1,344,550	1,666,800	-322,250	103,845,062,500
Green grams	28	1,288,800	1,701,000	-412,200	169,908,840,000
Onions	8	1,264,750	1,348,800	-84,050	7,064,402,500
Cashew nuts	18	740,350	1,490,250	-749,900	562,350,010,000
Honey	9	976,950	1,282,500	-305,550	93,360,802,500
Pond Fish	10	777,750	1,387,750	-610,000	372,100,000,000
Chicken Eggs	13	176,820	281,970	-105,150	11,056,522,500
Cotton	8	460,380	390,000	70,380	4,953,344,400
Coconuts	19	91,010	113,505	-22,495	506,025,025
Bananas	9	639,920	441,600	198,320	39,330,822,400
Sesame seed (SimSim)	8	471,845	368,000	103,845	10,783,784,025
Cassava	9	50,265	108,000	-57,735	3,333,330,225
Butternuts	10	93,245	152,000	-58,755	3,452,150,025
SUM	**365**	**25,897,338**	**32,368,750**	**-6,471,412**	**4,169,242,827,394**

Source: Research Data, 2019

From table 4.28 above the sum of incomes for the two years referred to as x income for year 2017 and y income for year 2018 (2017 as score 1 and 2018 as score 2) was calculated and the differences determined between year 2017 and year 2018. The sum of the differences was calculated and squared and the formula below was applied to compare the mean on farm income for the 23 enterprise over the years under review.

$$t = \frac{(\sum D)/N}{\sqrt{\frac{\sum D^2 - \left(\frac{(\sum D)^2}{N}\right)}{(N-1)(N)}}}$$

Where
ΣD: Sum of the differences (Sum of x-y)
ΣD^2: Sum of the squared differences (Sum of $(x\text{-}y)^2$)
$(\Sigma D)^2$: Sum of the differences squared. (Sum of x-y squared)

t = -6,471,412/365/√{[4,169,242,827,394 – (-6,471,412)2/365]/(365-1)(365)}

t = -17,729.9/√{[4,169,242,827,394 – (41,879,173,273,744/365]/(364)(365)}

t = -17,729.9/√{[4,169,242,827,394 –114,737,461,023.96]/132,860}

t = -17,729.9/√{4,054,505.186.370.04/132,860

t = -17,729.9/√30,517,124.69

t = -17,729.9/5,524.231

t = -3.209

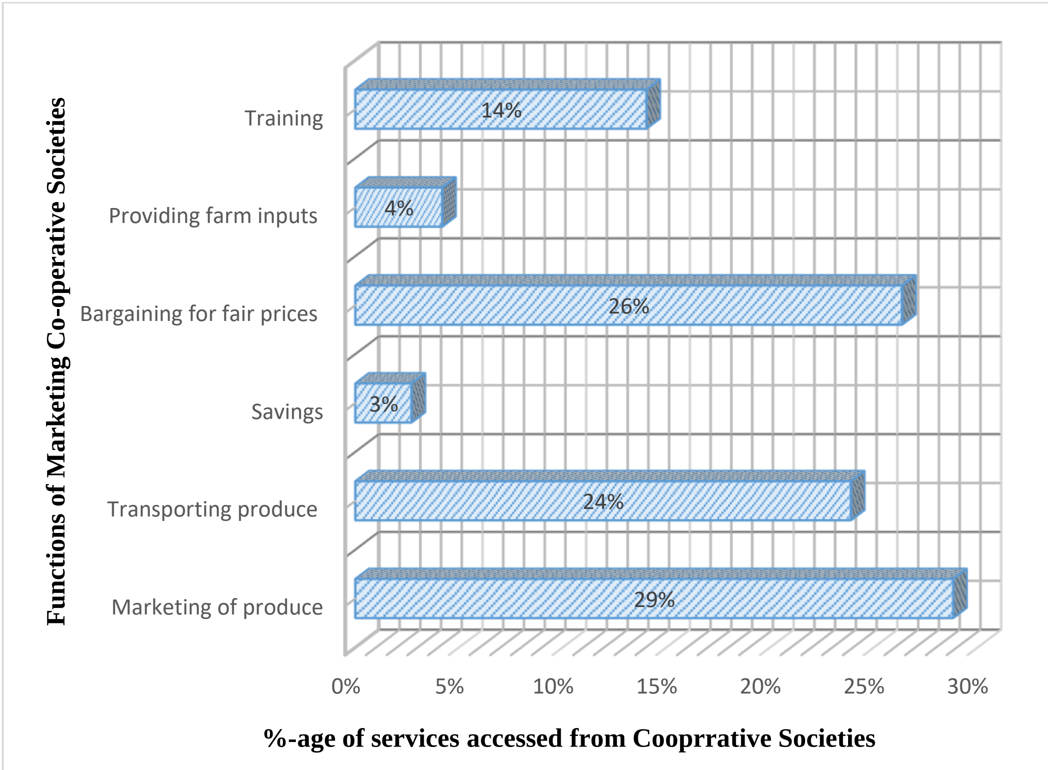
In the calculation 1 was Subtracted from the sample size to get the degrees of freedom (df). The study had a sample of 365 items, so 365-1 = 364. After calculating the t-value as above the p-value was found in the t-table, using the degrees of freedom 364 basing on an alpha level (Significance level) of 0.05 (5%). With df = 364, the t-value is 1.962. (See appendix V: t-test Table)

Comparing the t-table value (1.962) to the calculated t-value (-3.209), The calculated t-value is greater than the table value at an alpha level of .05. The p-value is less than the alpha level: $p < .05$. The minus sign is ignore when comparing the two t-values, as ± indicates the direction; the p-value remains the same for both directions.

Based on the t-test there was a clear and distinct difference between the mean for the year 2017 an 2018. The alternative hypothesis that there is a relationship between use of extension information services and marketing of agricultural produce was therefore qualified, considering that the comparison of the mean of on farm income for the two years revealed that there was an increment from Kes. 25,897,338 in 2017 to Kes. 32,368,750 in 2018.

Qualitatively, interactions with extension service providers revealed that the reduced number of extension information dissemination visits was as a result of non-prioritization of the six enterprises; Cotton, Coconuts, Bananas, Sesame seed, Cassava and Butternuts. While many farmers were engaged in these agricultural enterprises, production and marketing was still poor due to insufficient knowledge, this was coupled with the fact that the county government of Tana River had very few extension information service providers with expertise in these enterprises resulting into the inability to sustainably manage the extension information system.

Considering that literature review and the analysis of the major value chains had identified marketing of agricultural produce as a major constraint, the study found it relevant to analyze the functions of cooperative societies in the county. Through questionnaires total of 365 farming households were asked to provide an insight into the roles of cooperative societies and the bar graph in figure 4.2 below analyses the responses provide regarding the functions of Cooperative societies in Tana River County



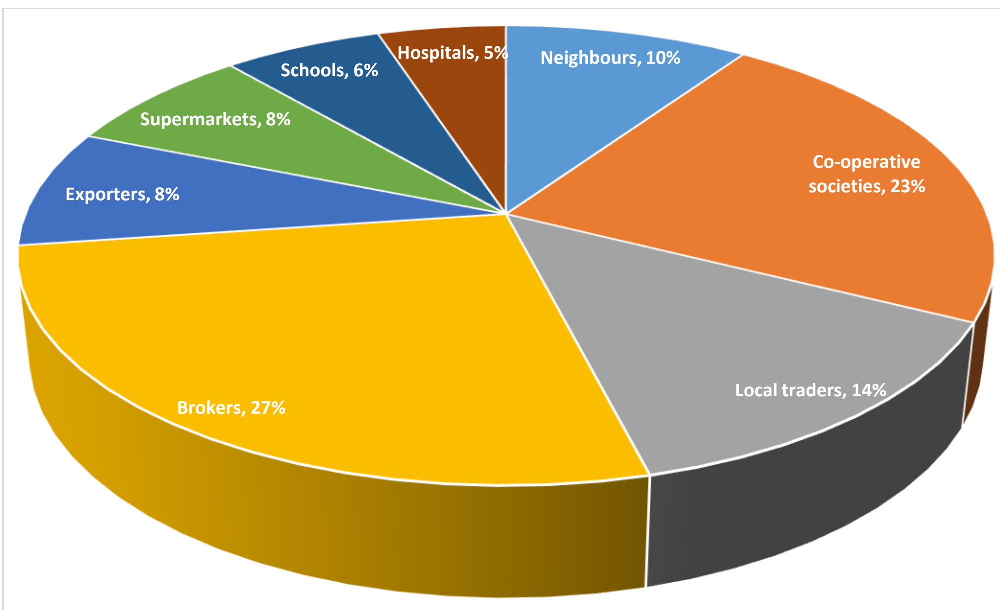
Source: Research Data, 2019

Figure 4.2: Functions of Marketing Co-operative Societies in Tana River County

From the analysis it was acknowledged that many farmers (29%) used cooperative societies to marketing agricultural produce. Cooperative societies were also helped farmers bargaining for fair prices (26%), but while farmers expressed the need for savings schemes and access to farm input, cooperative societies in Tana River County seemed not to prioritize these functions and only a few farmers (3% and 4% respectively) has received these services.

Through interviews 75 extension service providers were asked to provide information on the challenges facing the cooperative movement considering responses from farmers gave the impression that full benefits were yet to be realized. The qualitative information gathered revealed that, Tana River County government had made relentless efforts in supporting the forming and strengthening of cooperative societies in the county but organizational development challenges that were well pronounce in group dynamics and poor leadership, accountability and inefficient funding had seen the efforts not yield satisfactory results.

The study also evaluated the different markets for agricultural produce and the 365 respondents were asked to list available markets, this was to find out if extension information had helped agricultural produce marketing. The analysis of the main buyers of agricultural produce in tana river county was as given in the pie chart in figure 4.3 below;-



Source: Research Data, 2019

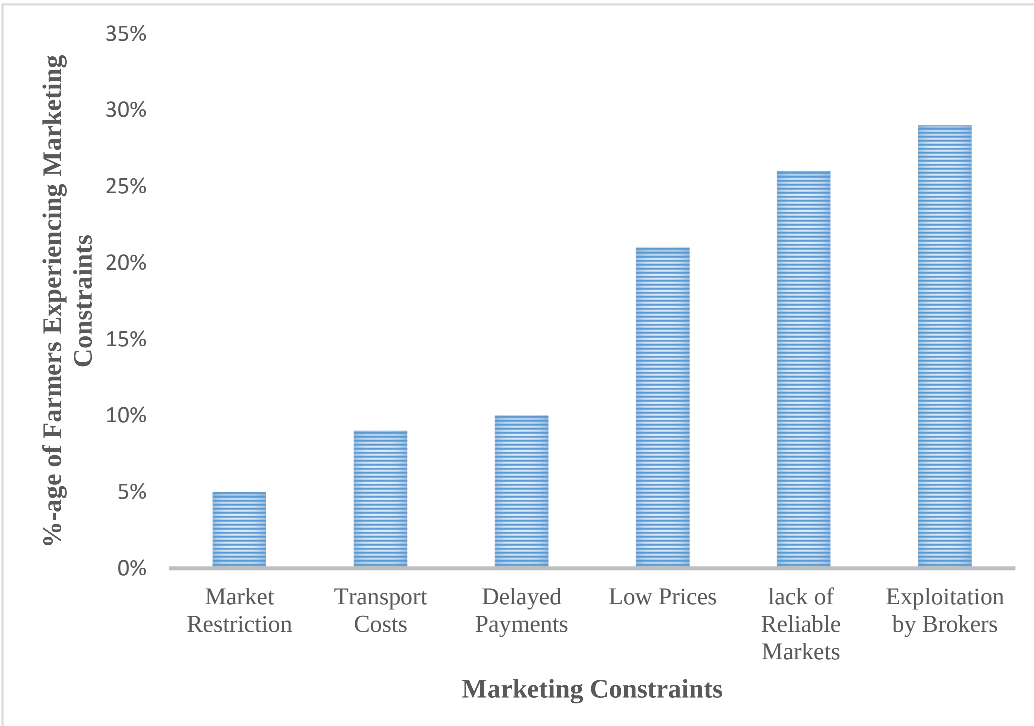
Figure 4.3: Main Buyers of Agricultural Produce in Tana River County

From the analysis in figure 4.26 above, the outcome indicated that a bulk of the agricultural produce was sold through brokers who played the role of middlemen between the farmers and the main markets. Cooperative societies and local traders also played a significant role in the marketing of agricultural produce.

Qualitative information gathered from the 75 extension information service providers also revealed that, while cooperative societies had made efforts in neutralizing the exploitative nature of the brokers they had not been able to fully take over the marketing function owing to poor leadership and group dynamics that made them not to be trusted by a majority of farmers. The cooperative movement was yet to gain acceptance and farmers treated them suspiciously due to previous unpleasant experience.

The study further analyzed the various constraints to marketing agricultural produce this was considered necessary as literature review had pointed out that agricultural marketing was a major problem in Tana River County.

A total of 365 smallholder farmer were asked to enumerate major Constraints to marketing of agricultural produce and a majority (29%) felt that exploitation by brokers was the main constraint followed by lack of reliable markets (26%) and low prices (21%). Market restriction (5%), transport costs (9%) and delayed payments (10%) were found to be the least constraints to marketing agricultural produce in Tan River because in most enterprises, brokers acted as middlemen between farmers and markets besides paying farmers and bearing the cost of transport as most commodities were transacted at farm gate. A summary of the findings is shown in figure 4.4 below.



Source: Research Data, 2019

Figure 4.4: Constraints to Marketing Agricultural Produce

Qualitative data gathered from interviews with the 75 extension service providers also revealed that lack of agricultural marketing information including quality standards, harvesting and post-harvest handling, value addition business acumen skills including arithmetic skills in calculation of gross margins, pricing, and the general poor networking hindered the effectiveness of agricultural marketing.

4.3.3 Relationship Between Use of ICT in The Dissemination of Extension Information and Agricultural Productivity.

The study also evaluated relationship between use of ICT in the distribution of agricultural extension information and agricultural productivity in Tana river County this was because literature review had pointed out that Information and Communication Technology (ICT) was essential in complementing and modernize existing extension approaches and methods thus enhancing efficiency in agricultural information delivery.

To assess this objective the research compared the performances of the maize enterprise in the county, where a sample of 28 maize farming households were grouped into two clusters each of 14 households through an evaluation of those accessing agricultural information through e-extension (mobile phone) and those only accessing information through the convectional direct training and farm visit. Data on number of times the farming households interacted with extension information service providers and corresponding maize production was captured through the use of questionnaires.

This analysis was possible for the maize enterprise as the public agricultural extension information service providers in Tana River county had an ICT information extension platform through the use of mobile phones to disseminate agricultural information to selected maize farmers.

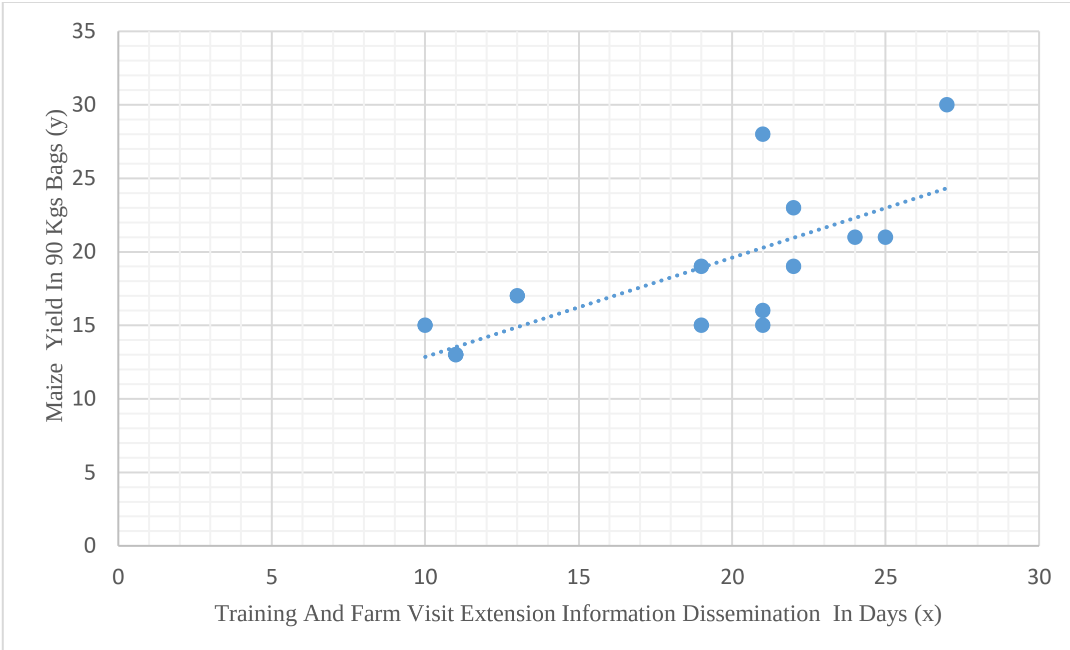
In the study, ***y*** is the dependent variable (Maize Yield in 90kg bags), while ***x*** is the independent variable (Extension information use measured in terms training and farm visits or the number of ICT information dissemination interactions between Extension officers and farmers through the mobile phone). The data collected is shown in Table 4.29 below.

Table 4.29: Maize Production Data for Non-ICT information Accessing Households (Direct Training and Farm Visit Extension Method)

2018 Non-ICT-Extension (Direct Training and Farm visit)						n=14
Extension Training and Farm Visits (*x*)	Maize Yield in 90kg bags (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Mean Maize Production per acre in 90kg bags (y/a)
24	21	504	576	441	3.5	6
21	28	588	441	784	4	7
13	17	221	169	289	4.5	3.8
25	21	525	625	441	5	4.2
19	19	361	361	361	2.5	7.6
21	15	315	441	225	2	7.5
11	13	143	121	169	3	4.3
27	30	810	729	900	2.5	12
22	19	418	484	361	2.5	7.6
11	13	143	121	169	4.5	2.9
10	15	150	100	225	2.5	6
19	15	285	361	225	2.5	6
21	16	336	441	256	3	5.3
22	23	506	484	529	3	7.7
$\Sigma x=266$	$\Sigma y=265$	$\Sigma xy=5305$	$\Sigma x^2=5454$	$\Sigma y^2=5375$	$\bar{x}=3.2$	$\bar{x}=6.3$

Source: Research Data, 2019

Using the x (extension Visits) and y (Maize yield) values a scatter graph was plotted to represent the direction of the relationship as shown in figure 4.5 below;-



Source: Research Data, 2019

Figure 4.5: Training and Farm Visit Extension Information Dissemination Vs Maize Yield

As shown in the scatter graph in figure 4.5 above, a line was drawn through the data to get the best fit or the least square line. In order to draw comparison between use of extension services information and Maize yield, This line of best fit was used to calculate the slope intercept form ***y* = *mx* + *b*** that was used to make true predictions.

The study then used linear regression to forecast the value of ***y*** (maize production) for a given value of ***x*** (extension information use), by determining, the line ***y* = *mx* + *b***

According to Lial, Greenwell and Ritchey, (2016), the "least squares" method is a form of linear regression that gives the relationship between the data points.

From the data analyzed data, extension information visits and maize production values were summed up and squared and the mean production calculated by dividing the maize yield by the acreage. The sum of extension visits ($\sum x$), sum of maize yield ($\sum y$), sum of extension visits multiplied by the corresponding maize yield ($\sum xy$), the sum of the squares of extension visits ($\sum x^2$), and the sum of the squares of maize yield ($\sum y^2$) were calculated as shown above in Table 4.27 above. Based on the analyzed data in table 4.29, the equations below was used to solve for ***m*** first, and then solve for ***b***.

$$m = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x^2) - (\Sigma x)^2} \qquad b = \frac{\Sigma y - m(\Sigma x)}{n}$$

m=14(5,305) – (266)(265)/14(5,454)-(266)2,

=74,270-70,490/76,356-70756

=3780/5600

m=0.675

b=265-0.675(266)/14, =265-172.9/1,

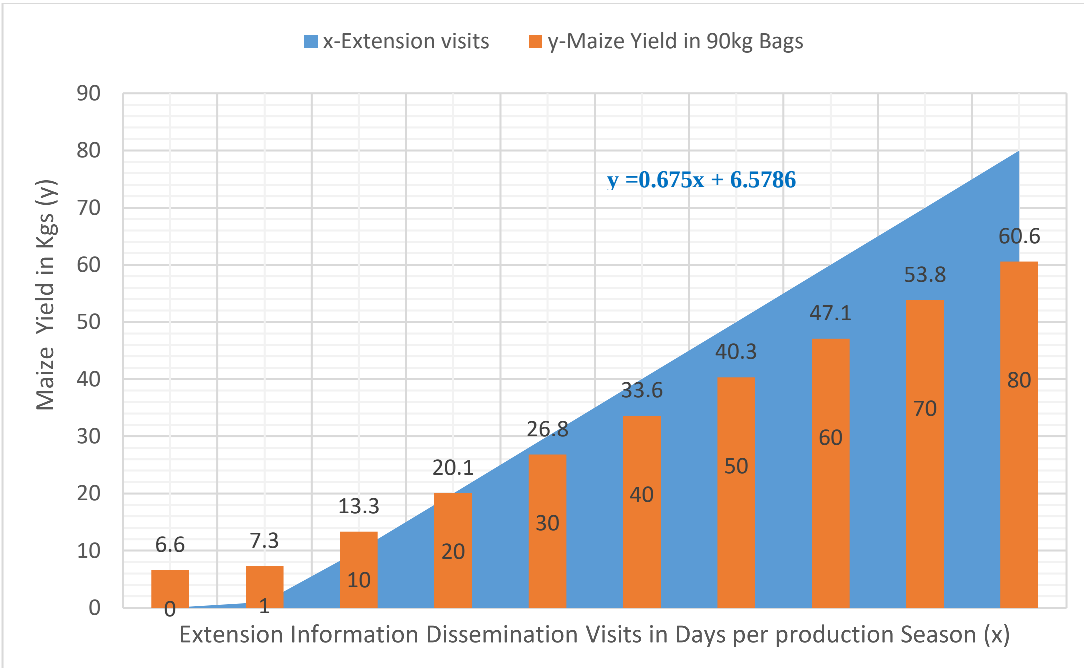
=92.1/14

b=6.5786

y = mx + b

y =0.675x + 6.5786

From the calculations, predictions of ***y*** (Maize production) were made from the given values of ***x*** (Extension information use***)*** using the equation **y =0.675x + 6.5786** as shown in the graph in figure 4.6 below;-



Source: Research Data, 2019

Figure 4.6: Maize Yield Based on Extension Information Use

From the graph in figure 4.6 above, the line starts out at 6.5786 bags and the y-values increase by 0.675 bags for every 1 visit that a public extension information service provider makes to a maize farming household in Tana River County. Using the function y =0.675x + 6.5786 predictions were made for the increase in maize yield (Production) as a result of increase or decrease in extension information use (visits).

The regression analysis also informed that households in Tana River County could still produce up to 6 bags of maize per acre using the previously acquired agricultural knowledge or information from other sources other than from public extension information service providers.

Additionally, qualitative data gathered from Public extension service providers informed that certified maize seeds sourced from Kenya Seed Company could yield up to a maximum of 60 bags per acre when farmers utilized agricultural information, and therefore a regression analysis was used to predict the maximum number of extension information dissemination visits required to attain maximum maize yields per acres using the linear regression analysis function $\boldsymbol{y = mx + b}$

$$y = 0.675x + 6.5786$$

$$60 = 0.675x + 6.5786$$

$$60 - 6.5786 = 0.675x$$

$$53.4214 = 0.675x$$

$$x = 53.4214/0.675$$

$$x = 79.1428.$$

This linear regression analysis implies that for a farmer to produce the optimal 60 bags of maize in a single production season from 1 acre of land, approximately 80 extension information dissemination visits would be required, however for any extra visits above the 80 the economic law of Diminishing Marginal Productivity would apply. Which implys that any extra visits beyond the optimal 80 will not yield any extra bags of maize. However, from the analysis it was noted that while the regression analysis helped in making predictions, to qualify the predictions a Correlation Coefficient analysis was required, in order to help describe how well the data would fit the calculated line.

The study therefore used the Pearson correlation coefficient (r) formulae to determine if the least squares line represented the data as shown below.

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

r=14(5305)-(266)(265)/√14(5454)-(266)^2 *√14(5375)-(265)

r=74,270-70490/√76,356-70756*√75,250-70,225

r=3,780/√5,600*√5,025

r=3,780/74.833*70.887

r=3,780/5,304.687

r=0.713

from the calculation, the correlation was closer to positive 1, implying that the data is highly correlated, and positive. Therefore suggesting that there is a strong positive relationship between use of agricultural extension information and maize productivity among farming households in Tana River County who access and use agricultural information from public extension offices using the convectional extension information dissemination method of direct training and farm visit.

Considering that literature review had informed that ICTs were very useful in the dissemination of agricultural information to farmers. The study decided to draw a comparison between use of ICT as a method of disseminating agricultural extension information and the use the convectional method of Direct farm visit and training the study analyzed Maize yield among smallholder farming households accessing agricultural information from Public extension information service providers through e-extension (Mobile phones).

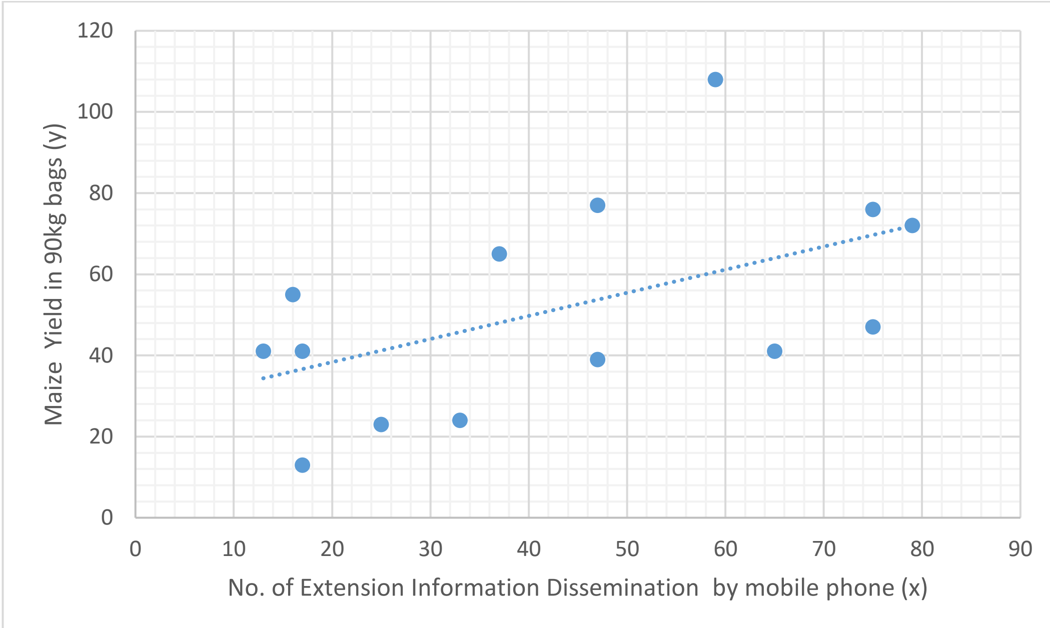
Data on number of times the farming households interacted with extension information service providers through e-extension (mobile phones) and corresponding maize production was captured through the use of questionnaires. This analysis was possible for the maize enterprise as the public agricultural extension information service providers in Tana River county had an ICT information extension platform through the use of mobile phones to disseminate agricultural information to selected maize farmers. The data collected is shown in Table 4.30 below.

Table 4.30: Maize Production Data for ICT Accessing Households

2018 ICT-Extension						n=14
No. of Extension information Dissemination through Mobile phone (*x*)	Maize Yield in 90kg bags (*y*)	(*xy*)	(x^2)	(y^2)	Acreage (a)	Mean Maize Production per acre in 90kg bags (y/a)
33	24	792	1089	576	3.5	6.9
17	13	221	289	169	2.5	5.2
47	39	1833	2209	1521	2	19.5
25	23	575	625	529	2	11.5
47	77	3619	2209	5929	4.5	17.1
59	108	6372	3481	11664	4.5	24
17	41	697	289	1681	5	8.2
13	41	533	169	1681	5	8.2
16	55	880	256	3025	5	11
37	65	2405	1369	4225	5.5	11.8
65	41	2665	4225	1681	2	20.5
75	47	3525	5625	2209	1.5	31.3
79	72	5688	6241	5184	2	36
75	76	5700	5625	5776	2.5	30.4
$\Sigma x=605$	$\Sigma y=722$	$\Sigma xy=35505$	$\Sigma x^2=33701$	$\Sigma y^2=45850$	$\bar{x}=3.4$	$\bar{x}=17.3$

Source: Research Data, 2019

Using the x (Extension information Dissemination through Mobile phone) and y (Maize yield) values, a scatter graph was drawn to represent the direction of the relationship as shown figure 4.7 below;-



Source: Research Data, 2019

Figure 4.7: E-Extension Information Dissemination Vs Maize Yield

In order to draw comparison between use of ICT in extension information dissemination and Maize yield, a line was drawn through the data as shown in the scatter graph in figure 4.30 above to get the best fit or the least square line. This line of best fit was used to calculate the slope intercept form $y = mx + b$ that was used to make true predictions. The study then used linear regression to predict the value of y for a given value of x, by determining, the line of best fit that describes the linear qualities of the data, and how well the line fit the cluster of points.

From the analyzed data, extension information visits and maize production values were summed up and squared and the mean production calculated by dividing the maize yield by the acreage.

The sum of Extension information Dissemination interactions through Mobile phone ($\sum x$), corresponding sum of maize yield ($\sum y$), sum of Extension information Dissemination interactions through Mobile phone multiplied by the corresponding maize yield ($\sum xy$), the sum of the squares of Extension information Dissemination interactions through Mobile phone ($\sum x^2$), and the sum of the squares of maize yield ($\sum y^2$) were calculated as shown above in Table 4.28 above. Each piece was then fed into the equations for ***m*** and ***b*** based on the original dataset in order to calculated the least squares line which has two components: the slope **m**, and y-intercept **b**. Based on the analyzed data in table 4.28, the equations below was used to solve for ***m*** first, and then solve for ***b***.

$$m = \frac{n(\Sigma xy)-(\Sigma x)(\Sigma y)}{n(\Sigma x^2)-(\Sigma x)^2} \qquad b = \frac{\Sigma y - m(\Sigma x)}{n}$$

$m=14(35,505)-(605)(722)/14(33,701)-(605)^2$

m=497,070-436,810/471,814-366,025

m=60,260/105,789

m=0.57

b=722-0.5696(605)/14

b=(722-344.85)/14

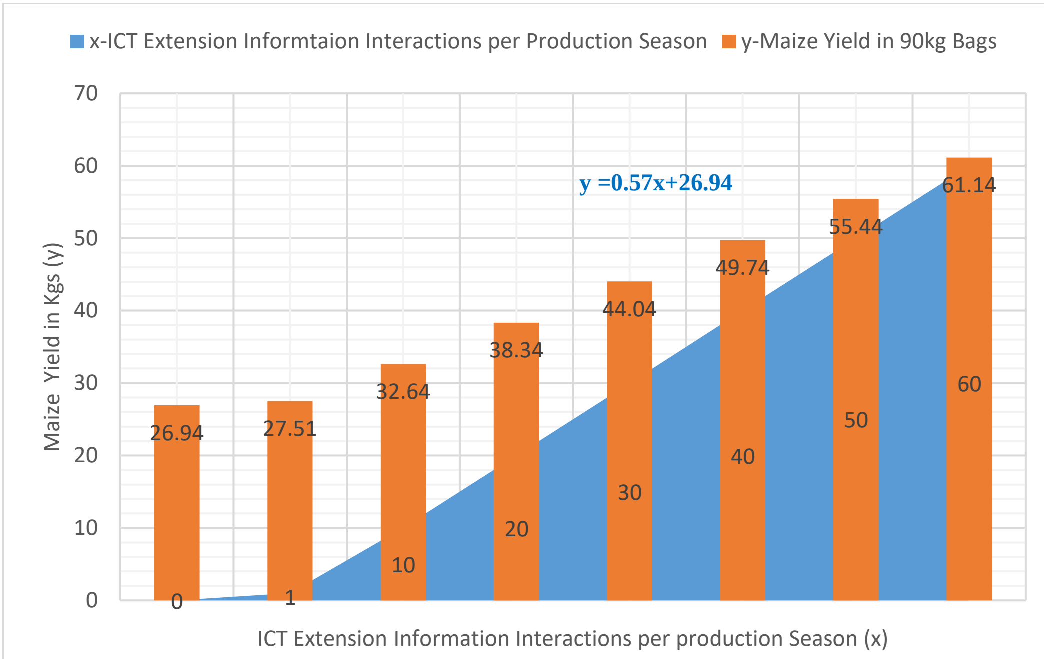
b=377.15/14

b=26.94

y = mx + b

y =0.57x + 26.94

Predictions of ***y*** (Maize production) were made from the given values of ***x*** (Extension information use***)*** using the equation: y =0.57x + 26.94**.** as shown in the graph in figure 4.8 below;-



Source: Research Data, 2019

Figure 4.8: Maize Yield Based on ICT Extension Information Use

From the graph above the line starts out at 26.94 bags of maize and the y-values increase by 0.57 bags for every 1 ICT interaction with a maize farming Household in Tana river county. Using the function y =0.57x+26.94, predictions were made for the increase or decrease in maize yield (Production) as a result of increase or reduction in extension information usage (ICT interactions)

The regression analysis informed that households in Tana River County using ICT to access agricultural information could produce up to 26.94 bags of maize owing to prior knowledge without applying the knowledge disseminated by public agricultural extension service providers. This implied that there were other source of agricultural information besides the public extension service providers. Additional qualitative data gathered from extension information service providers informed that the selection of farming households for the e-extension program was based on literacy levels and the ability to use a smart phone where illiterate farmers were omitted. The high productivity among these category of farmers could therefore be attributed the selection criterion.

Further qualitative data gathered from Public extension service providers also informed that certified maize seeds sourced from Kenya seed company coupled with use of Agricultural extension information could yield up to a maximum of 60 bags of maize per acre and therefore using the regression analysis it was possible to calculate the maximum number of ICT interactions required to attain maximum maize yields per acre using the function;- ***y = mx + b***

$$y = 0.57x + 26.94$$

$$60 = 0.57x + 26.94$$

$$60 - 26.94 = 0.57x$$

$$33.06 = 0.57x$$

$$33.06/0.57 = x$$

$$x = 58$$

This implies that for a farmer to produce the optimal 60 bags of maize in a single production season from 1 acre of land, 58 ICT interactions would be required, nonetheless any extra visits above the 58 will not yield any extra bags of maize as the economic law of Diminishing Marginal Productivity would apply. Nevertheless from the analysis it was determined that the use of ICT increased efficiency in agricultural information dissemination as depicted in the reduced number of interactions from 80 under the convectional direct training and farm visit as compared to 58 under e-extension to produce the same optimal quantity of 60 bags of maize from one acres of land.

However, while the regression analysis helps in making predictions, to qualify this forecasts a Correlation Coefficient analysis was required, which describes how well the data fits the calculated line. The study therefore used the Pearson correlation coefficient (r) formulae to determine if the least squares line was a good model for the data as shown below.

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} * \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$r=14(35505)-(605)(722)/ \sqrt{14(33701)-(605)^2} * \sqrt{14(45850)-(722)^2}$

r=497,070-436,810/√471,814-366,025*√641,900-521,284

r=60,260/√105789*√120,616

r=60,260/325.252*347.298

r=60,260/112,959.3691

r=0.533

The correlation value calculated above being closer to positive 1, implied that the data is moderately correlated, and positive. Therefore suggesting that there is a moderately strong positive relationship between use of ICT in dissemination of extension information and maize productivity in Tana River County.

However further comparison of the two correlational values calculated for both convectional direct training and farm visit (r=0.713) against the use of ICT (mobile phone) in dissemination of extension information (r=0.533), it was deducted that, while Maize productivity for households under ICT extension information dissemination was higher (average 17.3bags per acre) in comparison to the direct training and farm visit (Average 6.3 bags per acre) and less interactions were required to yield the same quantity of maize per acres, on the contrary there was a strong positive relationship between direct training and farm visit (r=0.713) and maize productivity than under ICT information dissemination (r=0.533).

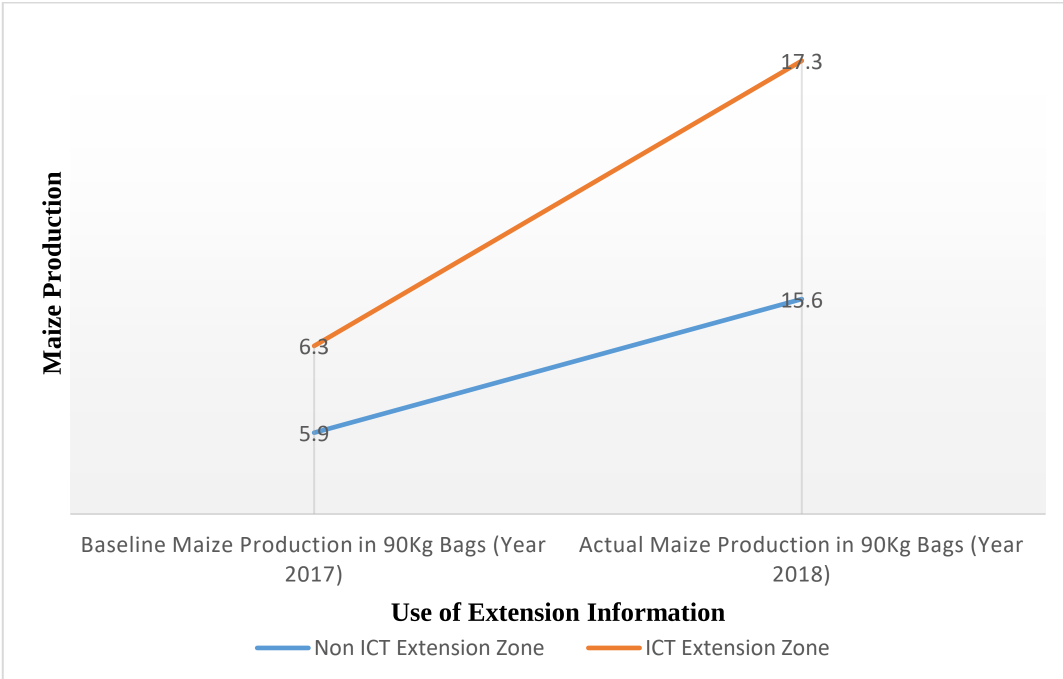
The explanation for the strong correlation was credited to the unit increment where under ICT for every 1 interaction, maize yield improved by 0.57 bags as compared to the convectional direct training and farm visit where for every 1 visit an increment of 0.675 bags was registered by maize farming Household in Tana River County.

The study also analyzed the impact of agricultural productivity in relationship to use of ICT in the dissemination of extension information by evaluating the Maize value chain, considering that the ministry of agriculture had started piloting the use of mobile phones in disseminating information to farming households under the maize value chain. This therefore offered a better comparison for the application of ICT in agricultural information dissemination against the convectional training and farm visit.

Through the recall method 28 maize farmers were requested to fill questionnaires by providing data on maize production for the year 2017 as a baseline and the year 2018 for the actual year under review.

The 28 maize farming households were equally grouped into two groups each of 14 households, those accessing information through e-extension (ICT) and those accessing through the convectional direct training and farm visit and the data gathered.

From the analysis, it was found that the follow-up production of both the ICT Extension farmers and non-ICT extension farmers had gradually increased from 6.3 to 17.3 bags per acres and from 5.9 to 15.6 bags respectively. However the rate of increase for farming households using e-extension model (ICT) was higher as compared to those under the convectional training and farm visit (Non-ICT). A summary of the findings is represented in the graph in fig. 4.9 below;



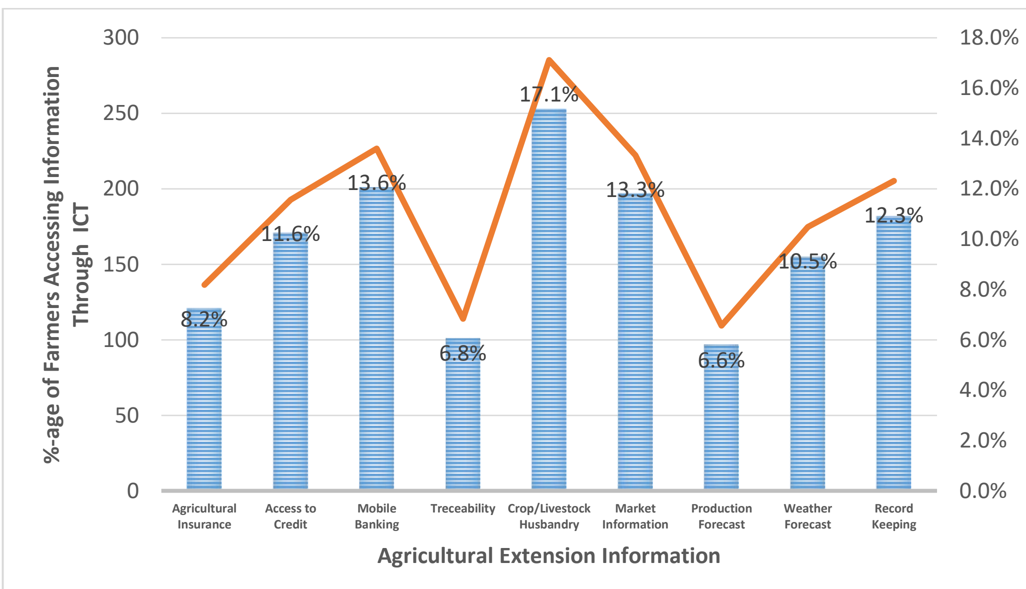
Source: Research Data, 2019

Figure 4.9: Production Performance of Maize by baseline and follow-up

Further qualitative data collected from Extension Service providers through interviews credited the difference in maize production to the fact that farmers under e-extension were able to provide better treatment for crops as a result of accessing timely information and therefore able to make informed decision regarding land preparation, variety selection, nutrition, pest and diseases control, harvesting and post harvesting handling and marketing, besides accessing other important information on agricultural technology and therefore, their production increased proportionately.

the study also evaluated the application of ICT (e-extension) in dissemination of agricultural information by appraising different kinds of Agricultural information accessed by farmers through ICT. Through questionnaires, 365 farming households were asked to provide the different types of information accessed through the mobile phone, internet, radio, television and print media.

From the data gathered, it was realized that e-extension was moist effective in disseminating information on crop and animal husbandry (17%), but farmers also applied Mobile banking (13.6%), accessed market information (13.3%) and used the mobile phone (12.3%) in record keeping. E-extension was however not well applied in production forecast (6.6%) and traceability (6.8%) in Tana River County. The a summary of the data gathered is shown figure. 4.10 below;



Source: Research Data, 2019

Figure 4.10: Application of ICT in Dissemination of Agricultural Information

Qualitative data gathers revealed that, though Mobile banking and online access to credit was a new concept many farmers seemed to be quickly embracing the technology and this was attributed to financial institutions requirement for proper farm record keeping before advancing credit.

Additional qualitative data gathered from interviews with the extension service providers informed that, owing to the risks associated with farming a few farmers especially those under contract and those accessing credit facilities had also taken agricultural insurance through the use of mobile phones and premiums were being paid via MPESA and Equitel mobile banking services respectively offered by Safaricom Plc. and Equity Bank.

Further qualitative data showed that the use of Mobile banking through MPESA, Airtel, Telecom and Equitel was gaining popularity and some farmers had adopted online banking services offered by financial institutions for ease of access to financial information.

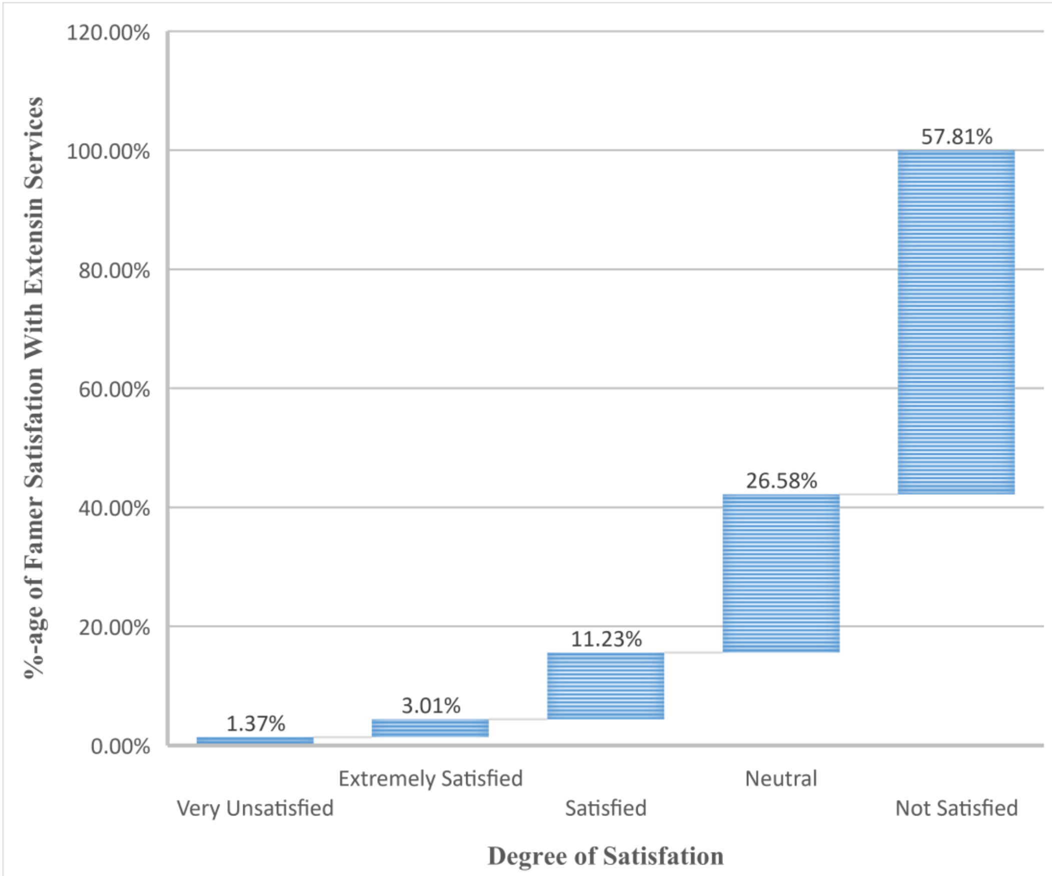
4.3.4 Relationship between constraints in accessing extension information services and agricultural productivity.

In order to appreciate if the constraints that smallholder farmers in Tana River County faced in accessing and utilizing agricultural extension information was related to their agricultural productivity, the study evaluated the level of satisfaction farmers had with extension information disseminated.

The study therefore collected the opinions about farmer satisfaction with the extension information provided using an odd 5-Point Likert Scale that included 4 extreme options with a neutral choice to measure the degree of satisfaction.

Through the use of questionnaires a total of 365 farmers were asked to provide their level of satisfaction with extension services provided based on the Likert scale.

The study found out that out of the 365 farming households that participated in the study, a majority were not satisfied (58%) with the extension information services disseminated. as only a few (11%) were satisfied. However a good number of farmers (27%) did not finding any value in the extension services provided because they were too infrequent with the extension service provider not being well equipped to handle an extension training session owing to deficiency in both pedagogy and andragogy and therefore in spite of the visit the farmers could not precisely tell whether the interactions had any relationship with agricultural productivity. The data gathered is summarized in the bar chart in figure 4.11 below.



Source: Research Data, 2019

Figure 4.11: Farmer Satisfaction with Extension Services

From the qualitative data collected from the interviews with the 75 extension information service providers it was deducted that, one of the possible reasons as to why agricultural productivity had declined in Tana River County was as a result of the agricultural sector failure to improve the effectiveness of the extension information system, and this fact was substantiated by the extension service providers who confirmed that desirable results were yet to be felt due to inefficient financing needed for setting up demonstration plots where farmers could learn essential agricultural concepts.

The extension information service providers also attested to the fact that there was the tendency for under provision of activity facilitation funds such as vehicles and inputs needed for effective extension operations and demonstrations, besides the bureaucratic system characteristic of all government funded projects as extension officers lacked the authority to change the definition of their duties.

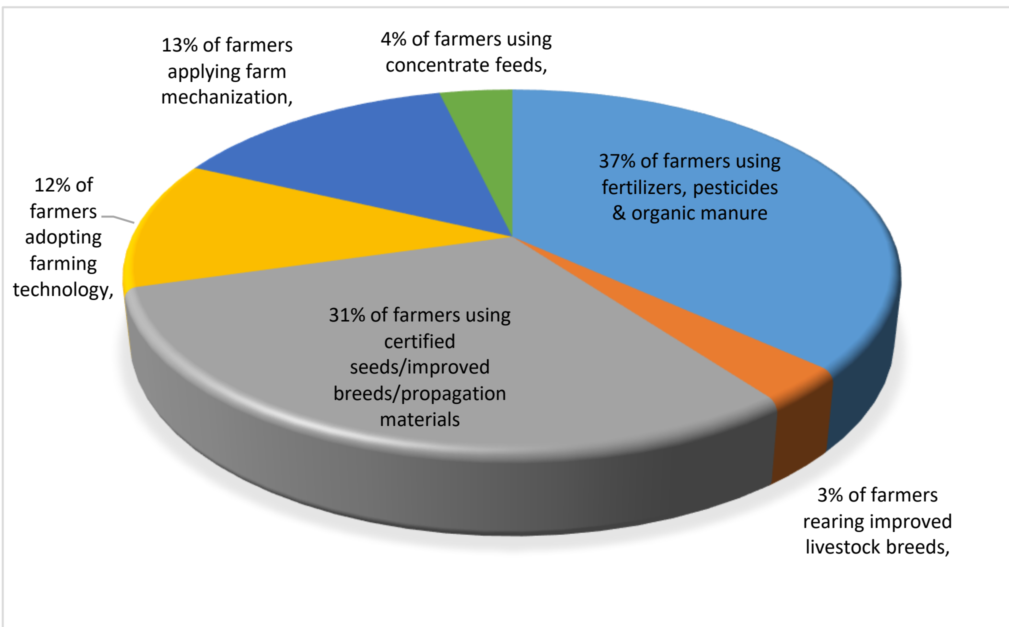
Qualitatively however, there was the general feeling among all the respondents that efficiency in information dissemination was essential in order to offer a seamless access to relevant and timely information that will impart relevant skills in agricultural sciences and technology.

In an effort to appreciate the relationship between constraints to utilization of extension services information and agricultural productivity, the study sought to find out the level at which farmers in Tana River County had embraced good agricultural practice as a result of accessing and utilizing agricultural extension information. This was in an effort to understand how effective the agricultural extension information system had contributed to improving productivity.

A total of 365 farmers were requested to fill questionnaires in order to find out if they utilized the information received from the extension service providers. It was realized that out of the 365 farming households engaged in the study, a majority (37%) were found to be using fertilizers, pesticides and concentrate feeds, a few farmers (3%) reared improved livestock breeds or used concentrate feeds (4%).

However a significant number of farming households (31%) were using certified seed improved breeds and propagation materials.

Nevertheless it was worrying to note that few farmers (13%) had embraces farm mechanization or adopted any farming technology (12%). This implied that, besides having not embraced demand driven access to extension information services, utilization of agricultural information by smallholder farmers in Tana River County was relatively low. The data gathered is summarized in the pie chart in figure 4.12 below.

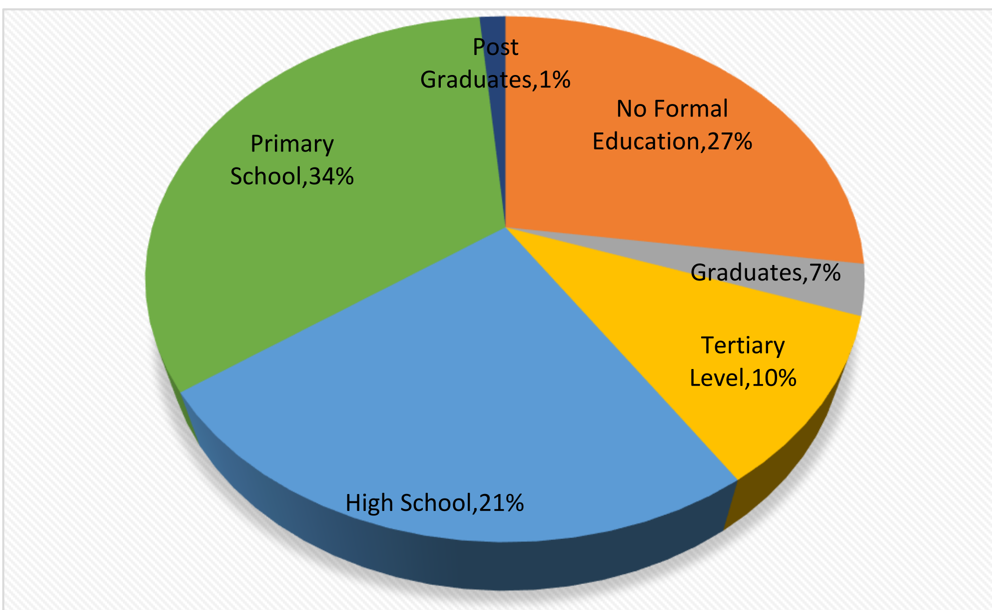


Source: Research Data, 2019

Figure 4.12: Use of information to enhance Agricultural Productivity

Considering the fact that low agricultural productivity was attributed to the constraints to accessing and using extension information the study sought to evaluate the literacy levels of famers in Tana River County. Through questionnaires a total of 365 farmers were requested to provide their level of education so as to lay the basis for effective access and utilization of extension information.

From the data gathered it was appreciated that most of the farmers had low literacy level with most having only received primary education (34%). It was however also worrying to realize that a significant number of farmers either had no formal education (27%) and therefore could neither read nor write properly and therefore considered illiterate. The data gathered is summarized in the pie chart in figure 4.13 below.



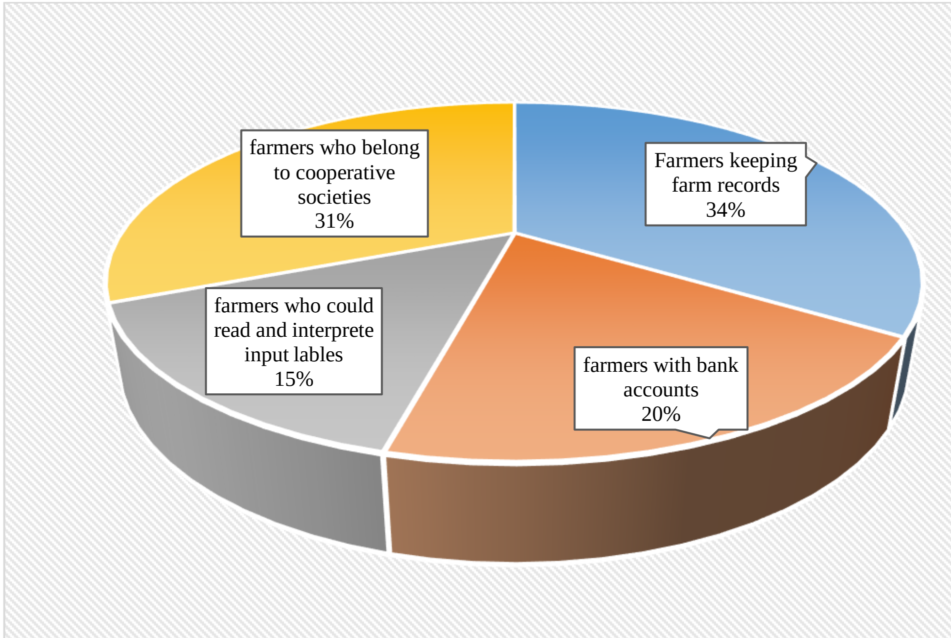
Source: Research Data, 2019

Figure 4.13: Literacy levels of famers in Tana River County

From the qualitative data gathered through interviews with extension information service providers it was gathered that a majority of the farmers in Tana river county could not satisfactorily search and utilize agricultural information without the guidance of an extension information service provider. A bulk of the farmers in Tana River County were not able to keep farm record, read farm input labels, open bank accounts hence needed the assistance of the extension information service providers.

The study further sought to assess the Competence abilities of famers in Tana River County to run an agribusiness. The sampled 365 households were asked to confirm if they belonged to any farmer business organization, kept farm records, could read and interpret input labels and instructions and had an active bank account.

Data gathered revealed that, a good number of farmers in Tana river kept Farm record (34%) and belonged to cooperative societies (31%). However only a paltry size of farmers had active bank accounts (20%) and very few could properly read and interpreted input instructions of read labels (15%). The data gathered is summarized in the pie chart in figure 4.14 below;-



Source: Research Data, 2019

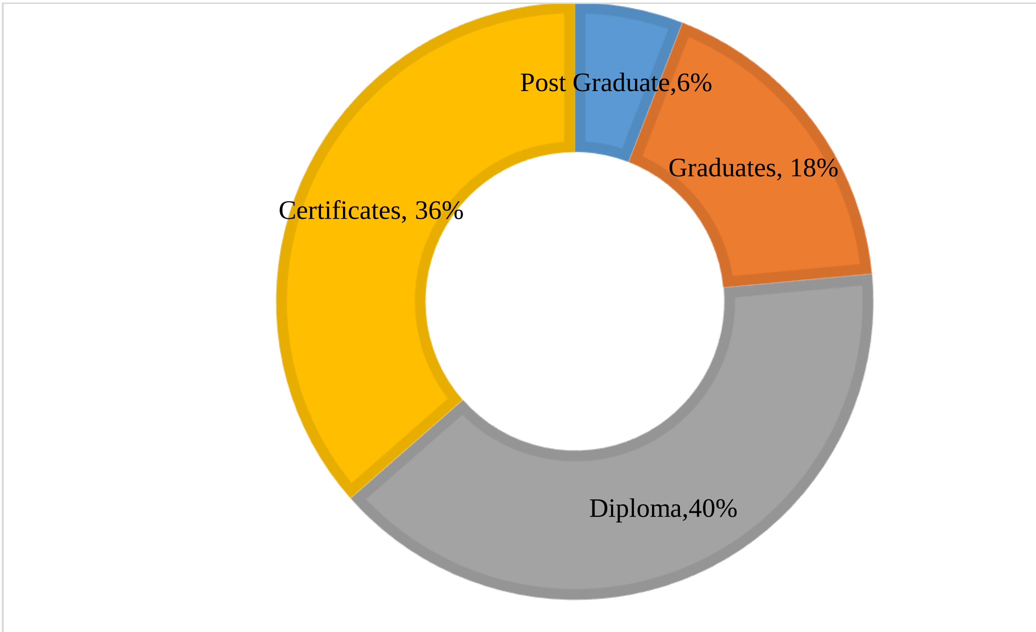
Figure 4.14: Competence Abilities Of Famers In Tana River County

In view of the foregoing the study found it necessary to evaluate the education levels of extension information service providers in an effort to demonstrate the skills possessed by extension service providers considering the fact that for the illiterate farming households to adequately receive and utilize extension information in order to improved agricultural production there was need for an extension information team to possess essential skills in information dissemination methods.

This analysis was carried out through both direct interviews with the extension service providers and as a desk review where the qualifications of the 85 deployed extension information team was appraised.

From the data assembled , it was evidenced that, there was a need to retrain the extension service providers especially on delivery methods and rural sociology, considering that out of the 85 extension service provider deployed in the county only five (6%) had post graduate qualifications thus considered to possess analytical and research skills, even though none of the post graduate qualifications were in agriculture education and extension. This was a clear indicator of the limitations the agriculture department had in the area of training, research and development.

The data revealed that, most extension service providers in the county neither possessed andragogy nor pedagogy skills and out of the 15 (18%) extension information service providers who were graduates in agriculture, non-had studied agriculture education and extension, and while the County had the bulk of the extension agents having certificate (36%) and diplomas (40%) only three out of the total 85 (3.5%) extension service providers in Tana River County had relevant skill in agriculture education and extension. The data is summarized in the doughnut in figure 4.15 below.



Source: Research Data, 2019

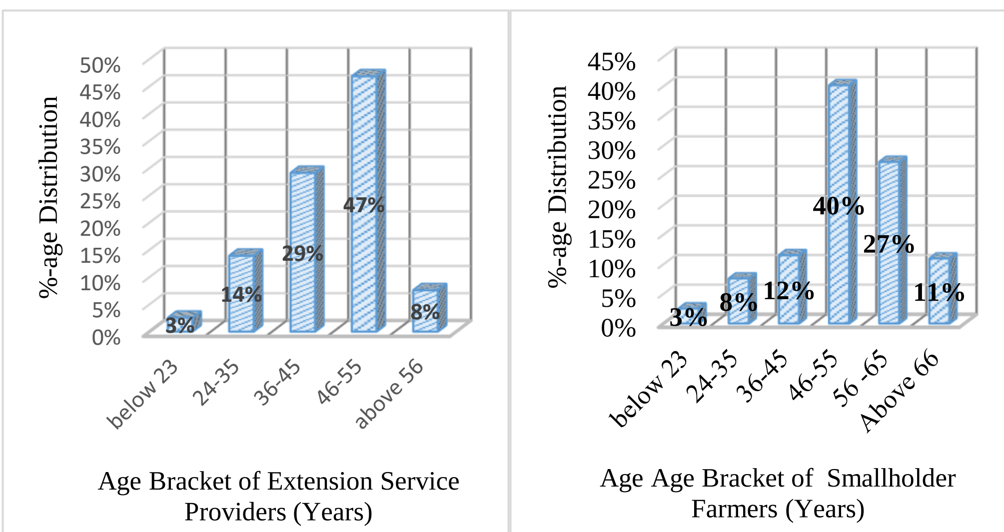
Figure 4.15: Extension Information Service Providers Qualifications

Further qualitative data gathered indicated that in view of the illiteracy levels of the smallholder farmers coupled with no background in modern agriculture the lack of knowledge and skills in extension information delivery methods was directly related to the low agricultural productivity considering that information was an important input in agricultural production.

Furthermore, qualitative data collected from extension service providers revealed that, extension services were not demand driven hence the inability to cost share hindered the sustainability of the public extension programs in Tana River County.

The study also found it necessary to evaluate the age of extension information service providers and farmers considering the fact that literature review had confirmed that age influenced the adoption of agricultural technology. Through interviews with the extension team data was collected on the different ages of the 85 deployed extension information service providers. Similarly through questionnaires heads of farming households were asked to provide their ages.

From the data, it was clear that most of the extension information service providers were between the ages of 45-55 years therefore considered to be nearing retirement (47%) while a majority of the farmers were between the ages of 46-55 years (40%) and therefore were not conversant with modern farming technologies. This age factor was found to be a constraint to the adoption of relevant agricultural concepts, technologies and application of research and development and therefore negatively affected agricultural productivity in Tana River County. The gathered data is summarize in the bar graphs in figure 4.16 below.

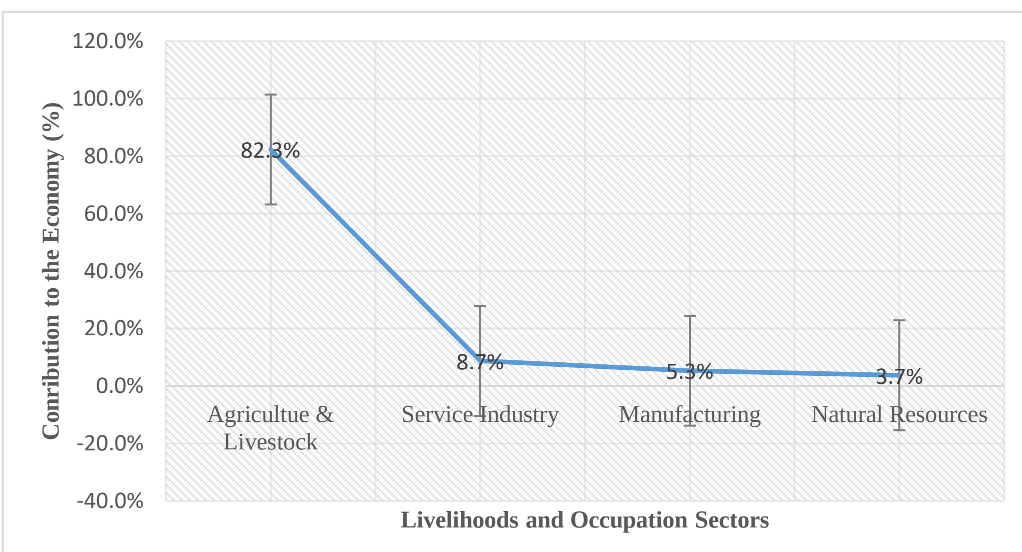


Source: Research Data, 2019

Figure 4.16: Age of Extension Service Providers and Smallholder Farmers

The study also found it necessary to evaluate the importance of agriculture in the economy of the county in view of the fact that literature review had revealed that agriculture was the backbone of the economy. Through the use of questionnaires 365 farming households were asked to list their main sources of income.

From the data gathered, the study acknowledged that a majority of the County's population dependent on agriculture and livestock production (82%) and it was therefore paramount that extension information delivery needed enhancement for improved productivity. Further analysis revealed that, natural resources (4%) and the manufacturing industry (5%) had not been fully exploited and while the service industry (9%) was showing some signs of growth, its effect on the economy were very minimal. The data gathered is summarized in the line graph in figure 4.17 below;

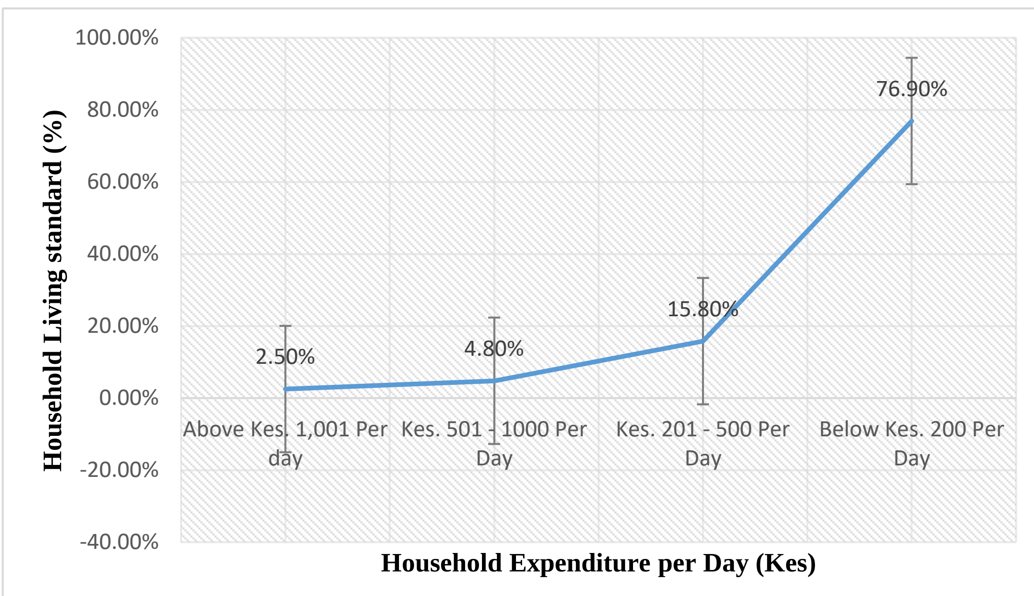


Source: Research Data, 2019

Figure 4.17: Contribution of Agriculture to the Economy of Tana River County

The study having confirmed that the economy of the county depended on agriculture there was a need to evaluate the living standards of the county's population. Through questionnaires 365 farming households were asked to provide data on their daily expenditure.

From the data collected, it was considered the a majority of Tana River County population was living below two dollars per day (77%) considering that one USD Dollar was equivalent to about kes.100. This therefore evidenced that a majority of the population was poor, and with a population growth rate of 2.8%, (KNBS, 2019) the County was faced with the challenge of feeding the increasing population. The responses Are summarized in the line graph in figure 4.18 below.



Source: Research Data, 2019

Figure 4.18: Tana River County Living Standards

Interviews with the public agriculture extension information agents was carried out in order to understand the Minimum Technical Staff to Farmer Ratios this was because literature review had revealed that the recommended ratio was 1:640 (NASEP, 2012, MoALF, 2017) in an Agro-Pastoral Farming System typical to Tana River County.

From the data gathered, it was considered that, a single agricultural information extension service provider was accountable for over 900 farming households as compared to the desired 640 farmers in an agro-pastoral farming system, this ratio evidenced the difficulties in attending to all the information needs of the farmers and as a consequence negatively affecting agricultural productivity as farmers did not access timely agricultural information. The data collected is summarized in table 4.31 below.

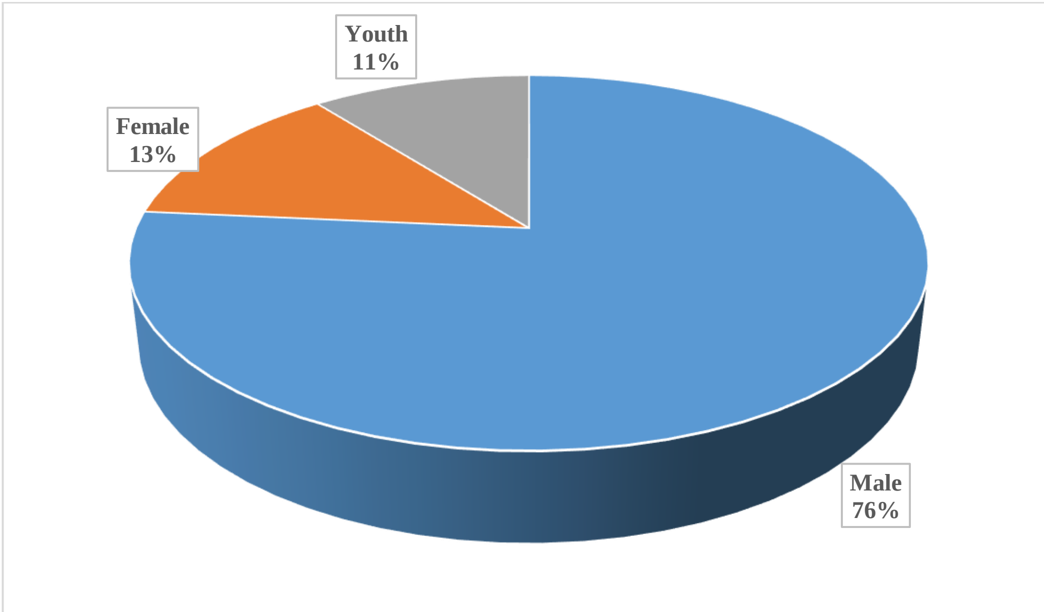
Table 4.31: Ratio between Agricultural Extension Information Service Providers and Farming Households

Sub-County	Agricultural Ward	No. of Extension Service Providers (e)	Approximate Farming Population (p)	Approximate Farming Households (h)	Ratio (Extension Service providers: farming Household) (h/e)
Tana Delta (Garsen)	Garsen South	5	26,113	6223	1245
	Garsen Central	12	25,449	5090	424
	Garsen West	4	17,438	3488	872
	Garsen North	3	18,158	3632	1211
	Kipini East	2	13,852	2784	1392
	Kipini West	3	15,747	3149	1050
Tana River (Galole)	Kinakomba	6	23,414	5683	947
	Chewani	15	25,657	6131	409
	Wayu	5	25,165	5033	1007
	Mikinduni	3	14,310	2862	954
Tana North (Bura)	Chewele	4	24,362	4872	1218
	Hirimani	9	23,706	5741	638
	Madogo	8	25,508	6102	763
	Sala	3	15,777	3155	1052
	Bangale	3	21,287	4297	1432
Total		**Σ=85**	**Σ=315,943**	**Σ=68,242**	**$\bar{x}$=974**

Source: Research Data, 2019

Through the demographic data collected, gender issues affecting agricultural extension were also exposed. The study revealed that, gender disparities similarly affected the quality of extension information services, for the reason that, the prevailing information sources and systems were affected by factors such as illiteracy, language barrier, poverty, inability to set aside time for research and availability of untrustworthy information.

From the data collected, it was exposed that there were inequality between the number of male, female and youthful extension information services providers. The number of females was too low in contrast to the number of males, considering that out of the 85 extension service providers in the county only eleven (13%) were female and nine (11%) were below the age of 35 besides them being all male. This therefore implied there was a gender disparities in extension service provision in Tana River County with the extension team being dominated by the male gender (87%) The data collected is summarized in the pie chart in figure 4.19 below.



Source: Research Data, 2019

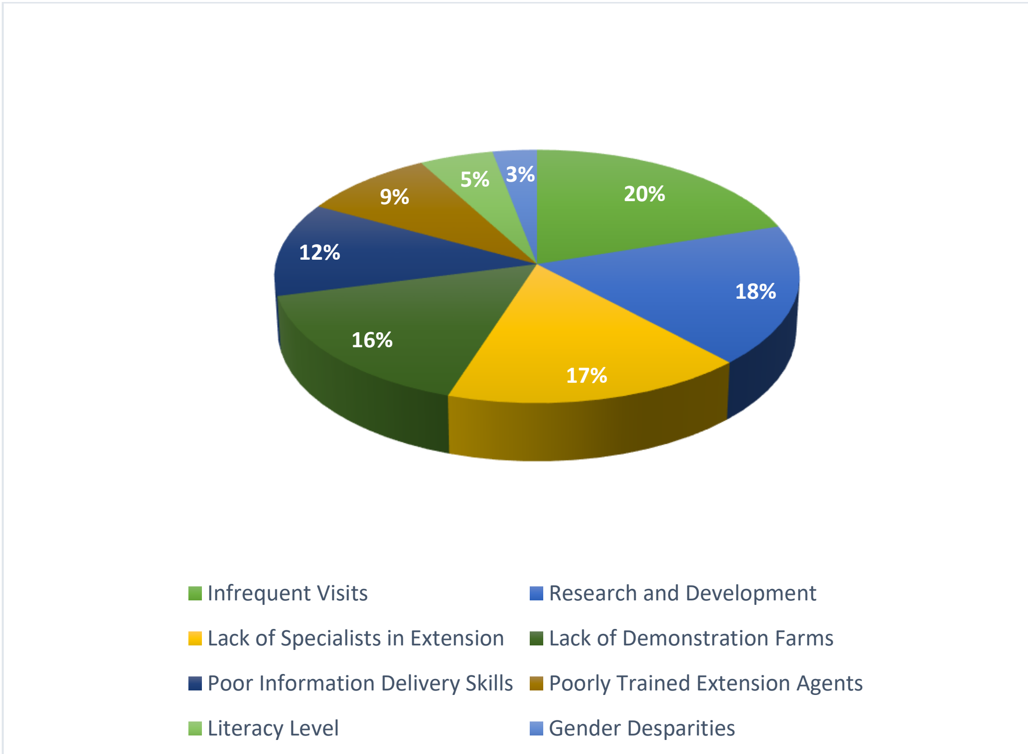
Figure 4.19: Gender Distribution in Agricultural Extension information Service Provision

Further qualitative data collected gathered from interviews with the extension information service providers informed that this inequality in extension personnel affected extension delivery in that, sometimes female farmers were not comfortable under the guidance of a male extension officer. These factors were found to be affecting the effectiveness of extension information services and eventually the constraints lowered agricultural productivity in Tana River County.

The study also evaluated the degree at farming households felt various identified constraints to accessing agricultural information affected agricultural productivity, through the use of questionnaires 365 farming households were asked to provide the major limitations faced in accessing relevant agricultural information.

From the data gathered, it was noted that the main constraint to accessing agricultural information was the infrequent visits by extension information agents (20%), though the inability to carry out research and translate the results to farmers (18%) plus the lack of specialized extension experts (17%) and lack of demonstration farms (16%) were mentioned as other major constraints that affected agricultural productivity in Tana River County.

Unpredictably while the study had revealed that a majority of the farming population in Tana river County was illiterate, and that most extension information service providers were male, illiteracy levels (5%) and gender disparities (3%) in extension were found not to be major constraints affecting the dissemination of agricultural information and therefore not perceived to be adversely affecting agricultural productivity. Other constraints identified were poorly trained extension agents (9%) and Poor information delivery skills (12%). The findings are summarized in the pie chart in figure 4.20



Source: Research Data, 2019

Figure 4.20: Constraints to Accessing Agricultural information

The study therefore concluded that farmers in Tana River County were confronted by numerous constraints in accessing information and this greatly contributed to low agricultural productivity. An ineffective extension system was blamed for the challenges and there was a need to streamline information delivery to farming households

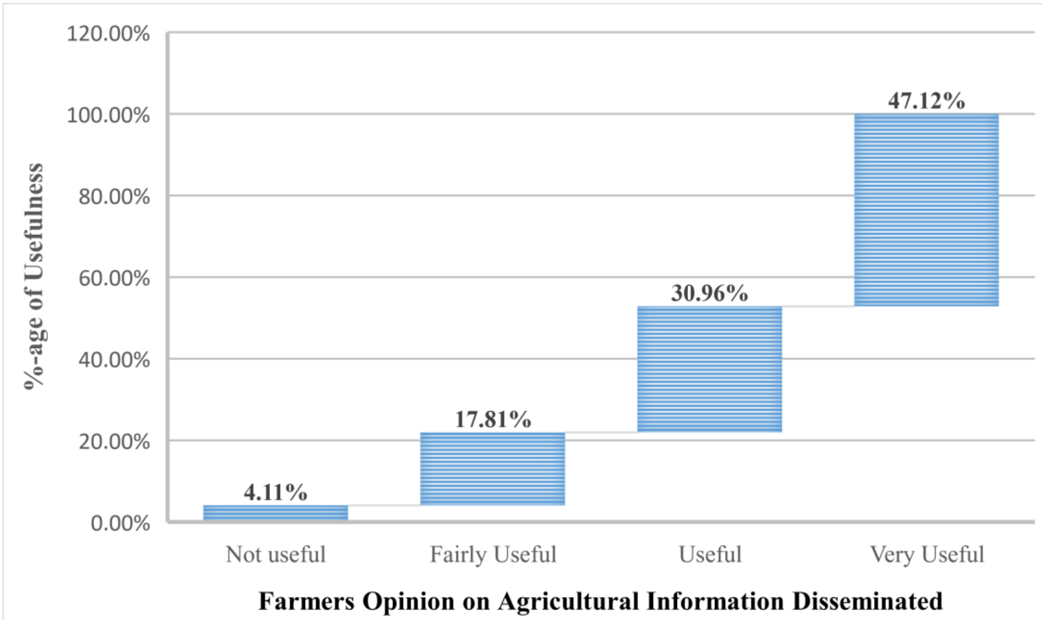
4.3.5 Relationship between methods used in the dissemination of extension information services and agricultural productivity.

In an effort to evaluate the Relationship between Extension Information Delivery Methods and Agricultural Productivity the study evaluated various methods that agricultural extension information service providers employed in disseminating information to farmers in Tana River County. This was to gain an understanding of whether the farmers found the information disseminated useful in improving agricultural productivity.

A psychometric Likert scale was used to measuring respondent's opinion or attitude towards the disseminated agricultural information. An even 4-Point Likert Scale that included 4 extreme options without a neutral choice was used to measure the degrees of usefulness.

Through the use of questionnaires a total of 365 farming households were asked to state on an even Likert scale of up to 4 how useful the information disseminated was in relationship to improving agricultural productivity.

The research findings revealed that a majority of the farmers (47%) in Tana River County found the information disseminated very useful in relationship to improving agricultural productivity and only a few (4%) did not did not apply the information disseminated mainly because they found it absolute and outdated. This were the category of knowledgeable farmers who were applying agricultural technology that was not familiar to the extension service providers and this pointed to the need for the retraining of the extension service providers. The results are summarized in the bar graph in figure 4.21 below.



Source: Research Data, 2019

Figure 4.21: Farmers Views On Disseminated Agriculture Information

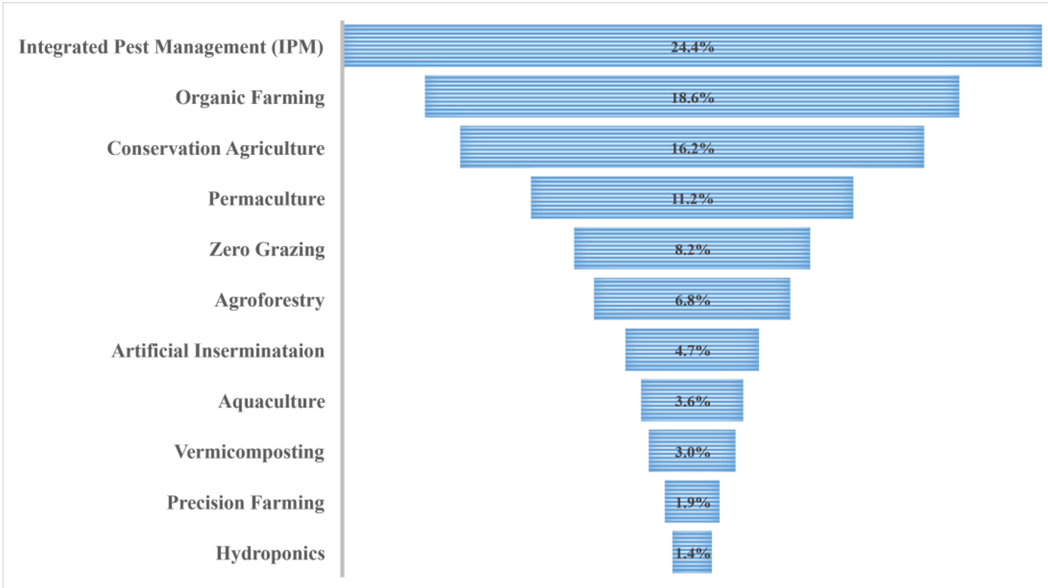
Further Qualitative data from the farming households revealed that farmers who were unsatisfied attributed it to the infrequent visits and the ill trained and unprepared of extension agents. A majority of the farmers were either fairly satisfied or felt that the services met expectations though they were of the opinion that more resources should have been allocated to the department of agriculture and that the county government required sound agricultural extension policies so are to ensure efficiency in service delivery.

Following the revelation that extension agents had incapacities skills and that some farmers were applying agricultural technologies that was not familiar to the extension service providers, the study sought to analyze skills in various specialized agricultural sciences possessed by extension information service providers in Tana River County.

From data gathered, it was acknowledged that a good number of extension service providers had knowledge and skills in integrated pest management (24%), organic farming (19%), conservation agriculture (16%) permaculture (11%), and zero grazing (8%). but were generally deficient in other Specialized agricultural science skills where very few has relevant skills in agroforestry (7%) artificial insemination (5%), aquaculture(4%) and vermicomposting (3%).

Unfortunately nearly the entire extension team was found not to be having relevant skills in precision farming (2%) and hydroponics (1%), that entailed the integration of ICT through the use of farm Management information systems. These incapacities were attributed to the aging public extension information service providers.

The identified incapacities were found to be directly related to the poor agricultural productivity in the county especially in the specialized agricultural enterprises such as in the highly intensive protected farming where if exploited could double farming households production and incomes. The findings are summarized in the funnel in Figure 4.22 below.



Source: Research Data, 2019

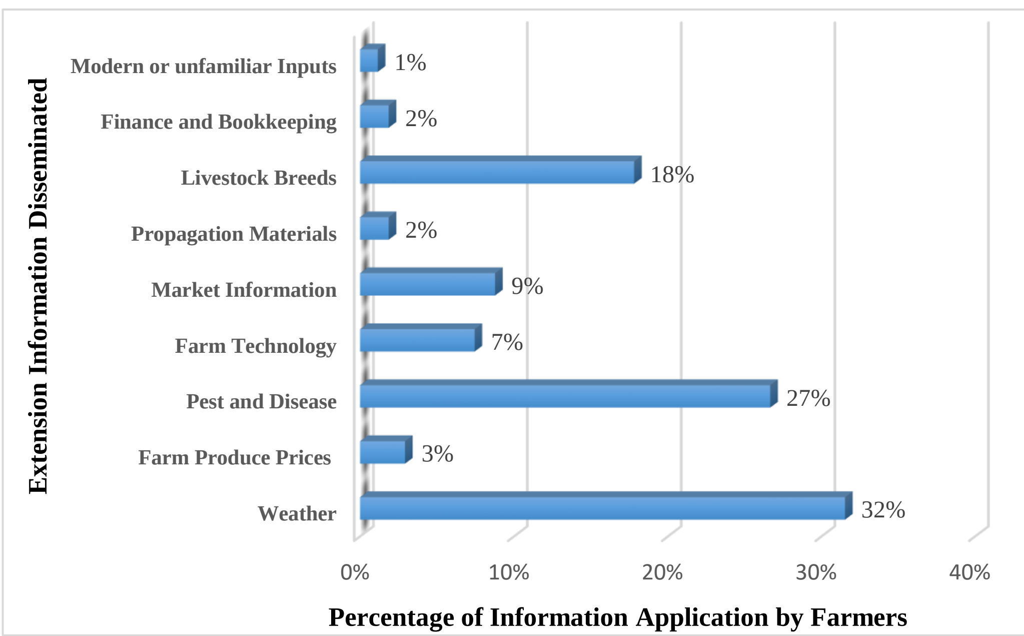
Figure 4.22: Extension information Service Providers Specialized Agricultural Science Skills

Further qualitative data gathered from extension service providers also revealed that while Tana River County was among the places with an elaborate extension system in Kenya, the findings exposed that, in spite of this, agricultural productivity had continued to decline because the services did not guarantee the were transmission of research results to farms and farmers had not been enabled to test results in real farming.

The skills gaps revealed by the study prompted an analysis of the types of extension information disseminated in Tana River County. Through questionnaires the sampled 365 faming households were asked to name major kinds of extension information disseminated by extension agents.

From the, it was clear that farmers were deficient in agricultural information, considering the fact that farmers revealed that only information on weather (32%), Pest and diseases (27%), and livestock breeding (18%) was given prominence. Weather information was given prominence especially during the rainy season when early warning regarding the flooding of River Tana was given.

From the study it was also noted that farmers were not being guided in decision making and prediction of farming outcomes only a few farmers (1%) had received guidance on the use of modern inputs finance, book keeping, propagation (2%), setting prices and margins analysis (3%), training on Farm technology (7%) and Market information (9%). The data gathered is summarized in the bar graph in figure 4.23 below.



Source: Research Data, 2019

Figure 4.23: Extension Information Disseminated in Tana River County

Furthermore it was also evidenced that while information on pest and diseases control was well disseminated, utilized could not be quantified, considering that pest and disease control was considered a major problem facing agricultural productivity in the county.

Qualitative data gathered from the extension information service providers confirmed the unfortunate conviction that most farmers did not believe in the knowledge imparted by extension service providers due to held perceptions regarding the training methodologies employed by service providers. this contributed to poor adoption of good agricultural practices eventually affecting agricultural productivity.

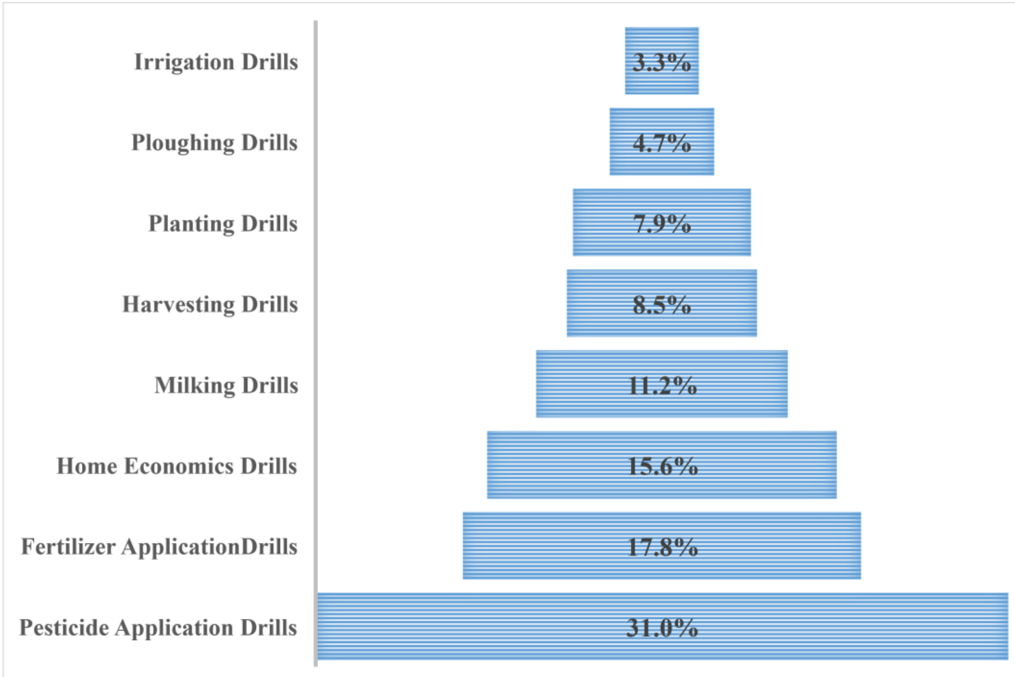
Further qualitative data collected from farming households revealed that farmers needed to be guided on how to apply modern or unfamiliar inputs and use farm technologies. It was definite that extension services could only help to reduce technology gaps if efficiently delivered so as to accelerate technology transfer, help farmers become better managers, bridge communication channels between agricultural scientists and farmers and offer guidance to farmers that is necessary for appropriate and timely decision making. This foregoing raised the fact that there was a huge gap between accessibility, affordability and utilization agricultural information and this negatively affected agricultural production in the county.

The study also analyzed the different activities that farmers were engaged in during extension training, this was to find out if extension service providers encouraged farmer centered learning through participation approaches to extension information dissemination.

Using questionnaires the sampled 365 farming households were asked to list activities they were engaged in during extensions sessions.

From the data collected, it was realized that most farmers had at some point participated in safe and effective use of pesticide drill (31%), fertilizer application drills (18%), home economics competitions (16%) for value addition and milking drill (11%) for dairy livestock farmers. However, very few farmers had had a chance to participate in irrigation (3%), ploughing drills (5%), planting (8%) and harvesting (9%) activities.

Learning through participation was considered necessary because adoption of new farming ideas could only be facilitated by articulating farmers' problems. Poor participation in learning activities led to poor articulation of various principled in agricultural production eventually these constraints inhibited the translation of research results as a consequence affecting agricultural productivity. The findings on participatory approaches in extension training in Tana River County are summarized in the pyramid in figure 4.24 below



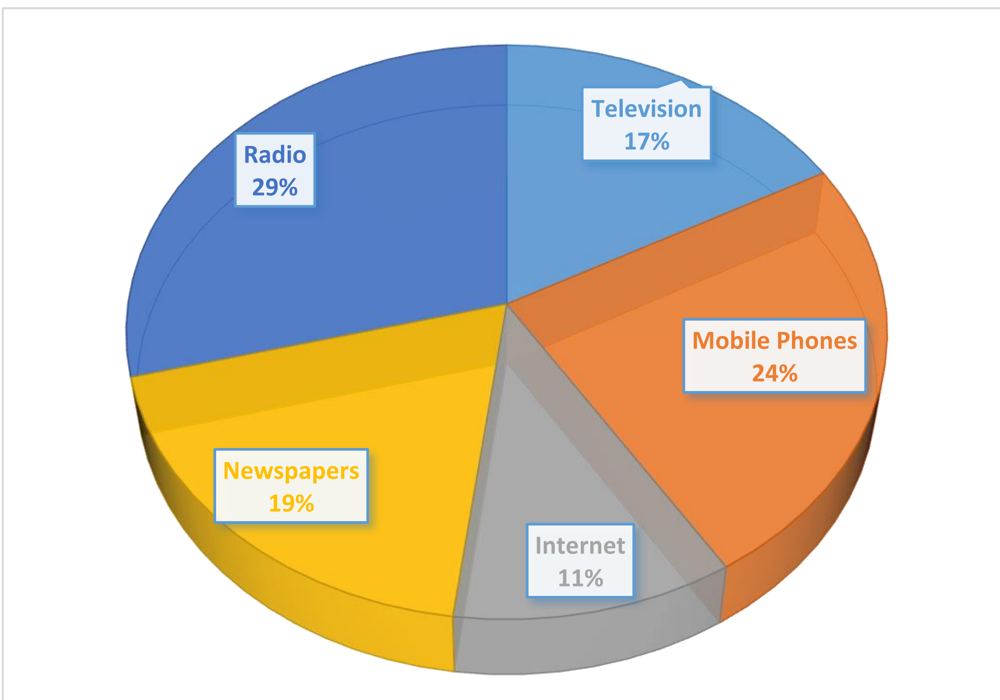
Source: Research Data, 2019

Figure 4.24: Participatory Extension Activities

The study also evaluated the role of mass media in extension information dissemination. Through questionnaires the sampled 365 farming households were requested to provide information on whether they accessed information through mass media.

From the data collected, it was acknowledged mass media was at the forefront in disseminating agricultural information. Most farmers attested to listening to the radio (29%) and television (17%) programs such as 'Shamba Shape Up' on Citizen Radio and Television and 'smart farmer' on the farmer TV. Mobile phones (24%) and newspapers (19%) were also found to have a wider application in accessing agricultural information. 'Seeds of Gold', a weekly farming magazine published by the Nation Media Group, and the 'Smart Harvest', farmer magazine published weekly by the Standard Media Group were found to have been useful in disseminating extension services information.

However very few farmers use the internet (11%) to access agricultural information this was attributed to poor connectivity in the county and lack of infrastructure such as computers and smart phones which were expensive and farmers lacked the skills to exploit this technology. The findings are summarized in the pie chart in Figure 4.25 below.



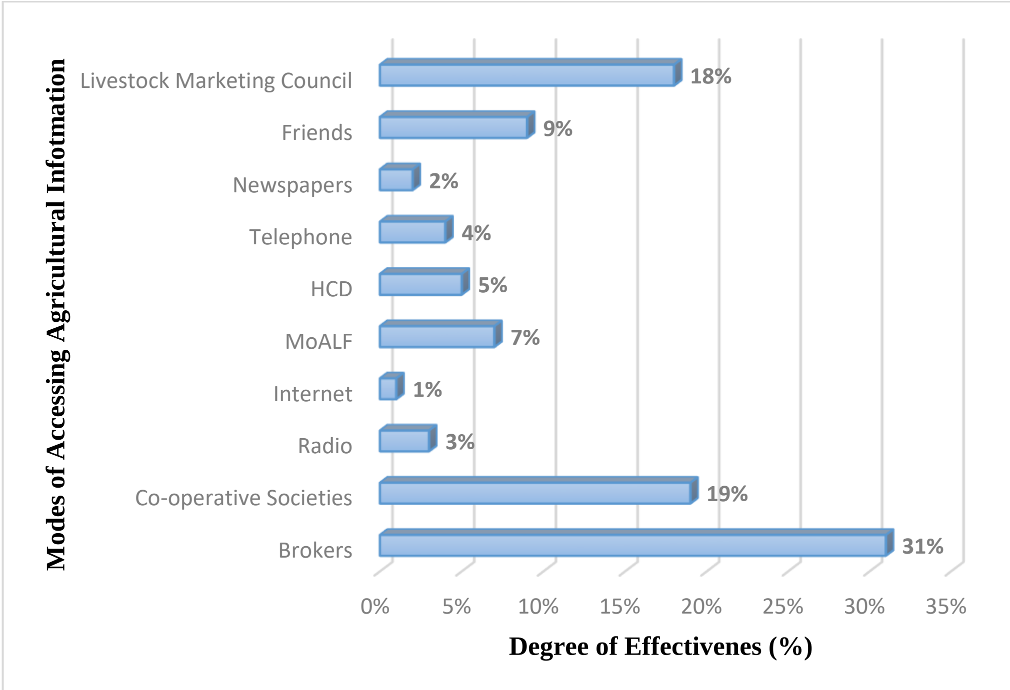
Source: Research Data, 2019

Figure 4.25: Role of Mass media in Agricultural information Dissemination.

Qualitative data gathered from extension service providers and farmers also revealed that, the farmer TV under standard media group was a favorite station for farmers during weekends and free time, groups of farmers would spent time watching agriculture programs. We Farm, a free text message service that was available on both feature and smart phones had also gained application as farmers were accorded a platform for the sharing of information. Farmers with smart phones also used social media as a means of sharing agricultural information. Many farmers had formed WhatsApp groups, were on Facebook, Instagram, Twitter, Linkedin and on email where they shared their farming experiences.

The study also evaluated how farmers access agricultural information. Using questionnaires a total of 365 farming households were engaged in the study in order to find out how they accessed agricultural information. From the data colected, it was realized that while brokers exploited farmers they also played an important role in providing farmers with relevant marketing information. Most farmers depended on information from brokers (31%), followed by cooperative societies (19%) livestock marketing council (18%).

However very few farmers were conversant with online information searching and threfore the use of the internet (1%) was the least method used in accesing marketing information. A summary of the responses is analyzed in the line graph in figure 4.26 below;



Source: Research Data, 2019

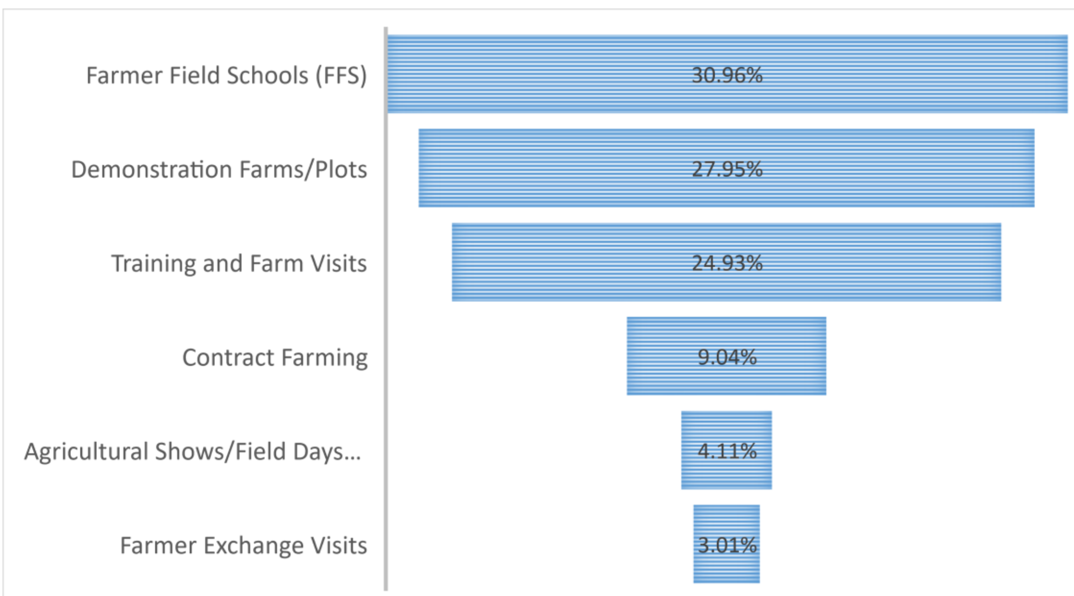
Figure 4.26: Access to Agricultural Information

From the qualitative data gathered from farming households, the study realized that, the use of cell phones had had a wide application as it allowed farmers to share their indigenous knowledge on agricultural production, however, it was noted that, low literacy levels was a key barrier to the dissemination of information services in rural areas in Tana River county. This therefore resulted into limited access to and use of extension information by small-holder farmers ultimately this affected agricultural productivity in Tana River County.

In analyzing constraints to access to and utilization of agricultural extension information, the sampled 365 farming households were asked to provide data on the delivery methods employed by extension service providers.

From gathered, it was clear that, the most preferred extension delivery method was through farmer field school (30%), this was followed by use of demonstration farms (28%) and training and farm visit (25%). However the study discovered that very few farmers had received information through Contract farming (9%), through agricultural field days (4%) and farmer exchange visits (3%). The inadequate application was attributed to limited resources to facilitated exchange visits, and very few farmers had marketing contracts as marketing of most agricultural produce was controlled by brokers and middlemen.

Their responses are summarized in the funnel in figure 4.27 below;



Source: Research Data, 2019

Figure 4.27: Extension Delivery Methods

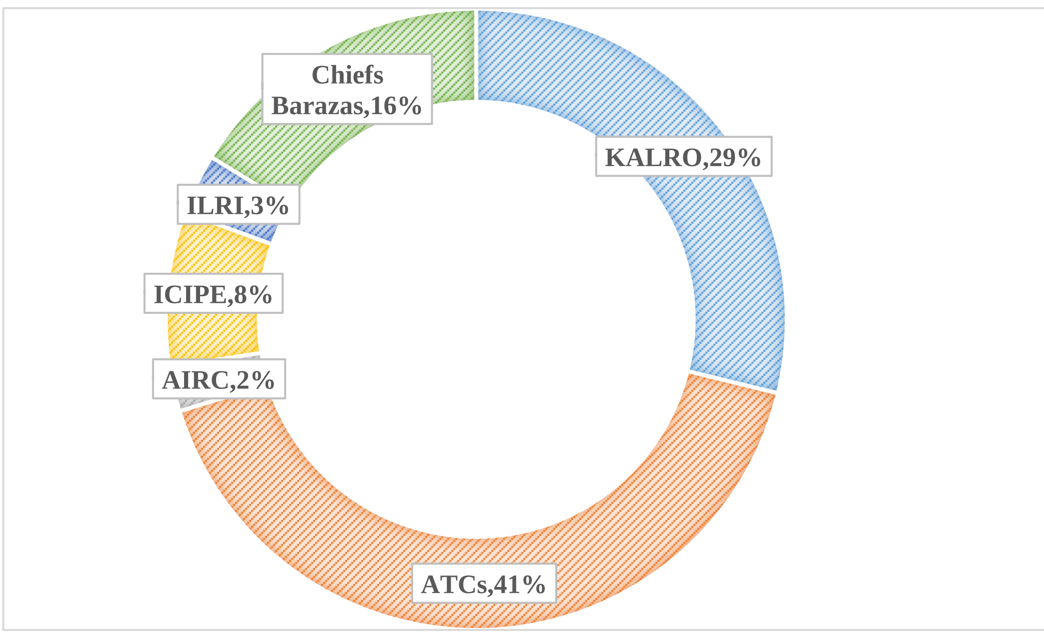
Further qualitative data gathered from farmers revealed that preferred methods such as the Framer field schools (FFS), demonstrations and training and farm visit attended to the farmers immediate needs and the interactions assisted in improving agricultural productivity. This was corroborated by information from the extension information service providers who revealed that farmers who preferred the farm visit and training method had a clear agreed upon visit schedule with the extension service providers and that they also interacted with the extension agents through telephone and text messages.

Further interviews with the extension information service providers, revealed that few agricultural firms were interested in contract marketing and the county Government did not have an annual agricultural show thus necessitating a visit to the Mombasa Agricultural Society of Kenya (ASK) show which was very far and expensive for farmers.

The study also discovered that, although the county had several lead farmers who were highly regarded as Community own resource persons (CORPs) and offered private agricultural extension training, this method was not widely applied as the lead farmers were ill trained and were found to be lacking in confidence to sustain an extension training and many farmers did not trust the information provided.

From the literature reviewed, agricultural information and knowledge among smallholder farming communities continued to be essential in enhancing productivity. The study therefore evaluted the sources of agricultural information by engaing 365 farming households through questionnairs.

From the collected, it was realized that, dissemination of agricultural research information was mainly done through Farmers' Agricultural Training Centers (41%) in the county, the Kenya Agricultural and Livestock Research Organization (29%), and chiefs' Barazas (16%), however the Agricultural Information Resource Centre (2%) through the International Livestock Research Institute (3%) and International Centre of Insect Physiology and Ecology (8%). A findings are summarized in the doughnut in figure 4.28 below



Source: Research Data, 2019

Figure 4.28: Sources Of Agricultuural Information In Tana River County

The study further exposed that, through extension meetings, farmers were enabled to share experiences which formed a pool of knowledge on agricultural production.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the study findings, the conclusions made thereafter and finally, a number of recommendations as put forward by the researcher. The purpose of this study was to evaluate the relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya. This chapter summarizes the major findings recorded and discussed in chapter four, makes conclusions from the findings and presents recommendations, besides presenting suggestions for further study.

5.2 Summary of the Findings

5.2.1 Relationship between use of Extension Services information and Agricultural Productivity

Through the calculation of the Pearson Correlation Coefficient (r), the study summed up that there was a weak relationship (averaging r=0.4) between use of extension information services and agricultural productivity among the crop enterprises under the department of agriculture extension information services with sesame seed enterprise showing a near zero relationship (r=0.048). However livestock enterprises under the veterinary and livestock extension services department depicted a strong relationship (averaging r=0.723), while the fisheries department had a very strong near perfect relationship (averaging r=0.893). Overall there was a moderately strong relationship between use of extension information services and agricultural productivity (averaging r=0.6 for all the 23 agricultural enterprises) among smallholder farmers in Tana River County, therefore qualifying the study alternative hypothesis (H1) that there is a relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County, Kenya.

5.2.2 Relationship between use of Extension services information and Agricultural Produce Marketing

The study summarized that, there was a strong Relationship between use of extension information services and agricultural produce marketing. This strong relationship influenced the choice of agricultural enterprise and household income.

For illustration, a T-Test was calculated to compare the mean incomes for the year 2017 and 2018. During the year 2017 farming households in Tana River County extremely preferred producing Mangoes, Cattle Milk, Maize, Citrus fruits, Tomatoes and Camel Milk and they were visited a total of 2,886 times by extension information service providers, with a corresponding income of Kes. 12,963,718 for the year. In the corresponding year 2018, extension training and visits in the same enterprises increased to 3,851 generating a corresponding increased income of Kes.15,758,450. This change in on farm household income and the fact that farmers continued promoting these enterprises was attributed to the increased use of extension information services.

However, for enterprises that were least preferred by the farming households, such as the chicken eggs, cotton, coconut, bananas, sesame seed, cassava and butternuts, the study confirmed that there was a reduction in the use of extension information and this contributed to the reduced revenues where in the year 2017 only 1,892 farm visits were made by the extension information service providers, resulting in a consolidated household income of Kes. 1,983,485. In the following year 2018 the farm visits were further reduced to 1,452, with a corresponding significant reduction in the on-farm incomes to Kes. 1,855,075.

5.2.3 Relationship Between Use of ICT in The Dissemination of Extension Information and Agricultural Productivity.

The study acknowledged that the use of ICT in extension was essential in enhancing efficiency in information delivery that increasing agricultural output. Through linear regression the study established that households in Tana River County could produce up to 17.3 bags of maize per acre when accessing information through e-extension as compared to a paltry 6.3 bags of maize per acre using the Convectional Training and Farm visit.

From the linear regression analysis the study summed up that to produce the optimal 60 bags of maize per acres, a farming household required 58 information dissemination sessions under e-extension while 80 farm visit were required to produce the same optimal quantity of 60 bags of maize per acre. It was therefore deducted that, less interactions were required under e-extension in comparison to the direct training and farm visit. The findings therefore established that ICT enhanced efficiency in information delivery, besides having the ability to complement and modernized existing extension approaches and methods.

5.2.4 Relationship between Constraints to Accessing Extension Information and agricultural productivity

In analyzing the Relationship between the Constraints to Accessing Extension Information and agricultural productivity in Tana River County, the study acknowledged that a majority of smallholder farmers in Tana River County were not satisfied with the extension information services. The interactions were found to be too infrequent with the extension service provider not being well equipped to handle an extension training session owing to deficiency in both pedagogy and andragogy. The study attributed low agricultural productivity in Tana River County to the constraints in accessing extension information services.

The findings acknowledged that, a single agricultural information extension service provider in Tana River County was accountable for over 900 farming households as compared to the desired 640 farmers in an agropastoral extension system typical of Tana River County, the ratio therefore evidenced the difficulties in attending to all the information needs of the farmers and as a consequence negatively affected agricultural.

5.2.5 Relationship between Extension Information Delivery Methods and Agricultural Productivity

The study summarized that a good number of extension service providers had knowledge and skills in crop and animal husbandry, but were generally deficient in delivery methods and the integration of ICT in extension had not fully been exploited. The profound inefficiencies in information dissemination affected the seamless access to information. Nevertheless the study recognized the role of mass media in extension information dissemination and confirmed the important role played by the Radio, television and smart phones in the dissemination of information in rural areas in Tana River county.

5.3 Conclusion

The purpose of this study was to evaluate the relationship between use of extension information services and agricultural productivity among smallholder farmers in Tana River County in Kenya. The study resulted in Five (5) main conclusions as follows;-

Firstly, the study qualified the alternative hypothesis (H1) that, the use of extension information services correlated with agricultural productivity among smallholder farmers in Tana River County in Kenya. Through the use of the Pearson's Correlation Coefficient (PCC) the study calculated the statistical relationship between the two study variables i.e. use of extension information services and agricultural productivity among the prioritized agricultural enterprises in Tana River

County and concluded that there was an increase in production for farmers who utilized extension information and vice versa.

Secondly, through the application of a T-test to compare the mean on farm income, the study findings revealed that smallholder farmers in Tana River County depended on the availability of Market information when selecting suitable agricultural enterprise. This implied that the use of extension information, influenced agricultural enterprise preference, sales and household income in Tana River County. This was validated and confirmed by comparing the mean annual on farm income for the year 2017 and 2018 through the use of a t-test that established that, increased use of agricultural information proportionately increased household incomes and vice versa.

Thirdly, through the calculation of simple linear regression, the study was able to predict expected production from the use of extension information. By applying the linear regression function **y = mx + b,** the analysis helped the study to conclude that, application of e-extension (ICT) led to increased production in comparison to the convectional training and farm visit extension model. The regression analysis, confirmed the fact that ICT was essential in enhancing efficiency in information delivery and that, embracing Information and Communication Technology (ICT) in agricultural extension, complemented and modernized existing extension approaches and methods.

Fourthly, in analyzing the Relationship between constraints to accessing extension information and agricultural productivity, the study concluded that a majority of smallholder farmers in Tana River County were not satisfied with the extension information services. The interactions were found to be too infrequent with most extension service providers not being well equipped to handle an extension training session owing to deficiency in both pedagogy and andragogy. A single extension information service provider in Tana River County was accountable for over 900 farming households as compared to the desired 640 farmers in an agro-pastoral farming system typical of Tana River County, this adversely affected agricultural productivity.

Finally, in evaluating the relationship between extension information delivery methods and agricultural productivity, the study concluded that, most of the farmers in Tana River County found the information disseminated useful in relationship to improving agricultural productivity. However, those who were unsatisfied attributed it to the infrequent visits and the ill trained and unprepared extension agents. A good number of extension service providers had knowledge and skills in crop and animal husbandry but were generally deficient in other specialized agricultural science skills and therefore needed capacity building. The study therefore concluded that, poor participation in extension activities led to poor articulation of information disseminated therefore contributing to poor adoption of good agricultural practices eventually affecting agricultural productivity.

5.4 Recommendations

Recommendation made after research were dichotomized into those related to policy and those related to further research. The recommendations were generated based on negative findings from the concluded study with the aim of soliciting for viable interventions.

5.4.1 Policy Recommendations

The following recommendations made were directly linked to non-existent policies that needed to be formulated or policies that existed but were not being properly implemented.

i) The study discovered that, though ICT was essential in enhancing efficiency in information delivery and had the ability to complement and modernized existing extension approaches and methods, its application had not been fully exploited in the provision of agricultural extension information services and recommended that the County government of Tana River should review its agricultural extension policy, to give impetus to the use of ICT in transforming agricultural extension information.

ii) The study also revealed that extension information services were not well coordinated and this contributed to the characterized infrequent training and visits to farming households by the extension information service providers. The study therefore recommended that the Ministry of Agriculture

Livestock and Fisheries (MoALF) in the county should provide proper guidelines and standards for agricultural extension information and advisory services besides putting in place a clear monitoring and evaluation system for extension information delivery activities.

iii) The study having found out that the ratio between extension information service providers and farming households was too low, recommended that the County Government should address agricultural extension information dissemination in the County Integrated Development Plan (CIDP), besides allocating a sufficient budget to fully support extension activities including increased employment and retraining of extension service providers.

5.4.2 Recommendations for Further Research

The study recommended that further research should be conducted on:-

i) Applications of e-extension in the dissemination of information to smallholder farmers.

ii) Factors affecting accessibility and use of agricultural extension information.

iii) Perception of smallholder farmers towards agricultural extension information services.

iv) Training needs of extension officers and constraints in transfer of agriculture information and technology to smallholder farmers.

v) Information needs of smallholder farmers in an agropastoral farming systems.

5.5 Contributions of the Study

The findings of this study are a major contribution to knowledge in general and literature on the relationship between use of extension information services and agricultural productivity. The study has exhaustively addressed how the use of information can help enhance agricultural productivity besides considering the necessary requirements for setting up an effective agricultural extension system. It is assumed that this study will add credibility to the policy agenda for agricultural extension information dissemination and communication for rural development with the purpose of helping address food security and income generation, for sustainable livelihoods of smallholder farmers.

REFERENCES

Abbott, J. C. (1986).*Marketing improvement in the developing world: what happens and what we have learned* (Rev.Ed.), Food and Agriculture Organization of the United Nations, *ISBN 978-92-5-101427-1*

African Development Bank. (2016). *Feed Africa: Strategy for Agricultural Transformation in Africa* 2016-2025, Retrieved from https://www.afdb.org/fileadmin/uploads/afdb/Documents/-pdf

Aina, L. O. (1995). Information and Agriculture in Africa, (Rev. Ed.), *Agricultural Information in Africa,* Third World Information Services Ltd., Ibadan, pp. 1-11

Aina, L. O. (2007). Globalisation and Small-Scale Farming in Africa: What role for Information Centres? World Library and Information Congress: 73rd IFLA General Conference and Council 19-23 august 2007, durban, south africa http://www.ifla.org/iv/ifla73/index.htm

Alain, D,. & Sadoulet E. (2010).*Agriculture for development in sub-Saharan Africa: An update.* University of California at Berkeley, AfJARE 5(1).Retrieved from http://ageconsearch.umn.edu/bitstream/156657/2/1FINAL.pdf

Alonge, J. A. (2005). Bringing stakeholders into agricultural extension reform agenda: *A Participatory SWOT analysis of the Trinidad National Agricultural Extension Services, AIAEE 22nd Annual Conference Proceedings.* Retrieved from https://www.aiaee.org/attachments/article/906/012.pdf

American Psychological Association. (2010). *Concise Rules of APA Style,* (6th ed.) Washington, DC: American Psychological Association: APA.

American Psychological Association. (2010). *Publication Manual of the American Psychological Association* (6th ed.). Washington, DC: APA.

Anderson, J. R. (2008).*Agricultural Advisory Services; a background paper for "Innovating through science and technology",* Chapter 7 of the WDR 2008 July 2, 2007. Washington, DC: Agriculture and Rural Development Department, World Bank

Anderson, J. R., & Feder, G. (2007). "*Agricultural extension", In R.E. Evenson and P. Pingali (eds.), Handbook of Agricultural Economics, Chapter 44, Volume 3 Agricultural Development: Farmers, Farm Production and Farm Markets*. Amsterdam, Elsevier.

ASDSP, (2014). *Household Baseline Survey Report - Tana River County, Volume 1, 2014. KALRO,* ASDSP and UoN.

ASDSP, (2019). *Household Baseline Survey Report - Tana River County, Volume 2, 2019. KALRO,* ASDSP and UoN.

Ayoade, A. R. (2012). *Attitude of women farmers towards agricultural extension services in Ifelodun local government area*, Ladoke Akintola University of

Technology, Ogbomosho, Oyo State, Nigeria: Osun State Department of Agricultural Economics and Extension.

Bachhav, N. B. (2015). *Analysis of IT application in College Libraries: A Comparative Study of Urban and Rural College Libraries.* Yeola - Maharashtra, India: Swami Muktan and College of Science

Bachhav, N. B. (2012). Information Needs of the Rural Farmers: A Study from Maharashtra, India: A Survey. Nebrasca: University of Nebraska, Lincoln, Digital Commons. *library philosophy and practice-(e-journal) 1540*, Retrieved from http://www.scihub.org/AJSMS

Baig, M. B., & Aldosari, F. (2013). Agricultural Extension in Asia: constraints and options for Improvement. *The Journal of Animal & Plant Sciences*, 23(2), 619-632.

Bolo, M. and Makini, F. (2012). CTA Commissioned Case Study on Extension Land Advisory Services in Kenya

Byerlee, D., Diao, X., & Jackson, C. (2009). Agriculture, Rural Development, and Pro-poor Growth: Country Experiences in the Post- Reform Era. *Contribution of Agricultural Households to National Poverty Reduction in Africa* doi: 10.1146/annurev.resource.050708.144239.

Creswell, J. (2009). Research design: Qualitative, quantitative, and mixed methods approaches (3rd ed.). Thousand Oaks, CA: Sage.

Churi, A. J., Mlozi, M. R. S., Tumbo, S. D.,& Casmir, R. (2012). Understanding farmers'
Information communication strategies for managing climate risks in rural semi-arid areas, Tanzania. *International Journal of Information and Communication Technology Research*, 2(11), 838–845.

Cotton Development Authority [CODA] (2011). The Status Report on the Cotton Industry in Kenya. Compiled for the ICAC Plenary Meeting in Buenos Aires, Argentina September 4th – 10th, 2011. Retrieved from http://www.icac.org/meetings/plenary/70_buenos_aires/documents/country_reports/e_kenya.pdf

Crawford, I. M. (1997).Marketing Research and Information Systems. Vol. 4, Marketing and Agribusiness texts, Food and Agriculture Organization of the United Nations, ISBN 9285110053, 9789285110055,121 pages

Davis, K., Nkonya, E., Kato, E., Mekonnen, D., Odendo, M., Miiro, R., &Nkuba, J. (2010). *Impact of farmer field schools on agricultural productivity and poverty in East Africa*. Washington, DC: International Food Policy Research Institute.

Deloitte & Touche. (2016). *The Kenya Economic Outlook 2016, The Story Behind the Numbers. Nairobi:* Deloitte &Touche.

Deloitte & Touche. (2017). The Kenya Economic Outlook 2017, "*Joining the dots*" Nairobi; Deloitte & Touche.

Dittoh, S. (2006). *Effective aid for small farmers in sub-Saharan Africa- southern civil society Perspective.* Food and Nutrition Security Unit, University for

Development Studies Tamale, Ghana: Canadian Food Security Policy Group.

Fain, J. A. (1999). Reading, understanding, and applying nursing research. Philadelphia, USA: F.A. Davis Company.

FAO, (1988). Definition of several extension approaches. Available online http://www.fao.org/docrep/v9122e/ v9122e02d.htm

FAO. (2003). New ICTs and interactivity. *Agricultural Engineering Research Journal* 5(2): 19-26.

FAO. (2004). Cashew Nut production. In: http://www.uga.edu/fruit/cashew.html.

FAO. (2007). Poultry sector country review; The structure, marketing and importance of the commercial and village poultry industry: an analysis of the poultry sector in Kenya

FAO. (2011). Dairy development in Kenya, by H.G. Muriuki. Rome.

FAO. (2014). *Farming for the Future: Communication efforts to advance family farming.* Rome, Italy: FAO Communication for Development Office for Partnership, Advocacy and Capacity Development (OPC) Vialedelle Terme di Caracalla. Retrieved fromhttp://www.fao.org/3/a-i4223e.pdf. ISBN 978-92-5-108646-9

FAO, IFAD & WFP. (2015). *The State of Food Insecurity in the World 2015. Meeting the 2015 International Hunger Targets: taking stock of uneven progress.* Rome.
Retrieved fromhttp://www.fao.org/3/a-i4646e.pdfFAO ISBN 978-92-5-108785-5

FAO & OECD. (2016*). Agriculture in Sub-Saharan Africa: Prospects and Challenges for the Next Decade OECD-FAO Agricultural* Outlook 2016-2025. Paris: OECD Publishing Retrieved fromhttp://dx.doi.org/10.1787/agr_outlook-2016-en ISBN 978-92-64-25322-3.

FAO. (2017). *The state of Food and Agriculture: Leveraging Food Systems for Inclusive Rural Transformation.* Rome: FAO. Retrieved from http://www.fao.org/3/a-i7658e.pdf.ISBN 978-92-5-109873-8

FAO. (2017). Information and Communication Technology (ICT) in Agriculture A Report to the G20 Agricultural Deputies. http://www.fao.org

FAO, IFAD, UNICEF, WFP & WHO. (2017). *The State of Food Security and Nutrition in the World 2017: Building resilience for peace and food security*. Rome, FAO. ISBN 978-92-5-109888-2
Retrieved from http://www.fao.org/3/a-i7695e.pdf

Farm Africa (2018). Fact sheet on Butternut pumpkin farming. Retrieved from: https://farmbizafrica.com/farmbizopinions/2419-fact-sheet-on-butternut-pumpkin-farming

Feed the future. (2017) Policy Brief; Enhancing Investment Attractiveness In Kenya's Cotton Sector

Fraenkel, J. R., & Wallen, N. E. (2006). How to design and evaluate research in education (6th ed.). New York, NY: McGraw-Hill.

Gebremichael, B., Girmay, S. & Gebru, M. (2019). Camel milk production and marketing: Pastoral areas of Afar, Ethiopia. Pastoralism 9, 16 (2019). https://doi.org/10.1186/s13570-019-0147-7

Ganpat, W. G. (2015). *Agricultural Development and Food Security in Developing Nations*. Retrieved fromhttp://www.itu.int/ict.

Gautam, M. (2000). *Agricultural Extension: The Kenya Experience; An Impact Evaluation.* Washington, D.C.: World Bank, Operations, Evaluation Department. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/8447/wps3928.pdf?sequence=1.

Giovannucci, D., S., S., Nierenberg, D., Hebebrand, C., Shapiro, J., Milder, J. & Wheeler.
K. (2012). *Food and Agriculture: the future of sustainability. A strategic input to the Sustainable Development in the 21st Century (SD21) project.* New York: United Nations Department of Economic and Social Affairs, Division for Sustainable Development Retrieved
From http://www.un.org/esa/dsd/dsd_sd21st/21_pdf.

Government of Kenya. (2000). *Interim Poverty Strategy Paper (I-PSP), 2000–2003*. Retrieved From http://siteresources.worldbank.org/INTPRS1/Resources/Country-Papers-and-JSAs/Kenya_IPRSP.pdf

Government of Kenya. (2010). *Agricultural Policy in Kenya: Issues and Processes: A paper prepared for the Future Agriculture Consortium workshop, Institute of Development Studies*, 20-22. Nairobi: GOK.

Government of Kenya. (2010). *Agricultural Sector Development Strategy* (ASDS) 2010–2020.Retrieved from http://extwprlegs1.fao.org/docs/pdf/ken140935.pdf

Government of Kenya. (2012). *National Agricultural Sector Extension Policy (NASEP).* Retrieved from https://www.kenyamarkets.org/wp-content/uploads/2016/06/National-Agricultural-Sector-Extension-2012.pd

Government of Kenya. (2 0 1 9). *Agricultural Sector Transformation and Growth Strategy: Towards a sustainable agricultural transformation and Food Security in Kenya 2 0 1 9 - 2 0 2 9.*

Hellin, J. (2012). Agricultural Extension, Collective Action and Innovation Systems: Lessons on Network Brokering from Peru and Mexico, International Maize and Wheat Improvement Center (CIMMYT*). Journal of Agricultural Education and Extension* 18(2), 141159, Retrieved from https://pdfs.semanticscholar.org/

IFAD., (2012). *The future of world food and nutrition security: investing in smallholder Agriculture- an international priority.* https://maintenance.ifad.org/documents/10180/5a63638b-2285-4b8e-8cc2-bd6f31dadcbc

IFAD & UNEP. (2013). *Smallholders, food security, and the environment* Retrieved from https://www.ifad.org/documents/10180/666cac24-14b6-43c2-876d-9c2d1f01d5dd

IUCN. (2003).The World Conservation Union External Review October, 2003. Retrieved from https://www.iucn.org/downloads/iucn_external_review_2003.pdf.

Jirong, W., Gail L. C., & Wailes E. J., (1996). *Production efficiency of Chinese agriculture*: *evidence from rural household survey data Agricultural Economics IS 17-28 Department of Agricultural* Economics and Rural Sociology, University of Arkansas.

KALRO. 2008. New Cassava varieties for Coastal Kenya. Retrieved from: https://Kalro.org/ new-cassava-varieties-for=coastal-Kenya

KALRO, (2017) Cabbage cultivation manual, How to Grow Cabbages In Kenya: ISBN NO: 978-9966-30-030-0 Volume 1

KALRO (2018) Improved Green grams production, New early maturing large-seeded green gram variety; KAT 00308 for semi-arid Kenya

KAPP. (2015). *Fruits of our Toil, Increasing Agricultural Productivity and Incomes of Smallholder Farmers in Kenya*, IIRR, KAPP Report, World Bank, Republic of Kenya.

Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., & Mekuria, M. (2012). Interdependence in Farmer Technology Adoption Decisions in Smallholder Systems: *Joint Estimation of Investments in Sustainable Agricultural Practices in Rural Tanzania; Selected Paper for Presentation at the International Association of Agricultural Economists* (IAAE) Triennial Conference, Foz do Iguacu, Brazil, 18-24 August, 2012.

Kassie, M., Ndiritu S. W., & Shiferaw, B., (2012). Determinants of Food Security in Kenya: a Gender Perspective, International Maize and Wheat Improvement Center (CIMMYT), *Contributed Paper prepared for presentation at the 86th Annual Conference of the Agricultural Economics Society*, University of Warwick, United Kingdom 16 - 18 April 2012.

Keating, B.A., McCown, R.L., 2001. Advances in farming systems analysis and intervention. Agric. Syst. 70 (2–3), 555–579

Kemp, R., Parto, S., & Gibson, R.B. (2005). 'Governance for Sustainable Development:
Moving from Theory to Practice', *Int. J. Sustainable Development,* Vol. 8, Nos. 1/2, pp.12–30.

Kenya Coconut Development Authority (2013). National Coconut Survey, 2013 Final Report

Kenya National Bureau of Statistics. (2010). 2009 *Kenya population and housing census*. Nairobi: KNBS.

Kenya National Bureau of Statistics. (2020). 2019 *Kenya population and housing census*. Nairobi: KNBS.

Kenya National Bureau of Statistics (2016). Economic Survey 2016, Nairobi:

KNBS. ISBN: 9966-767-54-1
Kenya National Bureau of Statistics (2017).*Economic Survey 2017*, Nairobi: KNBS. ISBN: 978-9966-102-00-3
Kenyatta University. (2013). *Guidelines for Writing Academic Research Proposals and Theses in the School of Education,* Revised 2013, Kenyatta University, Nairobi
Kibet, C. (2011). *Major Challenges Facing Agricultural Sector*, International Extension Conference, Technical Center for Agriculture and Rural Cooperation ACP-EU 9CTA)
Kibett, J. K., Omunyi, M. E., & Muchiri. J. (2005). *Elements of agricultural extension policy in Kenya: Challenges and opportunitie*s. African Crop Science Conference Proceedings, Vol. 7. pp. 1491-1494, Printed in Uganda. All rights reserved ISSN 1023-070X/2005 $ 4.00, © 2005, African Crop Science Society, Department of Agricultural Education and Extension, Egerton University, Kenya
Kipkurgat, T., & Tuigong, D. (2015). Impact of Agricultural Extension on Food Security among Small Scale Farmers in Wareng District, Kenya. *International Journal of Agricultural Extension and Rural Development Studies* 2(1), pp.18-21.
Kirimi, L. (2012). *History of Kenyan Maize Production, Marketing and Policies,* Tegemeo Institute of Agricultural Policy Development Regional Workshop on an Integrated Policy Approach to Commercializing Smallholder Maize Production 6^{th} -7^{th} June, 2012 , at the Norfolk Hotel, Nairobi, Kenya.
Kiruthiga, K., Karthi, R., Asha Daisy B. A., SPillay, E.G,. (2015). *Agricultural Marketing – An Overview*, International Journal of Scientific and Research Publications, Volume 5, Issue 4, April 2015 1 ISSN 2250-3153 www.ijsrp.org
Kothari, C.R. (2004). *Research methodology: methods and technique***s.** –2nd ed. New Delhi: New Age International.
Krejcie, R.V., & Morgan, D.W. (1970). Determining Sample Size for Research Activities, *Educational and Psychological Measuremen*t, 30, 607.
Kuhlthau, C. C. (1991). Inside the search process: Information seeking from the users Perspective. Journal of the American Society for Information Science 42 (5), 361-371.
Kyaruzi, A.A., Mlozi, M.R.S., & Busindi, I.M. (2010).*Gender Based Effectiveness of Agricultural Extension Agents' Contacts with Smallholder Farmers in Extension Services Delivery: A Case of Kilosa District, Tanzania.*
Larry, T. (2017). Beginner Dairy Goat Fact Sheet, Iowa State University Extension. retrieved at: http://www.extension.iastate.edu/dairyteam/goats
Leauthaud, C., Belaud, G., Duvail, S., Moussa, R., & Grunberger, O. (2013). Characterizing foods in the poorly gauged wetlands of the Tana river delta, Kenya, using a water balance model and satellite data. *Hydrology and Earth System Sciences, European Geosciences Union* 17(8), pp. 3059 - 3075.

Lial, Greenwell and Ritchey (2016). Finite Mathematics and Calculus with Applications, 10th Ed. New York, NY: Pearson [ISBN139780133981070].

Linear Regression. (n.d.). Retrieved April 11, 2020, from http://www.stat.yale.edu/Courses/1997-98/101/linreg.htm

Livingston, G., Schonberger, S., & Delaney, S. (2011). Sub-Saharan Africa: The state of Smallholders in agriculture. Paper presented at the IFAD Conference on New Directions for Smallholder Agriculture 24-25 January, 2011.

Retrieved from https://www.ifad.org/documents/10180/78d97354-8d30-466e-b75c-9406bf47779c

Lwoga, E. T., Ngulube, P., & Stilwell, C. (2010). Understanding indigenous knowledge: Bridging the knowledge gap through a knowledge creation model for agricultural development. *South African Journal of Information Management***,** 12(1).

MAAIF. (2011). *Statistical Abstract, Ministry of Agriculture*. Animal Industry and Fisheries Republic of Uganda. Retrieved from http://www.agriculture.go.ug/userfiles.Statistical%20Abstract%202011.pdf

Mary A. Opiyo, Esther Marijani, Patriciah Muendo, Rezin Odede, William Leschen & Harrison Charo-Karisa (2018) A review of aquaculture production and health management practices of farmed fish in Kenya, International Journal of Veterinary Science and Medicine, 6:2, 141-148, DOI: 10.1016/j.ijvsm.2018.07.001

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review, 50(4)*, 370-96.

Matovelo, D. S., Msuya, J., & De Smet, E. (2006). Towards developing proactive information acquisition practices among smallholder farmers for empowerment and poverty reduction: a situation analysis. *International Association of Agricultural Information Specialists (IAALD) Quarterly Bulletin* 51: 3-4.

Mattee, A. Z. (2008). Reforming Tanzania's Agricultural Extension System: The challenges Ahead. *African Study Monographs*. 15(4), 177-188.

Mbo'o-Tchouawou, M., & Colverson K. (2014). *Increasing access to agricultural extension and advisory services:* How effective are new approaches in reaching women farmers in rural areas? Nairobi: International Livestock Research Institute (ILRI).

McLeod, S. A. (2018, May 21). Maslow's hierarchy of needs. Retrieved from https://www.simplypsychology.org/maslow.html

MoALF., (2013). Strategic Plan 2013 – 2017. Ministry of Agriculture, Livestock and Fisheries Republic of Kenya. Retrieved from: http://www.kenyamarkets.org/wp-content/uploads/2016/06/Ministry-of-Agriculture-Livestock-and-Fisheries-Strategic-Plan-2013-2017.pdf

Moris, J. (1991). Extension Alternatives in Tropical Africa. *Agricultural Administration Unit Occasional Paper 7.* Retrieved from https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7984.pdf.

Mtega, W. P. (2012). Access to and Usage of Information among Rural Communities: a Case Study of Kilosa District Morogoro Region in Tanzania. *The Canadian Journal of Library and Information Practice* 7(1), pp. 1-12.

Mugenda, O.M & Mugenda. A.G (1999). Research methods. quantitative and qualitative approaches. Nairobi, Kenya: ACTS Press.

Mugenda, O. M., & Mugenda, A. G. (2003). *Research methods: Quantitative and qualitative Approaches* (2nd ed.). Nairobi: African Centre for Technology Studies.

Mukesh, P., Deepati, T.P and Kanini, B. (2010). ICT for agriculture technology dissemination (http:pagropedia:litk.ac.in//aq=content//ICT-agriculture-technology-dissemination) Accessed 26/9/2019.

Munyua, H. (2000) Application of Information Communication Technologies in the Agricultural Sector in Africa: A Gender Perspective. In: Rathgeber, E, and Adera, E.O., Eds., Gender and Information Revolution in Africa, IDRC/ ECA, 85-123.

Mvuna, J. K. (2010). Agricultural extension services delivery in Tanzania. In W. H. Kimaro, L. Mukandiwa, & E. Z. J. Mario (Eds.), Towards improving agricultural extension service delivery in the SADC region. Proceedings of the Workshop on Information Sharing Among Extension Players in the SADC Region, 26-28 July 2010, Dar es Salaam, Tanzania (pp. 114–121).

NAFIS, (2019). Cost Benefit Analysis for Hives Retrieved from http://www.nafis.go.ke/livestock/bee-keeping/cost-benefit-analysis-for-various-type-of-hives/

Nairobi Declaration, (2011). In: Proceedings of the International Conference on Innovations in Extension and Advisory Services: Linking Knowledge to Policy and Action for Food and Livelihoods. Published by CTA, The Netherlands.

Nikkilä, R., Seilonen, I., Koskinen, K., (2010). Software architecture for farm management information systems in precision agriculture. Computer Electron. Agric. 70 (2), 328–336.

Obidike, N. A. (2011). Rural Farmers' Problems Accessing Agricultural Information: A Case Study of Nsukka Local Government Area of Enugu State, Nigeria. *Library philosophy and practice (e-journal).*

O'Donoghue, T., Punch K. (2003). *Qualitative Educational Research in Action: Doing and Reflecting.* Routledge. p.78.

Okpachu, A., Okpachu. S., Oche.G., & Obijesi, I. K. (2014). The Impact of Education on Agricultural Productivity of Small-Scale Rural Female Maize Farmers in Potiskum Local Government, Yobe State: A Panacea for Rural Economic Development in Nigeria. *International Journal of Research In Agriculture and Food Sciences* 2(4), pp. 26-33.

Olaniyi, O. A. (2013). Assessment of Utilization of Information and Communication Technologies (ICTs) Among Poultry Farmers in Nigeria : an Emerging Challenge. *Journal of Animal Science*, *3*(7), 361–369. Retrieved from http://www.tjournal.org/tjst_june_2013/03.pdf?i=1

Olwande, J. (2012). *Smallholder Maize Production Efficiency in Kenya,* Tegemeo Institute of Agricultural Policy and Development Regional Workshop 6th – 7th June, 2012 - The Norfolk Hotel, Nairobi, Kenya.

Olwande, J., Smale, M., Mathenge, M. K., Place, F., Mithöfer, D., (2015). Agricultural marketing by Smallholders in Kenya: *A comparison of maize, kale and dairy*, Food Policy, Volume 52, 2015, Pages 22-32, ISSN 0306-9192, http://www.sciencedirect.com/science/article/pii/S0306919215000196

Oso, W. Y., & Onen, D. (2011). Writing Research Proposal and Report: A Handbook for Beginning Researchers, Rsvd edn. Nairobi-Kenya: The Jomo Kenyatta Foundation.

Ouma J, Murithi F, Mwangi W, Verkuijl H, Gethi M, De Groote H.,(2015). Adoption of Maize Seed and Fertilizer Technologies in Embu District, Kenya. CIMMYT (International Maize and Wheat Improvement Center), Mexico, D.F; 2002.

Oxfam, (2018). How to Start Orange and Lemon Farming in Kenya. retrieve from; http://oxfarm.co.ke/agri_biz-insights/how-to-start-orange-and-lemon-farming-in-kenya/

Oxfam, (2018). Onion Farming Profit Per Acre. retrieve from; http://oxfarm.co.ke/crop-farming/onion-farming/onion-farming-profit-per-acre/

Ozowz, V.N. (1995). Information needs of small-scale farmers in Africa: the Nigerian Example. *Quarterly bulletin of the international association of agricultural information specialist* 40(1).

Poulton, C. & Kanyinga K., (2013). *The Politics of Revitalizing Agriculture in Kenya*. Retrieved from: https://www.researchgate.net/publication/272034199_The_Politics of_Revitalising_Agriculture_in_Kenya

Rao N.H. (2007). A framework for implementing information and communication technologies in agricultural development in India. *Technological Forecasting and Social Change*, *74*(4), 491-518. doi: 10.1016/j.techfore.2006.02.002

Republic of Kenya (2019), Agricultural Sector Transformation and Growth Strategy 2019-2029, *towards Sustainabke agricultureral transformation and food Security in Kenya pdf*

Republic of Kenya. 2010. Agriculture Sector Development Strategy (ASDS). (2009-2020).

Republic of Kenya. 2012. National agricultural sector extension policy (NASEP)

Republic of Kenya, (2015). *Economic Review of Agriculture* [ERA]: *Transforming our world: the 2030 Agenda for Sustainable Development.* Nairobi: Central Planning and Project Monitoring Unit Ministry of Agriculture, Livestock and Fisheries. Retrieved from http://www.un.org/.

Republic of Kenya. (2016). The Kenya National Treasury Financial Year 2016/2017 Budget. Retrieved from www.treasury.go.ke/publications/105-budget-2016-2017.html?...459...2016-2017.

Republic of Kenya, Ministry Of Agriculture, Livestock & Fisheries (2017). Guidelines And Standards For Agricultural Extension & Advisory Services

Republic of Kenya. (2019). Unpacking of the 2019 Budget Policy Statement, Parliamentary Budget Office.

Republic of Kenya (2013). Tana River County First County Integrated Development Plan, July 2013 – June 2018: towards a Globally Competitive and Prosperous Nation. Retrieved from http://cog.go.ke/images/stories/CIDPs/TanaRiver.pdf.

Salami, A., Kamara, A.B., & Brixiova, Z. (2010). *Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities.* African Development Bank (AfDB), Working Paper No. 105 April 2010.

Sarker, A., & Itohara, Y. (2009)..Farmers' Perception about the Extension Services and
Extension Workers: The case of organic agriculture extension program by PROSHIKA. *American Journal of Agricultural and Biological Sciences*, 4(4), 332– 337.

Saunders, M. Lewis, P. & Thornhil, A. (2007).Research Methods for Business Students (5th end) Chelmsford, United Kingdom. Pearson Education. Sesame organic cultivation guide, 2002, Naturland. Available also online www.naturland.de

Seyoum, E.T., Battese, G.E., & Fleming, E. M. (1998). Technical Efficiency and Productivity of Maize Producers in Eastern Ethiopia: A Study of Farmers within and Outside the Sasakawa-Global 2000 Project. *Journal of Agricultural Economics* 19: 341-348.

Shapiro, Robert. (2011). Public Opinion and American Democracy. The Public Opinion Quarterly. 75. 982-1017. 10.2307/41345919.

SHEP PLUS, (2017). Watermelon Production, *"Changing Farmers' Mindset from "Grow and Sell" to "Grow to Sell"* Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS)

Singh, Y. K. (2006). Fundamental of Research Methodology and Statistics.

Tadele, Z. (2017). Agronomy Review: *Raising Crop Productivity in Africa through Intensification*. Institute of Plant Sciences, Bern: University of Bern.

Tanko, L., Adeniji, O. B., & Nwachukwu, H. (2012). Evaluation of the access to and utilization of information communication technology (ICT) facilities among extension officers in Shiroro LGA, Niger State, Nigeria. *Journal of Agricultural Extension and Rural Development* 5(1), pp. 8-13.

Teye, F., Holster, H., Pesonen, L., Horakova, S., 2012. Current situation on data exchange in agriculture in the EU27 & Switzerland. In: Mildorf, T., Charvat, K., Jr (Eds.), ICT for Agriculture, Rural Development and Environment. Where we are? Where will we go? Czech Center for Science and Society/Wirelessinfo, Prague, pp. 37–47.

The American Association for Public Opinion Research. 2016. Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. 9th edition. AAPOR.

The Discovery of Statistical Regression. (2015, November 6). Price economics. http://priceonomics.com/the-discovery-of-statistical-regression/

UN General Assembly. (2015). Transforming our World: The 2030 Agenda for Sustainable Development. New York: UN News center. Retrieved from http://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf.

Van Crowder L. and Fortier F. (2000). National agricultural , rural knowledge and information system (NARKIS): a proposed component of the Uganda National Agricultural Advisory Service (NAADS).

Wambura, R. M., Acker, D., & Mwasyete, K. K. (2012). *Extension Systems in Tanzania: Identifying Research Gaps. Journal of Agricultural Sciences* 14(1), 43-56.

Wambura, R.M., Doamekpor, P.K., Mwaseba, D.L., Msuya, C.P., Masinde D.M., Mwanga, L.J., & Iranga G.M. (2015). Promotion of Agricultural Innovation Systems Approach: Policy Implications for Maize Extension and Advisory Services in Tanzania. *Tanzania Journal of Agricultural Sciences* 14(2), 112-118

Wanyama, R., Mathenge, M., Zachary Mbaka, Z., (2015). *Agricultural Information Sources and their Effect on Farm Productivity in Kenya*, Tegemeo Institute of Agricultural Policy Development Policy Brief No. 21 November, 2015.

Ward, D. (2013). Breathing New Life into Old Radio: Farm Radio International's Experience with Participatory Radio Campaigns

World Bank. (2001). *World Development Report 2000/2001: Attacking Poverty*. Washington, D.C.: World Bank. Retrieved from https://openknowledge.worldbank.org/handle/10986/11856 License: CC BY 3.0 IGO."URIhttp://hdl.handle.net/10986/11856

World Bank. (2008). *World Development Report 2008: Agriculture for Development*. Retrieved From http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf.

World Bank. (2016). *World Development Indicators 2016*. Washington, DC.: World Bank. Retrieved from https://openknowledge.worldbank.org/handle/10986/23969 License: CC BY 3.0 IGO." http://hdl.handle.net/10986/23969.

World Bank Group. (2017). *The Africa Competitiveness Report 2017: Addressing Africa's Demographic Dividend*, Geneva: World Economic Forum. Retrieved from www.weforum.org/acr. ISBN-13: 978-1-944835-09-5.

Singh, Y. K. (2006). Fundamental of research methodology and statistics. New Delhi: New Age International.

Yurttas, Z., & Atsan, T. (2006). Agricultural Extension and Communication Techniques. *Ataturk University Faculty of Agriculture Publications* No. 67. Erzurum, Turkey: Ataturk University.

Zarmai, J. U., Okwu, O. J., Dawang, C. N., & Nankat, J. D. (2014). A Review of Information Needs of Rice Farmers : A Panacea for Food Security and Poverty Alleviation. *Journal of Economics and Sustainable Development*, *5*(12), 9–16. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1017.8620&rep=rep1&type=pdf

APPENDICES

APPENDIX I: INTRODUCTORY LETTER TO SMALLHOLDER FARMERS

Kenyatta University,
Department of Library & Information Science
P.O Box 43844-00100 Nairobi

Dear Sir/Madam,

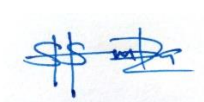
RE: QUESTIONNAIRE TO ESTABLISH THE RELATIONSHIP BETWEEN USE OF EXTENSION INFORMATION SERVICES AND AGRICULTURAL PRODUCTIVITY AMONG SMALLHOLDER FARMERS IN TANA RIVER COUNTY, KENYA

I am a PhD student in the Department of Library and Information Science, School of Education at Kenyatta University. I am currently conducting a research on the relationship between agricultural productivity and use of extension services information by Smallholder Farmers in Tana River County, Kenya.

I am kindly requesting for your assistance by completing the attached questionnaire, which will provide necessary information required for this study. I consider your responses to the questions invaluable to the success of this research project whose findings and eventual recommendations are expected to be of benefit to Agricultural stakeholders, in Tana River County, Kenya and other developing nations in general. The information given will be treated with utmost confidentiality and will be used for research purpose only.

Your co-operation will be highly appreciated.

Yours Faithfully,



Goudian Gwademba

APPENDIX II: QUESTIONNAIRE FOR SMALLHOLDER FARMERS

DEMOGRAOHIC DATA

NAME OF VILLAGE/AGRICULTURAL WARD…………………………….

NAME OF HOUSEHOLD HEAD (Optional)…………………………………….

GENDER ………………………………………………………………………

FAMILY SIZE [No. of Household Members (Optional].…………………...

LEVEL OF EDUCATION (Optional)…………………………………………...
AGE (Optional)…………………………………………………………………...
MARITAL STATUS…………………………………………………………..
PART A: The Impact of Agricultural information on Productivity

Where applicable Tick (√) ***and give details where necessary:***

1. Do you have extension officers in your area? YES □ NO□
2. If NO to question 1 above, how do you access agricultural information
3. If YES to question 1 above, do they visit your farm? YES □ NO□
4. If YES to question 3 above, fill in the Table below giving the number of extension visits against farm yields, in any of the given enterprises you were engaged in during the year 2017/2018,

	YEAR 2017			YEAR 2018		
Agricultural Enterprise	Agricultural Extension Information Dissemination Visits (Days Per Year)	Total Production (Units per Year)	Acreage/ plant/livestock population	Agricultural Extension Information Dissemination Visits (Days Per Year)	Total Production (Units per Year)	Acreage/ plant/livestock population
Cow Milk						
Goat milk						
Camel milk						
Eggs						
Honey						
Fish						
Maize						
Green grams						
Bananas						
Mangoes						
Chilies						
Oranges						
Water melon						
Cabbages						
Onions						
Tomatoes						
Kales						
Butternuts						
Coconuts						
Cashew nuts						
Cotton						
Simsim						
Cassava						
Total						

5. What crop varieties or livestock breeds do you manage?
6. Are the varieties/breeds indigenous or exotic?
7. Is your farming rain fed or dependent on irrigation?
8. How long does the crop or livestock take to mature?
9. How many seasons in a year do you actively produce?
10. Apart from the County government. What other organizations have been supporting agriculture projects in the county?
11. How many acres/ trees or livestock do you have?

12. How do you store or handle your produce after harvest?

PART B: The Use of Extension Information in Enhancing Agricultural Marketing

1. Do extension service providers visit your farm? YES ☐ NO☐
2. If your answer to question 1 above is No, How do you get information on marketing?
3. If your answer to question 1 is yes how long does an extension visit take

less than 1hour	☐	1 hours	☐
2 hours	☐	3 hours	☐
4 hours	☐	more than 4 hours	☐

4. Do extension service providers provide information on marketing of agricultural produce? YES ☐ NO☐

5. If your answer to question 4 above is do they provide any of the information mentioned below?

Postharvest handling	☐	Record keeping	☐
Marketing	☐	Access to Finance	☐
Agricultural Technologies	☐	Agro processing	☐

6. If extension service providers visit your farm, fill in the table below by providing your sold produce and the number of extension visits in the year 2017 and 2018, (Level of Preference:1-very low, 2-low, 3-moderate, 4-high, 5-very high)

Value Chain	Unit of Measurement	2017 Extension Visits	2017 Baseline Sales (a)		2017 Extension Visits	2018 Actual Sales (b)	Total Sales (a+b)	Mean Sales (a+b)/n	Level of Preference(1,2, 3,4,5)
Mangoes	Kgs								
Cattle Milk	Kgs								
Maize	Kgs								
Water melon	Kgs								
Cabbage	Kgs								
Camel Milk	Kgs								
Chillies	Kgs								
Citrus Fruits	Kgs								
Kales	Kgs								
Tomatoes	Kgs								
Goats Milk	Kgs								
Green grams	Kgs								
Onions	Kgs								
Chicken Eggs	Pcs								
Cotton	Kgs								
Coconuts	Kgs								
Bananas	Kgs								
SimSim	Kgs								
Cashewnuts	Kgs								
Cassava	Kgs								
Butternuts	Kgs								
Honey	Kgs								
Pond Fish	Kgs								

7. Do you belong to any marketing cooperative society ?YES □ NO□
8. If yes to question 7 above what are some of the functions of the marketing cooperative societies that you are a member?

Training	☐	Savings	☐
Provision of inputs	☐	Transportation	☐
Friends	☐	Bargaining for fair prices	☐

Others (Please specify) ……………………………………………………….

9. Who are the main buyers of your produce?

Friends	☐	Exporters	☐
Cooperative Society	☐	Supermarkets	☐
Local Traders	☐	Schools & Hospitals	☐
Brokers	☐	food processors	☐

Others (Specify)……………………………………………………

10. Do you know of any agricultural marketing board or marketing cooperative society in Tana River County? YES NO

Others, (Please specify) ………………………………………………………

11. Do you belong to any of the agricultural marketing cooperative societies or marketing boards mentioned in question 9? YES NO

12. If you answer to question 10 above is YES, which of the following ways have you been assisted to market your produce?

Marketing of produce	☐	Bargaining for fair prices	☐
Transporting produce	☐	Providing farm inputs	☐
Savings	☐	Training	☐

Others, please specify……………………………………………

13. Do the information gained from extension service providers help you market your agricultural produce? YES NO
14. Do you experience any challenges/constraints in marketing of agricultural produce? YES NO

If your answer to question above is YES do you experience any of the challenges below?

Low Price	☐	Lack of reliable markets	☐
Transport costs	☐	Delayed Payment	☐
Exploitation by broker	☐	Market restriction	☐

PART C: Constraints to Accessing Agricultural Extension Information

Do you have access to extension service providers? YES ☐ NO☐

If your answer to question 1 is NO, do you miss the services? YES ☐ NO☐

1. If your answer to question 21 above is YES, indicate your level of satisfaction on a scale of *1 – 5 Not satisfied; 2 – Somehow satisfied; 3– Satisfied; 4 – Very satisfied; 5 – Extremely satisfied.*

1	2	3	4

2. Do different extension service providers visit your farm? YES ☐ NO☐
3. If your answer to question 4 above is **YES,** do the visits help improve your agricultural productivity? YES ☐ NO☐
4. If your answer to question 5 above is yes, how do the visits affect your farming?

Accessing farming technology	☐	Improving record keeping	☐
Improving produce handling	☐	Improving Produce quality	☐
Accessing reliable markets	☐	Good prices	☐
Accessing agricultural Finance	☐	Increasing yield	☐

What good agricultural practices have you adopted as a result of information received from extension service providers

Using certified seeds	☐	Farm mechanization	☐
Livestock feed/concentrates	☐	Improved livestock breed	☐

Use of fertilizers &Pesticides	☐	Farm Technology	☐

Others, (Please specify) ……………………………………………..

5. What is your level of education?

No formal education	☐	High School	☐
Primary School	☐	Graduate	☐
Tertiary colleges	☐	Post graduate	☐

6. Which among the following competencies do you have?

Can read pesticide labels	☐	Can Keep Farm record	☐
Has a bank account	☐	cooperative society member	☐

7. What economic activity are you engaged in?

Agriculture & Livestock	☐	Natural resources	☐
Service industry	☐	Manufacturing	☐

8. How much do your household spent per day?

Above kes 1001	☐	Kes. 501 - 1000	☐
Kes 201-500	☐	Below kes 200	☐

9. Are following challenges encountered in accessing information?

Lack of specialized extension	☐	Infrequent visits	☐

Poor extension delivery methods	☐	Few female extension service providers'	☐
Poorly trained extension service providers'	☐	Low literacy level	☐
Lack of demonstration farms	☐	Little or no research and development	☐

Others (Please Specify) ………………………………………….

PART D: Agricultural Extension Information Delivery Methods

1. On a scale rating of 1 to 5, tick (√) as appropriate how useful you find information obtained from extension service providers in improving your agricultural productivity *1*- Useless*; 2*- Not useful*; 3*- Fairly useful*; 4*- Useful *;* *5*- Very useful

1	2	3	4	5

2. On a scale rating of 1 to 5, tick (√) as appropriate your evaluation of the performance of the extension service provider in increasing your agricultural productivity on a Scale rating: *1 – Unsatisfactory; 2 –fairly satisfactory; 3 – Meets Expectations; 4 – Exceeds Expectations;*

1	2	3	4

3. Do extension service providers have specific visiting days to your farm?

YES ☐ NO☐

4. If your answer to question 3 above is YES, do you agree on the visit days? YES□ NO□
5. What kind of knowledge do you receive from extension service providers?
6.

Unfamiliar inputs	□	Book keeping	□
Livestock Breeds	□	Propagation	□
Market information	□	Weather	□
Pest & Diseases	□	Prices	□

7. Do you participate in the activities undertaken by the extension service providers? YES□ NO□

8.If your answer to question to 7 is YES, which of the following activities have you participated in and helped improve your agricultural productivity?

9.

Ploughing competitions	□	Milking competitions	□
Spraying competitions	□	Harvesting drills	□
Home economics competitions	□	Planting competitions	□
Fertilizer application drills	□	Irrigation drills	□

10. Others, (Please specify) ………………………………………………………….
11. From the extension methods listed below, tick those you have been introduced to and improved your agricultural productivity.

Farm visit and training	□	Contract farming	□
Agricultural field days	□	Farmers field schools	□
Demonstration plots	□	Farm exchange visits	□

12. What are the main sources of agricultural information?

Chief's Barazas	□	ICPE	□
ILRI	□	KALRO	□
AIRC	□	ATCs	□

PART E: Application of ICT in Enhancing Agricultural Extension Information

1. Does your extension service provider use any of the following ICTs to enhance agricultural information dissemination?

Mobile phone	□	Internet	□
Radio	□	Newspapers	□
Television	□	Magazines	□

2. Has ICT assisted you in get any of the following information?

Agricultural Insurance	☐	Access to Credit	☐
Mobile Banking	☐	Weather Forecast	☐
Crop & Livestock husbandry	☐	Market Information	☐
Production Forecast	☐	Record Keeping	☐

3. How has the use of ICT improved your Maize productivity

Value Chain	Unit of Measurement	2017 Baseline Production (90 Kg Bags)	2018 Actual Production (90 Kg Bags)	ICT Application (√) Or Not (X)
Maize	90kg Bags			

Thank you for taking the time to answer the questionnaire

APPENDIX III: INTRODUCTORY LETTER TO AGRICULTURAL EXTENSION SERVICE PROVIDERS

Kenyatta University,
Department of Library & Information Science
P.O Box 43844-00100 Nairobi

Dear Sir/Madam,

RE : INTERVIEW SCHEDULE FOR ESTABLISHING THE RELATIONSHIP BETWEEN USE OF EXTENSION INFORMATION SERVICES AND AGRICULTURAL PRODUCTIVITY AMONG SMALLHOLDER FARMERS IN TANA RIVER COUNTY, KENYA

I am a PhD student in the Department of Library and Information Science, School of Education at Kenyatta University. I am currently conducting a research on the relationship between agricultural productivity and use of extension services information by Smallholder Farmers in Tana River County, Kenya.

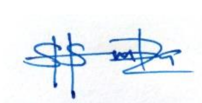
Being an agricultural extension service provider in Tana River County, you have been selected as one of the respondents to participate in this interview. I consider your responses to the questions invaluable to the success of this research project whose findings and eventual recommendations are expected to be of benefit to all agricultural stakeholders in the county, and Kenya in general.

I am kindly requesting you to participate by providing necessary information required for this study. **Please leave out those questions that do not touch on your professional area.**

I would like to assure you that all the information you provide will be treated with utmost confidentiality and will be used for research purposes only.

Your co-operation will be highly appreciated.

Yours Faithfully,



Goudian Gwademba

APPENDIX IV: AGRICULTURAL EXTENSION SERVICE PROVIDERS INTERVIEW SCHEDULE

BIO DATA

NAME OF ORGANIZATION………………………………………………………

DESIGNATION OF RESPONDENT …………………………………………..

DEPARTMENT (If different from organization)…………...………………….

RESPONDENTS GENDER …………………………………………..…….

LEVEL OF EDUCATION (Optional)……….………………………………

AGE (Optional) …….……………………..……………………………………

PART A: The Impact of Agricultural information on Productivity

Where applicable Tick (√) ***and give details where necessary:***

1. In your department, how many extension service providers are deployed in the county?

Extension Staff Deployment			
Department	Current	Desired	Deviation
Agriculture			
Livestock			
Veterinary			
Fisheries			

2. How many farmers does each extension officer serve?

3. On a scale of 1 to 5, how would you rate the improvement in agricultural productivity as a result of dissemination of extension information:

   1-No improvement; 2-Slight improvement; 3-Average improvement; 4-Good improvement; 5-Great improvement?

1	2	3	4	5

4. As per the table below, What was the actual agricultural production against your extension visits in comparison to the expected optimum production in the years 2017 and 2018

Agricultural Production in the year 2017/2018	Total Number of extension information Dissemination Visits in the year 2017	Year 2017 Total Household Production (yields) in (kgs/bunches/lts/trays, livestock)			Total Number of extension information Dissemination Visits in the year 2018	Year 2018 Total Household Production (Yield) in(kgs/bunches/lts/trays, livestock)		
		Actual	Optimum	Deviation		Actual	Optimum	Deviation
Cow Milk								
Goat milk								
Camel milk								
Eggs								
Honey								
Fish								
Maize								
Green grams								
Bananas								
Mangoes								
Chilies								
Oranges								
Water melon								
Cabbages								
Onions								
Tomatoes								
Kales								
Butternuts								
Coconuts								
Cashew nuts								
Cotton								
Simsim								
Cassava								

Any other (Please specify) ……….

PART B: The Use of Extension Information in Enhancing Agricultural Marketing

1. Do you address marketing of agricultural produce in any of the following ways?

Value addition	
Livestock marketing council	
Aggregation of produce	
Information Desk	
Commodity Markets	
Standards and quality	

Others, (Please Specify) …………

2. Are the following agricultural information channels available to farmers and buyers in accessing timely agricultural marketing information?

MOALF Information Desk	
Cooperative society	
Livestock Marketing Council	
Market service centers	
Radio	
Telephone	
HCD	
Internet	

Others, (Please Specify) ………………………………

3. Do farmers access some of the following main markets?

Export	
Local Markets	
Regional Markets	
Processing Industries	

Others, (Please specify)………………………………………………

4. Are farmers engaged in contract farming? ***YES*** □***NO***□

5. If the answer to question 8 above is YES, how useful is contract farming in marketing of agricultural produce in the county?

Guarantee stable prices	
Offer timely purchase of produce	
Allow farmers to plan production	
Reduce wastage	
Train farmers on quality requirements	
Guarantees absorption of all produce	

Others……………………………………………………………

6. Do farmers experience any of the following challenges in marketing of agricultural produce?

Lack of reliable markets	
Exploitation by brokers	
Market restriction	
Delayed Payment	
Transport costs	
Low prices	

7. Do we have an agricultural information desk in the county? ***YES*** □***NO***□
8. Does the county have any agricultural marketing cooperative society or Produce Marketing Board? ***YES*** □***NO***□
9. If the Answer is to question 12 is YES, name some of the agricultural marketing cooperative society or Produce Marketing Board in the county?
10. Do the marketing organizations you have named in question 13 assist farmers in any of the following ways?

Marketing of farm produce		Training on record keeping	
Transporting produce to the market		Improving quality	
Providing farm inputs		bargaining for fair prices	
Accessing agricultural finance		providing farm inputs	

Others, (Please specify)……………………………………………………………

11. Does the county document yields of agricultural produce marketed in the county?

YES □***NO***□

12. If your answer to question 15 above is **YES**, as per the Table below what quantity was marketed quantities and what unit during the year 2017 and 2018

Agricultural Value Chain	**Total Number of extension information Dissemination visits in the year 2017**	**Year 2017 Total agricultural produce marketed (kgs/bunches/lts/trays, livestock)**			**Total Number of extension information Dissemination visits in the year 2018**	**Year 2018 Total agricultural produce marketed(kgs/bunches/lts/trays, livestock)**		
		units	unit price	income		Units	unit price	Income
Cow Milk								
Goat milk								
Camel milk								
Eggs								
Honey								
Fish								
Maize								
Green grams								
Bananas								
Mangoes								
Chilies								
Oranges								
Water melon								
Cabbages								
Onions								
Tomatoes								
Kales								
Butternuts								
Coconuts								
Cashew nuts								
Cotton								
Simsim								
Cassava								

13. Any other marketed produce (Please specify) ……

PART C: Constraints to Accessing Agricultural Extension Information

1.Are there any challenges being encountered in the dissemination of agricultural information to small scale farmers in Tana River County? ***YES*** □***NO***□

2. If the answer to question 17 above is YES are some of the following challenges being encountered in Tana River County

Lack of funds for R&D	□	Lack of transport	□
Funds to set up demonstration farms	□	Training of extension staff	□
Lack of refresher courses	□	Few extension staffs	□
Illiterate farmers	□	Gender inequality	□

Others, (Please specify) ....

3. Has research been effective in improving agricultural productivity? ***YES*** □***NO***□
4. If the answer to question 19 above is YES, has research made any impact on the following aspect of agricultural production

Pest and disease prevention and control	
Introduction of new farming technology	
Variety and breeds improvement	
Crop and livestock nutrition	

Others, (Please specify) ………………………………………

5. Has the county involved all stakeholders in the planning of extension programs?

YES □***NO***□

6. If the answer to question 21 is YES are the following coordinating mechanisms enforced

Profiling of all agricultural stakeholders and their roles	
Investing in research and development	
Formation of agricultural stakeholder's forum	
Monitoring and evaluation of extension services	

Others, (Please specify) ………………………………………………….

7. Does the county allocate enough resources to agricultural extension? ***YES*** □***NO***□
8. If the answer to question 23 above is NO, in your opinion do you think this could be some of the reasons for insufficient funding?

Poor planning	
Non prioritization of extension	
Insufficient funding to counties	
Extension is not demand driven	
Misapropriation of Funds	
Cost sharing not appretiated	

Others, (Please specify)……………………………

9. On a scale of 1-5 how would you rate the participation of farmers in extension education programs? *1-No participation; 2-Slight participation; 3-Average participation; 4-Good participation; 5-Excelllent participation*?

1	2	3	4	5

10. Has the Governments and NGOs attempted to overcome some of the perceived information failures related to technology adoption via agricultural extension services? ***YES* □*NO*□**
11. If the answer to question 26 is **YES,** has some of the following measures been taken

Training and demonstration	
Creation of information sharing platforms	
Targeting the youth in agriculture	
Provision of technology subsidies	

Others, (Please specify) …………………………………….

12. What Economic activity are people in Tana River County engaged in

Agriculture & Livestock	
Natural Resources	
Service industry	
Manufacturing	

13. What is your main source of information?

Extension service providers’	
Training and research institutions	
Lead Farmers /model farms	
Friends	

14. What is the average daily expenditure for Tana River County inhabitants as per the level given below.

Above Kes.1001	
Kes. 201-500	
Below Kes.200	
Kes. 501 - 1000	

PART D: Agricultural Extension Information Delivery Methods

1. Are any of the following methods used to disseminate information to smallholder farmers in the county?

Farm exchange visits	
Agricultural field days and shows	
Farmers field schools	
Demonstration farms/plots	
Farm visit and training	
Contract farming	

Others, (please specify) ……………………………………………………………...

2. From your experience as an extension officer are the following some of the notable information seeking behavior of smallholder farmers in the county.

Others, please specify……………………………………………….....................

3. From your experience as an extension officer are the following some of the notable information seeking behavior of smallholder farmers in the county?
Others, please specify

4. In your practice of extension what methods have you found to be effective in disseminating agricultural information to smallholder farmers’ in the county?

Exchange visits	
Agricultural field days and shows	
Farmers field schools	
Demonstration farms/plots	
Farm visit and training	
Contract farming	

Others, please specify………………………………..

5. Do farmers have a preference to some of the extension method you have mentioned?
   YES □***NO***□
6. If your answer to question 31 above is YES what extension methods are preferred?
7. Do you find it challenging to disseminate agricultural information to illiterate and old farmers? ***YES*** □***NO***□

8. If your answer to question 33 above is YES, do you apply some of the following methods overcome the challenges?

Farmers field schools	
Participatory approaches	
Demonstrations	
Teaching aids, models/real specimen	
Language translation	
Use of lead farmer in training	

Others, please specify………………………………………….

9. Are some of the following agricultural information specific farmers in Tana River County?

□Pest and diseases □Crop and livestock nutrition □Varieties and breed □Weather □Agricultural marketing □Agricultural finance □Agricultural technology □Harvesting and handling

Others, please specify………………………………………….

10. Are there other organizations that are offering extension services in the county? ***YES* □*NO*□**

11. If your answer to question 36 is YES, please name them and give their roles …………………………………………………………………………………

12. Do farmers in Tana River County still find and share some forms of indigenous knowledge in enhancing agricultural productivity? ***YES* □*NO*□**

13. If your answer to question 38 above is YES are some of the following indigenous forms knowledge relevant in Tana River County.

Weather changes	
Environment and natural resources management	
Post-harvest handling	
Crop and livestock nutrition	
Disease and pest control	
Crop varieties and livestock breeding	

Others, please specify………………………………………….

14. What role do your department/ organization have in enhancing agricultural productivity in Tana River County?
15. In your view does the information provided to farmers help them to solve their agricultural production needs? ***YES* □*NO*□**

PART E: Application of ICT in Enhancing Agricultural Extension Information

1. Do you use any of the following ICTs to enhance agricultural information dissemination?

Mobile phone	
Internet	
Radio	
Newspapers	
Television	
Magazines	

2. Do apply ICTs in disseminating agricultural information to farmers?

Agricultural Insurance	
Access to Credit	
Mobile Banking	
Traceability & Weather Forecast	
Crop & Livestock husbandry	
Market Information	
Production Forecast	
Record Keeping	

3. How has the use of ICT improved Maize productivity in Tana River County?

Maize enterprise						
Respondent	2017		2018		**Acreage (a)**	**ICT Application (√) OR (X)**
	Extension Training and Farm Visits (x)	**Maize Yield in 90kg bags (y)**	**Extension Training and Farm Visits (x)**	**Maize Yield in 90kg bags (y)**		
1						

Thank you for taking the time to participate in the interview

APPENDIX V: T-test Table

t-test table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

APPENDIX VI: NACOSTI RESEARCH AUTHORIZATION LETTER

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 3310571, 2219420
Fax: +254-20-318245, 318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/19/87098/28111**

Date: **15th February, 2019**

Goudian Kilemba Gwademba
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Relationship between agricultural productivity and use of extension services information by smallholder farmers in Tana River County, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Tana River County** for the period ending **15th February, 2020.**

You are advised to report to **the County Commissioner and the County Director of Education, Tana River County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GKalerwa

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Tana River County.

The County Director of Education
Tana River County.

APPENDIX VII: RESERCH PERMIT

THIS IS TO CERTIFY THAT:
MR. GOUDIAN KILEMBA GWADEMBA
of KENYATTA UNIVERSITY, 0-70101
HOLA,has been permitted to conduct
research in *Tanariver County*

on the topic: *RELATIONSHIP BETWEEN AGRICULTURAL PRODUCTIVITY AND USE OF EXTENSION SERVICES INFORMATION BY SMALLHOLDER FARMERS IN TANA RIVER COUNTY, KENYA*

for the period ending:
15th February,2020

Permit No : NACOSTI/P/19/87098/28111
Date Of Issue : 15th February,2019
Fee Recieved :Ksh 2000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

CONDITIONS

1. The License is valid for the proposed research, location and specified period.
2. The License and any rights thereunder are non-transferable.
3. The Licensee shall inform the County Governor before commencement of the research.
4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
5. The License does not give authority to transfer research materials.
6. NACOSTI may monitor and evaluate the licensed research project.
7. The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice.

National Commission for Science, Technology and innovation
P.O. Box 30623 - 00100, Nairobi, Kenya
TEL: 020 400 7000, 0713 788787, 0735 404245
Email: dg@nacosti.go.ke, registry@nacosti.go.ke
Website: www.nacosti.go.ke

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH LICENSE

Serial No.A 23187

CONDITIONS: see back page

APPENDIX VIII: RESERCH AUTHORIZATION LETTER FROM THE COUNTY COMMISSIONER TANA RIVER COUNTY

THE PRESIDENCY

MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT

Telegrams:
Email:countycommissionertanariver@gmail.com
Telephone: Hola (046)62448 and 6221
When replying please quote

OFFICE OF THE COUNTY COMMISSIONER
TANA RIVER COUNTY
P.O. BOX 1- 70101
HOLA

REF. NO. TCC/ADM.37/68

DATE: 24th APRIL, 2019

MR.GOUDIAN KILEMBA GUADEMBA
KENYATTA UNIVERSITY
P.O.BOX43844-00100
NAIROBI.

REF: RESEARCH AUTHORIZATION.

Reference is made to a letter from the National Commission For Science And Technology , Ref. No. NACOSTI/P/19/87098/28111 dated 15th February, 2019 addressed to you and copied to this office.

This office wishes to state that, it has no objection in your undertaking research activities as stated in the above referenced letter. We further wish you a good stay and success in your research endeavors.

Thank you.

GEOFFREY M. MWACHOFI
FOR: COUNTY COMMISSIONER
TANA-RIVER COUNTY.

CC.
THE COUNTY DIRECTOR OF EDUCATION
TANA RIVER COUNTY.

APPENDIX IX: RESEARCH TIMETABLE (The time line is in months)

Activity/Time	2016		2017												2018												2019										
	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
Selection of Research Topic	■																																				
Presentation of Concept Paper		■																																			
Development of Research Proposal			■																																		
Review of Chapter One of Research Proposal with Feedback from Supervisor				■																																	
Review of Chapter Two of Research Proposal with Feedback from Supervisor					■																																
Review of Chapter Three of Research Proposal with Feedback from Supervisor						■																															
Finalizing and Presentation of Research Proposal							■																														
Receipt of Panel, Internal and External Readers Reports								■	■	■	■	■	■																								
Review of Proposal as per the Panel, Internal and External Reports														■	■																						
Review of Proposal as per the Panel, Internal and External Reports with feedback from Supervisor																■	■	■																			
Submission of Proposal to Graduate School																			■	■																	
Feedback from Graduate School and Application for Reserch Authorization permit from NACOSTI																					■	■	■														
Pilot Study for Pretesting of Data Collection Instruments																								■	■	■											
Data Collection																											■	■	■	■							
Coding and Data Analysis																															■						
Chapter 4 Report Drafting																																■					
Chapter 5 Report Drafting																																	■				
Review by Supervisors and Feedback on draft Received																																		■			
Final Research Report Completed and Reviewed by Supervisors																																			■		
Final Research Project Prepared and Printed																																				■	
Final Research project Submitted																																					■

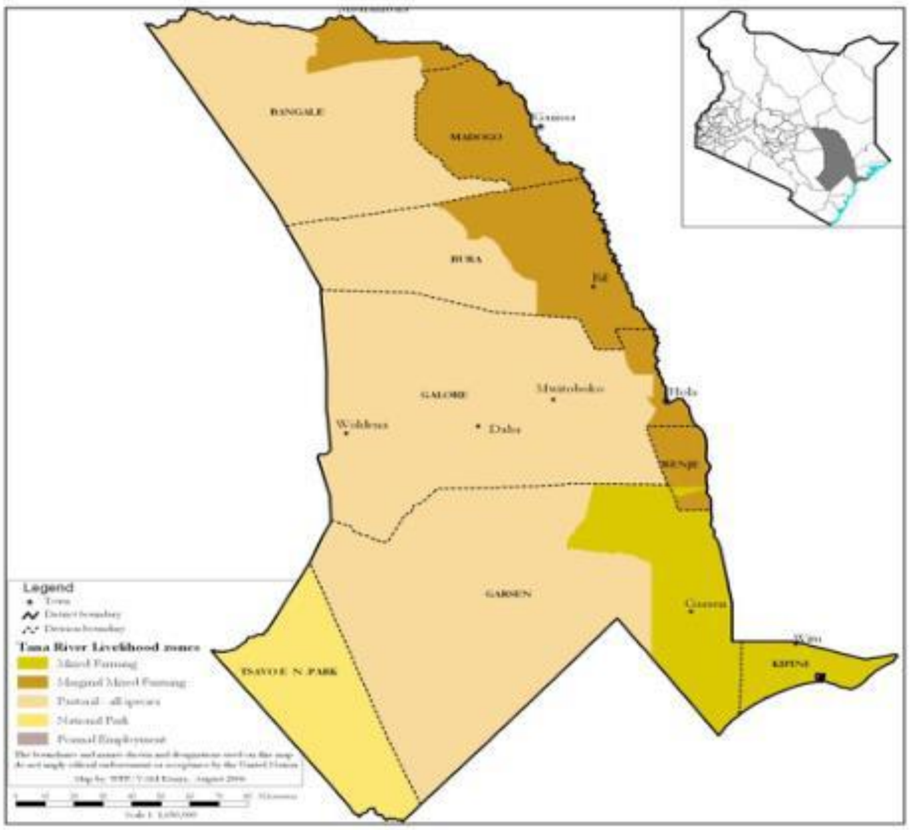
APPENDIX X: BUDGET

SR	Item/Expenditure	Cost (Kes.)
1	Transportation, accommodation, meals and refreshments costs during data collection	100,000.00
2	Communication airtime and internet services	20,000.00
3	Research and reading materials	50,000.00
4	Type-setting and computer services	50,000.00
5	Printing draft and final copies of concept, proposal and Final Thesis documents	50,000.00
6	Binding services	30,000.00
7	Stationery	10,000.00
8	Miscellaneous	10,000.00
	TOTAL EXPENDITURE	320,000.00

APPENDIX XI: LOCATION MAP: TANA RIVER COUNTY

TANA RIVER COUNTY

2016 LONG RAINS FOOD SECURITY ASSESSMENT REPORT



A Joint Report by the Kenya Food Security Steering Group (KFSSG)[1] and the Tana River County Steering Group (CSG)

August, 2016

[1] Shadrack Oyugi (Agriculture and Food Authority), Elizabeth Owino (WFP) and Liya Mango (FEWSNET)

APPENDIX XII: LOCATION MAP: TANA RIVER COUNTY LIVELIHOOD ZONES