

**ADOPTION OF IMPROVED CASHEWNUT PRODUCTION
TECHNOLOGIES BY SMALLHOLDER FARMERS IN MTWARA
DISTRICT, TANZANIA**

SUITBERT FRANCIS MAGANI



**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN RURAL
DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE.
MOROGORO, TANZANIA.**

10 MAY 2016

2013

ABSTRACT

The economy of Mtwara District heavily depends on cashew nut production. However, low production threatens the survival of more than 75% of the people who depend on cashew and also the economy of the district. Many technologies were developed by researchers and were made available to the farming communities to increase productivity. Technical backstopping from research was also provided from time to time to equip key stakeholders with appropriate knowledge and skills necessary to scale up cashewnut production. Despite those efforts, adoption of improved cashew technologies has not improved. The study was conducted to investigate the internal and external factors influencing adoption of improved cashew technologies among 200 smallholder farmers in 14 villages in Mtwara District. Binary logistic regression analysis was adopted to analyze the factors affecting adoption of improved cashew technologies. From the analysis it was found that, access to information, farm size, number of active labour in the household and years of schooling had significantly affected adoption of improved cashew technologies at ($p < 0.05$). From this study, it was found that more than 50% of the improved cashew technologies developed by Naliendele Agricultural Research Institute (NARI) have reached cashew growing areas and about 43% of the respondents in the study area belonged to the adopter category and 57% were non-adopters of improved cashew technologies. Theories guiding this study indicated that, the departure from low productivity to attain high productivity was through adoption of science-based technologies that eventually will enable farmers to produce at economies of scale. In this context knowledge and technologies available in cashew, issues of acquisition of improved cashew materials and crop husbandry, aspects of insect pests and diseases control, methods of technology dissemination are highlighted.

Additionally, challenges and opportunities facing cashew industry are discussed and waysforward suggested.

Therefore, this dissertation presents results of the findings and explores further options to improve uptake of cashew technologies by resource-poor farmers.

DECLARATION

I, Suitbert Francis Magani, do hereby declare to the Senate of Sokoine University of Agriculture that this is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.



.....
Suitbert Francis Magani
(MA. Rural Development)

21/05/2014

.....
Date

The above declaration is confirmed by



.....
Prof. Reuben S.O.W.M
(Academic Supervisor)

21/5/2014

.....
Date

COPYRIGHT

All rights are reserved. No part of this dissertation may be reproduced, stored in any retrieval system, or transmitted in any form or by any means without the prior written permission of the author or Sokoine University of Agriculture in that behalf.

DEDICATION

This work is dedicated to my beloved mother, the late Mwalimu Amalia Alfred Magani, the greatest person I will ever know who laid down for me the foundation of Education. Her invaluable assistance to keep the ball rolling will always be remembered and appreciated. To you my dear mother, I dedicate this dissertation. May your Soul Rest in Eternal Peace. Amen.

ACKNOWLEDGEMENTS

In the first place, I am grateful to God for giving me the inspiration to move on amidst hardships. To you O God, I ascribe all the greatness and glory.

Secondly, my heartfelt appreciation and gratitude go to my academic supervisor Prof. Reuben S.O.W.M for encouragement, constructive critique, comments and timely advice starting from research proposal to the completion of the research work. Thank you for providing your invaluable guidance and always being there when I needed your help, without which, production of this dissertation would not have been of higher standard.

I am also very grateful to Dr. K.A. Kayunze for his constructive comments during research proposal development and all academic staff of DSI for the cordial cooperation extended to me throughout my stay at the Sokoine University of Agriculture which has enabled successful completion of this dissertation.

I would like to express my deepest gratitude and appreciation to the Zonal Director, Research and Development Dr. E.M. Kafiriti for permitting me to join SUA for post graduate studies and for provision of good working environment and positive thoughts and facilitation that enabled me pursue and complete this dissertation and Master's Degree on time.

This gratitude is extended to Lead Scientist Cashew Research Programme, Dr. P.A.L Masawe, Cashew Research Agronomist Dr. Louis Kasuga and Cashew Research Pathologist Dr. Mark Sijaona, a GIS expert L. Emmanuel all from Naliendele Agricultural Research

center for their technical information and facilitation on various aspects of cashew production activities. Your support has been of great value to me.

I would also appreciate the valuable expertise, assistance and support of all resource persons from the Naliendele Agricultural Research Institute during field work and data collection. Special thanks and sincere appreciation go to Kidunda, B. RandMwakanyamale, D.F for their invaluable guidance and constant cooperation in sharing with me experience and resources during research work. In addition, my profound gratitude goes to Mtwara District Agricultural, Irrigation and Cooperative Officer, Onesmo Hava, Village Agricultural Extension Officers and all respondents in the study area for their honesty and valuable information that have enabled successful production of this dissertation.

Those acknowledgements would not be complete without mentioning my family members: my brother Salvatory, Dennis and Steven Mtamanda and my sisters Lucy and Leticia, my lovely wife Salome Magani and my precious children Francis and Lucy whose support, encouragement, compassion and love were source of inspiration during research work. To all, very warm and sincere thanks for everything you gave me on my way.

Lastly but not least, many people have helped me at different stages of this work but it is not possible to adequately acknowledge everyone who helped me in this space. Rest assured that, your input is highly appreciated, to you all, I say thank you very much.

TABLE OF CONTENTS

ABSTRACT.....	i
DECLARATION.....	ii
COPYRIGHT.....	iv
DEDICATION.....	v
ACKNOWLEDGEMENTS.....	vi
TABLE OF CONTENTS.....	vii
LIST OF TABLES.....	xiii
LIST OF FIGURES.....	xiv
LIST OF PLATES.....	xv
CHAPTER ONE	1
1.0 INTRODUCTION.....	1
1.1 Background Information.....	1
1.2 Problem Statement and Justification.....	3
1.2.1 Problem statement.....	3
1.2.2 Research justification	5
1.3 Objectives of the Study.....	6
1.3.1 Mainobjective.....	6
1.3.2 Specific objectives.....	6
CHAPTER TWO.....	7
2.0 LITERATURE REVIEW	7
2.1 Overview.....	7

2.1.1	Origin of cashewnut.....	7
2.1.2	Cashew nut production in Tanzania.....	8
2.1.3	Definition of concept.....	9
2.2	Theoretical Framework.....	10
2.2.1	Awareness.....	10
2.2.2	Interest and persuasion towards the innovation.....	11
2.2.3	Evaluation or decision to adopt or not to adopt.....	11
2.2.4	Trial and confirmation about the decision made.....	11
2.2.5	Adoption or confirmation stage.....	12
2.2.6	Categorization of farmers in relation to adoption of innovations.....	12
2.2.7	Theory of reasoned action (TRA).....	14
2.2.8	The Population and technology theory by Esther Boserup.....	16
2.2.9	The High Pay-off input model by Theodor Schultz.....	17
2.2.10	The peasant mode of production by Alexander Chayanov.....	18
2.2.11	Agricultural Sector Development Program (ASDP).....	18
2.3	Initiatives and Research Conducted in Technology Development and Transfer.....	19
2.3.1	Multiplication and distribution of improved planting materials.....	20
2.3.2	Dissemination of research technologies to farmers.....	22
2.3.3	Conceptual framework.....	25
CHAPTER THREE.....		28
3.0	RESEARCH METHODOLOGY.....	28
3.1	Overview.....	28
3.1.2	Description of the study area and justification.....	28

3.1.3	Location, climate and topography	28
3.1.4	Economic activities.....	30
3.1.5	Justification for selection of Mtwara District.....	32
3.2	Research Design and Sampling.....	33
3.2.1	Research design.....	33
3.2.2	Data sources and instrument for data collection.....	33
3.2.3	Sampling procedure, sample size and data collection methods.....	34
3.2.4	Data processing and analysis.....	34
3.2.4.1	Binary logistic regression model (BLRM).....	35
CHAPTER FOUR.....		37
4.0	RESULTS AND DISCUSSION.....	37
4.1	Overview.....	37
4.1.1	The socio-economic characteristics of respondents.....	37
4.1.2	Distribution of respondents according to agricultural production activities..	41
4.1.3	Other Sources of income to the respondents.....	44
4.1.4	Major food crops grown by respondents.....	45
4.2	General Information on Cashew Management and Production Activities.....	46
4.2.1	Farmers' adherence to 'best practice' to increase productivity.....	46
4.2.2	Reasons for low adoption of recommended planting space of cashew.....	48
4.2.3	Reasons for low adoption of top-working.....	49
4.2.4	Farmers' awareness about improved cashew technologies.....	51
4.2.5	Reasons for lack of awareness about improved cashew technologies.....	52
4.2.6	Adoption and utilization of cashew technologies by respondents.....	52

4.2.7	Types of improved cashew materials planted by respondents	53
4.2.8	Reasons for low adoption of the improved cashew materials	54
4.2.9	Use of fungicides to control important cashew diseases	55
4.2.10	Farmers' awareness and understanding of important insect pests of cashew...	59
4.2.11	Challenges experienced in controlling insect pests and diseases in cashew..	62
4.2.12	Farmers' main sources of improved planting materials of cashew	66
4.2.13	Trend of improved cashew trees planted over the years	67
4.2.14	Age category of cashew trees planted between 1990 and 2010	68
4.2.15	Cashewnut production trend in Mtwara district	70
4.2.16	Availability of extension services.....	71
4.2.17	Frequency of contact between farmers and VAEO on yearly basis	71
4.2.18	Perception of farmers on improved cashew materials.....	72
4.3	Logistic Regression Results on Adoption of Improved Cashew Materials.....	75
4.3.1	Years of schooling.....	76
4.3.2	Household labour force available to work on the farm enterprises.....	77
4.3.3	The size of cashew farm owned	77
4.3.4	Access to information on cashew materials	78
4.3.5	Age of respondent.....	79
4.3.6	Years of experience in cashew farming.....	80
4.3.7	Access to extension services	81
4.4	Technology Transfer.....	82
4.4.1	Effective methods of technology transfer to cashew farmers	82
4.4.2	Benefits associated with use of improved cashew technologies	84
4.4.3	Respondents' achievements after adopting improved cashew technologies.....	85
4.5	Constraints to Uptake and Utilization of Improved Cashew Technologies.....	87

4.5.1	Challenges related to institutional support and micro-finance services	88
4.5.2	Limitations to loan acquisition among cashew farmers	90
4.5.3	Suggestions to improve adoption of cashew technologies by respondents.....	91
CHAPTER FIVE.....		94
5.0 CONCLUSIONS AND RECOMMENDATIO.....		94
5.1	Conclusion and Implications for Research, Extension and Policy.....	94
5.2	Recommendation.....	95
REFERENCES.....		99
APPENDICES		120

LIST OF TABLES

Table 1: Respondents according to their socio-economic characteristics (n =200).....	40
Table 2: Respondents according to agricultural production activities (n=200).....	43
Table 3: Farmers' engagement on production activities.....	44
Table 4: Major food crops grown by respondents	46
Table 5: . Farmers' adherence to 'best practice' to increase productivity.....	47
Table 6: . Farmers' awareness about improved cashew technologies (n=200).....	51
Table 7: .Control of cashew diseases.....	58
Table 8: Farmers awareness (knowledgeable) about insect pests of cashew.....	61
Table 9: Uses of pesticides in controlling insect pests and diseases in cashew.....	65
Table 10: Availability of Extension services (n=200).....	71
Table 11: Perception of farmers towards improved cashew materials.....	74
Table 12:..Logistic regression results on adoption of improved cashew materials.....	76
Table 13:..Respondents' views on effective methods in technology transfer.....	84
Table 14:.. Whether respondents benefited after adopting cashew technologies.....	85
Table 15: Respondents' achievements after adopting improved cashew technologies.....	85
Table 16:..Constraints/challenges to adoption of improved cashew technologies.....	87
Table 17:..Whether the farmer had received formal credit/loan (n= 200).....	90
Table 18: Suggestions on how to improve adoption of cashew technologies.....	93

LIST OF FIGURES

Figure 1: A model of five stages in the Innovation-Decision Process (IDP).....	12
Figure 2: Adopter Categorization based on Innovativeness.....	13
Figure 3: Diffusion as a linear model.....	14
Figure 4: Theory of Reasoned Action.....	16
Figure 5: A revised conceptual framework adopted from Duvel model of behaviour analysis and change.....	27
Figure 6: Mtwara Regional map indicating its districts.....	29
Figure 7: A map of Mtwara District indicating distribution of sampled villages for adoption study of improved cashewnut production technologies.....	30
Figure 8: Other sources of the income to the respondents.....	45
Figure 9: Reasons for low adoption of recommended planting space of cashew.....	49
Figure 10: Reason for low adoption of top-working.....	50
Figure 11: Reasons for lack of awareness about improved cashew technologies.....	52
Figure 12: Farmers' utilization and adoption of improved cashew technologies.....	53
Figure 13: Types of improved cashew materials planted by respondents.....	54
Figure 14: Reasons for low adoption of planting materials of cashew.....	55
Figure 15: Sources of improved planting materials to farmers.....	67
Figure 16: Percentage of respondents who have planted improved cashew trees.....	68
Figure 17: Age category of cashew trees planted between 1990 and 2010.....	69
Figure 18: Production Trend as per 2006-07 up to 2012-13 in Mtwara district.....	70
Figure 19: Frequency of contact between farmers and VAI:O on yearly basis.....	72
Figure 20: Limitations to loan/credit acquisition to cashew farmers.....	91

LIST OF PLATES

Plate 1:	Polyclonal seed are raised at CDCs.....	21
Plate 2:	Grafted cashew seedlings.....	21
Plate 3:	Technology transfer.....	23
Plate 4 :	Good Agricultural Practices.....	24
Plate 5:	Upgrading cashew orchard.....	51
Plate 6:	Cashew diseases.....	56
Plate 7:	Controlling insect pests and cashew diseases.....	59
Plate 8:	Insect Pests of cashew.....	61
Plate 9:	Attributes of improved cashew materials.....	75
Plate 10:	Benefits of improved cashew yield. reduction of income poverty.....	86

LIST OF APPENDIX

APPENDIX 1: Sample size calculation.....	119
APPENDIX 2: Selected villages for adoption study	121
APPENDIX 3: Questionnaire for adoption study.....	122

LIST OF ABBREVIATIONS

AAADI	African Agro-Industry and Agribusiness Development Initiatives
ADB	Agricultural Development Bank
AKF	Agha- Khan Foundation
AMCOS	Agricultural and Marketing Cooperative Society
ANOVA	Analysis of Variance
ARIN	Agricultural Research Institute Naliendele
BLRM	Binary Logistic Regression Model
CAADP	Comprehensive Africa Agricultural Development Programme
CBO	Community Based Organization
CBT	Cashewnut Board of Tanzania
CDC	Cashewnut Development Centers
CIP	Cashewnut Improvement Programme
CRP	Cashew Research Programme
DAICO	District Agricultural, Irrigation and Cooperative Officer
DC	District Council
DSI	Development Studies Institute
DTIS	Tanzania Diagnostic Trade Integration Study
FCF	Federation of Cashew Farmers
FFS	Farmers Field Schools
FINNIDA	Finland International Development Agency
FSR	Farming System Research
GAP	Good Agricultural Practices

GIS	Geographical information System
HHs	Households
ICMP	Integrated Cashewnut Management Programme
IDP	Innovation Decision Process
IFAP	International Federation of Agricultural Producer
IPM	Integrated Pest Management
JICA	Japan International Cooperation Agency
LGA	Local Government Authority
MDG	Millennium Development Goal
MDP	Makonde Dissected Plateau
MoAFC	Ministry of Agriculture, Food Security and Cooperative
NARI	Naliendele Agricultural Research Institute
NBS	National Bureau of Statistics
NGO	Non-Governmental Organization
NORAD	Norway Agency for Development
NSGRP	National Strategy for Growth and Reduction of Poverty
OFAR	On-farm Adaptive Research
PCS	Primary Cooperative Society
PHC	Population and Housing Census
PLA	Participatory Learning and Action
PMD	Powdery Mildew Diseases
REPOA	Research on Poverty Alleviation
RIPS	Rural Integrated Programme Support
SACCOS	Savings and Credit Cooperative Society

SPSS	Statistical Package for Social Science
SSA	Sub-Saharan Africa
SUA	Sokoine University of Agriculture
SWISSAID	Switzerland International Development Agency
TAMOFA	Tanzania Mozambique Friendship Association
TBC	Tanzania Broadcasting Cooperation
ToT	Training of Trainers
TRA	Theory of Reasoned Action
TV	Television
UNICEF	United Nations Children Education Fund
UNIDO	United Nations Industrial Development Organization
URT	United Republic of Tanzania
VAEO	Village Agricultural Extension Officer
VICOBA	Village Community Banks
VoP	Voice of People
WEO	Ward Executive Officer
WRS	Warehouse Receipt System

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Cashewnuts (*Anacardium occidentale* L. Anacardiaceae) is one among the most important export crops in terms of foreign exchange earnings, and a leading source of income for over 300 000 households in South-Eastern Tanzania (Northwood and Tsakiris, 1967). An average cashew farmer owns 1-2 hectares of cashew farms managed using family labor (Northwood and Tsakiris, 1967). Area under cashewnut cultivation is estimated to be 400 000 ha in mono or mixed (in combination with maize, groundnuts, cassava etc.) cropping system (Topper et al., 1998). The average yield in farmers' fields ranges from 500 to 800 kg/ha. The annual report by Cashew Research Programme indicated that, over 80% of the crop comes from Mtwara, Lindi Regions and Ruvuma (Tunduru District) Regions and small quantities come from Tanga and Coast Regions (ARIN, (2007-2010). Cashewnut production continued to rise from 7 000 metric tons in the 1940s to 42 000 metric tons in the 1960 and up to 145 000 metric tons in 1973-74. By the mid-1980s, cashewnut productions trends declined to a level of 16 400 metric tons in 1986 (Brown et al., 1984). Reasons for decline in productivity were as follow:

Villagilization settlement programme adopted by Tanzanian government in 1974 had a detrimental effect to cashewnut industry (CIP, 1993). The main aim of this programme was to make it easier to provide services (e. g. extension services and mechanical cultivation). And social infrastructure (e.g. schools, clinics, and water supply) to the rural population by moving them into registered villages where communal production was encouraged. In many cashew growing areas, farmers were being re-allocated away from

their original farms and habitation as a result many cashew farms were either not managed or neglected completely. Bush fires, diseases and insect pests infestation especially Powdery Mildew Diseases (PMD) (*Oidium anacardii*) and Helopeltis bugs (*Helopeltis anacardii*) were serious problems in some of the major cashewnut growing areas while unreliable weather and old age of cashew trees added to the problem (Ellis, 1980). Others include reduced funding for research and ineffective extension efforts, lack of improved planting materials and economic crisis that reduced the incentives to farmers to invest in the cashewnut industry (Brown *et al.*, 1984).

Absence of improved planting materials of cashew forced farmers to resort to traditional seeds and methods of production with mediocre yields (CIP, 1993). In the 1990s, Naliendele Agricultural Research Institute (NARI) engaged on extensive and intensive work to find ways to increase cashew productivity through outreach programme such as On-Farm Adaptive Research (OFAR) and demonstration plots replicated in different cashew growing areas. These were focal points for farmers, extension worker and other stakeholders to get knowledge on improved methods of cashewnut production activities anticipating that, learning by seeing/doing would increase the impact and adoption of improved cashewnut technology (Badrage *et al.*, 2009; Van den Berg, and Jiggins, 2007; Wandjiet *al.*, 2007). The short-term approach concentrated on multiplication and distribution of improved planting materials of cashew in form of polyclonal seeds and grafted seedlings. The long-term strategy focused on breeding high yielding cashew clones (hybrids) with good nut quality tolerant to common diseases such as PMD, leaf and nut blight, anthracnose and sucking insect pests such as helopeltis bugs (Mnoney and Mantell, 2006; Croxford, 2006). The use of botanical pesticides is still under investigation.

However, a breakthrough with the last two options would maximize farm profit and enable a shift from heavy dependence on chemicals that have negative impact on the environment to options that are cost effective, socially acceptable and environmentally friendly (Ngatunga *et al.*, 2000; Majule *et al.*, 1997). This will also respond to the demand of organic products in the world market.

Despite those efforts, there was persistent low productivity at farmer level attributed by low adoption of the improved cashew materials. Result demonstration revealed a yield gap between farmers' fields of 19 kg/tree/season compared to that of the on-farm research experimental plots of 49 kg/tree/season (Masaweet *et al.*, 2005; Kasuga, 2003). The focus of the study is thus geared towards investigating and addressing the reasons for poor adoption of improved cashew production technologies and come up with possible intervention to save the cashew industry.

1.2 Problem Statement and Justification

1.2.1 Problem statement

Research findings have clearly indicated a great opportunity for cashew farmers to increase yielding potential of their cashew farms from 19 kg/tree/season to above 49 kg/tree/season when they adopt options of improved cashew production technologies at their disposal (ARIN, 2007-2010). These technologies include: use of polyclonal seeds and grafted cashew seedlings, rehabilitation and subsequent upgrading of low and unproductive cashew orchards using options such as top-working, use of fungicides and insecticides plus cultural and management practices (ARIN, 2007-2010). Furthermore, it has been demonstrated that improved clones of cashewnut have the potential of giving economic yield of above 24 kg/tree/season much earlier at an average age of six years under good agricultural practices (GAP) while the local types give economic yield of 19

kg/tree/season at the age of 12 years and above (Kasuga, 2003; Masawe, 2006). However, despite all of the known benefits and rewards associated with use of improved cashew technologies, the research findings have met with scant success, as their adoption at farmer level has remained very low and quite disappointing (Kafiriti, 2010). Study conducted by Voice of People (VoP) in Mtwara and Lindi Regions in 2007 indicated that, 70% to 80% of cashew farmers have never used any input (REPOA, 2007). Furthermore, experience from various researchers reveals a low adoption rate of new agricultural technologies among smallholder farmers. On average adoption rate in sub-Saharan Africa (SSA) was 22% as opposed to 78% in South Asia and 84% in East Asia. Low technology uptake results into limited productivity due to farmers' inability to produce at economies of scale (Evenson and Gollin, 2003).

Currently, technical reasons for declining cashew productivity and increasing rural poverty among smallholder cashew farmers are widely recognized as documented by CIP when investigating reasons for declining in cashew productivity across cashew growing areas that occurred beginning 1974 (CIP, 1993). However, there was insufficient understanding on background factors such as household and farm characteristics that influenced farmers' decision on use or non-use of improved cashewnut production technologies. This was despite studies and interventions by government institutions, NGOs and other donor partners in cashew growing areas.

This study therefore, intended to capture and document the social and ecological contexts not adequately covered by other stakeholders on understanding that, the factors limited uptake of improved cashew production technologies may result from both external and internal forces apart from technical related factors.

1.2.2 Research justification

Cashewnut is one of the main export crops and a leading source of income, and over 75% of the rural population in Mtwara District derives its income from cashewnut production activities (Cashewnut Board of Tanzania, 2005). According to DTIS (2005), in 2002 Tanzania was the fourth largest producer of raw cashewnut after India, Brazil and Vietnam in which 92 000 metric tons of raw cashewnuts were produced, 98% of the production being from small-scale farms majority being from South East regions. Based on earlier research findings conducted by Cashew-Pathology and Protection sections based at NARI, it was found that failure to control insect pests and cashew diseases might cause a yield loss of 70% to 100% depending upon phytosanitary measures taken to reduce sources of inoculum (Sijaona, *et al.*, 2006).

This study bears a direct relevance to the National Vision of Kilimo Kwanza Pillar No. 1, item 1.2 focusing on transforming peasant and smallholder farmers by emphasizing on productivity and tradability (TNBC, 2009). The increase in cashew productivity will contribute to reduction of income poverty of both men and women in rural and urban areas as stipulated in the National Strategy for Growth and Reduction of Poverty (NSGRP), Cluster 1: Goal number 4 and 5 (URT, 2007) on 'Reducing Income Poverty of both Men and Women in Rural and Urban Areas'. Implementation of the above will go concurrently with attainment of the Millennium Development Goal 1a (MDG 1a) of the United Nation, CAADP aiming at 'Reducing Abject Poverty and Number of People facing Food Insecurity by 50% by the year 2015'.

Knowledge or findings of this study, in this regard (feedback or farmers' reactions towards improved cashew technologies) will be of paramount importance to policy

makers, cashew stakeholders and researchers in designing/refining technologies that will be more effective and tailored to meet the needs and aspirations of cashew farmers. Cashew stakeholders will also evaluate themselves whether the approach adopted were technology -oriented or demand driven and client oriented. hence, call for a need to redesign appropriate methodologies applicable to cashew farmers (Birner and Anderson, 2007; Sahin, 2005). New/current or unsolved technical problems and challenges addressed by cashew farmers become gaps for further research.

1.3 Objectives of the Study

1.3.1 Main objective

The study was conducted with the general objective of assessing and documenting the level of adoption of improved cashewnut production technologies by smallholder cashew farmers in Mtwara district.

1.3.2 Specific objectives

To meet the general objective, the study worked on the following specific objectives.

- (i) To assess farmers awareness on improved cashewnut production technologies.
- (ii) To find the proportion of cashewnut farmers who have adopted technologies to increase cashewnut yield.
- (iii) To determine household socio-economic and farm characteristics affecting adoption of improved cashewnut production technologies.
- (iv) To determine the most effective methods in disseminating and promoting improved cashewnut production technologies to smallholder farmers.
- (v) To investigate farmers' constraints or limitations to adoption of cashew production technologies.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

Research is dynamic and an on-going activity whereby researchers continuously develop new findings (innovations, technologies) or refine existing technologies to meet needs of the farming communities (Mwantomwa, 2008). Cashewnut is grown in an environment that is complex, diverse, risk-prone and uncertain. It is imperative that cashew farmers get precise information about new cashewnut production technological packages to enable them make informed decisions and incorporate scientific insights into their repertoire of options and adaptations. This idea is in line with Asiabaka who believed that, for farmers of different agricultural zones to adapt a new technology they must be aware of the technology, have valid and up to date information on the technology, the applicability of the technology to their farming system and receive the technical assistance (Asiabaka *et al.*, 2001). Though, this may not necessarily guarantee an immediate or early adoption of innovation, as several factors may influence decision-making process by resource poor farmers who differ in degree of risk management (Ajayi and Okunlola, 2006; Rivera, 2006)

2.1.1 Origin of cashewnut

Cashewnut (*Anacardium occidentale* L.) is a native of South America with a likely source of origin in Central Brazil (Mitchell and Mori, 1987). Initially, planting of cashewnut was done to check erosion on the coastal areas in India and in Mozambique, but later on, it became an important crop particularly for poor farmers in rural areas (Northwood and Tsakiris, 1967). The Portuguese and Colonial missionaries introduced it in East Africa in the 16-century (Mitchell and Mori, 1987).

The cashewnut has since then spread to several countries, primarily between latitudes 15 degrees north and south of the equator, altitude up to 1000 m above sea level and mean annual temperatures range from 24°C to 28°C. Cashew produces well where the average annual rainfall is between 800-1600 mm with pronounced dry period of 5-6 months during fruiting/harvesting period.

Major cashew producing countries are Vietnam, India, Brazil, Tanzania, Mozambique, Ivory Coast and Nigeria. Other countries include Benin, Ghana, Guinea Bissau, Guinea Conakry, Madagascar, Togo, Indonesia, Uganda, Kenya, Zambia, Malawi, Senegal, Burkina Faso, China, Sri Lanka, Thailand and Malaysia (Johnson, 1973). African continent produces more than one third of the world's cashewnut. The main consumers of cashew kernels produced worldwide are USA 50%, Europe 30% and others 20% (CBT, 2005).

2.1.2 Cashewnut production in Tanzania

Cashewnut is one among the most important export crops in terms of foreign exchange earnings, thereby contributing to economic growth and poverty reduction. By the 1960s and 1970s, Tanzania was among the major producers of cashewnut in the world and virtually its entire raw nuts were being exported to India for processing and marketing (CBT, 2005). In 1986-87 season, total production of raw nuts in Tanzania was as low as 16 000 metric tons but picked up again in 1998-99 following increased research activities particularly in the control of PMD. The latter was coupled with the use of sulphur dust. Sulphur in form of dust or wettable have shown to adequately control PMD in cashew (Sijaona 1984).

Recent studies have clearly demonstrated that, yields have increased with increased use of sulphur. For instance, with 0.5 kg of sulphur /tree/season (two rounds) yields varied from 1kg - 10 kg/ tree/season while with 1.25 kg of sulphur/tree/season (the recommended rate of five rounds) the yields varied from 1kg - 19 kg/tree/season (Shomari, 1998). However, given the right impetus there is potential to increase cashewnut yield to over 200 000 metric tons, but this remains to be a challenge to key players in the cashew industry (CBT, 2005).

2.1.3 Definitions of concept

Adoption is a social-cultural process and takes place in a social context with farmers discussing their ideas with other farmers. Decision to adopt is done in response to a consideration of a wide range of issues. However, much adoption occurs when the idea or practice to be adopted has become part of the normative concept of good farm management (Phillips and Gray 1995; Vanclay and Laurence 1995).

Nevertheless, adoption has been defined in different ways by different theorists. Feder *et al.*, (1985) defined adoption as a mental process an individual passes from first hearing about an innovation to final utilization. According to Feder an individual will evaluate the innovation before the decision to adopt or not to adopt is reached. Other scholars defined adoption as decision of full use of an innovation as the best course of action available while the process in which an innovation is communicated through certain channels overtime among the members of a social system, is known as diffusion (Feder and Savantano, 2006; Rogers, 2003). According to Fisher *et al.* (2000), diffusion differs from adoption in that, it is a process by which new technologies are spread/circulate among users whereas, adoption is said to be an individual internal decision.

All definitions considered adoption as a long-run concept, which occurs when farmers have complete information about, and are convinced of the superiority of the new technology over the existing one.

On the other hand, technology is the relationship between inputs and outputs or the set of hardware (physical) and software (techniques) tools that allow for a different mapping of inputs and outputs (Foster and Rosenzweig, 2010).

In the agricultural context, the hardware refers to improved planting materials of cashew and pesticides whereas; software refers to practices such as intercropping, weeding, pruning etc. In this context, technology adoption is therefore defined as the use of tools or techniques that relate inputs to outputs and the allocation of inputs for the purpose of increasing outputs (Foster and Rosenzweig, 2010).

2.2 Theoretical Framework

Many theories have attempted to explain the adoption of new technology, but the most popular one is the "diffusion of innovation theory model" described by Rogers (2003). Depending on relative advantages, compatibility, complexity, trial-ability and observability of its benefits, adoption as a process, has five stages as described in the following section (Rogers, 2003; Gregor and Jones, 1999).

2.2.1 Awareness

Communication channels are very important in creating awareness about improved cashew technologies. Method of information dissemination such as demonstration plots, on-farm trial and farmers' field school and others play a major role in influencing adoption or non-adoption of innovation. In this stage, a person becomes aware of an

innovation and has some idea of how it functions. In this step, an individual learns about the existence of innovation and seeks information about the innovation. "What?" "How?" and "Why?" are the critical questions in the knowledge phase

2.2.2 Interest and persuasion towards the innovation

As knowledge builds up a person forms a favorable or unfavorable attitude toward the innovation, the individual shapes his or her attitude after he or she knows about the innovation. A farmer is motivated by the rewards attached with use of agricultural innovation. Aspect such as trialability, complexity, observability and compatibility will guide a farmer in adoption or non-adoption of innovation.

2.2.3 Evaluation or decision to adopt or not to adopt

Farmers are rational in making decision whether to adopt or not to adopt an innovation. At this stage, a person engages in activities that lead to adoption of the innovation. Basically, the farmer is well informed about the risks, uncertainty and the rewards associated in adopting a particular agricultural innovation. Socio-economic characteristics, personality variables and communication behavior will influence a farmer to adopt or not to adopt agricultural innovation.

2.2.4 Trial and confirmation about the decision made

This is an implementation stage whereby a farmer incorporates technologies into his/her farming system. Depending on ecological and socio-economic circumstances a farmer (as a risk taker) engages into a trial and error business implementing the innovation either in small scale or large scale. The importance of farmer experimentation was also documented by Sumberg and Okali (1988).

2.2.5 Adoption or confirmation stage

A person evaluates the results of an innovation or decision already made and the individual looks for support for his or her decision. Accumulated experience and performance of the innovation such as increase in production will more likely determine willingness of the farmer to continue to use the innovation or reject from further use of the technology.

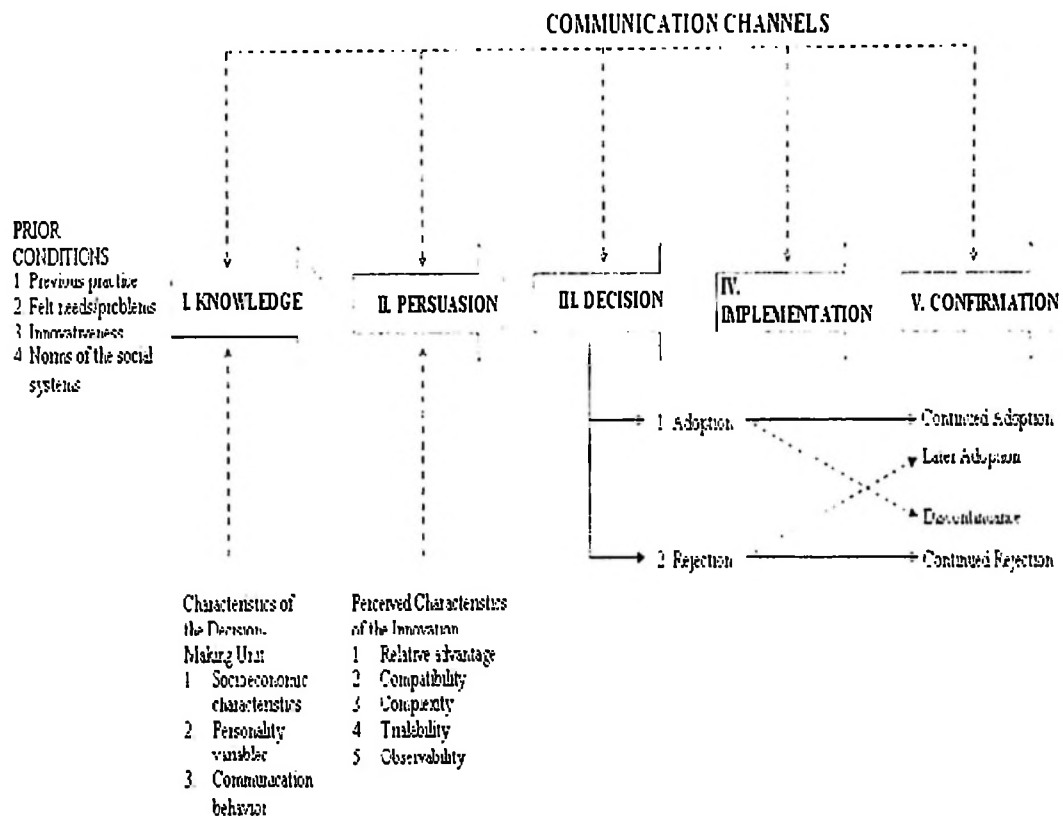


Figure 1: A model of five stages in the Innovation-Decision Process (IDP)

Source: Rogers, 2003

2.2.6 Categorization of farmers in relation to adoption of agricultural innovations

Since not all potential adopters in a social system adopt a new product at the same time, adopters can be classified into categories, depending on when they adopt the product.

Rogers (2003) classified adopters into five categories namely innovators, early adopters, early majority, late majority, and laggards. The categories are important because they can aid the targeting of new prospects for a new product, assist in developing marketing strategies to penetrate the various adopter categories, and assist in predicting the continued acceptance or rejection of a new product. Figure 2 shows that the distribution of adopters as a normal distribution.

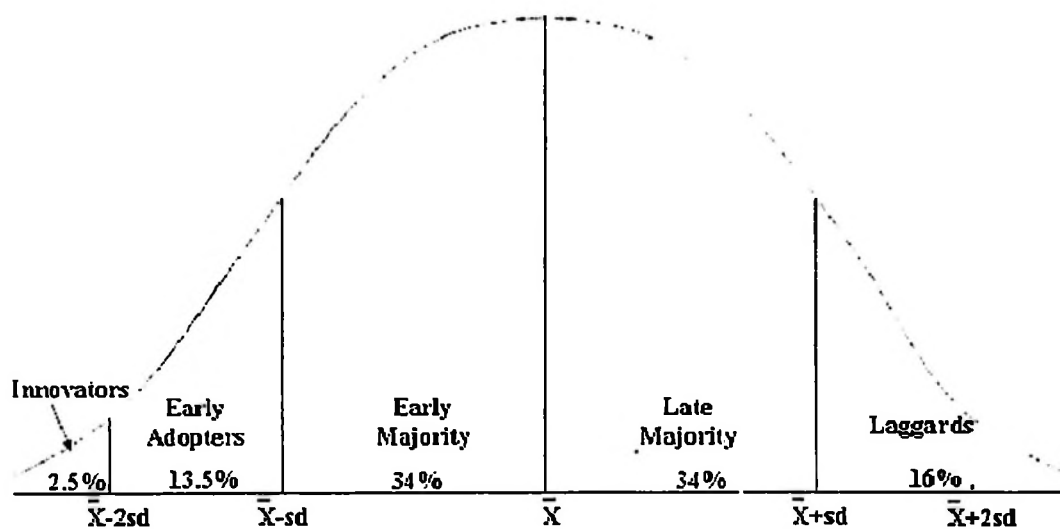


Figure 2: Adopter Categorization based on Innovativeness

For Rogers (2003), innovators were willing to experience new ideas. Thus, they are prepared to cope with unprofitable and unsuccessful innovations, and a certain level of uncertainty about the innovation. Early adopters are more limited within the boundaries of the social system. Since early adopters are more likely to hold leadership roles in the social system, other members come to them to get advice or information about the innovation. In fact, "leaders play a central role at virtually every stage of the innovation process, from initiation to implementation, particularly in deploying the resources that carry innovation forward" (Sahin, 2005). The early majority has a good interaction with

other members of the social system and their interpersonal networks are important in the innovation-diffusion process. The late majority includes one-third of all members of the social system who wait until most of their peers have adopted the innovation. Although they are skeptical about the innovation and its outcomes, economic necessity and peer pressure usually force them to adopt the innovation. Laggards have the traditional view and they are more skeptical about innovations and change agents than the late majority. Because of limited resources and lack of awareness and knowledge of innovations, in most cases the outcome of the innovation would convince them to adopt. Within the agriculture sector Rogers (2003) provides a linear process of technology development and dissemination culminating in adoption of new technology by farmers. The major weakness with this theory lies in its inherent top-down approach with farmers as major recipients of those technologies. Lack of farmer participation and incorporate indigenous technology has been source of poor adoption of technologies.

The model of the diffusion process

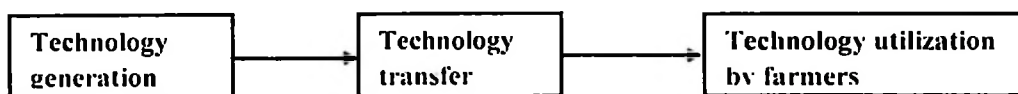


Figure 3: Diffusion as a linear model

Source: Rogers (2003)

2.2.7 Theory of reasoned action (TRA)

Theory of Reasoned Action (TRA) focuses on behavioral determinants of the individual instead of technological characteristics (Green, 2005). The Theory of Reasoned Action (TRA) enables to gain deeper insight into how attitudes and beliefs are correlated with individual intentions to perform (Fishbein and Ajzen, 1975). The basic assumption is that, people are more often than not, rational beings who make systematic use of available

information, considering the repercussions of their actions before deciding whether or not to engage in a given behavior (Ajzen and Fishbein, 1980). This theory contends that the behavioral intention of an individual to perform (or not perform) a certain target behavior, is solely and directly responsible for influencing that individual's target behavior (Marandu *et al.*, 2010). Similarly, an individual's behavioral intention is said to be jointly determined by two factors: attitude towards behavior that refers to an individual's subjective forecast of how positive or negative he/she will feel when performing the target behavior and the subjective behavior which refers to a person's perception of the social pressure exerted upon her to perform or not perform the behavior being contemplated (Ajzen and Fishbein, 1980). Furthermore, an individual's attitude towards performing the target behavior is itself determined by his/her beliefs regarding the consequences of performing the target behavior, as well as the evaluation of these consequences. Likewise, an individual's subjective norm is the by-product of his/her normative beliefs and motivation to comply. Figure 4 depicts a graphical representation of TRA, which illustrates that external variables (i.e. personality, demographics, etc.) do not have a direct influence on target behavior, but, rather, are mediated by the TRA model.

The major weakness of this theory is that, it places too much importance in internal factors forgetting the external factors such as policy issues and other environmental factors that affect farmers' behavior and decision making process. Importance of this theory is that, it is human-centered and considers that, changes whatsoever, begins with changes in the mind set of an individual.

Nevertheless, there are many variables both internal and external and that human being is more rational in decision making and manipulating some calculation for example: when to adopt and in what combination and how much to adopt and the likely rewards thereafter. Based on heterogeneity nature of the farming communities, basic knowledge on those

human factors would enable facilitators in planning appropriate methodologies in technology transfer to the farming communities because what is applicable in one agricultural area or zone may not apply in another agricultural area and this would entail a need to re-design approaches to fit in with each farming system and agricultural zone.

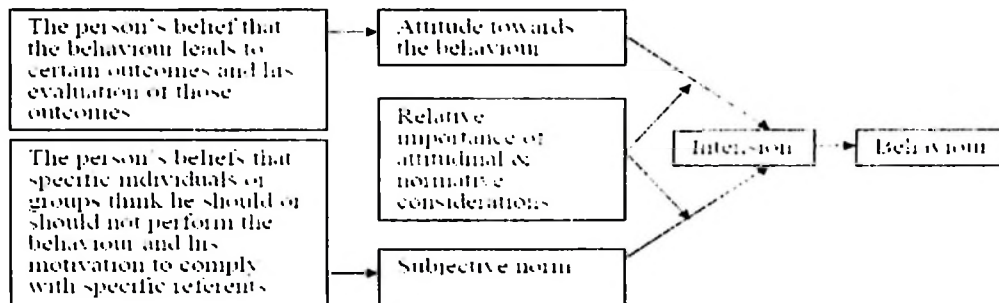


Figure 4: Theory of Reasoned Action

Source: Jackson *et al.* (2006).

2.2.8 The Population and technology theory by Esther Boserup

Another supporting theory for the proposed research comes from Boserup (1993) in her book 'Population and Technology' emphasizing on intensification of farming practices to increase agricultural productivity. According to Boserup (1993), when expansion of cultivated area is not possible, increased population density will eventually result into a more intensive technique of land use and that, new inputs would contribute to further intensification. Boserup (1993) theoretical perspective is valid and applicable in places with high population density where getting additional land for agricultural production is difficult as observed in Mtwara District where sources of getting land is mainly through inheritance and purchases. The annual population growth rate of 2.4% in the district would result to scarcity of land with majority of people owning small parcel of land or few

cashew trees. Agricultural intensification remains to be viable options for people owning small plots of land. This explanation fits exactly resource-poor farmers in Mtwara district.

2.2.9 The High-Payoff input model by Theodor Schultz

This study is also supported by the High-Payoff Input Model by Theodor Schultz, emphasizing on the need to adopt new science-based methods of production that include new technological components such as new varieties, cultural practices, commercial fertilizers, pesticides as well as new crops and new farming system. According to Schultz, the industrial sector should develop new agricultural inputs and supply them to farmers; cheap agricultural credit should be made available to poor resource farmers and the need for Agricultural extension service to educate farmers to apply technologies and use new inputs (Schultz, 1961).

This theory was criticized on ground that, it leads to unsustainable agriculture and land degradation, but experience obtained from the Green Revolution and Asian countries in the latter half of nineteenth century indicated that, high inputs in cereal production was associated with high output.

This argument was strongly opposed by Chamber on the basis that, approaches and methods of transfer of technology which have served industrial and green revolution do not fit the resource- poor farmers of the third, complex, diverse and risk prone agriculture. Farmers need to own the technologies and the best way of doing that was by participatory technology transfer (Chambers, 1994). The World Bank Development Report of 1998 and (Borlaug 1992; Asiabaka *et al.*, 2001) also supported the High-Payoff Input Model.

Despite those challenges, the High-Payoff Input Model appears to be more applicable in cashew farming communities and Mtwara district in particular. If the key players and other interested stakeholders work diligently and efficiently, the forward and backward linkage would create a win-win situation thereby stimulating agricultural productivity and rural development. Mtwara District is desperately in need of these development linkages to stimulate rural development. Hence investing in cashewnut production is among potential areas for high economic growth and possibly this will stimulate the district economy.

2.2.10 The peasant mode of production by Alexander Chayanov

The proposed study also borrows some ideas from Alexander Chayanovian theory based on his popular "Peasant Mode of Production" showing how to transform traditional rural societies to overcome the misery, squatter, and illiteracy of peasantry and how the peasants can modernize their agriculture, especially their farming techniques in carrying transformation and modernizing the entire national economy. Despite criticisms in the use of homogeneity and failure to consider the differences in political systems, his ideas are still valid and relevant in our country and Mtwara district in particular, where traditional farming is still predominant. Majority of farmers produce at subsistence level using hand-hoe allowing very limited coverage, little use of technology such as improved seed, inadequate and untimely procurement of fungicides and pesticides, poor access to credit, inputs and inefficient marketing system (Chayanov, 1966). Improvement in those areas is important to enable the district and resource-poor farmers to make the most out of cashew.

2.2.11 Agricultural Sector Development Program (ASDP)

Furthermore, the study is consistent with the Agricultural Sector Development Program (ASDP) supported by United Nations Industrial Development Organization (UNIDO) as

documented by UNIDO's Program for Tanzania 3ADI whose objective is to boost production in collaboration with other stakeholders. Farmers will, therefore, have access to cashewnut production packages, strengthening farmers training campaigning for re-planting and providing the necessary inputs for pests and diseases control, improving the farmer's access to credits through organization, cooperatives unions and assure timely availability of inputs. All these will likely contribute to increased productivity, profitability and income thereby enhancing food security at household levels (UNIDO, 2011).

Basically, the above theories indicate that, the departure from low productivity to attain high productivity is through adoption of improved and science-based technology that will enable smallholder farmers to produce at economies of scale to increase productivity. This is what many farmers aspire and what Kilimo Kwanza and Agricultural research policy advocate on the transformation of smallholder farmers into commercial farmers.

2.3 Initiatives and Research Conducted in Technology Development and Transfer

Naliendele Agricultural Research Institute (NARI), is a government institution with a National mandate to modernize and commercialize agriculture activities particularly in cashew production for peasant, small, medium and large scale cashew producers which is in line with its vision and mission statements: 'To be a 'Center of excellence for development of agricultural technologies and communication systems for high adoption of research products by stakeholders in order to improve their livelihood by 2020 in the southern zone.' The mission is to conduct agricultural research and disseminate technologies that address the needs and aspirations of clients for improved crop production and productivity for better livelihoods of the farming communities in the

southern zone of Tanzania. The vision and mission of NARI is in line with the Agricultural and Livestock Research Policy of Tanzania which emphasizes on the need of raising agricultural production through application of both scientific and technical knowledge to local conditions and crops by combining modern knowledge with the accumulated experiences of the peasant farmers (URT, 1983, 1997). The vision and mission of NARI also bears a relevance to the National Vision of Kilimo Kwanza Pillar No. 1, item 1.2 focusing on transforming peasant and small farmers through emphasizing on productivity and tradability by the year 2015.

To meet its vision and mission of increasing awareness and promoting research outputs to clients, the Audio-Visual Aids unit based at NARI, collaborated with National Mass Media Stations especially Tanzania Broadcasting Cooperation (TBC) and Star TV to air documentaries on various subjects related to cashew promotion and production activities. Additionally, use of radio, video show, feature articles, leaflets, newspapers and booklets made farmers more aware and accessible to research outputs and information.

2.3.1 Multiplication and distribution of improved planting materials

During the 1990s, extensive and intensive efforts were made by the CRP based at NARI Mtwara to find ways in which yield per tree or area productivity could be increased. To meet that objectives eight Cashewnut Development Centers (CDC's) were established in the major cashewnut growing areas which include: Naliendele (Mtwara), Nyangao (Lindi), Mangaka (Masasi), Nakayaya (Tunduru), Nanyhanga (Tandahimba), Mtopwa (Newala) and Mkuranga. These are expected to serve as hubs for multiplication and distribution of improved and reliable sources of planting materials of cashew (clones) to

famers such as AC1, AC4, AC6, AC10, AC14, AC22, AC28, AC34, AC43, AZA2, AZA17 and others (ARIN, 2007-10).



Plate 1: Polyclonal seed are raised at CDCs

(a) Visual appearance of improved cashew seed

(b) Internal quality of the seed. (well-filled kernel).

Courtesy: ARIN, 2007-2010.



Plate 2: Grafted cashew seedlings
(a) Improved grafted cashew seedlings at Nanyhanga CDC (Tandahimba)

(b) Individual Farmer Nursery

Courtesy: ARIN, 2007-2010.

Additionally, individual farmers and groups of interested farmers were taught on various aspects of nursery establishment and management including grafting skills to meet the demand of improved cashew materials in cashew growing areas (Plate 2:b). Good attributes of improved cashew materials include early bearing (short maturity period), big kernel size, partial resistance/tolerance to common diseases such as PMD, leaf and nut blight, anthracnose, and good fruit taste compared to the local landraces (Masawe, 2006).

2.3.2 Dissemination of research technologies to farmers

Over several years, cashew research in Tanzania generated a wealth of useful knowledge and appropriate technologies (e.g. varieties, husbandry practices) for increasing cashew productivity (ARIN, 2007-2010; Topper and Kasuga, 2003; Martin and Kasuga 1995). However, it has been difficult to reach the beneficiaries particularly resource-poor farmers due to inefficient agricultural extension services. This necessitated cashew researchers to develop an alternative system that will efficiently enhance the transfer of these technologies to the farming communities.

The Integrated Cashew Management Programme (ICMP) developed in 1994 appeared to have addressed this problem. This was an inter-disciplinary, technology-development and knowledge transfer tool comprised a basket of improved cashew management options from which farmers could choose those that are appropriate to their ecological, socio-economic and environmental circumstances (Davis, 2010; Mwantimwa, 2008). In most cases the final choices seemed to reflect better most of their farming constraints in which resources would have their optimal use (Sikana, 1998). This is similar to 'Farmer First Approach' which generate baskets of choices to enable farmers to vary, complicate and diversify their farming systems (Scoones and Thompson 1994; Chamber 1989).

Specifically, characteristics of the ICM initiative were;

- (i) A shift from developing standard package of recommendations to generating a basket of options to suit the social-economic circumstances of different farmer categories and different farming environments.
- (ii) A shift from working with individual farmers to working with village based groups of farmers.
- (iii) Emphasis on the dissemination of cognitive knowledge frameworks which allow farmers to incorporate scientific logic to their ecological and practical knowledge to suit their social - economic circumstances of different farmer categories (Sikana, 1998). Refer to Plate 3: a and b.



Plate 3: Technology transfer

(a) Technician explains the ecology of cashew diseases

(b) Participants learn grafting techniques

Courtesy: ARIN, 2007-2010

To make ICMP sustainable, participatory training programs, workshop and field excursions to cashew farmers and extension workers were conducted aimed at building their capacity by imparting appropriate skills associated with utilization of various cashew

technologies. These strengthened the Research-Extension-Farmer Linkages by reducing the spatial and epistemological distance between scientists, extensionists and farmers by the three parties entering an iterative and interactive process of mutual learning by endeavoring to speak the same language (Sikana, 1995; Lele, 2010).

Technical backstopping from research was provided from time to time, the overriding concept being to keep key players abreast of changes taking place in the domain of agriculture. These farmers presented role models for the remaining farmers hoping that, with time new technology will trickle down or diffuse throughout the farming communities (de Waal, 1997). Refer to Plate 4: a and b



Plate 4 : Good Agricultural Practices
(a) Farmers' adherence to 'best practice'

Courtesy: ARIN, 2007-2010.

(b) Participatory Learning and Action
(PLA)

However, despite the demonstrated positive impacts and options at farmers' disposal to increase cashew productivity, there has been a generally low adoption of the improved cashew production technologies with persistent reduction in cashewnut yields at farmer level (Kasuga, 2003).

2.3.3 Conceptual framework

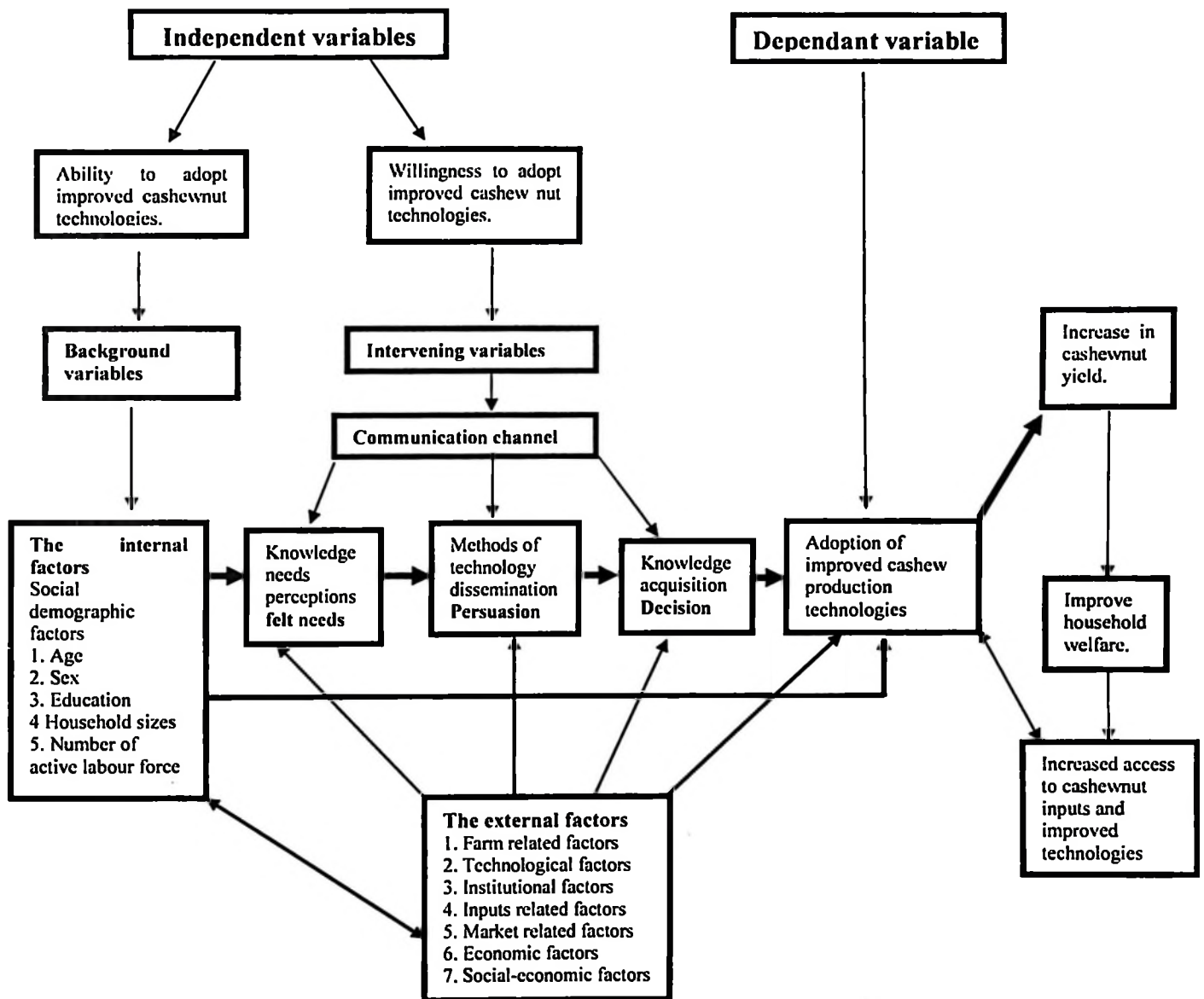
The study adopted the Conceptual framework of 'Duvel Model of Behavior Analysis and Changes' with some modifications to fit in with the proposed study (Duvel, 1975). This model provides a basis for behavior modification. The choice of this model is based on the fact that, it is an interdisciplinary model that potentially encompasses all influences on decision making behavior focusing on needs, perception and knowledge. Additionally, it also focuses on intervening variables which are assumed to represent forces directly responsible for adoption behavior.

In this regard it considers human factors that influence decision making in adoption of innovation. The internal variables such as age, level of education and sex while the external factors are technological, farm related factors, institutional among others and the intervening variable of which the communication channel plays a pivotal role in determining effectiveness and efficiency in technology transfer.

Applicability of the model lies in the fact that, agricultural and rural development implies behavioral change that usually is the result of external intervention. The model goes further indicating the associations between inputs and outputs which are rare to find in other models. It depicts a diagrammatical flow or sequence of technology adoption for example; it indicated the adoption of improved cashew technologies as a linear model comprising technology generation, technology transfer and utilization by cashew farmers.

It is conceptualized that, the research institutions and the Extension services are the ones which develop technological packages (impact points or messages). The latter is a conduit (transfer) of technical and scientific packages to the consumers who are the farmers to bring the desired changes such as an increase in crop output (Birner *et al.*, 2007; Sahin

2005; World Bank, 1998). The basic assumption is that, adoption would take place when farmers are aware and full knowledgeable about the rewards they are likely to obtain when they adopt improved cashewnut production technologies (Tesfaye *et al.*, 2010; Lenin *et al.*, 2009; Reddy, 2006). The increase in knowledge base of extension workers and cashew farmers who participated in training programme such as workshop and seminars has enabled a shift from conventional compliance model based on prescription to a knowledge-based model grounded on deep cognitive understanding (Sikana, 1994). For example, a thorough understanding on insect pests and cashew diseases ecology made them aware and know exactly when and how much chemical to apply for controlling insect pests and cashew diseases (Van den Berg and Jiggins, 2007).



Key:
 1. Direct relationship \longrightarrow

Figure 5: A revised conceptual framework adopted from Duvelmodel of behaviour analysis and change (Duvel, 1975).

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Overview

This chapter presents the methods used to collect and analyze data from the study area. The chapter is divided into four sections. Section one presents the location of the study area and justification of the selection. Section two presents research design and sampling procedure while section three presents data collection methods employed. Section four describes methods used in data processing, analysis and presentation.

3.1.2 Description of the study area and justification

The proposed study was conducted in Mtwara district, one among the six districts engaging in cashewnut production in Mtwara Region. Other districts are Tandahimba, Masasi, Newala, Nanyumbu and Mtwara Urban. Refers to Figure 6.

3.1.3 Location, climate and topography

Mtwara District borders with Mtwara Urban and Indian Ocean to the east, the Ruvuma River in the South which forms a boundary with Mozambique. Tandahimba District to the West and Lindi District to the North. The district has a population of 228 003 according to 2012 Population and Housing Census (NBS, 2012). The area of Mtwara Rural is 3 597 sq. km (21.5%) of regional land area with a population density of 63.3 people per sq. km. Most of the residents are from the Makonde and Makua tribes. The annual population growth rate is 2.4% with average household size of 3.9. Administratively, it has 6 divisions, 28 wards and 118 registered villages (Data compiled from 2012 Population and Housing Census (PHC)).

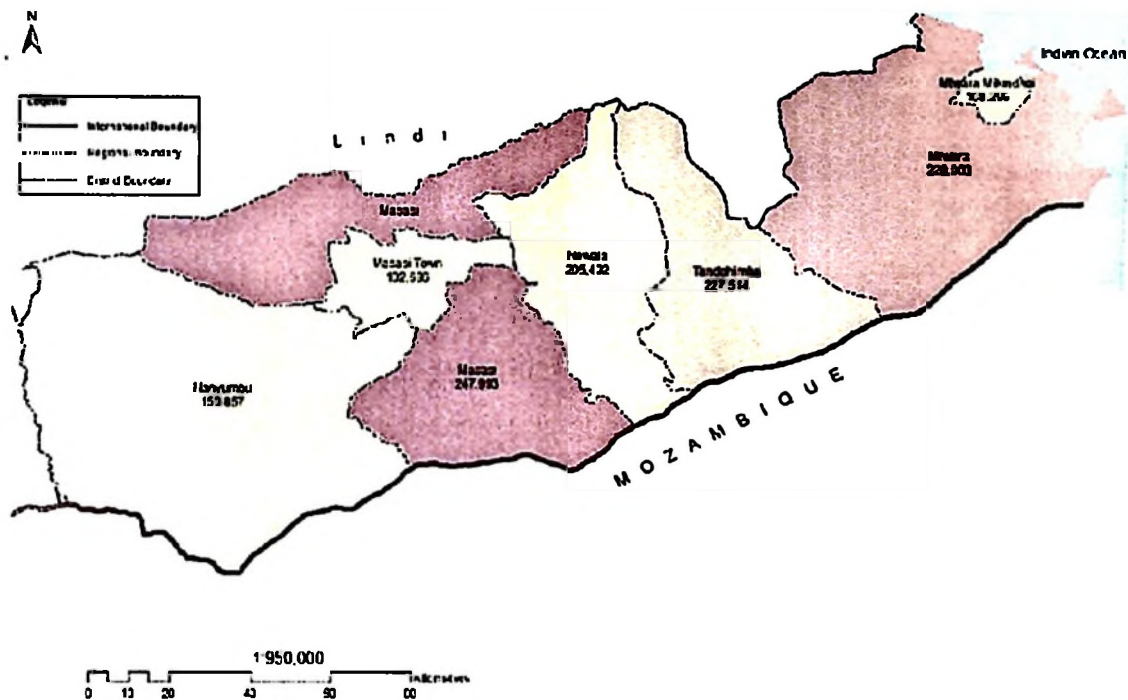


Figure 6: Mtwara Regional map indicating its districts

Courtesy: National Bureau of Statistics, Population and Housing Census 2012

According to ecological classification, Mtwara District belongs to Makonde Dissected Plateau (MDP). Southeastern Tanzania has two main seasons; a humid and hotter wet season (November to May) and a cooler, less humid dry season (June to October) with an average temperature of 28⁰ C. Mean annual rainfall ranges from 800 mm inland and central areas to 1 200 mm in the hills and plateau near the coast with 85% of this falling between December and April, interrupted by a dry spell of one or two weeks often occurs at the end of January or at the beginning of February (FSR, 1992).

Most of the soils are well-drained, moderately deep sand soils. In some parts, there is reddish sandy clay with moderate organic matter (Ngatunga *et al.*, 2001).

Cashewnut is the predominant cash crop in the district. Small-scale processing of cashew is another important activity among small groups of women, and contributes greatly to income stability as the processed crop has a longer shelf life compared to raw cashew. Other important crops grown are: starchy staples notably sorghum, maize, rice, cassava and millet; leguminous crops mainly pigeon pea, cowpea, green gram and bambaranuts; oilseeds especially sesame and groundnut which also contribute to the cash income of smallholder farmers; vegetables such as onion, tomato and sweet potato; and tree crops particularly orange, banana and coconut that is important along the coast (Lamboll, 1991). Livestock keeping is not traditional among the district population; hence contribution of this sector in the district economy is insignificant. Fishing is done on a 125 km of the coastal strip and along the Ruvuma River using poor equipment and dynamite. There are considerable commercial activities at Msimbati village on the border with Mozambique confluence the Ruvuma River and the Indian Ocean (data compiled from 2012 population census).

There are more than 8 donor agencies (service providers) operating in Mtwara district namely: UNICEF that provides funds for the child survival and protection development, NORAD donates funds for the protection, proper Management and Sustainable Utilization of Mangrove. FINNIDA finances Rural Integration Project Support (RIPS), AMREF endeavors to improve the social-welfare through community based projects while Concern Tanzania deals with supplying agricultural inputs and facilities for farming and education. Others include Save the Children, Agha Khan Foundation (AKF) SWISSAID, TAMOFA, JICA, Action Aid, and quite a number of CBOs and NGOs working to protect and conserve the environment, empowering rural communities through sustainable socio-

economic interventions with the prime objective of improving households' food security and poverty reduction (NBS, 2012).

3.1.5 Justification for selection of Mtwara District

Mtwara District's economy depends heavily on cashewnut production. Stabilization of the district economy so as to increase per capita income depends much on the development of the cashewnut industry. This will be achieved through the rehabilitation and upgrading of abandoned cashew orchards and the planting of new and high yielding cashew clones. Hence investing in cashewnut production is among potential areas for high economic growth. Eventually, this will stimulate the district economy.

Furthermore, Mtwara District was among the project intervention areas since the 1990s with many participatory pilot projects in cashew being implemented. Besides, farmers were extensively exposed to different methods and practices of cashew production aimed at increasing productivity through participatory outreach programs. However, low farmer commitment had resulted to high levels of diseases and insect pests' infestation in cashew farms while failure to use fungicides and other pesticides resulted to persistent low average cashew output of 1.5 - 5 kg/tree/season (Sijaona, 1984).

However, despite exposure and research interventions, there had been negative responses reflected by failure of cashew farmers to exploit fully the opportunities at their disposal to upgrade their cashew farms thereby, increasing cashew output on tree basis or area productivity. The results or methodologies used in this study could have a wide application elsewhere particularly in cashewnut growing areas of Tanzania.

3.2 Research Design and Sampling

3.2.1 Research design

A cross-sectional research design was adopted and enabled to meet the overall aim and objectives of the study. Both qualitative and quantitative household data were collected at one point in a time which covered several items of interest to the study using questionnaire. This method was quite useful in descriptive study particularly in determination of relationships between variables (Thisted, 2006).

3.2.2 Data sources and instrument for data collection

The data for the study were generated through the use of structured questionnaire which was administered with the help of trained enumerators. Prior to actual survey, the interview schedule developed was suitably modified and refined based on feedback from pre-testing that was conducted to nearby villages. Head of households were interviewed on various aspects including socio-demographic and family/household characteristics, cashewnut management, farmers' opinion and perceptions towards improved cashew technologies. Other areas of interest were knowledge acquisition on improved cashewnut production activities, production constraints, input and institutional support services.

Secondary information used in this study was collected from various sources including Naliendele Agricultural Research Institute annual reports, proceedings, review of publications and official reports and other online information. The data were also enriched by including information obtained through personal communication with key informants at village, ward and district levels including: VAEOs, WEOs and DAICO Mtwara. Others contacted were stockiest/input dealers and scientists at NARI.

3.2.3 Sampling procedure, sample size and data collection methods

Purposive and simple random sampling techniques were used to draw samples for interview. Purposive sampling was used to select Mtwara District for the survey. A total of 14 villages (12%) were randomly sampled as representative in Mtwara District including those along the Coast namely: Namgogoli, Imekuwa, Dihimba, Makome and Mbawala while those in the interior part of the district were Nanyamba, Mwang'anga, Namtumbuka, Kitama-Bondeni, Nitekela, Kitaya, Mtimbwilimbwi, Milango-minne and Chikwaya. Refers to Mtwara District map Figure 7 and selected villages in appendix 2

At village level, a simple random sampling was also used to draw respondents for interview. Using the formula for calculating sample size for cross-sectional study, a total of acceptable sample size of 200 household farmers was obtained as suggested by Bailey, (1998). Each village among those sampled contributed equally to the study sample size which was drawn with a support of transect walk technique. A large sample size reduced random errors and increased the validity and precision of the study (Kothari, 2009). Refer to appendix 1

3.2.4 Data processing and analysis

Data from the primary source was verified, coded and analysed using Statistical Package for Social Sciences (SPSS 16.0 for windows) computer software. Descriptive statistics such as means, standard deviation, graphs, frequency distribution and pie charts were used to describe the data. The information obtained from these statistics provided information to support the results from Binary logistic regression.

3.2.4.1 Binary logistic regression model (BLRM)

Since the dependant variable has only two outcomes: 'adoption and non-adoption of improved cashew technology' a Binary regression Model (BRM) was used (Chaves and Riley, 2004; Adesina *et al.*, 2000; Bekele and Holden, 1998; Ayuk, 1997). In this study, it was conceptualized that, a farmer who had 28 or more of the improved cashew trees and had controlled pests and cashew diseases to 28 or more among the improved cashew trees qualified to be an adopter and thus ranked 1, otherwise ranked 0. All respondents undertaking those combination of cashew technologies in principles qualified to the "Adopters" otherwise they were "Non-adopters" of improved cashew technologies.

This study applied logistic regression model to analyze the factors affecting adoption of improved cashew technologies. Literatures indicate that, decision-making process by farmers involved in adopting new technologies can be quantitatively analyzed using logistic regression modeling approach. The dependent variable "adoption of improved cashew technologies" was a binary variable with a value of 1 if the farmer adopted and 0 for Non-adopter.

The likelihood of the farmer to be an adopter of improved cashew production technologies was predicted by the natural odds $Y=P(Y=1)/(1-P(Y=1))$ which was expanded using the following equation:

$$\text{Log}(P/1-n) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots \beta_n X_n + \text{error} \dots \dots \dots (1)$$

Where

Log (P/1-n) = the logit, which is the positive logarithm of the odd ratio of a farmer adopting a technology against non-adopter (dependent variable) indicated by $Y = 1$ and $Y = 0$.

- β_0 = Y intercept
- $\beta_1 \dots \beta_n$ = Coefficients of independent variables.
- $X_1 - X_n$ = Independent variable under observation
- X_1 = Age of respondent (years)
- X_2 = Sex of the respondent
- X_3 = Number of years in school (years)
- X_4 = Cashew farming experience (years)
- X_5 = Number of active labour in the household
- X_6 = Total farm land owned (size of the cashew farm in hectare)
- X_7 = Access to extension services (frequencies of contact with VAEO)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Overview

This study was conducted to get insights into background factors such as household and farm characteristics that influenced farmers' decision on use or non-use of improved cashew materials. In this context, knowledge and technologies available in cashew, issues of acquisition of improved cashew materials and crop husbandry, aspects of insect pests and diseases control and methods of technology dissemination are highlighted. Additionally, challenges and opportunities facing the cashew industry are discussed and ways forward suggested. Therefore, this chapter presents results of the findings and explores further options to improve uptake of cashew technologies by resource-poor farmers.

4.1.1 The socio-economic characteristics of respondents

The socio-economic characteristics of respondents' results show that 94% of the respondents were male and 6% were female. The over presentation of men suggests that, majority of households in Mtwara District are headed by men. With respect to marital status, 95% of the respondents were married and living with spouse that means many families (households) were stable as compared to broken marriage or divorce (3%) (Table 1). Stable families are important in agricultural production because they can supply labor and concentrate more on production than unstable ones.

Further findings revealed that, the average age of respondents was 48 years old, the minimum being 20 and the maximum was 86 years (Table 1). About 27.5% of the respondents belonged to the active age bracket of between 30 and 40 years and only few

(13%) were above 60 years. The mean age of 48 years suggested that, majority of respondents were in their prime productive ages and could therefore contribute to the development of the cashewnut industry.

Information on education revealed that, 80% of the respondents had studied up to primary level. 3.5% had secondary education while 16.5 % had no formal education (Table 1). This implied that, majority of the people in the study area were literate and could therefore follow simple agricultural instructions and technical recommendations (Matata *et al.*, 2008). This is consistent with results by Benor *et al.* (1997) who agreed that education is important in creating positive mental attitude towards adoption of modern farming.

The average household size was 6 people of which on average 3 contributed to labour. Nevertheless, family labour was overwhelmingly the most important source of labour for cashew related activities which was conceived as a family enterprise in which members of the household were allocated specific roles and responsibilities. Where possible, contract labour was employed for chemical spraying to control insect pests and cashew diseases.

Findings indicate that, sources of labour during peak periods for households were as follows: about 56% of the respondents in the study area used family labour, while 18% reduced area of crop cultivation or number of cashew trees for chemical application as a coping strategy to laborers shortage (Table 1). Only 14% of the respondents were able to hire laborers while 7% used all of the alternatives mentioned and the remaining 5% used farmers' own labour. Many respondents mentioned to experience labour shortage to undertake various farm activities. It is undoubted that, the attraction of alternative ways of earning income from non-agricultural activities in some cases competes with farming, reducing the pool of labour required to undertake various farm activities.

Through dialogue with the respondents, it was reported that pressure of work among various farm enterprises build up beginning May up to August. This is because harvesting and processing of annual crops coincide with weeding, controlling insect pests and diseases in cashew together with harvesting and marketing of cashew.

In this regard, concerted efforts should be done by the government to spearhead social measures such as pension schemes and payment of a minimum income to the aged who cannot work productively to reduce the burden and work load they experience at an advanced age. The income will enable them to undertake simple agricultural production activities including paying the extra labour that they may require.

Table 1: Respondents according to their socio-economic characteristics (n=200)

Socio-economic variable	Frequency n	Percent
Sex		
Male	188	94
Female	12	6
Age		
20 – 30	16	8
30 – 40	55	27.5
40 – 50	49	25
50 – 60	38	19
60 – 70	26	13
70 – 80	10	4
≥ 80	6	3
Marital status		
Single	2	1
Married	189	95
Divorced	7	3
Widowed	2	1
Level of Education		
Informal education	33	16.5
Primary education	160	80
Secondary education	7	3.5
Coping strategies with labour peaks		
Farmers' own labour	8	5
Family	89	56
Hire external laborers	22	14
All of the above	11	7
Reduce crop area	29	18

4.1.2 Distribution of respondents according to agricultural production activities

Findings indicate that, about 64% of the respondents had experience in cashew farming for more than 16 years followed by 24% of respondents who had experience of between 6 and 15 years and the remaining 12% of respondents had experience in cashew farming for less than 5 years (Table 2). Virtually, this implied that majority of the respondents interviewed had adequate experience in cashew farming.

The findings continued to depict that 46.5% of the respondents are operating on small-scale owning 0.2 – 2.5 ha of cashew farm while about 33.5% are operating on medium scale with farm size ranging between 2.6– 5ha and the remaining 20% operates on large scale owning more than 5.1ha of cashew farm (Table 2). The average farm size was 2.9ha, the lowest being 0.3ha and the highest was 18ha. Most land was privately owned without a formal title. It is generally accepted that, land size can influence adoption of technology (Nkonya *et al.*, 1997; Putler and Zilberman, 1988; Rahm and Huffman, 1984). Nevertheless, given the structure of the land tenancy and demographics, the common mode of acquiring land or cashew farm was through inheritance that was deep-rooted in the patriarchal system. The youths are frustrated because they do not own land except the elders while the females are frustrated because traditional system of inheritance exclude them from owning land or big assets.

Respondents continued to explain that, subdivision of holdings among households' members prevails and resulted to fragmentation of landholdings with family members ended up owning a small parcel of land or few cashew trees. This explains best why resource-poor farmers lag behind in adoption of new innovation and un-creditworthy on issues related to loan acquisition. Small size of their land holdings make difficult for them

to become viable economic entities thus limit ability of the farmers to produce at economies of scale. These results conform to the 'High-Payoff Input Model' by Schultz who indicated that, principles of producing at economies of scale work better with large farm size than small farm size (Schultz, 1961).

On the other hand the 'Population and technology' theory of Boserup emphasizing on intensification of farming practices to increase productivity is more applicable in Mtwara District where majority of resource-poor farmers survive on subsistence economy using meager resources with little or none to spare. The only viable option for them would be to intensify their agricultural production using science-based technologies to increase farm productivity on their small plots of land they own. This approach worked better in adopting soil conservation practices in Karatu and Kongwa Districts of Tanzania as indicated by Adeola, (2010).

Further results in Table 2 indicate that majority 83.6% of respondents had acquired improved cashew trees/farms by planting themselves against 48.9% of respondents who planted local cashew trees by themselves. It was further revealed that 15.5% of the respondents have acquired improved cashew farm through purchase against 26.1% of the respondents who had purchased local cashew trees. Similarly, 0.9% of the respondents had acquired improved cashew trees through inheritance while 25% of the respondents had inherited local cashew trees.

Nonetheless, shortage of agricultural land was cited among the major driving force for the youths' migrating to towns and big cities to seek social and economic well-being, but eventually end up as street vendors popularly known as 'Marching guys'. Based on

results from this study, it can be envisaged that, the district annual population growth rate of 2.4% would soon or later result into high density making it increasingly more difficult for the youth to get land for farm activities. It is time the government should establish legal measures to enable farm owners to transfer the lease on their land (formal transfer of the land) to their descendants interested in agricultural investment.

Table 2: Respondents according to agricultural production activities (n=200)

Variable	Frequency (n)	Percentage (%)
Farming experience in cashew		
Low ≤ 5 years	24	12
Medium 6 - 15 Years	48	24
High ≥ 16 Years	128	64
Agricultural land size owned (ha)		
Small scale 0.1 - 2.5	96	46.5
Medium scale 2.6 - 5	63	33.5
Large scale ≥ 5.1	41	20
Source of ownership of improved cashew farm		
Inheritance	1	0.9
Purchased	18	15.5
Planted by myself	97	83.6
Source of ownership of local cashew farm/trees		
Inheritance	46	25
Purchased	48	26.1
Planted by myself	90	48.9

4.1.3 Other Sources of income to the respondents

Cashewnut is the dominant crop and the primary source of income to most of the respondents interviewed in the study area. Study findings indicated that 64% of the respondents were full time engaged in agricultural activities while 36% engaged in both agricultural and other income earning activities (Table 3).

Table 3: Farmers' engagement on production activities

Production activities	Frequency	Percentage
Full time engaged in agricultural activities	128	64
Engaged in agricultural and other income activities	72	36

Of the 36% of the respondents who engaged in other income generating activities, 29% of the respondents indicated shop business as the common source of income followed by selling livestock products (22%). Others were in the following order: crop sale (19%), fishing (13%), formal employment (10%) and food processing (7%). In addition to these, the following were reported though practiced on small proportion: charcoal selling, masonry, traditional healing, tin smith, carpentry, local brew making and selling forestry products. Uncertainty about the profitability (productivity) of new technologies and risk avoidance in case of crop failure was a major reason that compelled farmers to engage in non-agricultural earning activities. With all these activities, food security for the families was well guaranteed. This has been reported also by Kaguongo *et al.*, (1997); Kristjanson (1987); Feder *et al.*, (1985); Feder and Slade, (1984).

Since many families engage in agricultural production activities, the government should create and promote enabling environment for agricultural productivity such as improving or rehabilitating the physical infrastructure services such as road networks to lower

production and consumption costs. Deliberate efforts should also be done to support the agricultural sectors in terms of timely availability of inputs, technology and extension services, attractive producer price for their produce, and availability of soft loans such as Village Community Banks (VICOBA) and Saving and Credit Cooperative Society (SACCOS) to people intending to invest in agriculture or other enterprises. This will increase employment opportunities in both formal and informal sectors, eventually, people will appreciate the great potential of making decent and better life in rural areas without necessarily migrating to towns or cities.

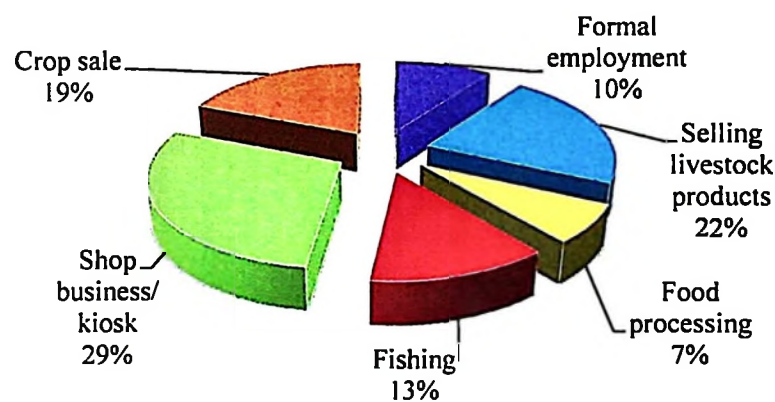


Figure 8: Othersources of the income to the respondents

4.1.4 Major food crops grown by respondents

Apart from cashewnut, other food crops grown by the respondents in the study area were cassava, maize, rice, sorghum, bambaranuts, cow peas, pigeon peas and yams (Table 3). Sesame and groundnutswere grown for marketing and contributed greatly to household income. These crops were intercropped in cashew farms so as to survive the period until the new improved cashew materials produces income and contributed more to household food security. Operating on subsistence economy, the farmers normally consumed and sell some of the cereal crops/products and the money obtained was used to meet other family

commitments including investing in cashew activities which is the main source of income to rural communities.

Table 4: Major food crops grown by respondents

Main food crops grown	Responses n	Percent	Percent of cases
Cassava	77	6	39
Maize	125	10	63
Rice	180	14	90
Sorghum	166	13	83
Bambaranuts	151	12	76
Cow peas	165	13	83
Pigeon peas	187	15	94
Yams	198	16	99
Total	>1249*	100	625

>*The number of responses exceeds 200 because some of them cultivated more than one crop

4.2 General Information on Cashew Management and Production Activities

4.2.1 Farmers' adherence to 'best practice' to increase productivity

Study findings indicate that, management practices enhance vegetative growth of cashew trees and often results to remarkable changes in both quality and quantity of cashew yield. On the whole, the crop husbandry and package of improved planting materials of cashew requires farmers to adhere to good agricultural practices (GAP) including the use of proper spacing, weeding, intercropping, thinning, pruning, top-working and gap filling. Percentage of farmers doing those practices are indicated in Table 4 in the following order; weeding 100%, pruning 86.5%, protection against fire outbreak 84%, gap-filling 75%, thinning 74%, intercropping 57%, use of recommended spacing 43% and top-

working 14.5%. Research findings indicate that failure to do gap-fillings and improper or random planting of cashew trees resulted to reduced number of cashew trees per unit area with cashew trees excessively spaced creating empty spaces while closer spacing and failure to remove cashew trees (thinning) resulted to overcrowding of cashew trees per unit area. Both cases resulted to reduce in yields per area. It was also observed that, intercropping with annual crops contributed to improving household food security and cash income. Above all, good management to cashew farms reduced risk of fire attack. In general, failure of cashew farmers to adhere to best practices in cashew management has resulted to increased number of abandoned and neglected cashew farms with minimum contributions to the family and district economy. Based on findings in this study, the incentive packages to extension agents should be improved. These will motivate and enable them improve on the service delivery mechanisms, and eventually increase productivity among the farming communities.

Table 5: Farmers' adherence to 'best practice' to increase productivity

Management practices	Frequencyn	Percent
Weeding	200	100
Pruning	173	86.5
Protection against fire outbreak	168	84
Gap filling	150	75
Thinning	148	74
Intercropping	114	57
Use of recommended planting space	86	43
Top-working	29	14.5

4.2.2 Reasons for low adoption of recommended planting space of cashew

Among the management practices performed by respondents in the study area, use of recommended plant spacing of cashew was low about 43%. Reasons for low adoption of recommended plant spacing were lack of technical advice from agricultural extension officers at planting time (36%), the respondents not aware about recommended planting space of cashew (29%), lack of knowledge, resources and skill in carrying out the planting exercise (20%) and the respondents had acquired cashew farm through purchasing or inheriting cashew trees that are improperly planted (15%). (Figure 9).

As documented by Meinzen-Dick *et al.*, (2003), the frequency of contact with VAEO, knowledge of technology, source of knowledge, methods and time of dissemination are important in influencing adoption of new agricultural innovation (Meinzen-Dick *et al.*, 2003; Obeta and Nwagbo, 1991).

Based on the above statistics, poor adoption of recommended plant spacing for cashew was largely due to inefficient service delivery by the extension officers. For real changes to take place in methods of agricultural production, the extension agents should be provided with transport for effective coverage and must be well remunerated. These are among the generic problems confronting the extension services.

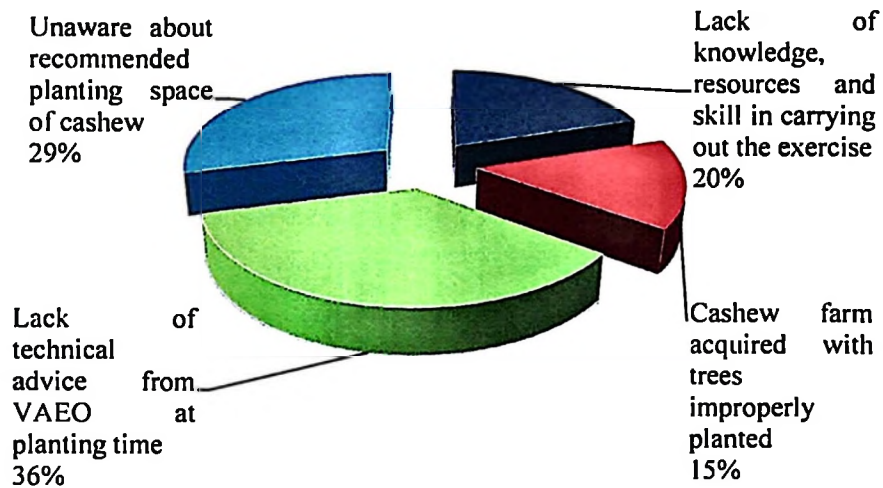


Figure 9: Reasons for low adoption of recommended planting space of cashew

4.2.3 Reasons for low adoption of top-working

Top-working is among upgrading options aimed at improving tree productivity by changing the genetical make up of unproductive and low yielding cashew tree into high yielding cashew tree. Farmers can use grafting skill (technique) to top-working trees that give yields below economic levels. As previously indicated in Table 4, only 14.5% of the respondents in the study area practiced top-working. The main reasons for low adoption of top-working were lack of grafting skill 42%, uncertainty about the life span of top-worked trees 37% and the farmer not aware about top-working 21% (Figure 10).

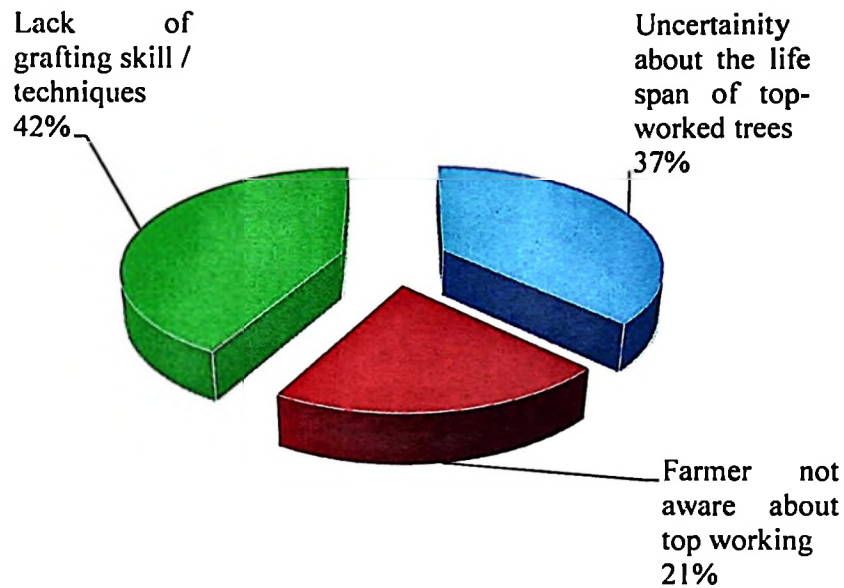


Figure 10: Reason for low adoption of top-working

It was also mentioned that, cutting down old and large cashew trees was extremely difficult and labour intensive, besides; one has to pay for the grafting skill service if he/she does not have the skills.

Essentially, study conducted in cashew growing areas indicated that, many of the cashew trees owned by farmers are old, low yielding and produce small nuts that are less competitive in the domestic and international market. In this regard, farmers are advised to upgrade their cashew trees to increase tree productivity. In order to achieve that, training should focus more on the provision of knowledge and skill-based technologies particularly grafting skill to enable cashew farmers to replace unproductive trees with high yielding cashew materials. This will contribute to the well-being of the people and boost district economy.



Plate 5: Upgrading cashew orchard

Farmers are busy upgrading unproductive and low yielding cashew trees by top working.
 Courtesy: ARIN, 2007-2010.

4.2.4 Farmers' awareness about improved cashew technologies

This section presents the extent, intensity and rate of adoption of various cashew technologies disseminated to the farming communities in the past 10 to 15 years. Results in Table 6 indicate that, 92.5% of respondents are aware about the presence of improved planting materials of cashew and 89.8% of the respondents are also aware about strategies employed in controlling insect pests and cashew diseases. This implied that there is a high level of awareness among farmers about improved planting materials of cashew and strategies in controlling insect pests and cashew diseases.

Table 6: Farmers' awareness about improved cashew technologies (n=200)

Responses on awareness about cashew technologies	Frequency	Percent
Awareness about presence of improved cashew materials	185	92.5
Aware of strategies to control insect pests and cashew diseases	158	89.8

4.2.5 Reasons for lack of awareness about improved cashew technologies

Several reasons have contributed to lack of awareness about various cashew technologies by respondents. The low awareness level expressed by respondents was due to limited contact with village agricultural extension officer (VAEO) 42% while limited exposure and opportunities accounted for 28%. Others were low priority given to cashew farming (18%) and poor interaction among or with other farmers (12%) (Figure 11).

Nevertheless, increase farmers' exposure and opportunities to improved cashew technologies through on-farm trials and demonstration plots will result into quick adoption of improved cashew technologies by farmers.

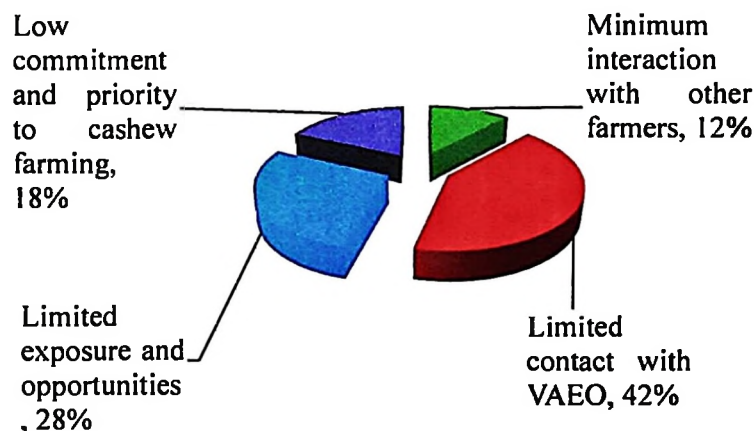


Figure 11: Reasons for lack of awareness about improved cashew technologies

4.2.6 Adoption and utilization of improved cashew technologies by respondents

Several improved cashew technologies have been developed and adopted by cashew farmers to increase productivity. Based on Figure 12, adoption and utilization of those technologies was in the following order; use of improved planting materials of cashew 45%, use of pesticides and fungicides to control insect pests and cashew diseases 37% and

use of grafting techniques to upgrade cashew trees 18%. Basically, uses of improved planting materials and insect pests and diseases control in cashew are the most determinant of cashew yield assuming other factors and management practices are constant. It can therefore be concluded that, the notable increase in the district's cashew records of 5 149 metric tons in 2009-10 to 11 701 metric tons in 2012-13 as indicated in Figure 18, was due to positive impact in adoption of cashew technologies by farmers.

Based on results discussed and conversation with respondents, there is a great opportunity and potential for the district to scale up cashew production if deliberate efforts are done to improve the incentive packages such as input subsidies, attractive price for raw nuts and efficiency in the marketing system. Improvement on those areas is important for the district to make the most out of cashew.

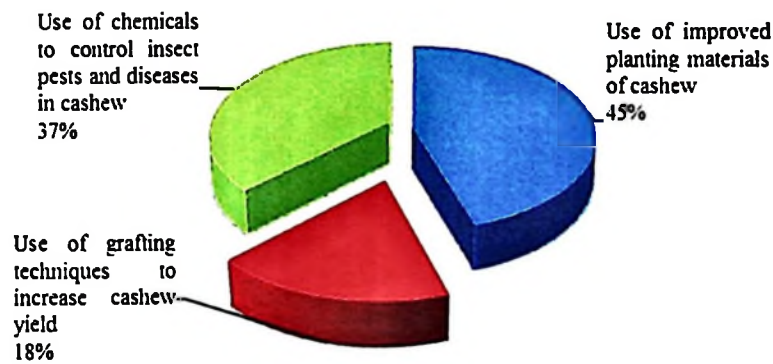


Figure 12: Farmers' utilization and adoption of improved cashew technologies

4.2.7 Types of improved cashew materials planted by respondents

Various forms of planting materials were available to cashew farmers. Based on convenience, the most preferred forms of planting materials used by a large section (65%) of the respondents was polyclonal seed while 32% used grafted seedlings and about 3%

used both polyclonal seeds and grafted materials (Figure 13). Through dialogue with respondents it was clear that, those who used polyclonal seeds were influenced by factors such as accessibility, management and germination success unlike grafted seedlings which are labour intensive and more risky in event of bad weather.

Essentially, use of any form of improved planting materials of cashew will assure farmers of getting products of high quality unlike use of local materials. Therefore, stakeholders involved in cashew production activities should encourage farmers to plant improved cashew varieties/clones for maximum benefits.

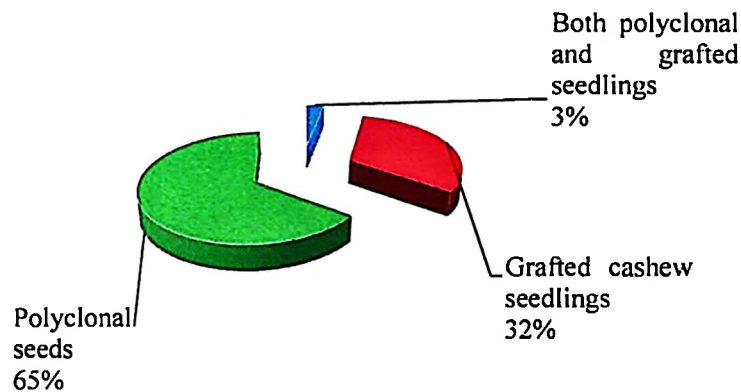


Figure 13: Types of improved cashew materials planted by respondents

4.2.8 Reasons for low adoption of the improved cashew materials

Factors responsible for low adoption of the improved cashew materials were inadequate capital (41%), risks, uncertainty and challenging conditions in cashew production (26%). Others were unavailability of improved planting materials (20%) and lack of awareness about improved cashew materials (13%) (Figure 14). Essentially, cashew farmers differ in degree of risk management and economic situation, hence adoption of improved cashew materials will more likely differ among cashew farmers; those with adequate resources

will tend to adopt earlier while the marginalized ones with meager resources will lag behind in adopting improved cashew technologies.

These results suggest that, the local government should establish nurseries at ward or district level to increase accessibility and affordability of improved cashew materials to the rural farming communities.

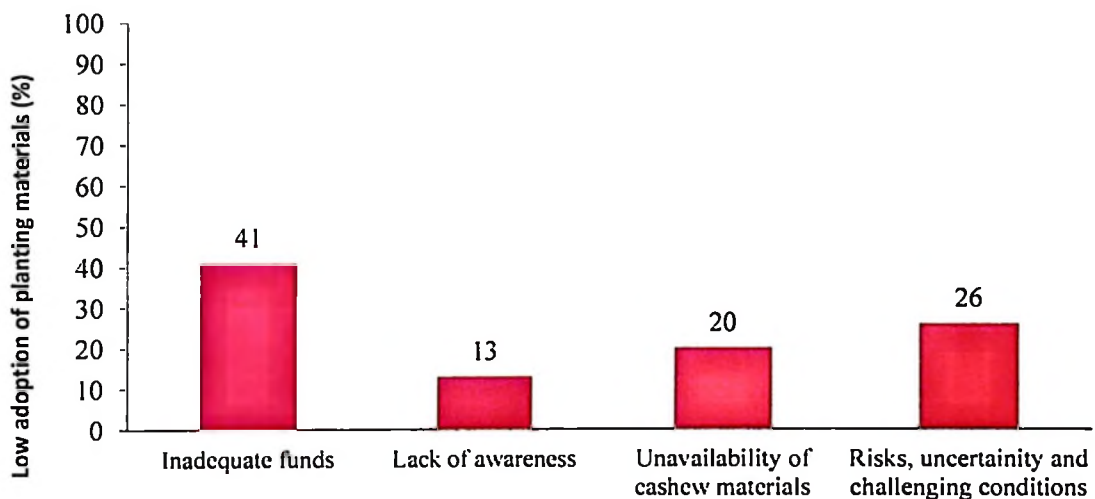


Figure 14: Reasons for low adoption of planting materials of cashew

4.2.9 Use of fungicides to control important cashew diseases

Available research reports and empirical evidence across many countries engaged in cashew production have indicated that, failure to control insect pests and cashew diseases on time might lead to yield losses of between 70% and 100% (Sijaona and Shomari, 1987). Principally, research conducted by NARI came up with recommendations requiring cashew farmers to practice tree sanitation to reduce diseases epidemic. By reducing

sources of inoculum, farmers will maximize profits by using fewer inputs and fewer rounds of fungicides/insecticides applications.

As can be seen in plate 6; a, b and c high infection of diseases causing organisms can cause death to vegetative and flowering shoots and deformation of the nuts. This reduces the marketing value of the crop and the farmer will fetch very low price.



Plate 6: Cashew diseases
(a) Symptoms of PMD on tender leaves

(b) Symptoms of blight on nut

(c) Poor quality nuts and fruits due to attack of PMD

Courtesy: ARIN, 2007-2010.

Study findings in Table 7 indicate that, 97.3% of the respondents used various types of fungicides to control leaf and nut blight, 83% controlled PMD and 7.5% controlled die-back diseases.

Additionally, it was further revealed that only 19% of the respondents interviewed owned motorized spraying machines while 81% hired the services at the cost ranging between 70/= and 300/= per tree for a single application. High prices of motorized spraying machines were cited as the major factor limiting cashew farmers to own the machine and

possibly this resulted to limited number of cashew trees that were chemically controlled. To curb this problem, farmers should be encouraged to form groups to increase their bargaining power. Input subsidies should also be introduced on motorized spraying machines.

Further findings in Table 7 revealed that 65% of the respondents were dissatisfied with service provided by the blower operators. The most critical challenges associated with chemical spraying were untimely application due to long queue of farmers waiting for the blower service (85%) and inefficient spraying (poor coverage) on tree canopy particularly for huge cashew trees (15%). Cumulatively, these implied that farmers were not able to achieve the recommendations for fungicides and insecticides applications, hence resulted to substantial reduction in cashew yields at household and district levels.

Table 7: Control of cashew diseases

Control of cashew diseases	Frequency	Percent
Important cashew diseases controlled		
Leaf and nut blight	194	97.3
PMD	166	83
Die-back	15	7.5
Ownership of motorized spraying machine		
Owned motorized spraying machine	38	19
Do not owned motorized spraying machine	162	81
Sources of spraying services		
Hired blower team for spraying service	159	98.7
Use local methods	2	1.3
Whether satisfied with hired blower services		
Satisfied	56	35
Not satisfied	103	65
Reasons for dissatisfaction		
Untimely application due to long queue	88	85
Inefficient spraying/poor canopy coverage	15	15



Plate 7: Controlling insect pests and cashew diseases

A female blower operator uses a cocktail (mixture) to control insect pests and cashew diseases.

Courtesy: ARIN, 2007-2010.

4.2.10 Farmers' awareness and understanding of important insect pests of cashew

There are quite a number of insect pests attacking cashew trees, including those which suck on tender leaves and young nuts like Helopeltis (*Helopeltis anacardii*) and Coconut bugs (*Pseudotheraptus wayii*) and those which bore and cause much damage to branches and even death of cashew trees such as Cashewnut weevil (*Mecocorynus loripes*) and Stem girdler (*Paranaleptes reticulata*). Other important insect pests of cashew are Mealy-bug (*Pseudococcus longispinus*) that results to defoliation and wilting of attacked parts

and Thrips (*Thrips rubrocinctus*) which cause yellowing and defoliation of leaves. Absence of chemical control may result to substantial reduction in total yields.

Results in Table 8 revealed that, 89.8% of respondents had knowledge of Helopeltis, while 48.5% and 48% had knowledge of Mealy-bug and Mecocorynus respectively. These three are the most destructive insect pests of cashew and failure to control them on time may result to reduced cashew yields. Results suggest that, many farmers are aware about important cashew pests and strategies used to control them.

Study findings in Table 8 continued to reveal that, 72% of respondents used fungicides to control Helopeltis, 49% of the respondents controlled Mecocorynus and 5% controlled cashew Mealy bug. Based on findings from this study, concerted efforts are needed by dealers in inputs to ensure that, resources and all necessary inputs reach cashew farmers at the right time and in sufficient amount to enable timely insect pests and diseases interventions.

Plate 8: a, b, d, e and f show the most common insect pests of cashew while plate c indicates symptoms of attack of coconut bug on immature nuts. In general, under heavy attack, the growth of the tree is seriously retarded, fruit deformed and at the same time attacked panicle or flower shoots are reduced. Affected kernels are spotted which lower their market value as indicated in plate c. Severe attack of Mecocorynus and stem girdler may result to death of the tree.



(a) Mosquito bug: a sucking
Insect pest of cashew



(b) Coconut bug: a sucking
insect pest of cashew.



(c) Symptoms of attack of
coconut bug on immature
nuts



(d) Tender leaves attacked by
mealy-bug



(e) Adult stem weevil.



(f) Larva of stem weevil,
the most destructive stage

Plate 8: Insect Pests of cashew

Courtesy: ARIN, 2007-2010.

Table 8: Farmers awareness (knowledgeable) about insect pests of cashew

Knowledge on insect pests	Frequency	Percent
Aware about insect pests of cashew		
Helopeltis	158	89.8
Mecocorynus	96	48
Mealy bug	97	48.5
Controlled insect pests in cashew		
Helopeltis	144	72
Mecocorynus	98	49
Mealy bug	10	5

4.2.11 Challenges experienced in controlling insectpests and diseases in cashew

From this study, it was established that out of 46 586 cashew trees (1.46%) owned by the respondents in the study area, 38 075 cashew trees (81.7%) were controlled against insect pests and cashew diseases. According to report from DAICO Mtwara, the district has 3 182 020 cashew trees while the number of spraying machines operating is 62 giving a ratio of 51 323:1. This implied that, the machines were overworked and therefore reduced their efficiency and durability. According to research report, for better performance and long economic life, a spraying machine should cover 1 500 cashew trees per season (ARIN 2007-2010).

The situation was different in many cashew growing areas in the district since a single machine covered more than 2000 trees per season resulted to frequent breakdown of the machine. This was coupled with poor services and maintenance, eventually resulted to reduced number of cashew trees that were chemically controlled against insect pests and cashew diseases. Nevertheless, those farmers who managed to control insect pests and cashew diseases were not able to achieve the recommended rates of chemical applications for example; 35% and 31% of the respondents sprayed four and three rounds of fungicides per season respectively. Others sprayed five rounds (28%) and two rounds (5%) depending on availability of the fungicides and blower services.

The recommended application round for fungicides is 5 per season. It is important to note that, application rounds for chemical control varied from year to year and also among agricultural zones depending on pressure of insect pests and diseases attack. It was also reported that, by performing tree sanitation farmers may delay the onset of diseases build up and eventually may end up having fewer applications rounds of insecticides and fungicides (Sijaona and Mansfield, 2001).

Similarly, 34.5% of the respondents sprayed 3 rounds and 20.4% sprayed four rounds of insecticides. Other spraying rounds for insecticides were as follows: two rounds (20.4%), one round (13.4%) and five rounds (11.3%) Table 9. Recommendation on insecticides application is three rounds at 21 days interval per season. However, routine application of insecticides is recommended for young developing cashew trees to control helopeltis bugs.

The most common used fungicides was Sulphur dust (79.2%) that was applied at the average rate of 200g per tree per round, the minimum being 60g and the maximum was 735g (the recommended rate is 250g/tree/round for sulphur dust and 15mls/tree/round for liquid fungicides). The results also indicate that, the common insecticides used by respondents was karate (81%) that was applied at the average rate of 3 mls/tree/ round a little bit lower to the recommended rate of 5mls/tree/round (Table 9).

Normally these were applied singly when the target was insect pests or cashew diseases, but in most cases a cocktail of insecticides and fungicides were used in single application to control both insect pests and cashew diseases.

Further results in Table 9 indicate that, problems and challenges faced respondents on the use of fungicides and insecticides were similar namely: untimely and inadequate supply of the inputs (70%), inadequate knowledge on insect pests and diseases ecology/management (16%) and inadequate funds (14%).

Principally, available literature and research reports have indicated that, incorrect use of fungicides or insecticides whether over-dose or under-dose have detrimental effect; for example applying lower rates than the recommended ones make the pathogens to build up

resistance against the fungicide while excessive use of inorganic pesticides can lead to high levels of the chemicals above authorized limits in the kernel, unnecessary environmental pollution and unnecessary additional cost to the farmers (Sijaona and Mansfield, 2001).

On overall, these findings suggest that, packages of chemical inputs should include training components to cashew farmers with special focus on appropriate use of fungicide and insecticides to reduce risks associated with improper use of those chemicals.

Table 9: Uses of pesticides in controlling insect pests and diseases in cashew

Common Fungicides	Frequency	Percent
Sulphur dust	118	79.2
Bayfidan	10	6.7
Mupavil	10	6.7
Mupafidan	5	3.4
Voltrad	4	2.7
Kumulus	2	1.3
Application rounds for fungicides		
One round	0	0
Two rounds	8	4.8
Three rounds	52	31.7
Four rounds	58	34.9
Five rounds	47	28.6
Common insecticides		
Karate	119	81
Ninja	18	12
Duduall	8	5.6
Selectron	1	0.7
Helerat	1	0.7
Application rounds for insecticides		
One round	19	13.4
Two rounds	29	20.4
Three rounds	49	34.5
Four rounds	29	20.4
Five rounds	16	11.3
Challenges in use of insecticides and fungicides		
Untimely procurement and inadequate inputs	39	70
Inadequate knowledge on pests and diseases ecology	9	16
Inadequate funds	8	14

4.2.12 Farmers' main sources of improved planting materials of cashew

It has been approved that, use of certified seed can assure farmers of a good crop return. In this study, unaware and unavailability of improved planting materials of cashew were cited as bottlenecks to adoption of improved cashew technologies among smallholder farmers. As can be observed from Figure 14, sources of improved planting materials to cashew farmers were in the following order: NARI and Cashewnut Development Centers (CDCs) (42%) followed by farmer to farmer (34%). Other sources of improved cashew materials were Extension Services (Local government) (20%), Primary Cooperative Society (3%) and farmers' own sources (2%).

These results suggest that, apart from NARI and CDCs, farmer to farmer contact played a pivotal role in dissemination of cashew technologies. The increasing interaction such as group gathering and other social networking existing in rural communities had effectively facilitated dissemination and adoption of improved cashew materials. This is due to the fact that, farmers' evaluation on an innovation does not always conform to that of the research or scientific world view but rather through the subjective evaluation of near-peer/neighbors who have adopted the innovation.

It was also acknowledged that, farmers who participated in ICMP during 1994 became role models and had facilitated adoption of improved cashew materials within and across villages through farmers' interactions (de Waal, 1997).

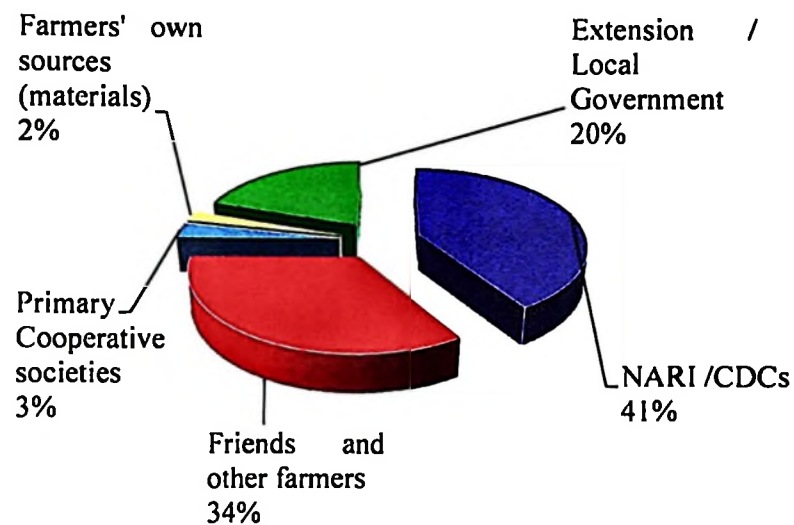


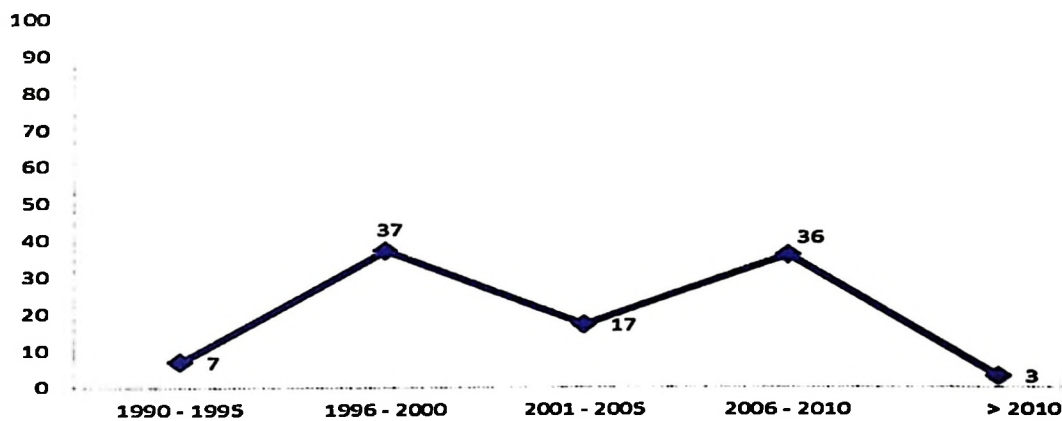
Figure 15: Sources of improved planting materials to farmers

4.2.13 Trend of improved cashew trees planted over the years

Figure 15 shows periods when farmers started growing improved cashew materials. According to Cashew Agronomy based at NARI, major adoption of improved cashew materials started between the years 1990 and 2000 and also between 2005 and 2010 respectively although the number varied from year to year. This corresponded to the period in which the breeding and the vegetative propagation sections based at NARI did a lot of extensive and intensive research work that enabled multiplication and release of new high yielding clones that were tolerant to major cashew insect pests and diseases (Masawe, 2006). These materials were then tested under farmers' conditions in different agro-ecological zones using on-farm trials and demonstration plots. Farmers were impressed with yield performance of improved cashew materials and were eager to try those technologies in their plots. As indicated in Figure 15, about 37% of respondents

planted improved cashew materials during 1990-2000 seasons and 36% during 2005-2010 seasons.

However, the trend of planting improved materials has been increasing, but sharply declined beginning 2010 to present probably due to market problems like low producer price offered to cashew farmers, delayed payment, inadequate and untimely supply of inputs to cashew farmers. These were disincentives to cashew farmers to continue investing in cashew enterprises.



Trend of planting cashew trees

Figure 16: Percentage of respondents who have planted improved cashew trees over the years

4.2.14 Age category of cashew trees planted between 1990 and 2010

In this study, it was established that, the total number of cashew trees owned by the respondents in the study area was 45467 of which 12 210 (174 ha) were improved cashew trees and 34257 (489 ha) were local cashew trees. Among the improved cashew trees, 39% were young developing below 8 years, 57% were middle aged between 9 and 25 years and 4% were aged above 26 years. Similarly, among the local trees, 8% were below

8 years, 35% were middle aged and 57% were aged more than 26 years (Figure 16). Based on research findings, improved cashew materials give economic yield of above 26 kg/tree/season beginning years 6 and reach peak production period at 12 years under good crop management while the local types give economic yield of 19 kg/tree/season beginning year 12 and reach peak of cashew production at 16 to 18 years and above (ARIN, 2007-2010). These statistics further revealed that, most of the improved cashew trees have reached their yielding potential and contributed significantly to total cashewnuts harvested. On the other hand, majority of the existing stock comprised old and low yielding cashew trees with little contribution to the district economy. This calls for a need to replace old and unproductive cashew trees with improved and high yielding cashew varieties. However, cashew seeds of local varieties should be preserved in gene banks for future research work in order to avoid genetic erosion.

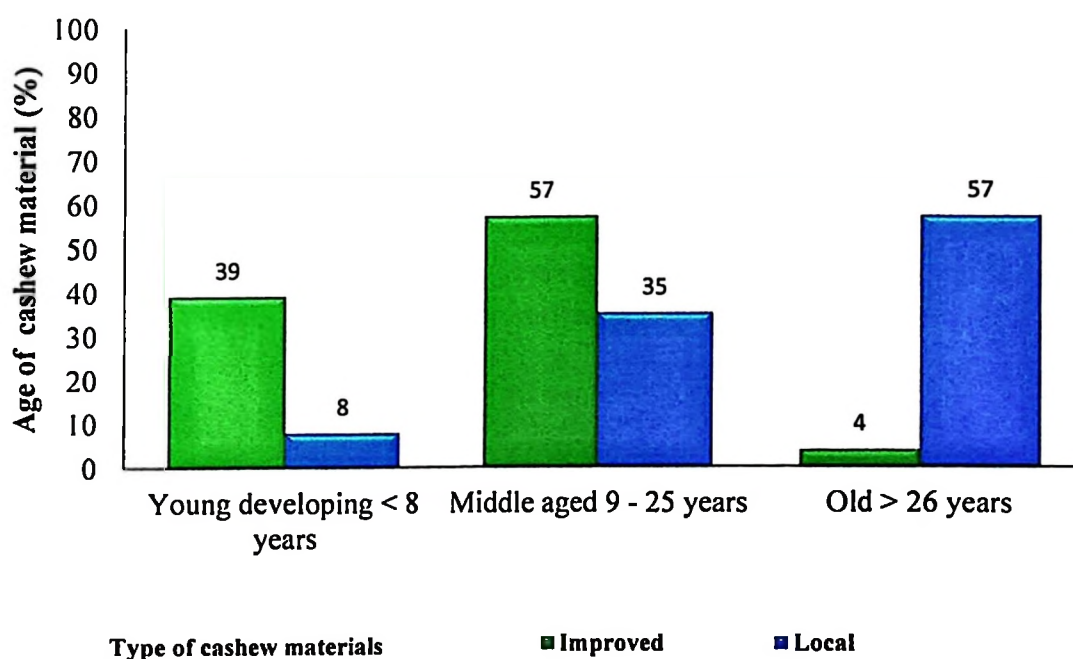


Figure 17: Age category of cashew trees planted between 1990 and 2010

4.2.15 Cashewnut production trend in Mtwara district

Based on Figure 17, statistics indicate a notable increase in cashewnut production for the period 2010-11 up to 2012-13 and stabilized at 11 472 metric tons. This is attributed to abandoned and neglected cashew farms being brought back into production and also improved cashew trees planted beginning 2006-07 season were able to give economic yields and possibly contributed significantly to 11 472 metric tons recorded in Mtwara district. As a result, livelihood and economic well-being of families committed to cashew production were also improved. These results suggest that, the district has the potential to boost cashew productivity if strategic plans are established to support smallholder farmers who are the main producers of cashewnuts.

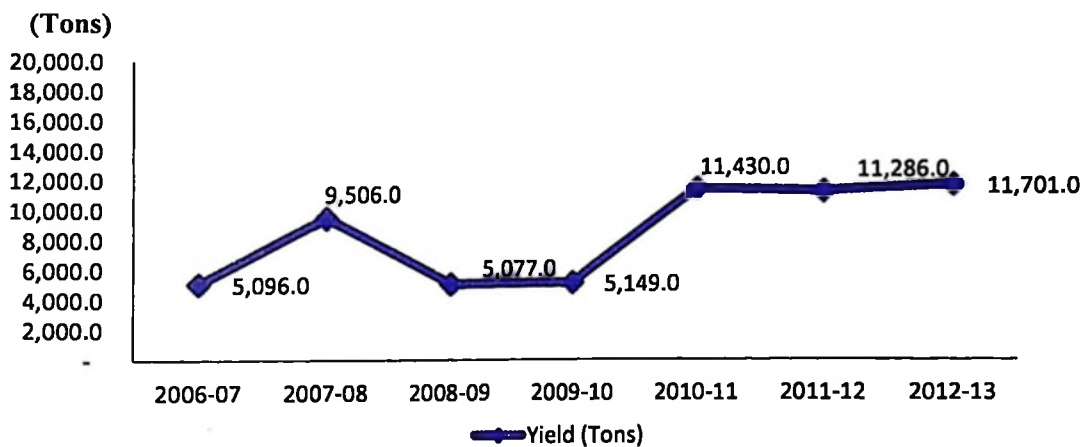


Figure 18: Production Trend as per 2006-07 up to 2012-13 in Mtwara district

Source: ARIN, 2007-2010

4.2.16 Availability of extension services

The agricultural extension service is one of the institutional support services that have a central role to play in the transformation process. The major objectives of the Tanzanian's agricultural extension services are to advance farmers' technical know-how and raise the efficiency of farming operations to increase level of crop output. Uneven accesses to agricultural extension and information services have been mentioned by farmers as bottleneck to achieve high productivity. Similarly, studies conducted to assess the effectiveness and efficiency of the extension service has indicated that, poor performance in service delivery by the extension service was a major limiting factor to increased productivity (Rasouliazar and Fealy, 2008). Results in Table 9 indicate that, majority (71%) of the respondents did not get extension services. Only 29% of the respondents received extension services. Based on these findings, the local government should take steps to ensure greater farmer participation in determining research and Extension agendas.

Table 10: Availability of Extension services (n=200)

Access to Extension services	Frequency	Percent
Contacted with Extension agent	58	29
Not contacted with Extension agent	142	71

4.2.17. Frequency of contact between farmers and VAEO on yearly basis

Findings in Figure 18 show that, out of 29% of respondents who had contact with VAEO, the frequency of contact was in the following order: once in a year (49%), twice per year (40%), once per month (8%) and once per week (4%). The low rate of contact was undoubtedly due to the fact that, the agricultural extension service is seriously understaffed and its effectiveness was consequently compromised (Fealy *et al.*, 2007).

However, depending on the degree of interactions within and across the villages, those respondents who were contacted by VAEO became volunteer extension agents' to their fellow farmers in dissemination of useful information.

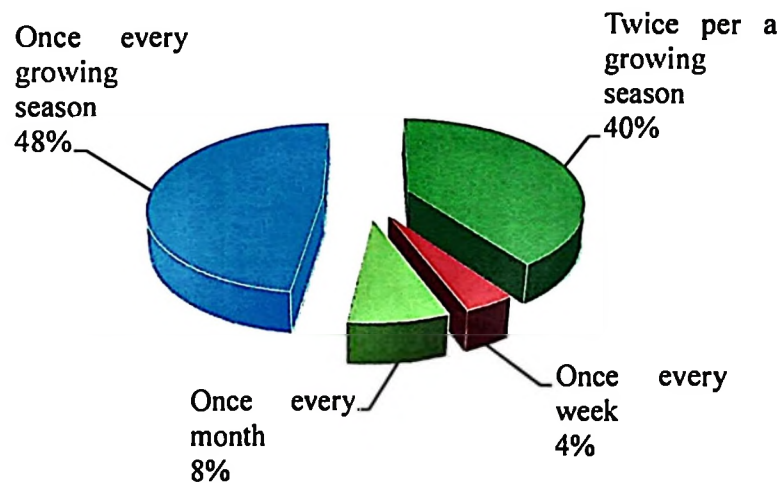


Figure 19: Frequency of contact between farmers and VAEO on yearly basis

4.2.18 Perception of farmers on improved cashew materials

The adoption and diffusion model is based on “voluntarism” on the part of the farmers’ decision making and the economic gains attached to the new behavior (Alene *et al.*, 2000). Experience and empirical evidence across many countries have shown that, success in adoption and spread of agricultural innovations required substantial changes not only in practice, but also in mindset of all concerned stakeholders (Derpsch, 2008a). Practically, it could be particularly difficult to convince farmers to adopt new technology if they do not experience strong environment or economic pressures to change. This is particularly true

for late adopters as classified by Rogers. (2003). Nevertheless, it has been strongly emphasized by theory of reasoned action (TRA) that, people are rational beings who make systematic use of available information considering the repercussion of their action before deciding whether or not to engage in a given behavior (Ajzen and Fishbein, 1980; Marandu *et al.*, 2010).

The production of cashew is primarily for the market; both domestic and export markets. In this situation quality and standard of the produce become much more important since competitiveness depends largely on quality of the produce.

Being a market-oriented crop, farmers' preferences on improved cashew materials was being reflected by aspects of nut quality such as size and kernel weight which determine acceptability of raw cashew at domestic and export markets (Masawe, 2006). Table 11 presents different attributes of improved cashew varieties as perceived by the respondents in the study area. The most important attribute of nuts was clean, big and well filled nuts (21%). Other attributes are related more to tree characteristics namely: yielding potential (24%), easy pesticides application due to tree size (20%), early bearing (19%) and tolerance to cashew insect pests and diseases (16%). Similar results to the adopter perception were also reported by Fliegel and Kivlin (1962). Overall, farmers have a high and positive perception about improved cashew materials and about 62.5% of the respondents among adopters of improved cashew materials have insisted on continual use of improved cashew varieties in all subsequent farming activities.

On the other hand, it was learned from this study that, improved planting materials of cashew are labour intensive particularly care and routine management to the young developing cashew tree at the early stages of tree development. Management regimes such

as formative pruning, de-suckering and routine insect pests and diseases control are too technical for ordinary farmer unlike local materials that are easy to handle and require minimum attention. Also rejuvenation of old and unproductive cashew tree is extremely too laborious. All these appeared to be added burden to resource-poor cashew farmers hence: their adoption was rather on small scale.

However, despite those short-falls, improved planting materials of cashew are superior as compared to local materials that are under-performing. Practically, meeting quality of the produce depends heavily on the use of the right technologies and methods of production; therefore there is a need for local government to make concerted effort to encourage farmers to use the right and recommended cashew technologies to benefit from the market that demands nuts of high standards.

Table 11: Perception of farmers towards improved cashew materials

Attributes of improved cashew trees	Percent	Rank
Potentially high yielding	24	1
Clean, big and well filled nuts	21	2
Dwarf tree hence easy chemical application	20	3
Early bearing	19	4
Tolerance to common insect pests and cashew diseases	16	5
Total	100	



Plate 9: Attributes of improved cashew materials

(a) Potentially high yielding (big and well-filled nuts).

Courtesy: ARIN, 2007-2010.

(b) Early bearing.

A one year cashew seedling with flowers. Economic yield begins on year six.

4.3 Logistic Regression Results on Adoption of Improved Cashew Materials

It was hypothesized that a farmer's decision to adopt or reject innovation at any time is influenced by the combined effects of a number of factors related to the farmer's goals and means of achieving them. For that matter, the Binary logistic regression model was used to investigate the important factors influencing adoption of improved cashew materials in Mtwara District which are presented in Table 12. The -2 log likelihood was 242.395. The chi-square was 29.056 significant at 1% level. The factors predicted in the model revealed that years of schooling, number of active labour in the household, size of the cashew farm owned and access to information on cashew materials significantly influenced adoption of improved cashew technologies. These variables and others in the model are discussed in this section.

Table 12: Logistic regression results on adoption of improved cashew materials

Variable	β	SE β	Exp (β)	df	Sig.
Constant	-1.310	1.588	0.270	1	0.409
Age (years) of respondents	-0.001	0.016	0.999	1	0.944
Years of schooling	0.446	0.268	1.561	1	0.097*
Number of active labor in hhs	0.249	0.108	1.283	1	0.021**
The size of cashew farm owned	0.029	0.014	1.029	1	0.045**
Yrs of experience in cashew farming	0.110	0.167	1.116	1	0.509
Access to extension services	-0.202	0.365	0.817	1	0.580
Access to information on cashew	-0.788	0.314	0.455	1	0.012**

The Model summary:-2log likelihood =242.395; significant at 1%: 70% of cases

Predicated the model: Chi-square = 29.056 significant at 0.01. Dependant variable = (Adoption of improved cashew materials (1 was if adopted and 0 if not adopted)

Significant at 0.1

** Significant at 0.05

4.3.1 Years of schooling

It has been documented that the more educated the farmer is, the more efficient he/she becomes and the higher the productivity (Msuya and Ashimogo, 2006;BasnayakeandGunaratne, 2002). In this study there was a significant influence of education on adoption of improved cashew materials as noted that each additional year in education led to 1.561 (56%) increase in the log-odds of adoption of improved cashew materials. This implied that the probability of adopting improved cashew materials increases with increased level of education (Anandajayase and Martella, 1996). This is due to the fact that, educated farmers are rational in the choice of technology and tend to adopt earlier modern technology instead of developing negative attitudes towards new innovation: more appropriately, educated farmers are more receptive to advice from extension agency and more able to deal with technical recommendations. This conforms to

earlier results where 80% of the respondents in the study area were literate and 9% of the respondents mentioned newspapers and other written materials among their main sources of technology acquisition (Matata *et al.*, 2008).

4.3.2 Household labour force available to work on the farm enterprises

It is generally accepted that, number of active labour in the household had influence on adoption of agricultural innovation. for instance, results show that for every one unit increase in number of active labour in the household led to a 1.283 (28%) increase in the log-odds of adoption of improved cashew materials. This implied that the probability of adopting improved cashew materials is higher among households with large number of active labour compared to households with smaller number of active labour. Under item 4.1.1, the social-economic characteristics of respondents indicated that, family labour was the main source of labour for various farm activities of which on average three members contributed to household labour supply. Three members who are committed to cashew production activities can accomplish a lot and more likely to adopt labour intensive technologies such as top-working and use of recommended planting spacing in cashew.

4.3.3 The size of cashew farm owned

Several surveys conducted to study the relationship between farm size and the proportion of the farm devoted to the new technology have indicated that, the size of the farm owned by an individual has significant influence in adoption of new innovation holding other factors constant (*ceteris paribus*) (Feder and O'Mara, 1981; Rahm and Huffman, 1984; Putler and Zilberman, 1988). Findings in this study revealed that every one unit increase in farm size led to a 1.029 (3%) increase in the log-odds of adoption of improved

cashew materials. This implies that the probability of adopting improved cashew materials for a cashew farmer with large farm size is higher than that of a cashew farmer with small farm size. Essentially, Schultz (1961) in his 'high-payoff' input model' had clearly indicated that, principles of producing at economies of scale work better with large farm size than small farm size.

In earlier section in Table 2 item 4.1.2, it was found that 48% of the respondents in the study area belonged to small-scale cashew farmers owning cashew farms ranging between 0.3ha and 2ha. The medium scale cashew farmers who owned cashew farms ranging between 2.4ha and 4.8ha were 31.5% while large scale cashew farmers who owned more than 5.2ha were 20.5%. These findings suggest that, there is potential for the district to increase up-take of cashew technologies among resource-poor farmers through intensive application of science-based technologies. Possession of small landholdings explains best why resource-poor farmers lag behind in adoption of new innovation and un-creditworthy in issues related to loan acquisition.

4.3.4 Access to information on cashew materials

Information is a rather special type of input in many respects and presently, farming is becoming more information-intensive (Byerlee, 1998). Farmers have different types of information needs during each stage of crop production and that information can have many inherent valuations to concerned farmers. The slogan "information is power" is valid and had enabled farmers make informed decision particularly in allocating limited resources more efficiently and thereby boosting the current production of cashewnut not only in Mtwara District but also in Tanzania as a whole. Experience with Sasakawa-Global 2000 showed that with close extension interaction, farmers increased their crop

yields tremendously (Quinones *et al.*, 1992). It was revealed in this study that access to information on improved cashew materials led to a 0.455 (54.5%) increase in the log-odds of adoption of improved cashew materials. This entails that, probability of adoption increases as the stock of information pertaining to a 'new' production process increases. In this regard, adoption of improved cashew materials was higher among cashew farmers who had access to technical information on improved cashew materials than that of cashew farmers who did not have access to information on improved cashew materials.

Through discussion with respondents, it was clear that, farmers had a wide array of getting information about modern methods and techniques of cashew production including their own experimentation (trial and error) and from other members of their social networks. This explanation agrees with findings in item 4.4.1 in which 17% of the respondents claimed to have acquired cashew information and technologies through farmer to farmer interaction, 12% through agricultural exhibition and seed fair and 11% through technological spillover from demonstration plots and on-farm trials. This result also concurs with what Feder had indicated in his study (Feder *et al.*, 1985).

4.3.5 Age of respondent

Many studies have indicated that age of a farmer can increase or decrease the likelihood of adopting agricultural innovation. In many cases when young farmers were involved they tended to exhibit a lower risk aversion and likely to adopt new technologies that have long lags between investments and yields of benefits than when old farmers were involved (Mazvimavi *et al.*, 2010). This was due to the fact that old farmers worked for survival and could not cope with the added work which was associated with use of new technologies. On the other hand, it has also been documented that older farmers are more

receptive of new technologies because of the accumulated experience in farming and resources that would allow them to try new technologies (Romanthan, 2007).

However, quite contrary to most literatures, results obtained in this study indicated that age of respondents was not significant in influencing adoption of improved cashew materials. Possible explanation to this contradiction could be that, the age category among 42% of respondents who had adopted improved cashew materials did not differ significantly and hence difficult to make inference. The contradiction was also reflected by the fact that 13% of the respondents in this study were above 60 years with 27.5% belonging to the middle age bracket of between 30 and 40 years.

4.3.6 Years of experience in cashew farming

Study results show that years of experience in cashew farming is not significant in influencing adoption of improved cashew materials. This is contrary to many studies which indicated that, the more the years of farming experience the farmer had, the more the ability of the farmer to manage risks and uncertainty, hence the higher the adoption of new technologies. The plausible explanation to this contradiction could be that, cashewnut is grown in an environment that is complex, diverse, risk-prone and uncertain (Ajayi and Okunlola 2006; Rivera, 2006). It should also be noted that cashew is undertaken by resource-poor farmers who differ in degree of risk management. In this regard it is unlikely that years of experience of the farmer will influence decision making process in adoption of improved cashew technologies but rather complexity and ability of the farmer to manage risks and the uncertainties (Batz *et al.*, 1999). It may also be that over the years farmers might have been adopting bad agricultural practices and naïve to change in adopting recommended practices.

4.3.7 Access to extension services

The agricultural extension service by its nature has an important role in promoting the adoption of new technologies so that farmers can exploit and adopt those technologies to increase productivity. Many studies conducted indicated that a positive and significant influence exists between frequency of extension agent's contact and the adoption of improved farm practices. For example, a study conducted by Obeta and Nwagbo (1991) revealed that frequent contact with VAEO had minimized doubts among farmers and ensured timely purchase of inputs.

Results obtained show that, the extension services did not have significant influence on adoption of improved cashew materials. This might be attributed to a number of factors. For example the farmer-extension officer ratio presently ranges from 10 000 - 20 000:1, besides, the district has 62 village agricultural extension officers serving a population of more than 214 882 people who are highly dispersed across large area of land. This affects the quality of messages as well as the frequency of visits by the extension staffs who are also affected by poor incentives and poor mobility (Ashimogo *et al.*, 2008; Van den Ban and Hawkins, 1996; Moris 1991).

In addition to this, poor quality or inadequacy of the impact points (messages) communicated to cashew farmers might be due to the fact that, the extension staff lacks regular refresher courses to up-date themselves with changes and new recommendations developed by researchers. As a result, they are not in a position to supply farmers with up to date advice on cashew production and other related techniques. It might also be that, newly recruited VAEOs are not familiar or lacked the basic knowledge of improved cashew technologies. Previously, it was mentioned by 71% of the respondents under item 4.2.16 that, unavailability of VAEO was a major drawback to farmers' accessing

improved cashew technologies. Furthermore, under item 4.4.1 on effective methods of cashew technology transfer, the extension service was ranked the fifth out of eleven selected methods by 10% of the respondents who complained about inefficiency in service delivery.

Based on findings in this study, it can be noted that the negative influence between access to extension services and adoption of improved cashew technologies was attributed to a number of factors originated within the extension system itself. This calls for a need to re-examine the methods and system of approach used with a view to develop a workable plan that will ensure their responsibilities and accountability.

4.4 Technology Transfer

4.4.1 Effective methods of technology transfer to cashew farmers

Technology transfer is the movement of knowledge, skill, values, materials, organization and capital from the point of generation to the site of adoption and application (Mittleman and Pasha, 1997). NARI is continuously generating and fine tuning/refining cashew technologies while the Extension services transfer those technologies to the intended users to improve agricultural productivity. Farming is conceived as social-cultural practices governed, informed and regulated by social processes as a result knowledge and the outcome resulted from use of that technology is likely to have impact on adoption of that technology (Lesfaye *et al.*, 2010; Lenin *et al.*, 2009; Reddy, 2006; Jabbar *et al.*, 1998).

Farmers' decision to adopt, reject or defer is postulated to be influenced by the belief derived from the knowledge and perception about the technology at that point in time.

It is also conceptualized that methods of technology dissemination and communication channel employed, if properly organized and translate innovations to fit in with particular ecological and socio economic circumstances of the farming community, would exert a strong and positive influence in accepting and final adoption of an innovation (Meinzen-Dick *et al.*, 2003).

In this study, 17% of the respondents interviewed mentioned friends and other farmers as the most effective method in exchanging and sharing cashew information and materials, while 12% of the respondents claimed to have acquired various cashew technologies through agricultural promotion and exhibitions such as Nane-nane and seed fair. About 11% of the respondents claimed to have benefited from the technological spillover from demonstration plots, farmers field schools and on-farm trials. Other methods which had facilitated technology transfer were in the following order: extension services (10%), workshops and seminars (10%), newsprints and market gatherings (9%) each. Radio (6%) and TV/cinema (4%)(Table 13). The relative advantage of demonstration plots and On-farm trials over the other methods was that, respondents get opportunity to see and practice the innovation hence become easier to adopt. On the other hand, workshops and seminar presentations were rarely done due to limited funds while the major challenges with use of TV/cinema or Video-taped/recorded was underdeveloped or poor infrastructural services in rural areas particularly electricity. It was also noted that, farmers have different types of information needs at each stage of crop development. But programs broadcasted in Radio may not be timely and necessarily follow the calendar of activities of the priority crop thus fall short of the needs of the farming communities. But the most important weakness is that, these methods present one way learning process and not interactive. On overall, most of the cashew technologies developed by NARI have

reached more than 50% of the cashew growing areas which call for the need to put more efforts in extension services in order to further increase adoption of improved cashew technologies. In order to overcome the problem of inefficient extension services, training of trainers (ToT) strategy should be adopted who upon return to their respective villages would train other farmers. This is a good and sustainable way of improving the extension wing of cashew industry. Furthermore, use of demonstration plots and farmer field schools be intensified as there are reports that, technological spillover effect from on-farm trials and demonstration plots was higher and transcended both within and across villages.

Table 13: Respondents' views on effective methods in technology transfer to cashew Farmers

Methods of technology dissemination	Percent	Rank
Friends and other farmers (neighbors)	17	1
Agricultural / exhibition and seed fair	13	2
Demonstration plots and (FFS)	11	3
On-farm trials	11	4
Extension services	10	5
Workshops and seminars	10	6
Market gatherings	9	7
News print/ leaflets	9	8
Radio	6	9
TV /video- taped and cinema	4	10
Internet	0	11
Total	100	

4.4.2 Benefits associated with use of improved cashew technologies

Achievement has many dimensions including both the tangible and intangible ones. Based on findings in Table 14, the appreciation by 85% of the respondents about the importance and achievements after adopting improved cashew technologies was higher and quite

promising. These achievements will motivate other farmers to try those technologies in their farms so as to improve their economic and social well-being.

Table 14: Whether respondents benefited after adopting improved cashew Technologies

Responses	Frequency n	Percent
Benefited	170	85
Not benefited	30	15
Total	200	100

4.4.3 Respondents' achievements after adopting improved cashew technologies

Essentially, results from Table 15 show that, one of the most important achievement mentioned by respondents was improvement in household food security (12%) followed by qualitative and quantitative increase in cashewnut yield (11%). Other achievements were increased income and asset acquisition (11%), additional land for cashew farming (11%), increased accessibility to cashew inputs (10%), ability to implement good agricultural practices (10%), efficiency on use of chemicals in controlling insect pests and cashew diseases (9%), good farm management (9%), better understanding of insect pests and diseases ecology (9%) and reduced vulnerability or ability to recover from shocks (8%). Cumulatively, these enabled farmers to maximize farm profits and hence contributed greatly towards reduction of income poverty at household level.

Table 15: Respondents' achievements after adopting improved cashew technologies

Achievement to cashew farmers	Percent	Rank
Improved household food security	12	1
Cashewnut yielding potential	11	2
Increase in income and asset acquisition	11	3
Additional land for cashew farming	11	4
Increasing accessibility to cashew inputs	10	5
Ability to implement good agricultural practices	10	6
Efficiency on use of chemicals against pests	9	7
Good farm management	9	8
Timely control of pests and diseases in cashew	9	9
Ability to recover/cope from shock/stress	8	10
Total	100	

One among the benefits of increased production in cashew is that both men and women will get more income through value added to raw nuts. This is reflected in plate 10 and corresponds to *MKUKUTA* strategies (NSGRP Cluster 1: Goal number 4 and 5) (URT, 2007).



Plate 10: Benefits of improved cashew yield, reduction of income poverty.

Current price of a kilogram of roasted cashewnut is 15 000 TAS.

Courtesy: AAADI, (2006)

4.5 Constraints to Uptake and Utilization of Improved Cashew Technologies

Cashew farmers face a lot of challenges while adopting improved cashew production technologies. The results are summarized in Table 16 as follows: about 12% of the respondents experienced extensive prevalence of insect pests and diseases in cashew farming, and another 12% mentioned delay payment after selling their cashewnut to the Primary Cooperative Society as major production constraint limiting uptake of improved cashew technologies. Others were ranked in the following order: risks and uncertainty of the performance of improved planting materials of cashew (11%), untimely procurement and insufficient application of pesticides and fungicides (11%), inadequate information about cashew marketing (10%), low, fluctuating and unreliable farm gate price for raw nuts (9%), shortage of land (9%), limited methods of technology dissemination (9%), complex technology (8%) and inadequate capital (8%). This implied that, with increased challenges in cashew farming, many farmers would diversify or opt to grow other crops as a substitute to cashew which is more risk and require more resources.

Table 16: Constraints/challenges to adoption of improved cashew technologies

Challenges to adoption of cashew technologies	Percent	Rank
Extensive prevalence of pest and diseases	12	1
Delay payment to cashew farmers	12	2
Risks/ uncertainty with use of cashew materials	11	3
Untimely procurement of cashew inputs	11	4
Inadequate information for cashew marketing	10	5
Poor price incentives to cashew farmers	9	6
Shortage of land	9	7
limited methods of technology dissemination	9	8
Complex technology	8	9
Inadequate capital	8	9
Total	100	

Interaction with farmers had revealed that, low adoption of improved planting materials of cashew was based on experience with the dwarf varieties of hybrid coconut trees introduced in the 1980s. Despite yielding potential, the tree reached peak production in the fifteenth year followed by gradual decline in yield in the subsequent years. This had frustrated farmers who had planted hybrid variety of coconut and hence negatively impacted the adoption of improved cashew materials, fearing that the same experience might repeat. In addition to this, the life span of improved cashew trees particularly grafted and top-worked trees have not yet been established, these make cashew farmers hesitate to plant improved cashew materials although some have planted improved cashew varieties on small portion of the land on a trial and error basis.

Furthermore, some farmers hold a view that, since use of improved planting materials of cashew does not guarantee freedom from diseases and insect pests attack, there is no need to adopt improved cashew materials. This calls for a need for researchers to use participatory cashew improvement approach to adequately address farmers' needs. Demand-driven, client oriented approach with active participation of farmers in various aspects of improved cashew technologies would adequately address farmers' needs and aspirations.

4.5.1 Challenges related to institutional support and micro-finance services

There is great evidence that the major factor explaining low adoption of technology in Africa is lack of appropriate institutional and policy support (Kedir, 1998). This corresponds to results conducted by Van Den Ban and Hawkins (1998) indicating that, adoption of improved technologies is strongly affected by the policy environment like input supply, market, credit, price policies and improved supply system. Study conducted

by Okunyenye. (1986) emphasized that agricultural growth requires increased government intervention. Similarly, Kassam *et al.*, (2009) reported that suitable policies are needed to facilitate capital access for farmers to reduce the investment risk for early adopters. In Tanzania and Mtwara District in particular many farmers are un-creditworthy therefore it is essential for the government to assist small-scale farmers in the area of credit.

Basically, all the respondents in the study area agreed that credit was important as capital for purchasing inputs and services for undertaking cashew farming. Conversely, farmers refrain from taking bank loans because of the fear of crop failure or low farm gate price that will make them not able to repay (Amani, 2005). This bears a relevance to Ashimogo *et al.*, (2008) report on cashew profitability analysis conducted in few African countries engaged in cashew production. It was earlier mentioned that small farmers' constraints stem mainly from inadequate funds to control insect pests and cashew diseases. Outputs of the analysis in Table 17 indicate that, a high proportion of the respondents (94%) had never received formal loan to undertake farm activities in cashew. Only minority (6%) were able to access loan in form of cash or input such as pesticides, fungicides and blower machines that were sourced through the Primary Cooperative Society/AMCOS while cash loan was provided by SACCOS and commercial banks.

It was mentioned by the respondents that, with the collapse of the Cooperative Unions (agricultural credit system), farmers find it difficult to access some reliable form of formal credit to facilitate purchase of production inputs. Unfortunately, efforts made to initiate such system via the organization of SACCOS have so far achieved limited success in most of the areas visited. However, report from DAICO Mtwara indicated an increase in number of SACCO's centers from 10 to 21 over the last three years. This will more likely improve service provision in the district.

Table 17: Whether the farmer had received formal credit/loan (n= 200)

Responses	Frequency	Percent
Received	12	6
Not received	188	94
Total	200	100

4.5.2 Limitations to loan acquisition among cashew farmers

More than 80% of the bulky of cashewnut produced in the country comes from smallholder farmers who are constrained by technical, institutional, biological/environmental and market related factors. Cumulatively, these reduced their ability to produce at economies of scale. For farmers to invest in agriculture they need to accumulate savings from an income which is surplus to their immediate consumption requirements or they need to obtain credit. However, low level of farm output and income and little net surplus extremely limit possibility for farmers to invest out of their own resources.

Basically, access to agricultural credit has been positively linked to agricultural productivity in several studies. Chamber (1989) noted that access to credit is one way to improve farmers' access to new production technologies and increase productivity. Yet this vital input has eluded smallholder cashew farmers in Mtwara district. Issues of collateral and high interest rates screen out most of smallholder cashew farmers (Masawe and Kapunga, 2011; Ashimogo *et al.*, 2008; Amani, 2005). It was mentioned that lack of awareness about loan facilities (35%) and fear to take loan due to strictly repayment conditions (26%) were major limitations to access commercial loans among smallholder cashew farmers. Not only that, but also bureaucracy and long process in accessing commercial loans (16%), risks and challenging conditions in cashew production (13%), small farm size (6%) and un-creditworthy among respondents (4%) were also

Table 17: Whether the farmer had received formal credit/loan (n= 200)

Responses	Frequency	Percent
Received	12	6
Not received	188	94
Total	200	100

4.5.2 Limitations to loan acquisition among cashew farmers

More than 80% of the bulky of cashewnut produced in the country comes from smallholder farmers who are constrained by technical, institutional, biological/environmental and market related factors. Cumulatively, these reduced their ability to produce at economies of scale. For farmers to invest in agriculture they need to accumulate savings from an income which is surplus to their immediate consumption requirements or they need to obtain credit. However, low level of farm output and income and little net surplus extremely limit possibility for farmers to invest out of their own resources.

Basically, access to agricultural credit has been positively linked to agricultural productivity in several studies. Chamber (1989) noted that access to credit is one way to improve farmers' access to new production technologies and increase productivity. Yet this vital input has eluded smallholder cashew farmers in Mtwara district. Issues of collateral and high interest rates screen out most of smallholder cashew farmers (Masawe and Kapinga, 2011; Ashimogo *et al.*, 2008; Amani, 2005). It was mentioned that lack of awareness about loan facilities (35%) and fear to take loan due to strictly repayment conditions (26%) were major limitations to access commercial loans among smallholder cashew farmers. Not only that, but also bureaucracy and long process in accessing commercial loans (16%), risks and challenging conditions in cashew production (13%), small farm size (6%) and un-creditworthy among respondents (4%) were also

as limitations to loan acquisition (Figure.19). Inadequate funds made farmers to reduce crop area and number of cashew trees for insect pests and diseases control.

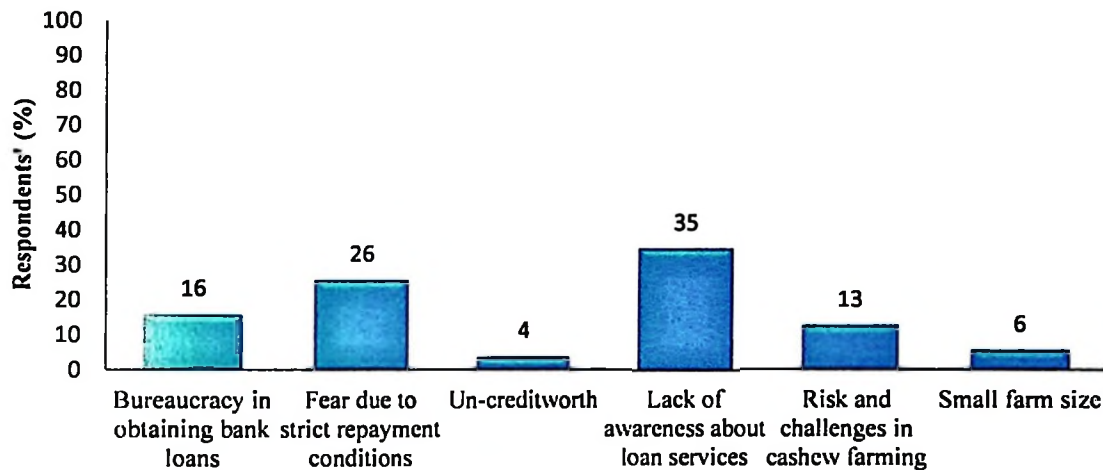


Figure 20: Limitations to loan/credit acquisition to cashew farmers

4.5.3 Suggestions to improve adoption of cashew technologies by respondents

In order to increase the extent of adoption of the improved cashew materials there are a number of cross-cutting issues that need to be considered and internalized within the cashewnut value chain. It is believed that, production of cashew nut can double if inputs are affordable and timely available. The use of subsidies needs to be re-examined since it failed to achieve the desired objective. Initially, the introduction of 50% input subsidization was aimed at making it more affordable to resource-poor farmers but it remains ineffective because the amount of pesticides/fungicides and spraying machines sourced through agricultural and marketing cooperative society (AMCOS) is usually not sufficient to all of the members (covering only 10% to 50% of the quantity needed) as a result farmers would have to complement what they get from the cooperative with their own contribution.

mentioned as limitations to loan acquisition (Figure.19). Inadequate funds made farmers to reduce crop area and number of cashew trees for insect pests and diseases control.

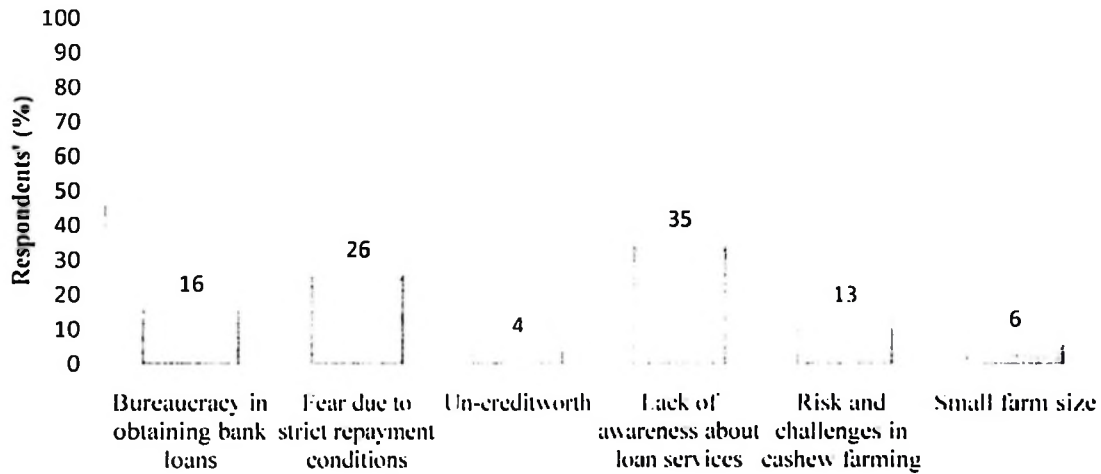


Figure 20: Limitations to loan/credit acquisition to cashew farmers

4.5.3 Suggestions to improve adoption of cashew technologies by respondents

In order to increase the extent of adoption of the improved cashew materials there are a number of cross-cutting issues that need to be considered and internalized within the cashewnut value chain. It is believed that, production of cashew nut can double if inputs are affordable and timely available. The use of subsidies needs to be re-examined since it failed to achieve the desired objective. Initially, the introduction of 50% input subsidization was aimed at making it more affordable to resource-poor farmers but it remains ineffective because the amount of pesticides/fungicides and spraying machines sourced through agricultural and marketing cooperative society (AMCOS) is usually not sufficient to all of the members (covering only 10% to 50% of the quantity needed) as a result farmers would have to complement what they get from the cooperative with their own contribution.

Strategies proposed by the respondents to improve uptake of cashew technologies are ranked in Table 18 in the following order: development of model cashew plots and use of farmers field schools (21%), strengthening the Research-Extension-Farmer linkage (15%), and increase cashew training to update and increase the knowledge base of key stakeholders (15%). Promoting cashew technologies to increase awareness among farmers (14%). Other suggestions were supportive role of the government in marketing subsidy and loan (13%), financial support through credit facilities (12%) and input dealers/stakeholders to ensure timely and adequate supply of cashew inputs (9%).

This study then suggest that the government should give support to strengthen priorities as mentioned by the respondents without forgetting the least prioritized: e.g. supportive role of the government and timely and adequate supply of cashew inputs.

Obviously, those suggestions were made on understanding that the bulky of raw cashewnuts comes from smallholder farmers. thus strengthening those channels would facilitate the successful adoption of cashew technologies. Essentially, any fault or weakness within any components in the system would jeopardize the whole system, and ultimately affect the cashew industry and paralyze the national economy.

These suggestions comply with Chayanovian theory on 'Peasant Mode of Production' emphasizing on the need of key stakeholders to cooperate in order to transform and modernizing traditional and rural societies. Promoting the rural-urban linkage is important in facilitating the forward and backward linkages that acts as catalyst in rural development.

Table 18: Suggestions on how to improve adoption of improved cashew technologies

Suggestions	Percent	Rank
Development of model cashew plots and intensify FFS	22	1
Strengthen the Research - Extension -Farmer linkage	15	2
Provision of training to update key players	15	2
Increase awareness of improved cashew technologies	14	3
Strengthen the marketing subsidy and input loan	13	4
Financial support through credit facilities	12	5
Ensure timely and adequate supply of inputs	9	6
Total	100	

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion and Implications for Research, Extension and Policy

Virtually, majority of the respondents interviewed were aware of improved cashew technologies and had adequate experience in cashew farming with an average farm size about 2.9 ha. Results show that about 41.5% of respondents qualified as adopters of which 62% had strongly emphasized on the need to continue using improved cashew technologies in all subsequent farming activities.

In most cases the social networking and increasing interactions among rural people such as group gathering and meeting at social events had effectively facilitated exchange and sharing of cashew technologies as contended by 17% of the respondents who appreciated the role of model farmers in technology dissemination and their final adoption by the farming communities.

In this study it was found that, cashew nut from improved cashew materials have better qualities acceptable at domestic and international market compared to local cashew nuts that are less competitive and require a lot of sorting and grading. This was proudly mentioned by cashew farmers who have benefitted much after adopting improved cashew materials. However, low adoption of improved cashew materials was associated with risks and uncertainty of the life span and growth performance of grafted cashew materials and top-worked trees, and complex nature of their care and management.

On the other hand, production constraints limiting adoption of improved cashew technologies were extensive prevalence of insect pests and cashew diseases, untimely and inadequate supply of subsidized inputs including motorized spraying machines, inefficient marketing system, delay payment to cashew farmers, poor loan/credit facilities and low producer price offered to cashew farmers. These were disincentives to small scale producers who are key players in the cashew industry, and hence negatively impacted adoption of improved cashew technologies.

5.2 Recommendations

Based on the analysis presented in chapter four, a number of recommendations have been highlighted. Those recommendations respond to both constraints and opportunities and have been discussed briefly below. Their implications to research, extension and policy have been elaborated.

Improve accessibility and affordability of improved planting materials of cashew

This certainly calls for a more concerted effort by the Local Government to have a strong campaign to develop rehabilitation and upgrading plan and encourage farmers to plant more cashew trees using improved cashew varieties/clones to replace old and low yielding cashew trees. Establishment of cashew nurseries at village or ward level is another area worthy of consideration. Nuts of high quality and standard would increase their marketing opportunities unlike local types that are less competitive and require more sorting and grading.

Additionally, NARI should strive to promote cashew production and management practices through mass media such as Radio, TV, books, leaflets, seed fair and booklets.

These will increase awareness of recommended cashew technologies among rural communities.

Improve accessibility and affordability of cashew inputs

Policy-makers should create favorable environment for provision of cashew inputs on time. Concerted efforts should also be done by the government and other interested stakeholders to sensitize and encourage farmers to join SACCOS, Village Community Banks (VICOBA) or register as primary cooperative members. This will enable them to get inputs and credit sourced via AMCOS and other related institutions.

Develop effective linkages between farmers and stakeholders

Policy-makers should take steps to streamline and strengthen the linkages between cashew farmers and service providers and purchasers of agricultural produce through telecommunication facilities. This will create a win-win situation and enable farmers to receive timely market information.

Improvement on the rural-urban linkages is also important to reduce production costs. Also, platform meetings of cashew value chain players at regular intervals would expose stakeholders to each other and strengthen exchange of ideas and ways forward.

Improve the capacity building of key stakeholders

These calls for the district to put in place an adequate and sustainable funding mechanism to support extension and farmer training and also need to strengthen the collaboration between extension personnel and researchers.

The government should support research in cashew activities

As more efficient methods and procedures of multiplying improved planting materials is developed by research using biotechnology (Tissue culture, trans-genetics or micro-propagation) to meet the increasing demand of planting materials, there is a need for the government to allocate more funds to enable researchers undertake sound and effective research aiming at boosting the national economy. On the other hand, research should put more effort on identifying technologies that are most cost-effective in small holdings. For example the problem of PMD, leaf and nut blight and helopeltis bugs need to be addressed by researchers perhaps by developing hybrid cashew clones resistant to common insect pests and cashew diseases. Likewise, development of eco-friendly packages for insect pests and diseases control in cashew will reduce overdependence on chemical control methods. Strategies such as integrated pest management (IPM) and use of botanicals that have been proved in research and experience will result to reduction of production cost. A breakthrough with these two last options would enable production of organic cashew and will greatly maximize farm profit. This will mark the beginning of a "green revolution" to the cashew industry.

The government should create enabling environment to encourage investors

With current increase in cashewnut production, policy-makers should create enabling and conducive environment that will attract investors to establish processing industries. Increased number of processing factories will create competition among buyers: eventually farmers would get a reliable farm gate price of raw nuts which will be an incentive to growers.

Improve access to Micro-credit

It is time the government should take initiative to introduce Agricultural Development Bank (ADB) that would provide credit and financial services to small farmers. Alongside, farmers should be encouraged to form groups since many lending institutions are more willing to support or channel credit through thrift groups (economic groups) rather than individual farmers.

Formation of Cashew Farmer Associations or Federations (FCF)

Cashew farmers should be mobilized to form association or federation to enable them become part-owner and engage in sensible dialogue with the rest of society through their representative organization structured from grass-root level as their legitimate voice. Small farmers, being generally less educated, are often serviced by agencies which exploit their lack of knowledge. According to International Federation of Agricultural Producer farmers' voice can be obtained through farmers' organization and it is through this organ farmers would have collective bargaining on issues related to cashew value chain (IFAP, 1993). This is in line with the Ministry of Agricultural Food Security and Cooperative (MoAFC) (1995) emphasizing on the need of farmers to form organization for easy extension services, input delivery and marketing.

The government should amend tenancy laws

Policy-makers should re-examine the tenancy laws with a view to increase its accessibility and affordability to the landless and near-landless to lease or acquire land. With tenancy becoming legalized and formalized, tenants can provide documentary-proof to financial institutions and procure loans. This will motivate and encourage more farmers to invest in tree projects like cashew farming which normally have long pay-back periods.

REFERENCES

- Anandajayasekeram P. and Martella, D. R. (1996). Conceptual framework to assess the Impact of agricultural research. *Journal of Agricultural Economics and Development* 1(1): 3 – 19.
- Adeola, R. G. (2010). Influence of Socio-Economic Factors on the Adoption of Soil Conservation Measures in Ibadan/Ibarapa Agricultural Zone of Oyo State. Report and Opinion 2010; 2(7)
- Adesina, A. A., Mbila, D., Nkamleu, G. B. and Endaman, D. (2000). Economic analysis of the determinants of adoption of alley farming by farmers in the forest zone of South West Cameroon *Agriculture, Ecosystems, Environment and Cooperative, Dar-es-Salaam, Tanzania*. 80:255-265.
- Ajayi, M.T and Okunlola, J.O (2006). Farmer's Perceived Agricultural input factors influencing adoption and Production of food crops in Akere Area of Ondo State, Nigeria. *Global Approach to Extension Practices*. 2(1); 1-8.
- Ajzen, I. and Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice Hall.
- Alene, A. D., Poonyth, D. and Hassan, R.M. (2000). Determinants of adoption and intensity of use of improved maize varieties in the Central Highlands of Ethiopia: A Tobit analysis. *Agrekon*. 39 (4)

Amani H.K.R (2005). Making agriculture impact on Poverty in Tanzania: The case on non-traditional Export crops. Paper Presented at a Policy Dialogue for Accelerating Growth and Poverty Reduction in Tanzania, Held at ESRF, Dar es Salaam, 12th May 2005.

Ashimogo, G., Mlozi, M. and Silayo, V. (2008). Cashew Profitability Analysis and Projection of the Sector's future performance in Kenya, Malawi, Mozambique and Tanzania. BACAS Consultancy Financial Report presented to PEA, Common Fund for Commodities, Regional Cashew Improvement Network of Eastern and Southern Africa -Mtwara, Tanzania.

Asiabaka, C., Morse, S. and Kenyon, L. (2001). "The Development, Dissemination and Adoption of Technologies Directed at Improving the Availability of Clean Yam Planting Material in Nigeria and Ghana in Asiabaka.

ARIN, (2007-2010). Annual Cashewnut Research Reports. Ministry of Agricultural and Food Security of Tanzania. Agricultural Research Institute Naliendele, P. O. Box 509 Mtwara, Tanzania

Ayuk, E.T. (1997). Adoption of Agro forestry technology. *The case of live hedges in the Central Plateau of Burkina Faso. Agricultural Systems*, 54:189-206.

- Badrage. A., Dinpanah. G., Aboeye. F. and Sinaki. J. M. (2009). An investigation of effective Factors involved in perception of wheat farmers regarding on-farm demonstration In Isfahan Township, Iran. *American-Eurasian journal of agricultural and Environmental science*. 6(5): 616 - 624.
- Bailey. D.K., (1998). *Methods of Social Research*. Fourth Edition. The Free Press, New York. 588 pp.
- Basnayake. B.M.J.K and Gunaratne. L.H.P. (2002). Estimation of Technical Efficiency. It's Determinants in the Tee small Holding sector in the Mid Country West Zone of Sri Lanka. *Journal of Agricultural Economics* 4: 137 -150
- Batz. F. J., Peters. K.J and Janssen. (1999). The influence of technology characteristics on the rate and speed of adoption. *Agricultural Economics* 21(2): 121-30.
- Bekele, Sand Holden. S (1998). Resource degradation and adoption of land conservation Technologies in the Ethiopian Highlands. *A case study in Andit'Id, North Shewa. Agricultural Economics* 18:147-233.
- Benor, D., Harrison. I. Q and Barter. M. (1997). *Agricultural Extension: Training and Visiting System*. Washington, D.C: the World Bank

- Birner, R. and Anderson, J.R. (2007). How to make Agricultural Extension demand-driven? The case of India's Agricultural Policy. IFPRI Discussion Paper 00729. Washington, D.C. International Food Policy Research Institute.
- Borlaug, N. (1992). Small-scale Agriculture in Africa: The myths and realities. Feeding the Future. *Newsletter of the Sasakawa Africa Association*, 4, 2
- Boserup, E. (1993). The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure. Earthscan Publications, London. 124pp.
- Brown, L.C., Minja, E. and Hamad, A.S. (1984). Cashew Production in East Africa. Paper Presented at the Conference, *Advancing Agricultural Production in Africa*, Arusha, Tanzania.
- Byerlee, D. (1998) "Agricultural Extension and the Development of farmers' Management skills". In J. Howel (ed), *Training and Visit Extension in Practice*. Agricultural Advisory Unit. Occasional Paper 8; ODI: London, pp8 - 27
- Cashewnut Board of Tanzania Procurement records (2005). National Cashewnut Production From 1945 to 2005 (000 tons).
- Chambers, R. (1989). Reversals, institutions and change. In Chambers, R., Pacey, A. and Thrupp, L. Eds (1989). *Farmer First, Farmer Innovation and agricultural research*. Intermediate Technology Publications. ISBN 1 85339 007 0

- Chambers, R (1994). Forward. In. Scoones, I. and Thompson, J., eds. (1994) *Beyond Farmer First. Rural people's knowledge, agricultural research and extension practices*. Intermediate Technology Publications. ISBN 1 85339 250 2
- Chamber, R (1994) Forward. In. Scoones, I. and Thompson, J., eds. (1994) *Beyond Farmer First. Rural people's knowledge, agricultural research and extension practices*. Intermediate Technology Publications. ISBN 1 85339 250 2
- Chaves, B. and Riley, J. (2004). Determination of factors influencing integrated pest Management adoption in coffee berry borer in Colombian farms. *Agriculture, Ecosystems and Environment* 87: 159-177.
- Chayanov, A.V. (1966). In *The Theory of Peasant Economy*, Eds Daniel Thorner, Basile Kerblay and R.E.F Smith. Homewood, Illinois: Richard Irwin for the American Economic Association.
- CIP. (1993). Results of planning workshop for 1994-1996 periods for cashew development. Mtwara, 22-26 November, 1993. Ministry of Agriculture, Agricultural Research Institute Naliendele, P.O.Box 509, Mtwara, Tanzania
- Croxford, A.E. (2006). A molecular study of the breeding system of cashew (*Anacardium occidentale* L.) in Tanzania. PhD Thesis, University of Reading, UK

- Davis, K. (2010). Impact of Farmer field school on Agricultural Productivity and Poverty in East Africa. IFPRI Discussion Paper 00992. Washington, D.C International Food Policy Research Institute.
- Derpsch, R. (2008a). No-tillage and Conservation Agriculture: A Progress Report. In: No-Till Farming Systems (Goddard, T. *et al.*, Eds.), pp. 7-39. WASWC Special Publication No. 3, Bangkok
- de Waal, D, (1997). *The integrated Cashewnut Management Village Workshops-December 1995*. Government of Tanzania. ODA/DRT Cashewnut Research Project, ARI Naliendele, Mtwara, Tanzania
- Duvel, G.H (1975). The Mediating function of Perception in Innovation-decision. *South Africa Journal of Agricultural Extension* 4.25-38
- DTIS. (2005). Tanzania Diagnostic Trade Integration Study. Cashewnut Report. Volume 2. Economy of Tanzania from Wikipedia. the free encyclopedia Tanzania Mining History Tanzania gold. Site visited on 17/7/2012
- Ellis, F. (1980). A Preliminary Analysis of the Decline in Cashewnut nut Production, 1974-1979: Causes, Possible Remedies and Lessons for Rural Development Policy. Economic Research Bureau, University of Dar-es-Salaam, Tanzania.

- Evenson, R.E. and Gollin, D. (2003) Assessing the Impact of the Green Revolution: 1960-1980, *Science*: 300: pp 758-762.
- Farming System Research (FSR) unit (1992). Diagnostic Survey Report of farming systems Zone 8. Mtwara, Tanzania. ARI –Naliendele
- Fealy, S., Pezeshkiraal, Gh. and Chizari, M. (2007). Investigating Effectiveness of Wheat Consultants Services in Tehran Province. *International Journal of Agricultural Extension Education*. 2007. 31: 73 - 83
- Feder, G. Just, R.E and Zilberman, D. (1985). Adoption of Agricultural innovations in Developing countries: *A survey on Economic Development and Cultural Change* 33(2): 255-297.
- Feder, G. and Slade, R. (1984). The acquisition of information and the adoption of the technology. *American Journal of Agricultural Economics* 66(3): 312-320.
- Feder, G. and O'Mara, G. (1981). Farm size and the diffusion of green revolution technology. *Economic Development and Cultural Change* 30:59- 76.
- Feder, G. and Savantano, S. (2006). The Role of Opinion Leaders in the Diffusion of new Technology: The case of Integrated Pest Management. World Bank Policy Research Working Paper 3916: World Bank Washington D.C

Fisher, D. K., Norvell, J., Sonka, S. and Nelson, M. J. (2000). 'Understanding technology Adoption through system dynamics modeling: implication for agribusiness management'. *International Food and Agribusiness Management Review*, vol. 3, no. 3, pp. 281-296.

Fishbein, M and Ajzen, I (1975). *Belief, Attitude, Intention and Behavior - An introduction to theory and research*, Addison-Wesley Publishing Company, USA.

Fliegel, F. C. and Kivlin, J. E (1962). 'Farm practice attributes and adoption rates'. *Social Forces*, vol. 40, no. 4, pp. 364-370.

Foster A. M and Mark, Rosenzweig. (2010). "Microeconomics of Technology Adoption" *Annual Review of Economics*, 2: 395 – 424.

Green I.F.R. (2005). *The Emancipatory Potential of a New Information System and its Effect on Technology Acceptance*. Dissertation Submitted in partial fulfillment of the requirements for the degree: M.Com (Informatics) Faculty of Economic and Management Sciences University of Pretoria

Gregor, S., and Jones, K (1999). Beef producers online: Diffusion theory applied. *Information Technology and People*, 12(1), 71-85.

IFAP (International Federation of Agricultural Producer), 1993. *The Role of Farmers and Farmers' Organization*. Mediterranean Committee. Second Session, Cairo, Egypt, April 1993. Proceedings

- Jabbar, M. A., Beyene, H., Saleem M. A. M. and Gebreselassie, S. (1998). *Adoption Pathways for new Agricultural Technologies; an Approach and an Application to Vertisol Management Technology in Ethiopia*. Research Working Paper No. 23. Livestock Policy Analysis Project. International Livestock Research Institute (ILRI). Addis Ababa, Ethiopia
- Jackson, E.L, Quaddus, M., Islam N. and Stanton J. (2006). Hybrid Vigor of Behavioral Theories in the Agribusiness Research Domain. Is It Possible? *Journal of International Farm Management Vol.3, No.3 - July 2006*
- Johnson, D. (1973). The Botany, Origin and Spread of the Cashewnut *Anacardium Occidentale* L. *J Plantation Crops* 1: 1-7.
- Kafiriti, E.A. (2010). Integrated Management of Major Insect Pests and Diseases of Cashewnut in East and West Africa. Farmers Information's Sources and Communication Pathways in Cashewnut Production and Marketing in Tanzania. Proceedings of Stakeholders Workshops, NARI Mtwara-Tanzania 4th May 2010.
- Kaguongo, W, Staal, S.J., and Ackello-Ogutu, C. (1997). Risk with intensification of Kenyan smallholder dairying. In: Proceedings of the Poster Paper Presented at XXIII International Conference of Agricultural Economists, 10 - 16 August, Sacramento, CA.

- Kassam, A. H., Friedrich, T., Shaxson, F. and Pretty, J. (2009). The spread of conservation agriculture: Justification, suitability and uptake. *International Journal of Agricultural Sustainability* 7(4): 1-29.
- Kasuga, L.J.F. (2003). Adoption of improved cashew (*Anacardium occidentale* L.) by smallholders in South Eastern Tanzania PhD dissertation. University of Reading UK. Chapter 9. 189pp
- KedirB. (1998). The role of SG2000 Project Credit System in The Adoption of Wheat Technologies by Smallholder Farmers in Ethiopia. The Case of Hetosa District. M.Sc. Thesis Sokoine University of Agriculture, Morogoro, Tanzania
- Kothari, C.R. (2009). *Research Methodology: Techniques* New Age International Publishers Limited New Delhi: 288pp.
- Kristjanson, P. M. (1987). The role of information and flexibility in small farm decision-making and risk management: evidence from West African semi-arid Tropics. University of Wisconsin, Madison, WI
- Lamboll, R.J. (1991). Review of FSR and FSR Activities in the Southern Zone, Tanzania. ARI- Naliendele, Mtwara, Tanzania.

Lele. U. (2010). Transforming Agricultural Research for Development. Paper presented at the Global Conference on Agricultural Research for Development: Montpellier, France

Lenin. V., Singh.B. and Vijayaragavan.K. (2009).Decision making by the farmers in Agricultural technology Management Agency. *Pusa-Agriscience*. 32: 79-82.

Majule. A.E., Topper. C.P. and Nortcliff. S. (1997) The Environmental effects of dusting Cashew (*Anacardium occidentale* L.) trees with sulphur in Southern Tanzania. *Tropical Agriculture* 74, No.1

Marandu. E.E., NkisangMoetil and Haika Joseph (2010).Predicting Residential Water Conservation Using the Theory of Reasoned Action. *Journal of Communication*, 1(2): 87-100 (2010)

Martin, P.J and Kasuga. L.J.F (1995). Variation in Cashewnut Tree Yields in Southeast Tanzania and the Implication for Management of Cashewnut Smallholdings *Tropical Agriculture (Trinidad)* 72 (4), 261-268

Masawe. P.A.L. and F.A. Kapinga (2011).Towards a Sustainable Cashew Industry in Tanzania. Proceeding of the Second International Cashew Conference held at Hotel Africana Kampala, Uganda, and 26th- 29th April 2009. CABI UK (In press)

- Masawe, P.A.L. (2006). Tanzania Cashewnut Cultivars. Selected Clones. Cashewnut Research Programme. Naliendele Agricultural Research institute. 1st Edition: February 2006.
- Masawe, P.A.L, Mfune, S. and Mbunda, Z. (2005). Performance of the first hybrids Developed from partial crossing between selected Clones in Tanzania. *Tanzania Agricultural and Training Newsletter* (In Press)
- Matata, P.Z., Ajayi, O.C., O'Doul, P.A. and Agumya, A. (2008). Socio-economic factors influencing adoption of improved fallow practices among smallholder farmers in western Tanzania. *International NGO Journal* Vol. 3 (4), pp. 068-073.
- Mazvimavi, K., Ndlovu, P.V., Nyathi, P. and Minde, J. I. (2010). Conservation Agriculture Practices and Adoption by Smallholder Farmers in Zimbabwe. Poster presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference. Cape Town, South Africa. September 19-23, 2010.
- Meinzen-Dick, R., Adato, M., Haddad, L., and Hazell, P. (2003). *Impacts of Agricultural Research on Poverty: Findings of an Integrated Economic and Social Analysis*. EPTD Discussion paper No. 111 and FCND discussion paper No. 164. IFPRI, Washington DC., USA
- Mitchell, J. D. and Mori, S.A. (1987). The Cashew and its Relatives (*Anacardium*, Anacardiaceae). *Memoirs of the New York Botanical Gardens*, 42: 1-76

Mittleman, J.H. and Pasha, M.K. (1997). Out from under development revisited. Changing Global Structures and the Remarking of the Third World. St. Martin's Press, New York.

Mnoney, E.E. and Mantell, S.H. (2006). Clonal Propagation of Cashew (*Anacardium Occidentale* L.) By tissue culture. *Journal of Horticultural Science and Biotechnology*. 77:649-657.

MoAFC (Ministry of Agricultural and Food Security). 1995. Participatory Demonstration and Training Extension System. Extension Task force. A. A, Ethiopia

Msuya, E. and Ashimogo, G. (2006). Estimation of Technical Efficiency in Tanzania sugar cane Production. A case study of Mtibwa Sugar Estate.

Moris, J. (1991). Extension Alternatives in Tropical Africa. *Overseas Development Institute Occasional Paper 7*. ISBN 0-85003-105-2

Mwantimwa, K. (2008). Relationship of indigenous knowledge and technological Innovation to Poverty alleviation in Tanzania. Paper presented at the IV *Globelics conference*, September 22-24, 2008 in Mexico City. 18pp.

National Bureau of Statistics (2012). *Population and Housing Census*. Ministry of Finance Dar-es-salaam. 88pp.

- Ngatunga, E.L., Cools, N., Dondeyne, S., Deckers, J.A. and Merckx, R. (2001). Soil Suitability for Cashew nut in Southern Eastern Tanzania. *The Land, Journal of International Land Use Society*, Vol.5.1: 3 -16
- Ngatunga, E.L., Cools, N., Dondeyne, S., Deckers, J.A. and Merckx, R. (2000). Buffering Capacity of cashew soils in South Eastern Tanzania. Soil Service Mtwara Project completion report. Annual report No.4/5. ARI Naliendele, Mtwara, Tanzania.
- Nkonya, E., T. Schroeder, and D. Norman "Factors Affecting Adoption of Improved Maize Seed and Fertilizer in Northern Tanzania. " *Journal of Agricultural Economics*, 48 No. 1 (January 1997):1-12.
- Northwood, P.J and Tsakiris, A. (1967). Cashewnut Production in Southern Tanzania-early Yields from a Cashew Spacing Experiment. *E. Africa. Agricultural Forestry Journal*, 33, 81-82.
- Obeta, M.E. and Nwagbo, E.C. (1991). "Adoption of Agricultural Innovation in Nigeria". A case Study of improved IITA. Access to Technology Package in Anambra State.
- Okunyenye, P.A. (1986). Farmers' production behaviour and agricultural labour productivity in Nigeria Social Change. *Journal of the Council for Social Development* 16 (4): 12 – 19.

- Phillips, E. and Gray, I. (1995). Farming Practice as Temporally and Spatially Situated Intersections of Biography, Culture and Social Structure. *The Australian Geography* 26. 127 – 132.
- Putler, D.S. and Zilberman, D. (1988). Computer use in agriculture: Evidence from Tulare County, California. *American Journal of Agricultural Economics*, 70:790–802.
- Quinones, M., Foster, A.M., Akibo-Betts, D. and Siciliana, N.P. (1992). Transferring Improved Production Technologies to small-scale farmers: Methodology used by Sasakawa-Global 2000 in Africa. In: Ekpere, J.a. Rees, D.J Mbwire, R. P and Lymo, N.G. (eds) *Proceedings of an International Conference on Agricultural Research, Training and Technology Transfer in the Southern Highlands of Tanzania. Past Achievements and Suture Prospects*. 5-9 October 1992. Mbeya, Tanzania.
- Rahm, M.R. and Huffman, W. (1984). The adoption of reduced tillage: the role of human capital and other variables. *American Journal of Agricultural Economics* 66: 405-413.
- Romanthan, K. (2007). The role of technology transfer services in technology capacity building and enhancing the competitiveness of SMEs Mongolia National Workshop on Sub national Innovation System and Technology Capacity-building Policies to Enhance Competitiveness of SMEs Organized by UN-ESCAP and ITMRC (Mongolia). Ulaanbaatar, Mongolia, 21 -22 March

- Rasouliazar, S. and Fealy, S.(2008). Factors affecting in farm management skills of wheat consultants in Iran.*Factors in Journal of Extension and Agricultural Economics*, 1(4): 45 – 54
- Reddy, G.P. (2006).Assessment Strategic Research Extension Plan (SREP). Methodology for up scaling and institutionalization of R-E-F linkage. Paper presented at the Agricultural Economists Conference, Gold Coast, Australia.
- REPOA, (2007).Research on Poverty alleviation. Tanzania Cashewnut Situation Analysis
- Rivera, W.M. (2006). Enabling Agriculture: The evolution and promise of Agricultural Knowledge frameworks. In Proceedings of the Association for International Agricultural and Extension Education: ed J.R Vreyens. AIAEE 22nd Annual Conference. Clearwater Beach, Florida, USA.
- Rogers, E.M. (2003). Diffusion of innovations (5th Ed). New York: Free Press.
- Schultz, T.W. (1961).Investment in human capital.*American Economy Review* Vol.51.*March*, pp.1-7
- Sahin, I. (2005). Understanding faculty adoption of technology using the Learning/adoption trajectory model: *A qualitative case study*. *The Turkish Online Journal of Educational Technology–TOJET* January 2005 ISSN: 1303-6521 volume 4 Issue 1 Article 10.

- Scoones, I and Thompson, J.(ed.)(1994). Knowledge, power and agriculture - towards a theoretical understanding.In, Scoones, I and Thompson, J., Eds (1994).*Beyond Farmer First: Rural Peoples' Knowledge, Agricultural Research and Extension Practice*.IntermediateTechnology Publications.SBN 1 85339 250 2
- Shomari, S.H. (1998). Research Impacts on Cashewnut Development: Experiences from Tanzania. *A Paper presented at the Cashewnut Production Workshop in Maputo Mozambique, August 26.*
- Sijaona, M.E.R., Reeder, R.H. and Waller.J.M. (2006). Cashewnut leaf and nut blight. New Diseases of cashew (*Anacardium occidentale*) in Tanzania caused by *Cryptosporiopsis* spp <http://www.bsapp.org.uk/ndr/jan 2006/2005-75: asp>.
- Sijaona, M.E.R and Mansfield, J.W. (2001). Variation in the response of Cashew genotypes to the Targeted application of fungicides flower panicles for control of powdery mildew diseases. *Plant Pathology*, 50: 244- 248
- Sijaona, M.E.R and Shomari.S.H. (1987).The Powdery Mildew Diseases of Cashew in Tanzania.TARO Newsletter, 11 (30:4-6).
- Sijaona, M.E.R (1984). Investigation into effectiveness of Sulphurwipes against *Oidium anacardii* Noak on Five Cashew tree types at Naliendele. *Rivista di Agricoltura Subtropicale e Tropicale*, 78:199-209.

- Sikana, P. M., (1998). Socio-economic assessment of the Integrated Cashew Management Programme: 1994-1998. Consultancy Assignment from the Department for International Development (DFID), UK.
- Sikana, P.M. (1994). Alternatives to current agricultural research and extension systems: village research groups in Zambia. In. Scoones and Thompson (eds), *Beyond farmer First: Rural Peoples Knowledge, Agricultural Research and Extension Practice*. International Technology Publications. London.
- Sikana, P.M. (1995). The Participatory Training Consultancy on the assessment and Identification of formal and customary village institutions. P.O. Box 509, Mtwara, Tanzania.
- Sumberg, J. and Okali, K. (1988). Farmers' on-farm research and the development of new technology. *Experimental Agriculture* 24. 333-342.
- Tesfaye, T., Karippai, R. S. and Tesfaye, T. (2010). Farmers training effectiveness in terms of Changes in knowledge and attitude: the case of Holeta, Melkassa and DebreZeit Agricultural research centers, Ethiopia. *Journal of Agricultural Extension and Rural Development*, 2(5):89-96.
- Thisted, R.A. (2006). The Cross-Sectional Study: Investigating Prevalence and Association Department of Health Studies and Statistics University of Chicago.

- Topper, C.P., Martin, P. J., Katinila, N., Kikoka, L.P., Lamboll, R., Masawe, P.A.L. and Shomari, S.H. (1998). The historical and institutional background of the Tanzania Cashew industry. 76-83 In: Topper C.P. *et al.* eds. (1998e) *Proceedings of the International Cashew and Coconut Conference: 17th to 21st February 1997*, Dares-Salaam, Tanzania.
- Topper, C. P. and Kasuga, L. J. (Eds.) (2003). Knowledge transfer for sustainable tree crop development: A case history of the Tanzanian Integrated Cashew Management Programme. Published by Biohybrids Agrisystems Ltd, PO Box 2411, Reading, RG6 5FY, UK. ISBN Number 9545192- 0-5.
- TNBC (Tanzania National Business Council). Proceeding of Ten Pillars of Kilimo Kwanza Resolution held on 2 - 3 June, 2009 at Kunduchi Beach Hotel, Dar-es-salaam to discuss Transformation of Tanzanian agriculture under the theme "KILIMO KWANZA".
- UNIDO (2011). Tanzanian's Cashew Value Chain: A diagnostic. United Nation Industrial Development Organization (UNIDO). Vienna, Austria.
- United Republic of Tanzania.(2007).The National Strategy for Growth and Reduction of Poverty (NSGRP) and Human Development Report.Vice President's Office Dar-es-Salaam.
- United Republic of Tanzania,(1983).The Agricultural Policy of Tanzania. Ministry of Agriculture, Government Printer, Dar-es-Salaam, Tanzania

United Republic of Tanzania.(1997).The Agricultural and Livestock Policy of Tanzania.
Ministry of Agriculture and Cooperatives. Dar-es-Salaam. Tanzania. 163 pp

Vanclay, F. and Laurence. G. (1995). The environmental imperative eco-social Concerns
for Australian agriculture' (Central Queensland University Press:
Rodehampton. Australia.

Van den Ban and A.W. Hawkins (1998).Agricultural Extension. Second Edition
Blackwell Science. the Netherlands. 249pp.

Van den Ban. A.W. and Hawkins, H. S. (1996).*Agricultural Extension*. Second Ed.
Blackwell Science. ISBN 0-632-04053-X

Van den Berg, H.. and Jiggins.J. (2007).Investing in farmers.*The impact of farmers' field
School in relation to integrated Pest Management*: World Development 35(4):
663-686.

Wandji, N., Binam, N., Mva. J.M and Gockwski, J. (2007).Assessing Political Impact of
Farmer Filed School Training on Perennial Crops in Cameroon:
AAAEConferenceproceedingssp.255-257

WorldBank (1998).National *Agricultural and Livestock Extension Rehabilitation Project
(NALERP) Implementation Report, May 1998*.Agriculture Operations. Eastern
and Southern Africa Department. World Bank.

APPENDICES

APPENDIX 1: Sample size calculation

The following formula was employed to determine the sample size.

Mtwara district has a total population of 228 003 according to 2012 population and housing census (NBS, 2012). The total population for each sampled village is indicated in appendix 2.

Therefore, the formula for calculating the sample size to select from a big (more than 10,000) or unknown population is:

$$n = \frac{Z^2 P (1 - P)}{d^2}$$

Where:

n = Sample size when population is greater than 10 000

Z = Standard normal deviate, set at 1.96 (in simple at 2.0) corresponding to 95% confidence level

P = Proportion in the target population estimate to have particular characteristics:

If not known use 50%

q = 1.0 - P

d = Degree of accuracy desired, set at 0.05 or 0.02

Therefore, the sample size will be

$$\begin{aligned}
 n &= \frac{Z^2 P (1 - P)}{d^2} \\
 &= \frac{(2)^2 (0.5 \times 0.5)}{(0.05 \times 0.05)} \\
 &= \frac{4 \times 0.25}{0.0025} = \frac{1}{0.0025} = 400 \text{ respondents}
 \end{aligned}$$

In this study, 50% of the calculated sample size was picked using a simple random technique. The sample size was supposed to be large enough due to the dispersion factor and heterogeneous nature of the farming community. In a situation of low rate of technology adoption, a large sample size will guarantee possibility of getting representative farmers both adopters and non-adopters of improved cashew technology. This reduced random errors and increased the validity and precision of the study (Bailey, 1998).

APPENDIX 2: Selected villages for adoption study

Villages and number of households selected for adoption study

Village	Total Population	Household number	Respondents		
			Male	Female	Total
Dihimba	2075	431	10	1	11
Namgogoli	1791	466	13	0	13
Imekuwa	1886	402	10	1	11
Nanyamba	5749	1194	32	0	32
Mwang'anga	2000	468	12	1	13
Milango-minne	1519	351	10	0	10
Mbawala	2041	364	10	0	10
Namtumbuka	2430	721	15	3	18
Kitama-Bondeni	1513	470	12	0	12
Nitekela	2680	570	14	0	14
Makome	1728	536	12	1	13
Mtimbwilimbwi	2729	725	17	1	18
Chikwaya	2800	500	8	4	12
Kitaya	1698	550	13	0	13
Total	32639	7748	188	12	200

APPENDIX 3: Questionnaire for adoption study

Questionnaire for the survey to assess adoption of improved cashewnut production technologies by smallholder farmers in Mtwara District of the South Eastern Tanzania

A questionnaire to be administered to household head

Questionnaire NO/CODE

GENERAL INFORMATION

Date:.....Name of Enumerator interviewer.....

Region:.....District.....Division.....

Ward.....Village.....Sub-Village.....

SECTION I BASIC INFORMATION

- 1.1 Name of respondent.....
- 1.2 Age of household head.....Years
- 1.3 Sex of respondent: 1. Male [] 2. Female []
- 1.4 Marital Status: 1. Single [] 2. Married [] 3. Divorced []
4. Widowed []
- 1.5 Level of Education in years
1. Informal Education [] 2. Primary []
3. Secondary [] 4. Post-secondary (Specify)[]
- 1.6 Number of years of schooling(Years)
- 1.7 Indicate Household size and labour productivity.**
- 1.7.1 What is the number of household member in your family.....
- 1.7.2 What is the number of active labor in your household?

1.7.3 Do your family members provide enough labor for agricultural production activities?

1. Yes [] 2. No []

1.8 If no, how do you cope during labour peak?

1. Your own manpower []
2. You and your family []
3. Hire laborers []
4. All of the above []
5. Reduce crop area []

1.9 Do you undertake any other income earning activities apart from agriculture?

1. Yes [] 2. No []

If yes, what are the other sources of income? Mention in order of importance.

1.9.1 Sources of income	1.9.2. Rank	1.9.3 Amount of income earned per annum
1. Carpentry		
2. Sewing		
3. Masonry		
4. Sale Livestock products		
5. Crop sale		
6. Shop/ kiosk business		
7. Food processing		
8. Charcoal making		
9. Herbalist /traditional practitioner		
10. Mechanical (motor-cycle)		
11. Fishing		
12. Tin smith		

SECTION 2 CROPS GROWN, LAND OWNERSHIP AND INCOME

2.1 Provide information on crops grown, land ownership and income earned for each crop Listed during the last season

S/N	2.1.1 Crop planted	2.1.2 Total Amount harvested	2.1.3 Size or area devoted to the farm/crop (Acre)	2.1.4 Main purpose of the crop 1. Food 2. Cash 3. Both 1&2 4. Livestock 5. All of the above	2.1.5. 1. Monetary value of the crop harvested
1.					
2.					
3.					
4.					
5.					
6.					

2.1.6 Is it possible to get additional land or increase farm size in your area?

1. Yes [] 2. No []

SECTION 3 GENERAL INFORMATION ON CASHEW MANAGEMENT AND PRODUCTION ACTIVITIES

3.1. Indicate Years of experience in cashewnut production activities

a) ≤ 5 years [] b). 5-10 years [] c). 10-20 years []
d). 20-30 years [] e). ≥ 30 years []

3.2 Are you aware of improved planting materials of cashew?

1. Yes [] 2. No []

3.3 If No, Why

- i.
- ii.
- iii.

3.4 Have you ever used improved planting materials of cashew in farming activities?'

1. Yes [] 2. No []

3.4.1 If No, Why

- i.
- ii.
- iii.
- iv.

3.5 Provide details for the following cashew production activities

S/ N	3.5.1 Details	3.5.2 Improved cashew trees	3.5.3 Local cashew trees
1	Total number of cashew trees owned		
2	Source of ownership of cashew trees 1. Inheritance 2. Planted by myself 3. Purchased 4. 1 & 2		
3	Indicate type of planting material used 1. Polyclonal seed 2. Grafted cashew seedlings 3. Both 1 & 2 4. Local		
4	Indicate methods of acquisition of improved cashew planting materials 1. Bought 2. Given free 3. Loan 4. Farmer's own material		
5	If bought indicate price of polyclonal seed		

6	Indicate price of grafted cashew seeding		
7	Indicate year of planting		
8	Did you use row planting? (recommended plant spacing) 1. Yes 2.No		
9	If yes, what planting spacing did you adopt? a) 12m x 12m b) 14m x 14m c) Any between 12m –16m		
10	If recommended planting space was no used, Why? i. ii. iii. iv. v.		
11	How is the cashew trees distributed in your farm? i. Evenly distributed (adequately spaced) ii. Overcrowded (closely spaced) iii. Both (i) & (ii) iv. Others (specify) / Randomly		
12	What is the cropping pattern used 1. Pure stand (Mono-cropping) 2. Inter-cropping		
13	If he/she has intercropped, name those crops i. ii. iii. iv. v.vi.		
14	Indicate average age of cashew trees in your farm 1. Young/developing ≤ 8 years 2. Middle aged 9 – 25 years 3. Old/aged ≥ 26 years		
15	Do you know any cashew disease? 1. Yes 2. No If yes; name important cashew diseases you experience in your farm. a) b) c)		

16	If you don't know, Why? a) b) c)
17	Does the farmer know the causes of the diseases? 1. Yes 2. No What are the signs/ symptoms of attack for the diseases i. ii. iii. iv. v.
18	What are the control strategies for the disease i. ii. iii. iv. v.
19	Did you use (chemicals) fungicide to control the diseases 1. Yes 2. No Name fungicide used to control the diseases a) Bayfidan (liter) ii. Mupavin (liter) iii. Mupafidan (liter) iv. Powershot (liter) v.Sulphur dust (kg) vi. Kumulus (kg) vii. Falmeno (liter) viii. Defender (liter)
20	Indicate total price and amount of fungicide used in kilogram or liter a) Amount bought kg/liter..... b) Amount used kg/liter..... c) Price per kg/liter.....
21	Indicate number of application rounds for the fungicide 1. One round 2 Two rounds 3. Three rounds 4. Four rounds 5. Five rounds 6. More than five rounds
22	Indicate the spraying interval for the fungicide a) 14 days b). 21 Days c). Less than 14 days d) More than 21 Days
23	Indicate total number of cashew trees treated with fungicide.....

24	<p>Do you know any insect pest of cashew? 1. Yes 2. No</p> <p>If yes: name important cashew pests you experience in your farm.</p> <p>a) Insect pest 1:</p> <p>b) Insect pest 2:</p> <p>c) Insect pest 3:</p> <p>d) Insect pest 4:.....</p>
25	<p>If you don't know cashew insect. Why?</p> <p>a)</p> <p>b)</p> <p>c)</p>
26	<p>Does the farmer know the signs/symptoms of insect pest attack on cashew tree? 1. Yes 2. No</p> <p>If yes, what are the signs/symptoms of attack on cashew</p> <p>i.</p> <p>ii.</p> <p>iii.</p> <p>iv.</p> <p>v.</p>
27	<p>What are the control strategies for the insect pest?</p> <p>a)</p> <p>b)</p> <p>c)</p> <p>d)</p>
28	<p>Did the farmer use (chemicals) insecticide to control the insect pest? 1. Yes 2. No</p> <p>If yes, name insecticide used to control the pest</p> <p>i. Karate (liter) ii. Helarat (liter) iii. Selectron (liter) iv. Duduall (liter) v. Ninja</p>
29	<p>If the farmer did not use insecticide to control pests in cashew, what are the reasons</p> <p>a)</p> <p>b)</p> <p>c)</p>
30	<p>Indicate total amount of insecticide used in liter.....</p>
31	<p>Indicate number of application rounds for the insecticide</p>

	1. One round 2 Two rounds 3. Three rounds 4. Four rounds 5. Five rounds 6. More than five rounds
32	Indicate the spraying interval for the insecticide a) 14 days b). 21 Days c).Less than 14 days d). More than 21 Days
33	Indicate total number of cashew trees treated with pesticide.....
34	Did you get assistance from VAEO in carrying out various farm and cashew production activities? 1. Yes 2. No
35	If yes, indicate frequency of contact with VAEO on yearly basis 1. 2. 3. 4.
36	Do you practice weeding in your cashew farm? 1. Yes 2. No
37	If yes, indicate the method of weeding in your cashew farm 1. Hand-hoe / tilling 2. Herbicides 3.Slashing
38	Indicate method of weeding coverage in your cashew farm 1. Whole farm weeding 2. Ring weeding
39	Indicate the frequency of weeding in your cashew farm 1. Ones per season 2. Twice per season 3. Thrice per season 4. Others
40	Do you prune your cashew trees 1.Yes 2. No If No, why a) b) c) d)
41	If yes at what period of the year a) November - January b). February - April c).May - June.
42	What is the pruning interval for your cashew trees? a) One year b). Two years c).Three years d). Every year e). No specific time interval
43	Do you practice thinning in your cashew farm? 1.Yes 2.No

44	If No why? a. b. c.
45	Do you fill the gaps? 1. Yes 2.No If No why a. b. c.
46	Have you established fire break for your cashew farm? 1. Yes 2. No If No why a. b. c.
47	Indicate sources of improved cashew material in your farm 1. NARI/CDCs 2. Extension Services 3. NGOs 4.CBOs 5. Friend/ other farmers

Farmers' opinion, attitude and perceptions towards improved cashew planting materials

(Reasons for use of improved cashew planting materials)

3.6 What are the reasons for planting improved cashew materials in your farm?

- i.
- ii.
- iii.
- iv.

3.6.1 What are the reasons for planting local cashew materials in your farm?

(Reasons for non- use of improved cashew planting materials)

- a)
- b)
- c)
- d)
- e)

3.6.2 Do you own a motorized spraying machine?

1. Yes [] 2. No []

If you do not own a motorized spraying machine, indicate the following

3.6.3 What is your main source of spraying services?

- a) Used to hire []
- b) Use contract services []
- c) Use local methods []

3.6.4 What is the cost of spraying) per tree/round?

3.6.5 Are you satisfied with spraying services provided? 1. Yes [] 2. No []

3.6.6 If not, explain your dissatisfaction with spraying services (explain weakness observed with spraying service)

- a)
- b)
- c)
- d)

**SECTION 5. INFORMATION AND KNOWLEDGE ACQUISITION ON IMPROVED
CASHEW PRODUCTION TECHNOLOGIES**

5.1.1 Type of improved cashew production technology	5.1.2 Do you have knowledge or skill about this technology? (refers to column 1)	5.1.3 Indicate your main sources of knowledge acquisition about this technology 1.NARI/CDCs 2.Extension officers 3.NGOs 4.CBOs 5. Business people 6. CBT 7. Friend/other farmers	5.1.4 Will you continue to use this technology? (refers to column 1)	5.1.5 Have you ever participated on training/worksho p about this cashew nut Production technology?
Polyclonal seed and grafted cashew seedlings				
Pesticides and fungicides				
Grafting skill or technology				

5.2 Rank the effectiveness of the methods of information dissemination for the improved cashewnut production technologies. (Likert type)

1. Strongly disagree 2. Disagree 3. Undecided 4. Agree 5. Strongly agree

S/N	Methods of technology transfer for improved cashew technologies	1	2	3	4	5
1	TV/ Video-taped/ cinema enhance dissemination of information on improved cashew materials					
2	Extension officers play a crucial role in dissemination of cashew technologies					
3	Mass media /RADIO are more efficient in technology dissemination					
4	Newsprint/Leaflets are adequate in technology dissemination					
5	Friends and farmers to farmer methods in technology dissemination should be strengthened					
6	Lecture meeting (workshops and seminars) are most applicable in rural areas					
7	Agricultural show and exhibition (Name-name. seed fair) are not effective in dissemination of cashew technology.					
8	Demonstrations plots and FFS are not important in dissemination of cashew technology.					
9	On –farm Trials should not be used in technology dissemination					
10	Use of Internet in technology dissemination is not applicable in rural community					

5.2.1 Have you benefited by adopting improved cashew production technologies?

1. Yes [] 2. No []

5.2.2 Rank the major changes you have achieved after adopting improved cashewnut production technologies

1. Not achieved 2. Lowly achieved 3. Medium achieved 4. Highly achieved

S/N	Possible types of benefits/achievements	Likert type scale			
		1	2	3	4
1	Increase in quantity and quality of cashewnut yield				
2	Increase ability to cope or recover from shock / stress (reduce vulnerability).				
3	Increasing in income and assets acquisition				
4	Better understanding on agronomic and cultural practices				
5	Better understanding on insect pest and cashew diseases ecology hence timely interventions				
6.	Efficiency on use of pesticides and fungicides in controlling insect pests and cashew diseases				
7	Increased access to cashew inputs				
8	Better farm management				
9	Improved household food security				
10	Expansion of farm size				

6.3 Indicate production constraints experienced by cashew farmers

Rank cashewnut production constraint experienced during the past three years.

1. Serious problem 2. Not a serious problem 3. Minor problem 4. Major problem

S/N	6.3.1 Type of constraint	6.3.2 Rank of constraint			
		1	2	3	4
1.	Infrastructure (rural road networks)				
2.	Transport costs for the produce				
3.	Price incentives for cashew				
4.	Marketing information on cashew				
5.	High local taxes (crop levies)				
6.	Payment to cashew farmers				
7.	Price fluctuation within the same buying season				
8.	Cheating in weight at buying points				
9.	Availability of blower machine services				
10.	Insect pests of cashew				
11.	Cashew diseases				
12.	Notorious weeds e.g. (MucunaSpp = Upupu)				
13.	Timely procurement of cashew inputs				
14.	Cashewnut attacked by wild animals (vermin)				
15.	Unpredictable weather (drought)				
16.	Declining soil fertility				
17.	Shortage of land				
18.	Shortage of labour				
19.	Availability of extension services				
20.	Packing materials and Storage facilities				
21.	Theft				

SECTION 7 INSTITUTIONAL SUPPORT AND MICRO-FINANCE SERVICES

7.1 Have you ever received any formal credit loan during the past three years?

1. Yes [] 2. No []

7.1.1 If not, why not?

1.
2.
3.
4.

7.1.2 If YES, what was the form of the loan?

1. Credit (cash loan) [] 2. Input loan []

7.1.3 If credit was offered what was the amount of cash given?

1. \leq 100.000 Tsh []
2. 150.000- 500.000 Tsh []
3. 550.000 - 900.000 Tsh []
4. \geq 1.000.000 Tsh []

7.1.4 If you get input loan, what was the type of the input?

1. Planting materials []
2. Chemicals (Pesticides and fungicides) []
3. Equipment (Motorized blower machine []
4. All of the above []

7.1.5 What was the source of the loan/ credit?

- | | |
|----------------------------|--------------------------------|
| 1. Commercial Banks [] | 5. Local lending agency [] |
| 2. PRIDE Tanzania [] | 6. NGOs [] |
| 3. CBOs [] | 7. VIKOBA [] |
| 4. SACCOs [] | 8. AMCOS CPS [] |

7.2 In your opinion, what are the major challenges in adopting improved cashewnut production technologies?

- a)
- b)
- c)
- d)
- e)
- f)
- g)

7.2.1 In your opinion, what should be done to assure sustainability and continuous use of improved cashew production technologies by smallholder cashew farmers?

- a)
- b)
- c)
- d)
- e)
- f)
- g)

THE END OF THE EXERCISE

THANK YOU VERY MUCH FOR YOUR TIME AND CO-OPERATION