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MODELLING THE RELATIONSHIP BETWEEN FARMER ATTITUDE TOWARDS FARMING, AND ON FARM PRACTICE

A CASE STUDY OF SMALLHOLDER FARMERS IN TANZANIA

Msc. Social Statistics

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Declaration

This is my original work and has not been presented for any academic award at UoN or in any other University

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This project report has been submitted for examination with my approval as the University Supervisor

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Dedication

I dedicate this work to my daughter Janell Amor and my father Apollo Odongo

Acknowledgement

My greatest appreciation goes is to God almighty who gave me the wisdom, the will and the resources to undertake this masters course. Secondly I thank the University of Nairobi, School of Mathematics for allowing me to pursue my professional dream through this course. I also want to thank my employer FIT Resources for facilitating my studies by awarding me a study loan and actually paying promptly so I do not worry about fees and could concentrate on my studies. My gratitude also goes to my well able supervisor (Dr. George O Muhua, senior lecturer, School of Mathematics UoN) for dedicating his time and expertise to walk me successfully through my project work.

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Abstract

Different models have been used in analysing agricultural data to establish level of agricultural productivity given various factors including land size, use of inputs, use of extension and modern technology, labour, capital etc. A few researchers have tried to understand farmers' attitudes towards farming and how this affects their on-farm practice

A TNS Global farmers' study in Tanzania funded by Bill and Melinda Gates 2011- focused on farmer agricultural productivity using a mix of Simple Regression and descriptive analysis based on the various factors of production. Findings showed that the more the farmers spent resources appropriately on factors that affect productivity; correct use of inputs, timeliness in land preparation, planting and input application etc, the better there land productivity. But those who actually improved on-farm practice were less than 50% of the target population, yet the entire population was exposed to the same treatment by the project. This is definitely an interesting result. One would wish to understand why the success rate is that low

In this study, I have used the TNS data to try and understand if farmers' attitude towards farming has a relation with their positive change in practice which would likely increase production. I attempted extraction of attitudinal constructs using factor analysis. Factor analysis on 43 likert-scale questions about farmer's attitudes was performed in order to obtain farmers' attitudinal segments. Six factors corresponding to different themes of farmer attitudes were obtained. These are ***Information focus***, ***Negative***-don't tell me to change, status quo is safer', ***Change orientation, Passive dependence, Heritage-***'Farming is my destiny', **Resigned unhappiness**- 'No hope to improve so would prefer to be something else'. Then used regression analysis to assess the impact of various other observable variables on the attitudinal segmentation, which revealed a positive relationship between farmer attitudes and their level of agricultural productivity with the more positive, information focused farmers showing energies to perform well while the negative ones who have somewhat not very good attitude not performing very well. On average an increase in the covariates studied here reinforced positive attitudes and lowered scores for the negative attitudes. The analysis presented in this thesis forms a basis for further research into the impact different attitudes have on farmers' productivity.

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CHAPTER ONE: INTRODUCTION TO THE STUDY

1. Introduction

This chapter discusses background, the statement of the problem in relation to small-scale farmers, set the scope that this thesis will cover and outline the hypotheses of interest. Assumptions that will guide the analysis and subsequently, the interpretation of the results as well as the limitations of this study are outlined as well.

1.1 Background to the study

According to the International Fund for Agricultural Development (IFAD), there are currently about 500 million small farms in developing countries that are feeding and supporting 2 billion people, which is almost one third of humanity. These smallholders, whose main economic activity is farming, continue struggling to live modestly and feed their families due to low agricultural productivity catalysed by the many challenges they face: lack of access to land and water, financial services to buy inputs (seeds, fertilizers, tools) and markets (due to poor road infrastructure and high cost of transport). In addition to these, some are also victims of the impact of climate change (droughts, floods, land degradation) and being located in remote areas, they do not get support from research and extension services. Rising on-farm productivity also encourages broad entrepreneurial activities through diversification into new products, the growth of rural service sectors, the birth of agro-processing industries, and the exploration of new export market.

Smallholder farming is the backbone of African agriculture and food security, with over 70% of the farming population in most of African countries being smallholders. Of the two-thirds of sub-Saharan Africa's population that resides in the rural areas, the majority can be considered as smallholder farmers. Their importance derives from their prevalence, their role in agricultural and economic development and the concentration of poverty in rural areas.

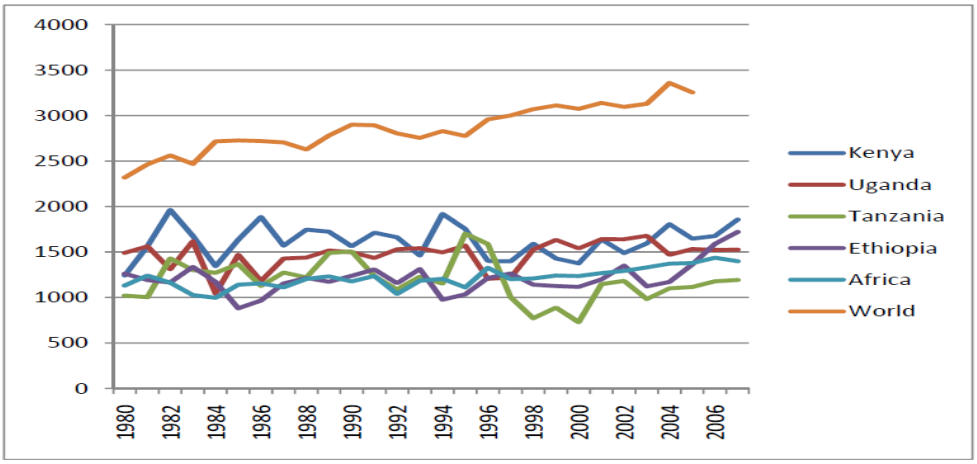
Thus, the definition of smallholders differs between countries and between agro-ecological zones. In

favourable areas with high population densities they often cultivate less than one ha of land, whereas they may cultivate 10 ha or more in semi-arid areas, or manage 10 head of livestock. Smallholders represent a large number of holdings in many developing countries and their numbers have increased in the last two decades. Evidence from the World Census of Agriculture for a small number of selected countries in Africa shows that between 1980 and 1990, the percentage of agricultural holdings of less than one hectare had increased from 50% to about 78% (FAO 1997).

The experience of four East African countries and their strategies for agricultural growth shows that technology adoption and increased access to land influence the overall productivity in different ways. While technology adoption improves productivity of all factors of production, increased access to land raises labor productivity at the expense of land productivity. Research underscore the role of economic incentives and high returns on technological adoption and agricultural innovation and most importantly farmers attitude.

The cereal yield per hectare remained virtually unchanged in all four countries during 1980 – 2007 and it is also way below the world average (Figure 2.3). It is in this context that Oxford Analytica (2009) concluded from its strategic analysis of East African agriculture that the yields of staple food such as rice and maize are only about one-half to one-third of what they could be with the proper application of fertilisers, irrigation and seeds.

Figure 2.3 Cereal Yield (kg per hectare), 1980 - 2007



Source: National Statistical Offices.

Mali is a large landlocked country with severe climatic and natural constraints. Many rural households face food scarcity in one out of three years. About 78% of the population lives in rural areas and over half the Malian people live on less than US$ 1.25 a day. Malnutrition is high with 38% children under five being stunted, according to national malnutrition statistics.

Agriculture accounts for almost 34% of the GDP. The majority of Malian farmers are subsistence-oriented: about 85% of them have less than 10 hectares of land, are poorly equipped, with poor access to credit. Forty-five percent of the population is less than 15 years old. Though the youth could be tapped, there is high unemployment, lack of training and employment support opportunities for them.
Crop yields of staples are very low due to poor soil fertility, high climate variability and rarely use improved inputs.

Tanzania has a population of 27M people. Tanzania is the second largest economy in the East Africa Community and the twelfth largest in Africa. The country is largely dependent on agriculture for employment, currently employs 77.5% of Tanzanians and contributes to 95% of food consumed in the country while providing 49% of the country's GDP (est. 1996). An estimated 34% of Tanzanians currently live in poverty. Agricultural output remains predominately based on small holder production.

Agriculture is among the pillars of the Kenyan economy, and is an important source of rural employment, food production, foreign exchange and rural incomes. The sector accounts for approximately 30% of the country’s GDP, 50% of the country’s export earnings, and 60% of total employment. Kenya is faced with a very high dependency burden with about 81% of its people depending on 19% of its population. Agriculture has been a key driver of the country’s economy for over four decades, and is the main source of livelihood for close to 80% of Kenyans in rural areas. This is according to world bank’s world development indicators and KARI report 2012 The agricultural sector in Kenya is mainly comprised of small-scale farming in areas with significant potential.

Smallholders in Kenya, Tanzania, Mali and other African counties however continue to face such challenges limited access to agricultural technology, the use of out dated technology, pests and diseases, lack of information on correct use of inputs, lack of enough capital, lack of knowledge on good agronomic practices/animal husbandry, poor market infrastructure, and climate change, culture, tradition and attitude related issues.

These challenges/factors are known to significantly limit the productivity and farm yields of farmers,

which are on average quite low.

1.2 Statement of the problem

Agriculture remains the main source of livelihood for the larger population of rural dwellers in most developing countries. It contributes to >30% of GDP in most of the developing countries. Over 70% of farming populations in most African countries are smallholders. Poor productivity remains a key challenge for smallholders as discussed in the background, with yields of staples such as rice and maize being ½ to 1/3 of potential according to World Bank. Many Interventions have tried to change this state with varied success, some changing for better while others remaining the same.

Many researchers have conducted studies and come up with very good analysis and recommendations on smallholder productivity. In most of the cases they look at productivity as a function of agricultural technology, land size, use of inputs, good agronomic practices/animal husbandry etc using various statistical models especially linear regression analysis.

A few researches have focused on farmer attitudes generally and how it influences adoption of specific practices with findings revealing farmer adoption of specific practices influenced by their attitudes. The studies however do not made attempts to understand different farmers' attitudinal profiles and how the varied profiles would affect their on-farm practice. This study seeks to understand smallholder farmers attitudes, segment farmers according to the different farmer attitudes using Factor Analysis based on Principle Component Analysis (PCA) and, evaluate the relationship between attitudinal segments and various variables or covariates of interest such as farmers' age, years of formal education, income from farming amongst others using (simple and multiple) regression analysis methodology

1.3 Objective of the study

The general objective of this study is to evaluate the relationship between farmer attitudes and their agricultural productivity.

Specifically the study seeks to:

1) To identify possible segments of farmer attitudes based on 43 Likert scale type questions using factor analysis methodology.
2) Having identified these attitudinal segments, to evaluate the relationship between attitudinal segments and various factors of interest such as farmers' age, years of formal education, income from farming amongst others using (multiple) regression analysis methodology.

1.4 Research hypotheses

Null Hypotheses (H0):

i. Farmer Attitudinal segment does not depend on education level of smallholders, farm input usage, farmer pro-activity in looking for markets, concept adoption, experience in farming, age and income from farming activity.

Alternative hypotheses (H1):

i. Attitudinal segment does not depend on education level of smallholders, farm input usage, farmer pro-activity in looking for markets, concept adoption, experience in farming, age and income from farming activity.

1.5 Significance of the study

This study is able to inform all organizations working on increasing agricultural productivity on how to structure their intervention strategies so that they are successful, where success means increased production among smallholders. In so doing, stakeholders can focus on the factors that would actually impact on productivity significantly.

1.6 Scope of study

The data used was from a national survey focusing on small holder farmers in Tanzania which has smallholder farmer profile similar to Kenya. This means that the outcomes and recommendations of this study can be adopted when implementing strategies to increase agricultural productivity in Kenya and other developing countries.

1.7 Limitations of the study

Limitations included lack of enough resources like time and finances to carry out a similar study on Kenyan smallholder farmers. This would have given us the exact situation with the Kenyan smallholder farmer. This study can only generalize since the smallholder farmer profiles are not so different

between Tanzania and Kenya.

1.8 Study assumption

The study also assumes that smallholder farmers in Tanzania have similar profile as those in Kenya and therefore the outcomes can be helpful in the Kenyan context.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

In order to understand the contribution that this thesis seeks to make amidst a myriad of already available research findings, we present a brief review of the already published literature. This will help in understanding the context and the gaps still existing in this research field some of which this thesis seeks to fill.

2.2. Statistical models used in measuring agricultural productivity

Kibaara et al (2008) analyzed trends in agricultural productivity using a nationwide household panel survey in Kenya. The study examined productivity changes for maize, tea, coffee, sugarcane, cabbages, Irish potatoes and dairy. The study used descriptive analysis to show trends in partial productivity and a Cobb-Douglas production function was used for productivity analysis. Results showed an impressive growth in maize and dairy sub sector productivity, maize growth was due to increased percentage of smallholder households using fertilizer, adoption of improved seeds and the availability of fertilizer retail outlets. Dairy sub sector growth was mainly due to increased investment in dairy production and production of fodder crops. Sugarcane and coffee productivity declined mainly due to management challenges. Cabbage and Irish potato productivity fluctuated over the panel period, and did not show any meaningful trend. In general, Kenyan agricultural productivity appears to be rising. It has been found that in order to sustain productivity growth and encourage farmers to increase production and productivity of major enterprises, farmers will require an improvement in innovative solutions.

In their study on "Agricultural policy, Investment and Productivity in sub-Sahara Africa (SSA)", Wiebe et al (2001) indicated that an expected increase in output from improved infrastructure and price policies were difficult to quantify, but such improvements were probably prerequisites to make possible the increases in productivity from the use of conventional inputs and research. Other important constraints to agricultural productivity were the quality and availability of education, research and

extension services, as well as institutional uncertainties that weaken incentives to invest in the maintenance or improved of land quality.

The study concluded that education of rural labour force and agricultural research is needed to improve the future prospects for productivity growth in SSA.

2.3 Specific factors influencing agricultural production

2.3.1. Age

The age of farming household heads was observed to have an inverse relationship with productivity of farmers in studies from Idjesa (2007). All of these studies were carried out in the humid forest, dry savannah, and moist savannah regions of Nigeria, except for the Coelli and Battesse study, which was carried out in India. This was understandable since it is expected that as a farming household head becomes older his or her productivity will decline.

2.3.2 Years of farming experience

Years of farming experience is another factor that enhances productivity among farming households Years of farming experience in Nigeria increases as age of the farmer increases. It is within this context that years of farming experience and age of farmers were discussed together in this section of the report. Age is also positively correlated with productivity; older farmers have also been observed to have higher productivity than younger farmers. For example Ajibefun et al (2002, 2006) and Idjesa (2007) observed that productivity in the humid forest and moist savannah agro-ecological zones of Nigeria was positively associated with more experience in farming.

2.3.3 Land Ownership

Closely related to the factor of residency status is the land ownership status of farming households. Akinseinde (2006) showed that farmers that owned parcels of land on which they farmed were more productive than non-landowning farming households. This was understandable since farmers that owned land on which they farm were ready to make huge investments on such land through the adoption of new technological packages which enhance productivity levels. Adekanye (1988) provided empirical evidence showing that women had a lower level of productivity than men because they had far less access to land and other productive inputs.

2.3.4 Education

Education is one of the key assets needed to foster productivity in any profession. Findings of Adeoti (2002), Ajibefun et al. (2002, 2006) and Idjesa (2007) and Kehinde (2005) confirmed that education was key to enhanced productivity among farming households in the humid forest, dry savannah and moist savannah agro-ecological zones of Nigeria and in New England. This was likely because good education propels heads of farming households to adopt new innovations and technologies that are vital to enhancing farm productivity.

2.3.5 Social Network

Another key factor vital to enhancing farm productivity is social networks or social capital. Idumah (2006) observed that social capital enhanced productivity among crop farmers in the humid forest, dry savannah, and moist savannah agro-ecological zones of Nigeria. This was likely because social capital tends to promote membership welfare and reduce conflict, which is important for enhancing productivity of farming households.

2.3.6 Farm Size

The effect of farm size on farm productivity is inconclusive. Lau and Yotopolus (1971) using the profit function equation found that small farms attained higher productivity levels than larger farms in India. Sahidu (1974) adopted the Lau-Yotopolous model to sample India wheat farms and came up with a contrary conclusion showing large and small farms exhibiting equal levels of productivity. Khau and Maki (1979) using the Lau-Yotopoulous model in Pakistan observed, however, that large farms were more efficient than small farms. Using a normalized profit function and stochastic frontier function, Ajibefun et al (2002) showed that large farm size enhanced productivity among farmers in the dry savannah and humid forest agro-ecological zones of Nigeria.

2.3.7 Crop Mix, Rotation, and Diversification

The issue of crop mix, rotation, and diversification and how it affects agricultural productivity were considered by Idjesa (2007) and Idumah (2006). Findings showed that crop mix, rotation, and diversification, when properly adopted, promoted productivity among crop farmers in the dry and moist savannah agro-ecological zones of Nigeria.

2.3.8 Dependency Ratio

A high dependency ratio and high ratio of female adult were factors identified by Akinseinde (2006) as detrimental to productivity. Using data envelopment analysis and the Tobit model, the study showed that the higher the dependency ratio and the higher ratio of female adults to all adults living on the farm in the humid forest agro-ecological zone of Nigeria, the lower the farming household productivity.

2.3.9 Labor

Adebayo (2006) and Ajibefun et al (2002) and Ogundele and Okoruwa (2006) all assessed how labor affected farm productivity in the dry savannah and humid forest agro-ecological zones of Nigeria. Using analytical tools such as the Cobb-Douglas production function, the normalized profit function approach, and the stochastic frontier model, Tella (2006) observed that the use of hired labor reduced productivity when not properly utilized. Adebayo (2006), Ajibefun et al, (2002), and Ogundele and Okoruwa (2006), however, showed that hired labor contributed positively to farm productivity.

Mochebele and Winter-Nelson (2002) investigated the impact of labor migration on technical efficiency performance of farms in Lesotho. Using stochastic frontier production, the study found that households that sent migrant labor to South African mines were more efficient than households that did not, with a mean technical efficiency of 0.36 and 0.24 respectively. Similarly, Nkonya et al. (2005) observed that pre-harvest labor positively affected crop production in Uganda.

2.3.10 Access to Roads and Transport

Access to roads and transport is also important to improving productivity. According to Adewuyi (2002) poor roads negatively affected farming households' productivity. Using a related factor, Okike (2000) used the stochastic frontier model to show that the high cost of transportation reduced productivity of livestock farmers in the dry savannah and humid forest agro-ecological zones.

2.3.11 Access to Credit

Another important factor that has been empirically proven to influence productivity is credit. Akinseinde (2006), using data envelopment and the Tobit model, showed that having access to credit facilities contributed positively to a household's production efficiency in the humid forest agro-ecological zone of Nigeria. Similarly, Obwona (2000), using the translog production function, showed that access to credit contributed positively towards the improvement of efficiency among tobacco farmers in Uganda.

2.3.12 Access to Extension Services

Access to extension services has been identified as key to farm productivity in a series of studies. Obwona (2000), using the translog production function, demonstrated that access to extension services by tobacco farmers improved their productivity in Uganda. In contrast, Bravo-Ureta and Rieger (1991) using the stochastic efficiency decomposition model based on Kopp and Diewert's deterministic methodology, concluded that extension services did not markedly affect productivity of farmers in New England. However, the studies of Adewuyi (2002) reported that extension services enhanced farmers' productivity in the humid forest and dry savannah agro-ecological zones of Nigeria.

2.3.13 Availability of Nonfarm Income

Akinseinde (2006), using data envelopmental analysis and the Tobit model, showed that nonfarm income earnings affected farm productivity. Specifically the higher the nonfarm income of farming households, the higher the inefficiency of these households in crop farming in the humid forest agro-ecological zone of Nigeria.

2.3.14 Access to Fertilizer, Agro-Chemicals and Improved Seeds/Planting

Access to fertilizer, agro-chemicals, and improved seeds/planting materials has been proven as an important driver of agricultural production and productivity among farmers in Sub-Saharan African. Using stochastic frontier model, Ogundele and Okoruwa (2006) observed that the use of fertilizer increased agricultural productivity of crop farming in the dry savannah and humid forest agro-ecological zones of Nigeria. Nkonya et al (2005) also alluded to the positive impact of fertilizer. The use of herbicides according to Ogundele and Okoruwa (2006) had a positive correlation with technical efficiency or productivity of farmers. However, Tella (2006), using the Timmer and Kopp indices, revealed that the use of chemicals contributed to productivity negatively if not properly utilized.

The use of improved seeds/planting materials on agricultural productivity were also documented in studies of Idjesa (2007), Ogundele (2003), Ogundele and Okoruwa (2006), and Tella (2006) in the humid forest, moist savannah and dry savannah agro-ecological zones of Nigeria. Findings of Idjesa and Ogundele and Okoruwa using the stochastic frontier model revealed that the use of improved seed had a positive impact on the technical efficiencies of crop farmers. This finding was consistent with Nkonya et al (2005), who also showed that purchased seeds had a positive impact on a farmer's productivity in Uganda. Tella (2006), however, showed that improved planting materials when not

utilized in the recommended proportion could reduce a farmer's productivity. However, the positive contribution to efficiency of farmers having access to improved planting materials could be reversed if the costs were relatively high and out of the reach of farmers. Adewuyi (2002) using the linear programming and Tobit models observed that the high cost and inadequate supply of input (plant material inclusive) negatively affected productivity. Assessment of Farmers' Attitude towards the Use of Chemical Fertilizers in Northern Agricultural Zone of Delta State, Nigeria by Okoedo-Okojie, D. U and A. Aphunu2 (2011) showed that Responses on perceived attitudes towards fertilizer use shows that respondents have unfavourable attitude towards the technology.

2.3.15Farmer attitudes towards extension service

Osun State Ayoade Adenike Rebecca (2012), assessed attitude of women farmers towards agricultural extension services in Ifelodun local government area of Osun State, using descriptive statistics, while Pearson Product Moment Correlation was used to test the relationship between the dependent and independent variables. The findings showed that majority of the respondents agreed that extension service helps women farmers to adopt new technologies. The most accessible extension service is demonstration of improved technology among others, and the major challenge faced is that of financial constraints in purchasing inputs. However, a significant relationship exists between the farm size, type of crop grown and the women's attitude towards extension service.

2.4 Literature summary

As can be seen from the literature, land, labour, inputs, capital etc are the basic factors of production. Different models and recommendations have been suggested. A few attempts to understand how farmer attutudes towards certain practices affected the uptake of those particular practices. The TNS Global Kenya, in their smallholder farmer study in Tanzania used descriptive statistics to understand productivity of the smallholders having benefited from the intervention which focused on promoting use of agricultural inputs. The outcome was varied across the respondents' profile, some improving productivity, some staying the same while a few even deteriorated. In this study we use the TNS data to attempt extraction of attitudinal constructs using factor analysis. The resulting factor components are assessed with regards to the attitudinal theme they represent and appropriate factor scores computed. Regression analysis using the derived attitudinal segments as the dependent variables is used to assess the impact of various factors on the attitudinal segmentation

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This section entails the research design used, sampling including target population, data collection, data analysis and reporting structures of this project work. It is reported that a participatory approach was used for data collection.

3.2 Data Analysis

3.2.1 Data description

The dataset used in this analysis was obtained from National surveys of small scale farmers in Mali and Tanzania in 2010. For this analysis however, we focused on the subset from Tanzania since the observed characteristics in Tanzania are quite similar to those expected to be observed in Kenya. In order to achieve the objectives highlighted earlier, various statistical concepts and methodologies were necessary in order to obtain valid inferences from the data. In table 1, the predictors used in (multiple) regression analysis of attitudinal segments are described briefly.

Table 1: Predictors to be used

Question	Description	Remark
q12_1a	Information search	Based on 8 binary questions
q1_3a	Age	Self-reported age
q1_11/12	Experience in farming	Experience in years
q1_5/6	Education level	Number of years in formal education
q4_9	Farm input usage	Based on 5 binary questions
q4_16	Farmer pro-activity in looking for markets	Binary response
q5_5	Income from farming activity	
q13_1-q13_5	Concept adoption	Based on 5 components –conduct Factor analysis

In order to use these variables for further analysis, some exploration based on summary statistics for continuous covariates and factor analysis for the Likert-scale questions was performed. Where it was deemed necessary, continuous covariates were centred or standardized using the overall mean for the available cases.

3.3 Statistical Methodology

3.3.1 Factor analysis

Factor analysis (Johnson & Wichern, 2007) is a dimension reduction technique that renders itself useful in analysis of Likert scale questions in psychological studies and other surveys. In most cases, researchers would like to study a feature that is either difficult, more costly or impossible to measure/quantify directly. A solution is to identify potential instrumental variables that may act as constructs for the unobservable latent variable. Once information on the instrumental variables is available, factor analysis is implemented in order to obtain the appropriate loadings (mixing weights) for the different constructs. In the situation where a researcher knows a priori that a particular latent structure exists underlying the questions directly asked, confirmatory factor analysis provides a tool for confirming whether the observed data actually exhibits this latent structure. In other situations, there may not be a priori information on the existence or actual composition of unobserved latent variables. Exploratory factor analysis provides a tool for finding out more about this structure from the observed data.

In this study, 43 Likert type questions addressing farmers' attitudes towards farming were collected. Let the matrix of the 43 Likert-type questions for which the factor analysis is to be based be denoted as shown in Equation 1.

$$\mathbf{X} = \begin{bmatrix} X_{1,1} & X_{1,2} \ldots & X_{1,43} \\ . & & \\ . & & \\ . & & \\ X_{i,1} & X_{i,2} \ldots & X_{i,43} \end{bmatrix} \quad \ldots\ldots (1)$$

We hypothesise that there may be different segments of farmer attitudes such as those who are contented with farming as a lifestyle, the totally unhappy farmers, farmers curious about emerging technologies and much more.

From equation 1, the mean vector and covariance matrices are μ and Σ respectively. The factor analysis model postulates that there are a fewer set of unobservable variables $F_1, F_2 \ldots F_m$ that **X** is linearly dependent on. In addition, there are p additional sources of variability $\varepsilon_1, \varepsilon_2 \ldots \varepsilon_p$ such that;

$$\mathbf{X}_1 - \boldsymbol{\mu}_1 = l_{11}F_1 + l_{12}F_2 + \ldots + l_{1m}F_m + \varepsilon_1$$
$$\mathbf{X}_2 - \boldsymbol{\mu}_2 = l_{21}F_1 + l_{22}F_2 + \ldots + l_{2m}F_m + \varepsilon_2$$
$$\vdots$$
$$\mathbf{X}_p - \boldsymbol{\mu}_p = l_{p1}F_1 + l_{p2}F_2 + \ldots + l_{1p}F_m + \varepsilon_p \qquad \ldots\ldots (2)$$

Here, $l_{11}, l_{21} \ldots\ldots, l_{p1}$ are the factor loadings for the set of 43 questions in the first Factor extracted from factor analysis.

In order to determine the values for the factor loadings, factor analysis based on principal component analysis (PCA) extraction method was performed. The factor loadings may also be used or interpreted as standard regression coefficients showing correlations with the respective factor-the closer the coefficient is to 1, the higher the correlation. PCA seeks the linear combinations as shown in Equation (2) that maximizes the variability explained by each component of the PCA. Mathematically, the different principal components ought to be independent in order to have linearly independent PCA. Thus, appropriate rotation to guarantee orthogonal attitudinal segments was performed based on varimax rotation while factor loadings resulting from the rotated solution were used to derive the new factor scores. Appropriate diagnostics for factor analysis such as eigen value check, tests for sphericity and sampling adequacy were performed. In presenting the results of factor analysis, each of the components was assessed with regard to the general attitudinal theme that the questions represent (hereafter referred to as the attitudinal segments) and labelled accordingly. Thereafter, these attitudinal segments were used for regression analysis.

The Bartlett test statistic	
H_0:	$\sigma_1^2 = \sigma_2^2 = \ldots = \sigma_k^2$
H_a:	$\sigma_i^2 \neq \sigma_j^2$ for at least one pair (i,j).
Test Statistic:	The Bartlett test statistic is to test for equality of variances across groups against the alternative that variances are unequal for at least two groups. $$T = \frac{(N-k)\ln S_p^2 - \sum_{i=1}^{k}(n_i - 1)\ln S_i^2}{1 + \frac{1}{3(k-1)}\left(\sum_{i=1}^{k}\left(\frac{1}{n_i - 1}\right) - \frac{1}{N-k}\right)}$$ In the above, s_i^2 is the variance of the i^{th} group, N is the total sample size, N_i is the sample size of the i^{th} group, k is the number of groups, and s_p^2 is the pooled variance. The pooled variance is a weighted average of the group variances and is defined as: $$S_p^2 = \frac{1}{N-k}\sum_{i=1}^{k}(n_i - 1)S^2$$
Sign. Level:	*α, variance unequal if, P< α Value* ***OR***
Critical Region:	The variances are judged to be unequal if, $T > \chi^2_{1-\alpha,k-1}$ where $\chi^2_{1-\alpha,k-1}$ is the critical value of the chi-square distribution with k - 1 degrees of freedom and a significance level of α.

3.3.2 Linear regression analysis

In order to assess the relationship between a continuous response variable and (possibly many) covariate(s) of interest, linear (simple/multiple) regression analysis may be performed (Kutner, et al., 2005). The main underlying assumptions of linear regression include: residuals are independently and identically normally distributed with zero mean and constant error variance σ^2. Moreover, the covariates are assumed to be measured without error and the response of interest is normally distributed. In this analysis, two phases of models were considered;

1) Each of the attitudinal segments resulting from factor analysis was regressed on each of the covariates in what we loosely refer to as simple regression analysis.

2) Predictors that were found significant in the first step were used in fitting a multiple linear regression model for each of the attitudinal segments derived.

In what follows, we present a general formulation of the simple and multiple linear regression models to be considered

Let Y_{ijk} be the score (outcome) for the k^{th} attitudinal segment (k=1…K) for the $i^{th.}$ If X is the set of covariates listed earlier X={Age, years of education, ……}, then a simple linear regression model for the j^{th} covariate is defined as follows;

$$Y_{ik} = \beta_0 + \beta_1 X_{ij} + \varepsilon_{ijk}$$

On the other hand, the multiple linear regression model will be of the form

$$Y_{ik} = \beta_0 + \beta_1 Age_i + \beta_2 Education_i + \beta_3 Experience_i + \beta_4 Input.use_i + ... + \beta_p income_i + \varepsilon_{ik}$$

Where $\beta_0 ..... \beta_p$ are the regression coefficients and ε_{ik} the measurement errors respectively. IBM SPSS Statistical software (version 22), R 3.0.2 and SAS 9.3 were used in estimation resulting in the output as presented in the following sub-sections.

3.4 Research Design

The study adopted mostly secondary data collection techniques, mainly data acquired from TNS/RMS Global-Kenyan chapter on 'Project Farmer Focus' in Mali and Tanzania in partnership with the Bill & Melinda Gates Foundation.

3.5 Target population

The data was collected from national survey exercise of small scale farmers in Mali and Tanzania. In Mali, two regions were excluded from the survey: Timbuktu because it falls in the Sahara desert and thus has few agricultural activities, and Kidal, because of insecurity. Respondents had to fulfil two important criteria they had to be smallholder farmers and decision makers in the farm. Large scale farmers were excluded from the study. Both the household head and the spouse were interviewed. Household head was defined as the adult person who is responsible for the organization of the household or who is regarded as such by the household members. The focus was on small scale farmers in line with Bill &Melinda Gates Foundation's objective to assist poor people living on less than $2 dollars per day.

3.6 Sampling

Optimal allocation method of stratification sampling technique was adopted in this study since different regions in those two countries have different population sizes and different farmer profiles. Based on optimal allocation, the best sample size for stratum h would be:

$$n_h = n * \left[(N_h * \sigma_h) / \sqrt{ch} \right] / \left[\sum (N_i * \sigma_i) / \sqrt{c_i} \right]$$

where nh is the sample size for stratum h, n is total sample size, Nh is the population size for stratum h, σh is the standard deviation of stratum h, and ch is the direct cost to sample an individual element from stratum h. Note that ch does not include indirect costs, such as overhead costs.

The effect of the above equation is to sample more heavily from a stratum when

- The cost to sample an element from the stratum is low.
- The population size of the stratum is large.
- The variability within the stratum is large.

The sample size **n =6607** including **10%** provision for non-response. For the quantitative part of the study, from Tanzania total population of about **27M** smallholder farmer population in Tanzania and a total population of **8M** smallholder farmers in Mali. For the sake of this analysis I used the Tanzanian data only.

3.7 Data collection

Focus group discussions were carried out to gain a deeper understanding of small holder farmer behaviour in adopting modern farming techniques. Information from these activities was used in developing the quantitative survey instruments. Quantitative data was then collected through face to face interviews using a structured questionnaire. A team approach to field work allowed male respondents to be interviewed by males and women by female interviewers. The selection of the household was done using the random route procedure suitable for rural settings

3.8 Reporting

The report with Kenya Markets Trust, and any other interested organizations for adoption and implementation of my recommendations since their projects are about improving agricultural productivity of smallholders, and with TNS/Research international who allowed me to use data from one of their projects.

CHAPTER FOUR: FINDINGS

4.1 Introduction

Having applied the methodology described in the previous sections, the following section presents some of the main results of the analysis. Statistical software used in the computations included SPSS 22.0, R 3.0.2 and SAS 9.3. Although any one of these software could adequately handle all the models presented in this thesis, they provide different flexibility in terms of ease of data manipulation, model parameterization and graphical interfaces.

4.2 Application of the methodology to the data

4.2.1 Factor analysis: extraction of attitudinal constructs using factor analysis.

Kaiser-Meyer-Olkin (KMO) is a test for sampling adequacy for which a value above 0.5 is preferred. In this case, KMO has a value of 0.905 which is an indicator that the sample is adequate in describing the underlying latent constructs. This is expected considering that sample size was large enough to be representative (N=5096). On the other hand, Bartlett's test is a hypothesis test for the independence between all the extracted factors. Significant results of this test as indicated in table 1 implies independence of the covariance matrix of the attitudinal segmentation constructs, which is what we would hope for.

Table 2: KMO and Bartlett'sTest for independence of the covariance matrix

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin *		0.905
Bartlett's Test of Sphericity**	Chi-Square	31269.327
	Degrees of freedom	903
	P-value	<0.0001

* Measure of sampling adequacy.
**Independence of the covariance matrix

The final solution was obtained under orthogonal varimax rotation from which six components

representing six different themes of attitudinal changes were identified. These attitudinal themes together with their loadings are presented in the following sections. The factor loadings are an indicator of the weight each of the underlying questions has on the attitudinal segment. A high and positive score indicates that farmers exhibited that particular character more strongly. If the underlying theme is a negative one e.g. negativity or passive dependence, a high positive score is an indicator of the negative energy these farmers exhibit towards those particular instrumental variables. We now present the six attitudinal segments with their factor loadings without further explanations.

Table 3: Information focus

Contributing statements	Loading
I frequently search out information about new farming methods and issues that interest me	0.623
My family and friends often ask my advice on farming	0.602
People often ask me for advice on farming	0.598
I often discuss farming methods and issues with other people	0.584
I look into new farming methods or crops very carefully before choosing to use them	0.58
I like receiving information about new products or practices in the area of farming	0.559
When I find a new farm method or idea that I really like I have to tell others all about it	0.538
I love trying out new farming techniques or ideas before anyone else catches on to them	0.53
Any farm method that saves me time is worth paying for	0.485
I only really take advice from other farmers if they are obviously successful	0.449
It is always possible to make improvements on my farm	0.439
I am always watching what other people are doing to see what I could improve on my farm	0.385
My choice of what farming method I employ is important – I believe that what I do on my farm says something about who I am	0.37

Please note that the loadings also eigin values can also be used as regression coefficients that would detect correlation between a particular statement and the attitudinal segments. Loadings close to 1 indicate high correlation while scores closer 0 indicate low correlation. For example frequent search for information about new farming methods has highest correlation (0.623) with this attitudinal segment. This can apply across all the other attitudinal segments discussed in this study.

Table 4: Negativity- 'don't tell me to change, status quo is safer'

Contributing statements	Loading
Farm work is a chore and has no joy	0.551
It's a big risk to start trying to grow a new crop or to keep a new type of animal	0.551
Experience shows that there is no point in making improvements on the farm (things are best left how they are)	0.542
Past failure has put me off doing things differently on the farm	0.539
There is no hope for poor farmers like us to improve	0.533

There is no need to take into account the opinions of other farmers to make changes on my farm	0.532
One has to take into account the possibility of witchcraft when deciding to do or not do something	0.481
If misfortune is meant to strike my farm I cannot avoid it	0.473
It is dangerous to be the first to implement something new on your farm	0.469
There is no point planning ahead in farming, no one can predict the future	0.448
It's the responsibility of NGOs and other organizations to make sure that my farm is successful	0.425
I do not want anyone to tell me what to do on my farm	0.416
Farmers experiencing problems are always wise to sit back and wait for things to improve	0.405

Table 5 Change orientation

Contributing statements	**Loading**
I think we need to do things differently on our farm in order to progress	0.555
Women and men should be equal partners when it comes to decision making in the farm	0.525
We should regularly make personal sacrifices to improve our farms (personal effort in farming always pays)	0.448
My spouse often follows my suggestions about what should be done on the farm	0.392

Table 6 Passive dependence

Contributing statements	**Loading**
You cannot be a good farmer unless you know a lot of people	0.503
There is no problem in farming that I cannot cope with	0.483
I often read packs and look at posters or other material to find out more about the farm inputs brands I am buying	0.45
You cannot be a successful farmer unless you get help from other people	0.449
I like to see something succeeding on other people's farms before I would try it out myself	0.444
There is no better investment than farming	0.425
I view my farm as a business	0.361

Table 7: Heritage- 'Farming is my destiny'

Contributing statements	**Loading**
God meant me to be a farmer	0.757
As a farmer I am following my father and grandfather and that is important to me	0.725
I am proud to be a farmer	0.559

Table 8: Resigned unhappiness- 'No hope to improve so would prefer to be something else'

Contributing statements	Loading
If I had a choice I would not be a full time farmer	0.592
There are very few areas in farming where we can make lasting improvements	0.462
I would prefer if my children do not end up working as farmers	0.447

The scores resulting from factor analysis are then used as the outcomes for analysing the effect different covariates of interest have on the attitudinal segments derived.

4.3 Data analysis

In this section, each of the attitudinal segmentations were regressed against the set of predictors previously presented. Only linear predictors were considered thus no other functional forms such as quadratic terms for continuous predictors were evaluated.

4.3.1 Exploratory data analysis

The first thing to note is that the six extracted components are already standardized values. Hence have zero mean and unit variance). In table 8 and figure 1 below, the descriptive statistics(plots) give an indicator that this assumption is not highly violated since the mean is approximately equal to zero. Moreover, at least 95% of the observations seem to be contained within 2 standard deviations interval.

Figure 1: A normal density curve overlaid on the histogram

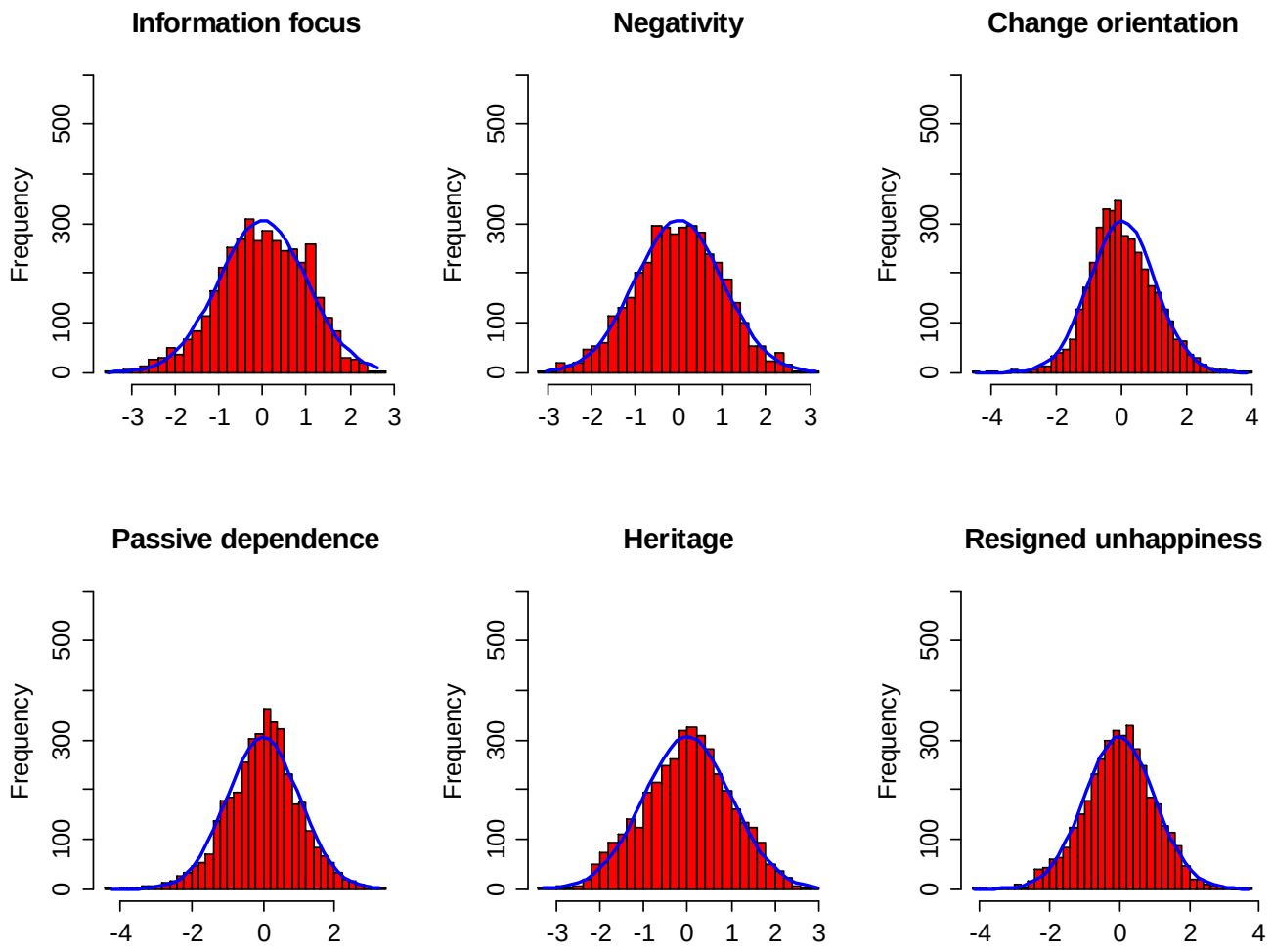


Table 9: A normal density curve overlaid on the histogram

	Information focus	Negativity	Change orientation	Passive dependence	Heritage	Resigned unhappiness
Min.	-3.545	-3.044	-4.504	-4.233	-3.286	-4.162
Median	0.02	0.025	-0.078	0.044	0.039	0.021
Mean	0	0	0	0	0	0
Max.	2.634	3.136	3.853	3.229	2.965	3.683

4.3.2 Simple regression models

As a simple check for the association between each of the attitudinal segments and the predictors of interest, we regress each of the six attitudinal segments on each of the eight proposed predictors in table 1. The models are parameterised such that the intercept is an indicator of the baseline value while slopes correspond to the rate of change of the particular element. A simple illustration is provided with the model for age as follows;

$$Y_i = \beta_0 + \beta_1 Age_i + \varepsilon_i$$

4.3.3 Dependence of attitudinal segments on age

In checking for the effect of age on different attitudinal segmentations, age was centred by subtracting the overall mean from each of the observations. In this way, the intercept for the model can be interpreted to coincide with the mean response for a person whose mean age is 41 years on the attitudinal segment considered.

Table 10: Farmer's self-reported age

	N	Mean	Median	Std Dev
Tanzania	3848	41.017	40	11.787

*Table 11***:** *Attitudinal segment versus age*

Attitudinal segment	**Intercept (SE)**	**P-value**	**Age (SE)**	**P-value**
Information focus	-0.007 (0.0174)	0.6866	-0.0011 (0.0015)	0.4616
Negativity	0.0316 (0.0169)	0.0612	0.0024 (0.0014)	0.0962
Change orientation	-0.0019 (0.0174)	0.9127	-0.0019 (0.0015)	0.196
Passive Dependence	-0.0234 (0.0174)	<.0001	0.0007 (0.0015)	0.6463
Heritage	-0.0476 (0.0175)	0.0066	0.0024 (0.0015)	0.1024
Resigned unhappiness	0.0125 (0.0173)	0.4705	-0.0072 (0.0015)	<.0001

As an illustration, consider the simple linear regression for dependence of information focus on age. The fitted model can be denoted as follows.

$$Y_i = -0.007 - 0.0011 Age_i$$

Based on the output shown, for a respondent of an average age (41 years), there was no significant effect of age on most of the attitudes apart from passive dependence and heritage. A one year change in age resulted in a significant reduction in the score for resigned unhappiness although there was no significant impact of age on the other five attitudinal segments.

4.3.4 Dependence of attitudinal segments on farming experience

There is a significant difference in the mean (median) years of farming experience as can be seen from the summaries table. As before, farming experience is centred using the mean and the resulting centred farmer's experience used in fitting regression models. The model intercept corresponds to the average score for the attitudinal segment for a farmer with 24 years of farming experience, while the slope of the model represents the rate of change of the attitudinal segment score for one year change in the

farming experience.

Table 12: Farming experience

	Farming experience			
	N Obs	Mean	Median	Std Dev
Tanzania	3848	24.710	22	11.948

In this case, farming experience did not significantly influence the rate of change in all the attitudinal aspects for a farmer with an average of 24.7 years of farming experience. However, there was a significant difference in the score of passive dependence, heritage and resigned unhappiness as years of farming experience increased. In particular, passive dependence and heritage scores were more reinforced with more years of farming experience, while the average response on resigned diminished as farmers became more experienced (slope coefficients in table 13).

Table 13: Attitudinal segments regressed against farming experience.

Attitudinal segment	Intercept (SE)	P-value	Farming experience (SE)	P-value
Information focus	0 (0.0161)	1	-0.0002 (0.0013)	0.8646
Negativity	1 (0.0161)	1.0000	-0.0024 (0.0013)	0.0741
Change orientation	0 (0.0161)	1.0000	0.0019 (0.0013)	0.1527
Passive Dependence	0 (0.0161)	1.00E+00	0.0038 (0.0013)	0.0045
Heritage	0 (0.0161)	0.9999	0.0052 (0.0013)	0.0001
Resigned unhappiness	0 (0.0161)	1	-0.0027 (0.0013)	<.001

4.3.5 Dependence of attitudinal segments on Income from farming activity

Farming is mainly performed for subsistence as well as for income generation. Income resulting from farming activities was assessed and its impact on attitudinal segments evaluated. Overall, there was a huge disparity between the mean and median income in Tanzania. Variability of income from farming was quite high at over 1.5 million in Tanzania.

Table 14: Income from farming

	N Obs	Mean	Median	Std Dev
Tanzania	3848	899,054.944	500,000.000	1,682,463.450

The impact of income from farming on farmers attitudes was assessed through a regression model with standardized income as a covariate. Standardization was based on overall mean and standard deviation.

Results of the regression model are shown in table 15 below.

Table 15: Impact of income from farming on farmers attitudes

Attitudinal segment	Intercept (SE)	P-value	Income (SE)	P-value
Information focus	0.0127 (0.0206)	0.5373	-0.0127 (0.0206)	0.5387
Negativity	0.0248 (0.0204)	0.0248	-0.0136 (0.0204)	0.5053
Change orientation	-0.022 (0.0205)	0.2826	-0.0328 (0.0205)	0.1096
Passive Dependence	-0.0477 (0.021)	0.0230	-0.0255 (0.021)	0.2236
Heritage	-0.0026 (0.0204)	0.899	-0.044 (0.0204)	0.0312
Resigned unhappiness	0.0197 (0.0208)	0.3451	-0.0245 (0.0209)	<.0001

Overall, income had a significant effect on negativity and passive dependence only for a farmer with the reported average farming income (Tsh 899,054⇔ Ksh 56,190). The rate of change of farming income was however significantly influenced heritage and resigned unhappiness as is seen in the p-values of the corresponding slopes.

4.3.6 Dependence of attitudinal segments on years of education attained.

The average number of years spent in formal education was about seven with a standard deviation of 1.774 as shown in table 16.

Table 16: Years of education received

	N Obs	Mean	Median	Std Dev
Tanzania	3848	7.091	7.000	1.774

Interestingly, the years spent in school had little impact on the attitudinal segments. There was a significant influence of additional years of schooling particularly on five of the six attitudinal segments (apart from information focus). The slope coefficients for years in education were positive for information focus, negativity and passive dependence an indication that the score on these attitudes increased with increasing years of formal education, while the negative slope coefficients were an indicator that the score for the corresponding attitudes decreased with increasing years of formal education (more details in table 17).

Table 17 Impact of years of education on attitudinal segments

Attitudinal segment	Intercept (SE)	P-value	Education (SE)	P-value
Information focus	-0.0628 (0.0716)	0.3805	0.0126 (0.0098)	0.2000
Negativity	0.0017 (0.0729)	0.0017	0.0334 (0.01)	0.0008

Change orientation	0.1231 (0.0723)	0.0886	-0.0198 (0.0099)	0.045
Passive Dependence	-0.1575 (0.0722)	0.0292	0.0252 (0.0099)	0.0108
Heritage	0.1722 (0.0718)	0.0165	-0.0271 (0.0098)	0.0058
Resigned unhappiness	0.0006 (0.0721)	0.9934	-0.0017 (0.0099)	<.0001

4.3.7 Dependence of attitudinal segments on concept adoption

Farmers were also rated on their willingness to adapt various concepts namely; farm insurance, new maize seed variety, farmer helpline centre, farmer training program and oilseed processing technology for which Likert scale responses were obtained. Factor analysis was then performed on the 5 likert-scale questions in order to construct the latent variable concept adoption. The KMO value was 0.806 indicating adequacy of the sample, while the Bartllet's test was highly significant (p-value<0.001). Only one component was extracted, explaining 51.079% of variability in concept adoption. The loadings on different aspects of concept adoption are presented in table 18.

Table 18: Loadings on different aspects of concept adoption

Likelihood of using these products if they were available	**Loading**
[q13_1_1] - Insurance	0.231
[q13_1_2] - New maize	0.268
[q13_1_3] - Farmer helpline	0.302
[q13_1_4] - Farmer training	0.308
[q13_1_5] - Processing	0.283
Extraction Method: Principal Component Analysis.	

All the five components (Insurance, New maize, farmer helpline, farmer training and processing) of the latent variable concept adoption had low factor scores between 23 and 30%, an indication that there was no much differentiation in preference across the various concepts available for farmers. This could also be seen from the Likert scale responses on concept adoption from which different segments of farmers ranked the different concepts equally with no much differentiation. We regressed the six attitudinal segments on concept adoption, results of which are presented in table 19 below

Table 19: Regression of attitudinal concepts on concept adoption

Attitudinal segment	Intercept (SE)	P-value	Concept adoption (SE)	P-value
Information focus	-0.0628 (0.0716)	0.3805	0.0126 (0.0098)	0.2
Negativity	0 (0.0161)	1.0000	0.0034 (0.0161)	0.8345
Change orientation	0 (0.0161)	1.0000	0.0734 (0.0161)	<.0001
Passive Dependence	0 (0.016)	1.000	0.1016 (0.016)	<.0001
Heritage	0 (0.0161)	1	-0.0399 (0.0161)	0.0133
Resigned unhappiness	0 (0.0161)	1	-0.0573 (0.0161)	<.0001

For a respondent with a zero score on concept adoption, there was no significant impact in the average score on the six attitudinal segments. An increase in the concept adoption score however resulted to a significant increase in the score for change orientation and passive dependence while it resulted to a reduction in the average score for heritage and resigned unhappiness

4.3.8 Dependence of attitudinal segments on farmer's proactivity in searching for market.

Farmers were also interviewed on whether they had recently sought for new buyers for their produce. The dependence of various farmers' attitudinal segments on their proactivity in searching for new markets was explored, results of which are presented in table 20. It is evident that there was a significant effect of farmer's proactivity in searching for new markets on their attitudes towards information focus, change orientation and heritage. For instance, farmers who were proactive in seeking market for their produce had an increase in information focus score of 0.1554 compared to those who did not.

Table 20: Dependence of farmer attitudinal segments on proactivity in searching for new markets

Attitudinal segment	Intercept (SE)	P-value	Farmers' proactivity (SE)	P-value
Information focus	-0.0851 (0.026)	0.001	0.1554 (0.034)	<.0001
Negativity	-0.0368 (0.026)	0.1568	0.0652 (0.0341)	0.056
Change orientation	0.1046 (0.0259)	<.0001	-0.1703 (0.034)	<.0001
Passive Dependence	0.0514 (0.0261)	0.049	-0.0639 (0.0342)	0.062
Heritage	0.0374 (0.0262)	0.154	-0.0701 (0.0344)	0.042
Resigned unhappiness	0.0152 (0.026)	0.559	-0.0104 (0.0341)	0.761

4.3.9 Dependence of attitudinal segments on information search

Farmers were also assessed about their efforts to search for information regarding fertilizer use, recommended seed variety, soil conservation focus, artificial insemination, advice on raising livestock,

planting methods, price of farm products and places to sell their produce. In the following subsections, we check for the effect of farmers' information search on each of the six attitudinal segments through a multiple regression model of the attitudinal segments as dependent variables and the set of variables representing information search as the independent variables.

4.3.9.1 Information focus

Overall, there was a significant impact on information focus for farmers in Tanzania for some of the specific variables of information search. In particular, farmers who sought for information about recommended seed variety or planting methods reported a higher score for information focus.

4.3.9.2 Negativity

Regressing farmers' negativity score on the eight variables about information they may have searched for revealed that; there was a significant impact on farmers' negativity for farmers who sought information about fertilizer use, recommended seed variety and planting methods. However, for the rest of the aspects that farmers' sought information about, there was no significant impact on the negativity score. For example, from table 21, farmers who sought for information about soil conservation exhibited reduced negativity score compared to farmers who did not seek any kind of information about farming.

Table 21: Negativity and Search for Information

Information search	Estimate	(SE)	P-value
Fertilizer use	0.001	0.038	0.9726
Recommended seed variety	0.078	0.037	0.0372
Soil conservation focus	0.04	0.037	0.2781
Artificial insemination	0.053	0.047	0.2589
Advice on raising livestock	-0.026	0.041	0.5343
Planting methods	-0.251	0.037	<.0001
Prices of farm products	0.033	0.04	0.4141
Place to sell farm produce	-0.008	0.042	0.8512

4.3.9.3 Change orientation

The impact of information search on farmers' attitude towards change orientation was assessed through a regression model as before. In this case, there was a significant impact of information search about fertilizer use, recommended seed variety, soil conservation and advice on planting methods compared to those that sought for no information at all.

4.3.9.4 Passive dependence

For farmers who did not search for information of any kind, there was a significant difference in their attitude towards passive dependence (overall intercept estimate 0.163; p-value=0.008). On the other hand, farmers who sought for advice on fertilizer use, recommended seed variety, artificial insemination and planting methods reported a significantly different score on passive dependence compared to those that did not seek any kind of information.

4.3.9.5 Heritage

Farmers score towards heritage was significantly different for those who sought for information about fertilizer use, recommended seed variety and soil conservation as compared to those that did not seek for any kind of information. On the other hand, there was no significant effect on heritage score for farmers who sought for information on the other aspects..

4.3.9.6 Resigned unhappiness

Farmers score on resigned unhappiness was significantly influenced by information search on fertilizer use, planting methods and price of farm produce. The regression coefficients for these three variables were all negative: an indication that the score of resigned unhappiness was significantly lower for farmers who sought for these specific information as compared to those who did not seek for any kind of information. Regression coefficients were -0.1655, -0.1305 and -0.101 for fertilizer use, planting methods and price of farm produce respectively. Dependence of attitudinal segments on input usage.

Farmers' usage of farm inputs such as chemical fertilizers, herbicides, pesticides, purchased weeds and other farm chemicals and their impact on the six attitudinal segments are explored next. In table 21, we present the p-values for the slope coefficients upon regressing each of the attitudinal segments on input usage.

Table 22: P-values for the difference between slope coefficients for regression of attitudinal segments

	Information focus	**Negativity**	**Change orientation**	**Passive dependence**	**Heritage**	**Resigned unhappiness**
Intercept	0.0085	0.5287	0.0009	0.0124	<.0001	0.1359
Chemical fertilizer	0.0021	0.0016	<.0001	<.0001	<.0001	0.0077
Herbicides	0.1120	0.2001	0.1309	0.0471	0.7384	0.0002
Pesticides	0.0781	0.0739	0.2147	<.0001	0.7033	0.0021
Purchased seeds	0.0024	0.0132	0.0680	<.0001	0.2154	0.8603

Other Chemicals	0.7151	0.7532	0.8208	0.0258	0.0758	0.0076

Overall, there was a significant effect on the average score for change orientation, passive dependence and heritage in the category of farmers that did not report usage of any of the five farm inputs (significant intercepts). In addition, there was a significant difference in the score for all six attitudinal segments with regards to farmers who used chemical fertilizers compared to those that did not use any output at all. Similar interpretations can be performed on the other farm inputs.

4.3.9.7 Multiple regression models

In this final stage, we fit multiple linear regression models for each of the attitudinal segments and assess the impact of all covariates of interest on these segments simultaneously. All eight covariates presented in table 1 are used in this section and no model selection techniques are applied. Future research focus may be in identifying a subset of these covariates that best describe the attitudinal segments.

4.3.9.8 Overall significance of the covariates on attitudinal segments

Table 22 summarizes the overall significance of each of the eight covariates in their impact on each of the six attitudinal segments. Significant p-values are presented in bold. The estimate for baseline difference should be interpreted to be the average score in the particular attitudinal segments, for an individual of average age (41 years), without farming experience, without any formal education, zero score on concept adoption, no reported farm input usage, no efforts reported in searching for information about farming and has a zero standardized income (actual income equivalent to overall mean income*standard deviation). In other words, this is a fresh farmer who is typically illiterate and not motivated to adapting new farming methods.

On the other hand, overall significance of slope estimates in the table is an indicator of differences in evolution of the attitudinal segments. For instance, age had a significant impact on change orientation and heritage. In other words, for every extra one year age difference between farmers, the two farmers will report different scores on their attitudes towards change orientation and heritage regardless of their response on the other covariates (having adjusted for other covariates in the model). Table 24 presents regression coefficients for all six models.

Table 23: Summary of the regression coefficients and overall significance of the eight covariates in their impact on the attitudinal segments
**: P-values <0.05.*

Parameter		Information focus	Negativity	Change orientation	Passive dependence	Heritage	Resigned unhappiness
	Intercept	-0.054	0.075	0.209	-0.016	-0.194	-0.134
	Age	-0.003	0.003	-0.005	0	0.007*	-0.015*
	Farming experience in years	0.004	0.003	-0.001	0.005	-0.006	0.009*
	Income	-0.009	-0.018	-0.025	-0.017	-0.041	-0.005
	Years of formal education	-0.011	0.02	-0.021	0.013	0	0.01
	Concept adoption	-0.021	0.051*	0.075*	0.111*	-0.022	-0.07*
	Proactivity in marketing produce	0.157*	-0.043	-0.085	-0.076	0.055	-0.112*
Farm input used	Chemical fertilizer	-0.073	0.127*	0.051	-0.199*	0.156*	-0.165*
	Herbicides	0.154*	-0.082	0.058	-0.079	0.007	0.147*
	Pesticides	-0.032	-0.101	0.08	0.236*	0.02	-0.04
	Purchased weeds	-0.14*	-0.125*	-0.152*	0.269	-0.025	0.002
	Other farm chemicals	-0.003	0.092	-0.05	0.019	0.069	0.176*
Information on farming	Fertilizer use	0.043	0.074	0.159*	0.019	0.079	0.271*
	Recommended seed variety	-0.132*	0.184*	-0.064	-0.017	0.18*	-0.17*
	Soil conservation focus	0.026	-0.01	-0.112*	-0.055	-0.085	0.061
	Artificial insemination	0.171*	-0.1	-0.015	0.049	-0.077	0.039
	Advice on raising livestock	-0.035	-0.119*	0.01	-0.19*	-0.018	0.006
	Planting methods	-0.236*	0.069	0.101	-0.14*	-0.003	-0.155*
	Prices of farm products	0.082	0.021	-0.04	0.033	0.033	-0.056
	Place to sell farm produce	0.028	-0.118*	-0.108	0.033	-0.055	0.036

CHAPTER FIVE: RECOMMENDATION AND CONCLUSION

5.1 Introduction

To wrap up this thesis, a brief overview of the issues tackled and the key result and recommendations is presented. A complete list of references for further details on different issues mentioned in this thesis is also presented.

5.2 Recommendations

In this analysis, we reviewed and analysed a case study of farmers in Tanzania. The original survey had been performed in a bid to assess the impact different interventions had on agricultural productivity of small scale farmers. The literature review also presented a comprehensive overview of issues previous analysts have focused on with regards to analysing data resulting from agricultural interventions surveys. It was evident that while past research mainly focused on assessing productivity as a function of access to agricultural technology, land size, use of inputs, good agronomic practices/animal husbandry etc. using various statistical models, little had been done in assessing the impact farmer attitude had on agriculture productivity in general. While there is enough justification to expect that these factors would have a significant impact on productivity, there is reason to expect that other more subtle and farmer specific attitudes would also have an impact on productivity.

In this analysis, our aim was to first identify various attitudinal segments in farmers Tanzania. Six attitudinal segments corresponding to themes such as information focus, negativity, change orientation, passive dependence, heritage and resigned unhappiness were extracted using factor analysis. The composition of these attitudinal segments was such that we could expect them to at least indirectly affect productivity. For instance, for the negativity theme, farmers who were not willing to change their farming status quo or make any improvements in farming hence we would expect that their on farm productivity would remain if not deteriorating.

A further step entailed regressing the various attitudinal segments on elements that had been shown in

past analysis to have an impact on productivity. In the first stage, each of the attitudinal segments was regressed on each of the covariates, and then on a later stage, a multivariate regression analysis performed. In modelling the data, the model was parameterised such that an estimate of the baseline average attitudinal score (intercept) and the rate of change of the attitudinal score as the covariate of interest changes(slope) could be obtained. This allowed for us to test for whether the variables affected each of the attitudinal segments differently for an average farmer profile (average age, zero standardised income, zero years of education, and negative response on dichotomous variables). This was important because the ultimate goal of this thesis was to generalize these results to Kenya, thus if findings were to suggest presence of significant differences then more caution would be needed while generalizing the results to Kenya.

This analysis has shown that for some of the covariates, there were no significant baseline differences in the average score for different attitudinal segments. Baseline profiles correspond to profiles of an average farmer in terms of the particular attribute for example age, or in the case of categorical covariates, a person with the baseline response e.g. no reported farm input usage. In such a case, the baseline effects observed in Tanzania could be generalized to other countries with similar profiles. Moreover, for the slope estimates, similar inference can be made.

5.3 Conclusions

Findings reveal that farmers are likely to have varied performance on the farm depending on their attitude towards farming. Six components corresponding to different themes of farmer attitudes were obtained. These are:

a. Information focus-always seeking information to improve;
b. Negative-don't tell me to change, status quo is safer';
c. Change orientation-very keen to see what new farming technologies are out there;
d. Passive dependence-quite dependent on other people, cannot start something until they have seen success with other farmers, these are laggards;
e. Heritage-'Farming is my destiny', traditional farmers who also often stick to what they have carried on from their parent;
f. Resigned unhappiness- 'No hope to improve so would prefer to be something else', they do farming for lack of something else to do.

From regressing attitudinal segments onto the various factors, On average, an increase in the covariates studied here **reinforced positive attitudes** such as **information focus** and **lowering** the score for **negative attitudes** such as **negativity**.

Specifically,

1) The years spent in school had little impact on the attitudinal segments. There was a significant influence of additional years of schooling particularly on five of the six attitudinal segments (apart from information focus)

2) A one year change from the average (41 years) in age resulted in a significant reduction in the score for resigned unhappiness although there was no significant impact of age on the other five attitudinal segments.

3) Farming experience did not significantly influence the rate of change in all the attitudinal aspects for a farmer with an average of 27.7 years of farming experience. However, there was a significant difference in the score of passive dependence, heritage and resigned unhappiness as years of farming experience increased

4) Overall, income had a significant effect on negativity and passive dependence only for a farmer with the reported average farming income (Tsh 899,054⇔ Ksh 56,190). The rate of change of farming income was however significantly influenced heritage and resigned unhappiness

5) Through factor analysis the concept adoption variable was found to have five components; Insurance, new maize, farmer helpline, farmer training and processing. All the five components of the latent variable concept adoption had low factor scores between 23 and 30%, an indication that there was no much differentiation in preference across the various concepts available for farmers. For a respondent with a zero score on concept adoption, there was no significant impact in the average score on the six attitudinal segments. An increase in the concept adoption score however resulted to a significant increase in the score for change orientation and passive dependence while it resulted to a reduction in the average score for heritage and resigned

unhappiness

6) Farmers with Information focus and change orientation attitudes and some extent the Heritage attitude were more proactive in searching for market and other relevant information on farming than the rest.

Programmes that are working at improving on-farm productivity among farmers should be cognisant of farmer attitudes and their potential to either positively or negatively affect behaviour change in improving on farm practices

In conclusion, the analysis presented in this thesis forms a basis for further research into the impact different attitudes having influenced farmer behaviour, affects farmers' on farm productivity. It will interesting to be able to do the same analysis using data from Kenyan farmers to validate the assumption that smallholder farmer profiles in Tanzania are similar to those in Kenya.

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