MODELLING THE RELATIONSHIP BETWEEN FARMER'S ATTITUDE TOWARDS FARMING AND FARM PRACTICES: A CASE STUDY OF SMALLHOLDER FARMERS IN TANZANIA

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Abstract

Different models have been used in analyzing agricultural data to establish the level of agricultural productivity. This is traceable to various factors including land size, use of inputs, use of extension and modern technology, labour, capital etc. However, few researchers have tried to understand the attitudes of farmers towards farming and how this affects their on-farm practice. A TNS Global farmer's study in Tanzania funded by Bill and Melinda Gates 2011 has focused on farmer's agricultural productivity. This was accomplished using a mix of Simple Regression and descriptive analysis based on 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 the land productivity. But those who actually improved on-farm practice were less than 50% of the target population. However, the entire population was exposed to the same treatment by the project. This is definitely an interesting result. Also, one would wish to understand why the success rate is that low. In this study, we have used the TNS data to try and understand if farmer's attitude towards farming has a relation with their positive change in practice which would likely increase production. We attempted the 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***- "always seeking information to improve", ***Negative*** – "don't tell me to change, status quo is safer", ***Change orientation –*** "very keen to see what new farming technologies are out there"**,** ***Passive dependence –*** "quite dependent on other people, who cannot start something until they have seen

success with other farmers; these are laggards"**, *Heritage* -** "Farming is my destiny", and **Resigned unhappiness** - "No hope to improve; so would prefer to be something else". Furthermore, we used regression analysis to assess the impact of various other observable variables on the attitudinal segmentation. Thus, this revealed a positive relationship between farmer's attitudes and their level of agricultural productivity. This is with the more positive information focused farmers showing energies to perform well, while the negative ones who have not very good attitude are 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 of different attitudes of farmer's productivity.

Keywords: *Farmer* attitude, modelling, regression, factor analysis, principal component analysis

Background to the Study

Introduction

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 two (2) billion people. Thus, this is almost one third of the world's population. These smallholders, whose main economic activity is farming, are struggling continuously to live modestly. They also find it difficult to feed their families due to low agricultural productivity catalysed by the many challenges they face. Thus, these challenges include: 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). Due to their being located in remote areas, they do not get support from research and extension services.

Consequently, agricultural productivity is one of the key determinants of high and sustained agricultural growth. In fact, it is a key determinant of its growth over the longer term. Faster agricultural growth has put countries on the path of a much broader transformation process. Thus, these transformation processes include rising farm incomes raising demand for industrial goods, lowering of food prices, curbing inflation and inducing non-farm growth, and creating an additional demand for workers. 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 (Harvey, 2006; World Bank, 2008). Additionally, as Gollin, Parente and

Rogerson (2002) underscore, rising agricultural productivity releases farmers for other activities, leading to structural transformation needed for Africa's income to catch up with more advanced economies.

Countries with abundant land or rapid expansion of off-farm work have expanded the area cultivated per worker by adopting labour-saving technologies. Given the relative abundance of land in the case study countries, a temporary sectoral growth strategy reliant on the expansion of area could be considered to be consistent with their resource endowments (Gordon, 2008). It would follow the historic path of other land-rich countries, such as Argentina, Australia, Canada, the Russian Federation, and the United States. In those countries, labour productivity rose sharply as additional land was brought into cultivation. Growth was accompanied by marked structural change in farming and by rapid technological adoption that reduced the labour requirements in agriculture. Over the longer-term, technological improvements and productivity gains would need to drive agricultural growth in East Africa as well.

Smallholder farming is the backbone of African agriculture and food security. Of the two-thirds of sub-Saharan Africa's population that resides in the rural areas, majority can be considered as smallholder farmers. Their importance is derived from their prevalence, their role in agricultural and economic development, and the concentration of poverty in the rural areas. The term 'smallholder' refers to their limited resource endowments relative to other farmers in the sector.

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 1 ha of land. Thus, they may cultivate 10 ha or more in semi-arid areas, or may 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 percent to about 78 percent (FAO 1997).

Most smallholders have diverse sources of livelihood which includes a significant off-farm income. Thus, they are still vulnerable to economic and climatic shocks. Their characteristics differ by country and farming system zone. For example, not only does smallholder farm size vary (as indicated above), but also their allocation of resources to food, cash crops, livestock and off-farm activities; their use of external inputs and hired labour; the proportion of food crops which are sold; and their household expenditure pattern.

The experience of four East African countries and their strategies for agricultural growth can be also viewed in the global context. The international experience shows that countries that have achieved sustained agricultural growth have done so by adopting technology, which led to an increased joint productivity of land, labour, and capital (that is total factor productivity). Furthermore, whether the pattern of technological change has been labour saving or land saving is dependent on which factor is relatively scarce. It is posit that technology adoption and expanding land holdings of individual smallholders i.e. changes in factor ratios, lead to productivity gains.

However, 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 labour productivity at the expense of land productivity. Research underscored the role of economic incentives and high returns on technological adoption, agricultural innovation, and most importantly farmer's attitude.

The cereal yield per hectare remained virtually unchanged in all four countries during 1980 – 2007. However, this 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 staples such as rice and maize are only about one-half to one-third of what they could be. Thus, this is with the proper application of fertilizers, irrigation, and seeds. Similarly, the agricultural value added per worker in the four countries has shown an upward trend during the last five years. Thus, this is with the average level far below that of the world average level. In addition, short of the level is needed to reduce rural poverty.

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 the total employment. Agriculture has been a key driver of the country's economy for over four decades. Therefore, it is the main source of livelihood for close to 80% of Kenyans living in the rural areas. This is according to world bank's world development indicators and KARI report 2012. The agricultural sector in Kenya is mainly composed of small-scale farming in areas with significant potential. Nationally, average farm size was less than 2 hectares (or approximately 5 acres) in 2010. However, a number of core challenges to small-scale farming in Kenya has remained. These include 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.

Smallholders in African counties continues to face such challenges which significantly limit the productivity and farm yields of farmers, which are quite low on an average.

Statement of the Problem

Poor productivity remains a key challenge for smallholders in most African countries. This is with the 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 are changing it for better, while others are remaining the same.

Many researchers have conducted studies and have 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, and good agronomic practices/animal husbandry etc using various statistical models especially linear regression analysis.

The studies however do not make attempts to understand different farmer's attitudinal profiles and how the varied profiles would affect their on-farm practice. This study seeks to understand smallholder farmer's attitudes and segment farmers according to the different farmer's attitudes using Factor Analysis based on Principle Component Analysis (PCA). Furthermore, it evaluates the relationship between attitudinal segments and various variables or covariates of interest such as farmers' age, years of formal education, and income from farming amongst others using (simple and multiple) regression analysis methodology

Objectives of the Study

The general objective of this study is to evaluate the relationship between farmer's attitudes and their agricultural productivity. However, the specific objectives include:

1) To identify possible segments of farmer's attitudes based on 43 Likert scale type questions using factor analysis methodology.

2) Having identified these attitudinal segments, it aims to evaluate the relationship between attitudinal segments and various factors of interest such as farmer's age, years of formal education, and income from farming amongst others using (multiple) regression analysis methodology.

Literature Review

Kibaara et al. (2008) analyzed trends in agricultural productivity using a nationwide household panel survey in Kenya. Consequently, 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. Also, a
Cobb-Douglas production function was used for productivity analysis. Results showed a general growth in the productivity of the sectors, which is mainly due to increased percentage of smallholder households using fertilizer, adoption of improved seeds, availability of fertilizer retail outlets, and production of fodder crops.

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. Therefore, such improvements were probably prerequisites to make possible the increase in productivity from the use of conventional inputs and research. The study concluded that the education of rural labour force and agricultural research is needed to improve the future prospects for productivity growth in SSA. Wiebe et al. (2001) also examined the impact of agricultural policies and investment on productivity in sub-Saharan Africa especially in Zimbabwe and South Africa. Also, it compares the effects of agricultural policies and investments on commercial and smallholder agriculture using previous studies.

Specific Factors Influencing Agricultural Production

Age

The age of farming household heads was observed to have an inverse relationship with the productivity of farmers in the studies of Adeoti (2002), Ajibefun et al. (2002, 2006), and Idjesa (2007). Thus, this study was carried out in the humid forest, dry savannah, and the moist savannah regions of Nigeria.

Land Ownership

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

Education

Findings by Adeoti (2002), Ajibefun et al. (2002, 2006), Idjesa (2007), and Kehinde (2005) indicated that education enhances productivity

among farming households in the humid forest, dry savannah, and moist savannah agro-ecological zones of Nigeria and in New England.

Social Network

According to Idumah (2006), social capital enhanced productivity among crop farmers since social capital tends to promote membership welfare and reduce conflict. However, this is important for enhancing the productivity of farming households.

Farm Size

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

Gender

The connection between agricultural productivity and gender was studied by Adekanye (1988) and Odii (1992). Odii (1992) observed that the contribution of female farmers to agricultural productivity was highly significant. Adekanye (1988) offered evidence of gender differentials in agricultural productivity in Nigeria with women's lower productivity arising from their weak bargaining position within the family and in the labour market. Further support for this gender bias in Africa is derived from the fact that women have far less access to land and other productive inputs (Babalola, 1988). Other factors such as dependency ratio, labour access to chemicals and credit, have been studied by researchers such as Akinseinde (2006), Adebayo (2006), Ajibefun et al. (2002), Ogundele and Okoruwa (2006), and Tella (2006). Mochebele and Winter-Nelson (2002) investigated the impact of labour migration on technical efficiency performance of farms in Lesotho. Nkonya et al. (2005) also showed that purchased seeds had a positive impact on a farmer's productivity in Uganda.

Methodology

Factor Analysis

Factor analysis (Johnson & Wichern, 2007) is a dimension reduction technique that renders itself useful in the analysis of Likert scale questions in psychological studies and other surveys. 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. Either confirmatory factor analysis or exploratory factor analysis can be used to provide a tool for confirming whether the observed data actually exhibits latent structure.

In this study, 43 Likert type questions addressing farmer's attitudes towards farming were collected. Thus, 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.

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

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

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

$$\begin{aligned} \mathbf{X}_1 - \mu_1 &= l_{11}F_1 + l_{12}F_2 + \ldots + l_{1m}F_m + \varepsilon_1 \\ \mathbf{X}_2 - \mu_2 &= l_{21}F_1 + l_{22}F_2 + \ldots + l_{2m}F_m + \varepsilon_2 \\ &\vdots \\ \mathbf{X}_p - \mu_p &= l_{p1}F_1 + l_{p2}F_2 + \ldots + l_{1p}F_m + \varepsilon_p \end{aligned} \quad \ldots\ldots (2)$$

Here, $l_{11}, l_{21} \ldots, l_{p1}$ 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. PCA seeks the linear combinations as shown in Equation (2) which 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 scree-plots, eigen value check, tests for sphericity, and measure of sampling adequacy were performed. In presenting the results of the factor analysis, each of the components was assessed with regard to the general attitudinal theme that the questions represent (hereafter, it was referred to as the attitudinal segments) and labelled accordingly. Thereafter, these attitudinal segments were used for regression analysis.

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. They include:

(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 to be significant in the first step were used in fitting a multiple linear regression model for each of the attitudinal segments derived.

However, we presented a general formulation of the simple and multiple linear regression models to be considered.

Let Y_{ijk} be the i^{th} score (outcome) for the k^{th} attitudinal segment for the j^{th} covariate; and X be 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 following 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. Application of the methodology to the data

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 0.899 which is an indicator that the sample is adequate in describing the underlying latent constructs. This is expected considering that the sample size was large enough to be a representative (n=6607). 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 1. KMO and Bartlett's Test 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

Data Analysis and Results

Exploratory Data Analysis

The first thing to note is that the six extracted components are already standardized values. Hence, they 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 two (2) standard deviations interval.

Figure 1. A normal density curve of the 8 covariates overlaid on the histogram

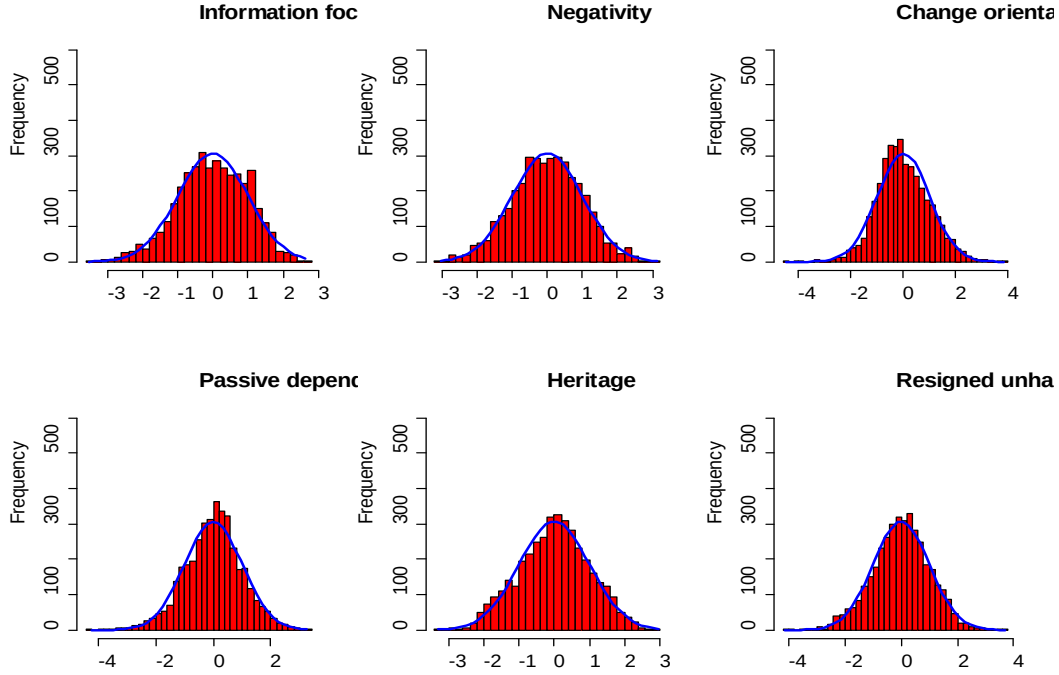

Table 1. A normal density curve overlaid on the histogram

	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

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. However, the slopes correspond to the rate of change of the particular element. A simple illustration is provided with the model for age as follows

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

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 were applied. Future research focus may be in identifying a subset of these covariates that best describes the attitudinal segments.

Overall Significance of the Covariates on Attitudinal Segments

The table below 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 which 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 an illiterate and who is not motivated by adapting new farming methods.

On the other hand, overall significance of slope estimates in the table is an indicator of the differences in evolution of the attitudinal segments. For instance, age had a significant impact on the 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. However, this is 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 2. Summary of the regression coefficients and overall significance of the eight covariates in their impact on the attitudinal segments *: P-values <0.05.

Parameter	Country	Information focus	Negativity	Change orientation	Passive dependence	Heritage	Resigned unhappiness
Baseline estimate	Tanzania	-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	-0.021	0.05	0.075*	0.111*	-	-0.07*

	adoption		1*			0.022	
	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

Conclusion

In conclusion, the findings of this study reveal that farmers are likely to have varied performance on the farm depending on their attitude towards farming. However, six components corresponding to different themes of farmer attitudes were obtained. These are:

1. Information Focus: Always seeking information to improve;
2. Negative: Don't tell me to change, status quo is safer';

3. Change Orientation: Very keen to see what new farming technologies are out there;
4. Passive Dependence: Quite dependent on other people, who cannot start something until they have seen success with other farmers; these are laggards;
5. Heritage: 'Farming is my destiny', traditional farmers who also often stick to what they have carried on from their parent;
6. 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 such as age, level of education, and income for some of the covariates, there were no significant baseline differences in the average score for different attitudinal segments.

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). Consequently, 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.

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 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 increases.

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 by heritage and resigned unhappiness

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%. Hence, this is 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 in a significant increase in the score for change orientation and passive dependence. Furthermore, it resulted in a reduction in the average score for heritage and resigned unhappiness.

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

It is therefore important for programmes that are working at improving on-farm productivity among farmers to be cognisant of these attitudes and their potential to either positively or negatively affect the desired change. They will then be able to develop interventions that would be the most effective, given the circumstances.

In conclusion, the analysis presented in this thesis forms a basis for further research on the impact different attitudes have on farmers' productivity. Thus, we acknowledge that much more research ought to be done in assessing the impact that these attitudinal segments would have directly on productivity.

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