Assessment of the influence of attitude and benefit-risk perceptions on yield variability among smallholder peri-urban commercial kale farmers in Wangige, Kenya

By:

Kelvin M. Shikuku
Carl Johan Largerkvist
Julius J. Okello
Nancy Karanja
Chris Ackello-Ogutu

Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia

102- Assessment of the influence of attitude and benefit-risk perceptions on yield variability among smallholder peri-urban commercial kale farmers in Wangige, Kenya

Kelvin M. Shikuku*[1], Carl Johan Largerkvist[2], Julius J. Okello[1], Nancy Karanja[1], Chris Ackello – Ogutu[1]

*Corresponding author (email: chishkelvin@yahoo.com)

1 University of Nairobi, Kenya

2 Sweden University of Agricultural Sciences

Abstract

Declining soil fertility largely explains the gap between actual and potential yield among smallholder farmers in sub-Saharan Africa. This study investigates the relationship between yield variability in smallholder commercial kale (*Brasica oleracea)* production in Kenya and farmers' attitudes for integrated soil fertility management (ISFM) as well as the relationship to a domain-specific risk-benefit preference scale. Data was collected from 125 peri-urban commercial kale farmers through personal interviews conducted by trained enumerators using a pre-tested questionnaire. Results of ordinary least squares regression indicate that farmers with strong attitudes in favour of ISFM experience decreased variability in yields. A significant negative relationship was observed between farmers expectation of benefits associated with soil fertility management technologies and yield variability. Farmers' risk perception associated with the use of nonconventional soil fertility management practices, particularly the use of human faecal manure, increase variability in yields. However, risk perception associated with the use of conventional soil fertility management practices including application of animal manure, chemical fertilizers, crop rotation and use of crop residues significantly reduce yield variability. Individual farmers base their choice of ISFM practices on their assessment of both risks and benefits. It is argued, therefore, that in order to scale-up adoption of ISFM, policy should focus on increasing farmers' access to information on the benefits associated with the practices while improving farmers' perceptions of the risks associated with the use of non-conventional technologies such as human faecal manure by addressing farmers' health concerns.

Key words: Attitudes, perception, benefits, risks, peri-urban farmers

1.0 Introduction

Risk plays an important role in farmers' investment decisions (Knight *et al.* 2003). An important measure of production risks is the gap between potential and actual yields which is majorly explained by the declining soil fertility in developing countries (Sanginga and Woomer, 2009). The increase in demand for food resulting from the growing human population has led to soil mining without due replenishment of soil nutrients (Shisanya *et al.* 2009; Henao and Baanante, 2006). Consequently, low soil fertility is a major contributing factor to the vicious cycle of low agricultural productivity, low incomes, and amplified poverty among smallholder farmers (Sanchez *et al*., 1997).

Kenyan farmers have an array of soil fertility management technologies that can be used to narrow the gap between the expected and actual yield (Odendo *et al.* 2010; Macharia *et al.* 2006). Organic soil amendments such as livestock manure, crop residues, green manure, and human faecal manure are potential technologies that have been used to supplement or substitute for expensive mineral fertilizers (Sanginga and Woomer, 2009; Akinola *et al.* 2009). Cultural practices such as crop rotation and intercropping as well as fallow cropping are also widely used (Place *et al.* 2003). The success of these technologies at enhancing soil fertility has however, been partial. Moreover, the degree of adoption of the technologies varies due to the differences in the demand for labour/effort (i.e., difficulty levels) associated with individual technologies.

The use of different soil fertility management technologies entails some benefits. Such benefits include improved crop yields, increased soil fertility, reduced fertilizer costs, and their overall contribution to sustainable agriculture. However, there are also risks associated with the use of technologies. Such risks include the lack of adequate amounts of livestock manure, competition for land between green manure production vis-à-vis food production, lack of enough crop residues, accumulation of heavy metals in the soil, and the possibility of disease infection from pathogens that might be in the manures.

Empirical evidence shows that in making their decisions to produce, farmers weigh alternatives among technological choices available (Barrett *et al.,* 2004). People's choices are a result of the trade-offs between the perceived benefits and risks of a particular technology (Kalogeras *et al*. 2012; Ueland *et al*. 2012). In the context of this study, perceived benefits have to do with those attributes that make a particular soil fertility management practice attractive to the farmer. On the other hand, risk perception is associated with the adverse consequences attached to the use of a particular technology and is defined as the subjective judgment of the probability of a specified type of a risky event (Ahsan, 2011; Ahsan and Roth, 2010; Sjoberg, 1998). An individual's risk perception is thus a function of the probability of a loss occurring as well as the potential effects of such a loss should it occur. Kalogeras *et al.,* (2012) argues that although both benefits and risks can be measured and studied separately, benefit and risk perception are often correlated. If there is a greater benefit associated with a product, more risk can be accepted thus reinforcing that there exists a trade-off between benefits and risks (Ueland *et al.* 2012).

Several studies have looked at farmers' decision making under risk. Nyikal and Kosura (2005) assessed farmers' risk preference and optimal enterprise combinations using quadratic programming approach. Olarinde *et al.* (2008) using the Target Minimization of Total Absolute Deviation (T-MOTAD) approach associates the lack of a prior analysis of attitude towards risk inherent in new technologies and the inability to ascertain farmers' trade-off between risk and return with the limited success in rural development programmes. Subsequently, cooperative marketing, contract farming, and diversified production are important strategies that farmers might use to reduce risks (Ahsan and Roth, 2010). Other studies have emphasized the importance of improving and diversifying the skill base of households and developing the rural non-farm (Karugia *et al.* 2006; Legasse and Drake 2005).

While these studies provide useful insights on the role that risk plays and the different ways of coping with the risks, farmers evaluate technologies based on their expectations of benefits and perception of risks. Hence, two domains, namely benefits and risks determine farmers' risk preferences. Although studies on risk preference consider the expected utility theory (EUT) as the underlying approach to measuring risk preferences, EUT does not measure domain-specific risk preferences. Expected utility theory (EUT) explains risk preference as a function of economic factors by measuring the curvature of farmers' utility functions. Hence, concave utility functions indicate risk aversion convex utility functions indicate risk loving (Lusk and Coble, 2005). Moreover, EUT violates the assumption of consistency of preferences (Abrahamsen and Aven, 2008; Kahneman and Tversky, 1979).

Therefore, psychometric approaches have been proposed as an alternative to EUT (Kalogeras *et al.* 2012; Ueland *et al.* 2012; Pohjola *et al.* 2012; Tijhuis, *et al.* 2012; Magnússon *et al.* 2012). Psychometric approach directly measures farmers' preferences for risks by asking individual farmers to respond to a set of statements on a Likert scale related to the sources of risks (Ahsan, 2011; Legesse and Drake, 2005). Hansson and Lagerkvist (2012), using a psychometric approach, argue that farmers' risk preferences are domain-specific and that farmers might be more risk averse in one domain and risk loving in another domain. A psychometric approach, therefore, allows for simultaneous risk aversion and risk loving among farmers in different domains.

ISFM involves both conventional[1] and non-conventional[2] technologies with associated benefits and risks. Hence, farmers' risk preferences related to ISFM is likely to be specific to the two domains but has not been adequately explored. Consequently, it is not well known how farmers evaluate potential benefits and risks associated with ISFM and how they form domain-specific risk preferences based on the trade-offs between the benefits and risks. This

[1] Conventional technologies as used in this study refers to animal manure, chemical fertilizer, crop residues and crop rotations)
[2] Non-conventional technologies in this study refer to human faecal manure, deep-rooting green manure, improved fallows, and biomass transfer).

study, therefore, specifically seeks i) to assess the influence of farmers' attitudes on yield variability; and ii) to assess the effect of farmers' domain specific benefit-risk preferences towards soil fertility enhancing technologies on yield variability.

2.0 Theoretical framework

The most commonly used approach for assessing decision making under risk is the expected utility theory (Teklewold and Kohlin, 2010; Binici *et al.* 2003; Lusk and Coble, 2005; Buschena and Zilberman, 2001; Buschena and Zilberman, 1999). The theory states that the choice facing a farmer (as a consumer of technologies) takes the form of a lottery with probability (p) of winning a prize x and (*1-p*) of winning a prize y. Defining the lottery therefore, as: $p \circ x \oplus (1-p) \circ y$, it is assumed that a farmer will not care about the order in which the lotteries are described and that a farmer's perception of a lottery depends only on the net probabilities of receiving the various prizes. Assuming further that an individual farmer's preferences are complete, reflexive, and transitive, the theory deduces the existence of an ordinal utility function that describes the farmers' preferences under risk. The expected utility function can be defined as:

$$Eu(x,y) = pu(x) + (1-p)u(y) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

Accordingly, an individual will choose one prospect over another if and only if the expected utility is larger for the chosen prospect than for the other prospect.

The expected utility theory has, however, been criticized on descriptive grounds (Ahsan, 2011; Rabin and Thaler, 2001). These studies argue that the expected utility theory fails to explain actual human behaviour. Kahneman and Tversky (1979), for example, argue that since utilities in the expected utility theory are weighted by their probabilities, people overweight outcomes that are considered certain relative to outcomes which are merely probable. Kahneman and Tversky (1979) define this tendency as the certainty effect and argue further that it contributes to risk aversion in choices involving sure gains and to risk-seeking in choices involving sure losses. The authors indicate that certainty effect leads to inconsistent preferences thus violating the expected utility theory.

Ueland *et al.,* (2012) argues that in addition to knowledge of risk probabilities and outcomes, people also take into account their beliefs, attitudes, and dispositions as well as social and cultural concerns in their perception of risks. The increasing recognition of the role of beliefs and attitudes in explaining human behaviour has led to the development and use of the psychometric multi-item scale approach (Hansson and Lagerkvist, 2012; Fischer and Frewer, 2009; Fischer *et al.,* 2006; Pennings and Garcia, 2001).

The psychometric approach measures constructs such as risk attitude by asking respondent to indicate the extent to which they agree or disagree with a set of statements. Recent studies measure attitudes, using the Rasch model, as a direct reflection of behaviour and the cost of performing the behaviour (Kaiser, *et al.*, 2010). Attitudes are thus measured as an arithmetic difference between peoples' abilities to perform a particular behaviour and the cost associated with the behaviour. Consequently, a person is said to have a strong attitude for something if the ability parameter is higher that the costs parameter.

Kalogeras *et al.,* (2012) argues that benefits and risks perception is context-specific. Decision makers can simultaneously be risk averse in some domains and risk-seeking in others. A domain-specific approach of assessing risk preferences is thus recommended (Hansson and Lagerkvist, (2012). Moreover, benefit and risk perception are to some extent inversely correlated, so that when something is perceived as being highly beneficial, it is correspondingly perceived as having low risk (Ueland *et al.,* 2012). It seems that if there is a greater benefit associated with a product, more risk can be accepted, thus, a certain trade-off between benefits and risks are present.

The statements captured on a Likert scale are subjected to exploratory factor analysis (EFA) in order to identify the dimensions in the data. Factor analysis identifies variables that correlate highly with a group of other variables, but with as little correlation with variables outside of that group as possible. The variables with high inter-correlations are said to be loading (i.e. representatives) of an underlying variable called a factor. Based on the factor, factor loadings are computed as correlations of the original variables with the factor. Squaring the factor loadings determines the amount of variance accounted for by that particular variable (Woods and Edwards, 2007).

3.3 Data and empirical methods

3.3.1 Empirical methods

Exploratory factor analysis was conducted in stata 10 in order to extract the benefit and risk domains and their respective factor scores. To facilitate interpretation of the factor matrix, oblique (oblimin) rotation was used because it allows for correlations among the factors. The factor scores were then regressed on the coefficient of variation in yield to explain the influence of expected benefits and risk perceptions on variability. Kaiser-Meyer-Oklin's (KMO) overall measure of sampling adequacy was used to test the suitability of the data for factor analysis. The individual and overall KMO has to be at least 0.5 to be factorable (Hansson and Lagerkvist, 2012; Hair *et al.*, 2010). The number of factors to retain was guided by the Eigen values. Factor loadings of 0.4 are considered significant (Hansson and Lagerkvist, 2012; Hair *et al.,* 2010). Additionally, item-to-total correlation, and Cronbach's alpha were evaluated to assess the reliability of the measurement scales obtained (Hair et al. 2010).

Risk was measured using a coefficient of variation (CV) in yield. Anderson *et al.* (2007) argues that CV gives a better measure of risk compared to other measures such as the range and variance. The author, for example, indicates that using the range as a measure of risk might not be adequate since it is based on only two of the observations and so is highly influenced by extreme values. Although using the interquartile range (IQR) overcomes the dependency on extreme values, IQR also makes use of only two of the observations. Anderson *et al.* (2007) further indicate that the squared units associated with variance makes it difficult to obtain an intuitive understanding and interpretation of the numerical value of the variance. Weber *et al*. (2004) defines the coefficient of variation (CV) as the standard deviation (SD) that has been standardized by dividing by the expected value (EV) and argue that it provides a relative measure of risk, i.e., risk per unit of return. Several authors have also used CV as a measure of risk (e.g. Pang *et al.* 2008; Weber, 2004, Weber *et al.* 2002). This study therefore, found CV as an adequate proxy for risk. CV is calculated as a ratio of standard deviation to the mean as shown in Equation 3.2.

$$CV = \left(\frac{standard\ deviation\ of\ (y)}{mean\ of\ yield\ (y)}\right) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 3.2$$

Where ‘CV’ is the coefficient of variation in yield and was calculated for a period of three years (2009 – 20011).

In order to explain variation in yield, ordinary least squares regression (OLS) was estimated, using Stata version 10, according to equation 3.3:

$$Ln\ cv = \sum_{i=1}^{15} \beta_i X_i + \varepsilon \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 3.3$$

Where *ln cv* is the natural logarithm of the coefficient of variation in yield and X_i is a set of explanatory variable as described in Table 3.1. B_i is a set of parameters to be estimated. The random error term (ε) is assumed to be normally distributed with mean (μ) equal to one and a constant variance (δ).

Table 1: Description of explanatory variables

Variable	Description
Totsc	Persons total (a measure of attitude) score from the Rasch analysis
Ben_noncov	Extracted factor representing farmers benefit perception in the domain of non-conventional practices
Ben_conv	Extracted factor representing farmers benefit perception in the domain of conventional practices
Risk_nonconv	Extracted factor representing farmers risk perception in the domain of non-conventional practices
Risk_conv	Extracted factor representing farmers risk perception in the domain of conventional practices
Distmkt (km)	Distance in km to the nearest local market
Fultmemp	Dummy Variable: 1 if full time employed; 0 otherwise
Educ	Number of years of formal education
Grp	Dummy variable: 1 if a farmer belongs to an agricultural group or association; 0 otherwise
Irrigate	Dummy variable: 1 if a farmer irrigates kale plots; 0 otherwise
Credit	Dummy variable: 1 if a farmer access credit; 0 otherwise
Gender	Dummy variable representing the gender of the farmer: 1 if male; 0 otherwise
Kplvsk	Dummy variable representing livestock ownership: 1 if a farmer owns livestock and 0 otherwise

Expr	Farmers experience in number of years of growing kale
Localtrd	Dummy variable: 1 if a farmer sells to local traders; 0 otherwise
Urbantrd	Dummy variable: 1 if a farmer sells to urban traders; 0 otherwise
Hfecal	Dummy variable: 1 if a farmer would use human fecal manure if animal manure became unavailable; 0 otherwise

Assumptions of OLS including normality, homoscedasticity, no multicollinearity, and model specification were tested for to ensure adequacy of the model.

Farmers' attitudes were measured using Rasch uni-dimensional measurement model (RUMM 2030) software. Persons' total scores were therefore generated as measures of attitudes reflecting the number of practices an individual farmer engages in to enhance soil fertility. The extracted principal factors from the factor analysis were used in the regression as a measure of the influence of the respective benefits and risks domains on yield variability.

3.2 Data

Primary data was collected from 125 peri-urban commercial kale (*Brasica oleracea)* farmers through personal interviews conducted by trained enumerators using a pre-tested questionnaire. Two administrative locations (Ruku and Chura) of Wangige were selected because they contained a large number of commercial kale farmers. A numbered list with the names of all commercial kale farmers was then compiled for each location. The names were sorted in ascending order and a probability proportionate sampling procedure used to sample seventy nine and forty six farmers from Ruku and Chura locations, respectively. Research randomizer was used to randomly generate the numbers to include in the sample. Wangige was purposively selected because it is one of the leading areas in commercial kale farming and is a major supplier of kale to the capital city, Nairobi. Kale is a high value crop and farmers in Wangige grow the crop with a motive of selling and making more profit. Soil fertility improvement is thus important for this category of farmers for increased yields.

Information on farmers' attitudes towards soil fertility management techniques, perception of the benefits of the specific technologies, and risk perception was obtained by asking farmers to respond to three sets of statements contained in the questionnaire. A binary Rasch scale was used to obtain responses on farmers' attitudes. Farmers were asked to respond to a set of thirty one statements by giving a yes / no answer to a particular soil fertility management practice to indicate whether they use the practice or not. In order to elicit farmers' perception of the benefits and risks associated with soil fertility improvement technologies, respondents were asked to consider 11 statements about actions suggested to affect yield. Two domains, namely benefit and risk, were constructed. Actions in the risk domain were worded as the negative of the suggested strategies in the benefit domain. For example, in the benefit domain, the strategy *combined use of chemical fertilizer and organic manure* was suggested to decrease the variability in yield. In the risk domain, this strategy was negatively worded into the form *not combining chemical fertilizer and organic manure* as an action that causes variability in yield.

The Likert scale for the benefits domain ranged from “not important at all (1)” to “very important (5)” indicating the extent to which farmers believed that using individual soil fertility management practices would increase soil fertility and reduce yield variability. The 5-point Likert scale for the risk domain ranged from “to a less extent (1)” to “to a very large extent (5)” to indicate the extent to which farmers thought not using a particular soil fertility enhancing technology would lead to low soil fertility thus yield variability.

4.0 Results and discussion

4.1 Characteristics of the respondents

Table 2 presents the characteristics of the farmers interviewed. As shown, the mean age of peri-urban commercial kale farmers was 47 years with mean years of experience of 19.36. Okello *et al.* (2012) found similar results. Older farmers are likely to adopt a technology because of their accumulated knowledge, capital and experience. However, the degree of risk aversion increases with age implying that at old age households might adapt less swiftly to a new phenomenon such as ISFM (Odendo *et al.* 2010). In addition, with advance in age, the ability of the household head to participate in strenuous manual activities such as application of manure decline and this might reduce the speed of the adoption of labour-intensive technologies.

The mean number of years of schooling was 8.4 indicating a higher level of literacy which implies that farmers are able to grasp information on soil fertility management. 48 % of the respondents were male indicating that commercial peri-urban kale farming is female dominated. Males tend to engage in non-farm activities such as running of small businesses and bicycle repairs. Most of the households, however, are male-headed with only less than 30% of the households being headed by females.

More than 80% of the farmers keep livestock of one type or another. This implies that farmers are able to obtain animal manure from their own farm hence substituting for expensive chemical fertilizer. Livestock keeping might also imply increased competition for crop residues between manure and fodder.

Table 2: Characteristics of survey respondents

Variable	Mean	Standard deviation
Age (years)	47.17	15.79
Gender (1=male; 0=female)	0.48	0.50
Education (years)	8.40	3.80
Livestock ownership(1=own; 0=not own)	0.88	0.33
Asset value (Kenya shillings)	91718	121218
Experience (Years)	19.36	14.49
Grow kale for sale and consumption on the same plot (1=yes; 0=no)	0.98	0.15
Irrigation (1=yes; 0=no)	0.74	0.44
Group membership (1=belong; 0=not belong)	0.49	0.50

Use of human faecal manure (1=yes; 0=no)	0	0
Neighbours using human faecal manure (number of persons)	0.02	0.13
Use human faecal manure if animal manure become unavailable (1=yes; 0=no)	0.42	0.50

1 US dollar was equivalent to 80 Kenya shillings at the time of the study

More than 70% of the farmers interviewed irrigate their kale while more than 90% of the farmers grow kale both for sale and home consumption on the same plot. Irrigation is an important complementary input to fertilizers and might reduce variability in yields. Growing kale on the same plot allows farmers to devote their time, inputs and energy on one plot. However, when kale for sale and home consumption is grown on the same plot, farmers might desist from technologies that they perceive are likely to be hazardous.

Results show that although farmers were not using human faecal manure, 42 % of the farmers indicated that they would use human faecal manure if animal manure became scarce. During the interviews, however, farmers reported that they would only use human faecal manure if it does not produce odour and is well sanitized, and certified by the government. The mean value of assets was 91,718 Kenya shillings.

4.2 Factor analysis

Exploratory factor analysis was used to extract the benefit and risk domains and their respective factor scores. The factor scores were then regressed on the coefficient of variation in yield to explain the influence of expected benefits and risk perceptions on variability. The rotated factor structure of farmers' benefit domains is displayed in Table 3. Item S2 had an individual KMO value of 0.4312 lower than the threshold of 0.5 (Hair *et al.* 2010). Moreover, the item-to-total correlations for items S2 and S7 were far below the required minimum of 0.2 (Kerlinger 1978). These two items were thus excluded from further analysis. After running the analysis again in the absence of the two items, item S3 was also dropped from subsequent analysis on the ground that it had a factor loading less than the threshold (0.4) set in this study. The items that were removed are displayed in italics in Table 3.

Table 3: Rotated factor matrix, benefit domains

Statement	Factor 1 Using nonconventional practices	Factor 2 Using common conventional practices
S1: Use of chemical fertilizer alone		-0.4601
S2: Use of livestock manure alone		
S3: Combined use of chemical and livestock manure		
S4: Incorporation of crop residues into the soil		0.5180
S5: Use of crop residues as mulch		0.8532
S6: Crop rotation with legumes		0.7712
S7: Leaving the farm fallow for sometime		
S8: Use of faecal wastes alone	0.8309	
S9: Combined use of faecal wastes and livestock manure	0.9680	
S10 Combined use of faecal and compost manure	0.9383	
S11 Use of other compost manure alone		0.4279
Overall KMO = 0.6985		
Item-to-total correlation range: 0.3695 – 0.4808		
Cronbach's alpha: 0.7106		

The Cronbach's alpha and the overall KMO of the final matrix was 0.7106 and 0.6985 respectively suggesting that the matrix is factorable (Hair et al. 2010). Two factors were retained in the final factor solution reflecting two benefit domains. Factor 1, interpreted as reflecting a benefit domain about use of nonconventional soil fertility management practices, comprised items about use of manure made from human faecal wastes alone or in combination with livestock and compost manure. Factor 2 comprised items relating to the use of chemical fertilizer, crop residues as mulch, incorporation of crop residues into the soil, and crop rotation and intercropping with legumes. This factor was interpreted as reflecting a benefit domain about use of the conventional soil fertility management practices.

The rotated factor structure of farmers' perceived risk domains is reported in Table 4. Items SS1, SS2, SS3, and SS4 were removed from the analysis because they had low values of corrected item-total correlations (< 0.2). The analysis was then re-run and one more item SS11 returned a factor loading of less than the threshold of 0.4 set in this study. The item was subsequently excluded from the analysis. All the items that were removed from the risk domains are displayed in italics in Table 4. The KMO of the final solution in the risk domains was 0.7128 while the Cronbach's alpha was 0.7889 suggesting that the matrix is factorable.

Table 4: Rotated factor matrix, perceived risk domains

	Factor 1	Factor 2
Statement	**Not using nonconventional practices**	**Not using conventional practices**
SS1: Not using chemical fertilizer alone		
SS2: Not applying livestock manure alone		
SS3: Not combining chemical and livestock manure		
SS4: Not practicing crop rotation with legumes		
SS5: Not using crop residues as mulch		0.8806
SS6: Not incorporating crop residues into the soil		0.8877
SS7: Not practicing fallow cropping		0.4423
SS8: Not using human faecal wastes alone	0.8333	
SS9: Not using combined human faecal manure and livestock manure	0.9792	
SS10: Not using combined human faecal manure and compost manure	0.9614	
SS11: Not applying compost manure alone		

Overall KMO: 0.7128
Item-to-total correlations range: 0.4474 – 0.5986
Cronbach's alpha: 0.7889

The exploratory factor analysis extracted two factors very similar to those in Table 3 and explaining a total variance of 72.16%. Thus, Factor 1 in Table 4 was interpreted as reflecting the perceived risk domain associated with not using nonconventional soil fertility management practices while Factor 2 was interpreted as reflecting the perceived risk domain associated with not using conventional soil fertility management practices. Moreover, communality was observed for the retained items. All the retained items had communality greater than the threshold value of 0.5 recommended by Hair *et al.* (2010). The results of factor analysis further show that the Bartlett's test of sphericity both in the benefit and risk domains was highly significant ($p < 0.01$), thereby indicating the adequacy of the sample taken to process the factor analysis.

4.3 Regression analysis

Table 5 shows results of the regression analysis. Both the unrestricted and restricted models were estimated. In the restricted model, variables that explained very little of the variability in the coefficient of variation in yield (Wald test *p-value = 0.9500*) were omitted. As shown in Table 5 the signs on the coefficients of both the restricted and unrestricted models are the same, indicating that the results are robust. The discussion below, therefore, focuses on the results of the restricted model.

Table 1: Linear regression results

	Unrestricted model		Restricted model	
Variable	coefficient	p-value	Coefficient	p-value
Intercept	1.46	0.192	1.22	0.218
Lntotsc	-0.78	0.071*	-0.78	0.036**
Ben_nonconv	-0.36	0.012**	-0.34	0.006***
Ben_conv	-0.29	0.023**	-0.27	0.027**
Risk_nonconv	0.32	0.003***	0.32	0.002***
Risk_conv	-0.26	0.078*	-0.24	0.081*
Grp	-0.63	0.038**	-0.64	0.029**
Irrigate	-0.65	0.047**	-0.66	0.033**
Educ	-0.09	0.013**	-0.08	0.015**
Lnexpr	-0.25	0.072*	-0.27	0.041**
Lndistmkt	0.30	0.096*	0.30	0.084*
Localtrd	-0.19	0.518	-	-
Urbantrd	-0.05	0.868	-	-
Kplvsk	-0.24	0.502	-	-
Credit	-0.14	0.747	-	-
Gender	0.03	0.908	-	-
Hfecal	0.09	0.751	-	-
Fultmemp	0.41	0.585	-	-

N=125
Dependent variable: lncv[3]
R^2: 0.49 ; p>F: 0.0000
Wald test: *p>F: 0.9928*

******* *indicates significance at 1%; ** indicates significance at 5%; while * indicates significance at 10%*

The mean variance inflation factor (VIF) was 1.45 with individual VIF range of 1.97 to 1.15 indicating absence of multicollinearity. Breusch-Pagan's test for Heteroscedasticity revealed constant variance *(p=0.1515).* Model specification was tested for using Ramsey's test. There was no evidence *(p>F=0.1113)* to reject the null hypothesis that the model had no omitted variables. The results of restricted model indicate that farmers' total score (a measure of attitude from the Rasch model) negatively and significantly *($p<0.05$)* influence yield

[3] cv stands for coefficient of variation in yield computed according to equation 3

variability. This implies that farmers with strong attitudes in favour of integrated soil fertility management (ISFM) technologies experience low volatility in yields. A strong attitude in favour of ISFM means that farmers view it favourable and try out several soil fertility management practices. Consequently, these farmers are able to improve soil fertility on their farms hence stability in yield.

The results show that variability in kale yield significantly decreases with farmers' expectation of the benefits associated with soil fertility management practices implying that the greater the perceived benefits the lower the variability in yield. Farmer's perception of the benefits associated with the use of nonconventional soil fertility management practices, specifically use of human faecal manure, significantly *(p=0.006)* reduces variability in yield. Similarly, the perceived benefits of using conventional soil fertility management practices such as the use of chemical fertilizer, livestock manure, crop residues, crop rotation, and intercropping with legumes significantly *(p=0.027)* reduces variability in yields at one percent level of significance. Consequently, farmers who have a strong preference for the use of conventional and nonconventional soil fertility management practices experience less variability in yields.

The results however, show that farmers' perception of risks associated with not using nonconventional soil fertility management practices increases variability in yields *(p=0.002)*. On the other hand, farmers' perception of risks associated with not using conventional soil fertility management practices reduces yield variability *(p=0.081)*. Farmers are conservative with regard to acceptance of technologies. Ueland *et al.* (2012) argue that in evaluating risks human beings favour traditional practices that are well known and that the same human beings are suspicious about practices that are not well known. Farmers' negative evaluation of the consequences of using human faecal manure might result to strong attitudes disfavouring use of the technology. Unfavourable attitude coupled with peoples' culture against use of human faecal manure might result to communities' classification human faecal manure as dirt.

Nevertheless, 42% of commercial peri-urban kale farmers indicated they would use manure from human faecal waste if cow manure became unavailable. This implies that farmers perceive that applying cow and human faecal manure could potentially increase soil fertility but they are cautious about use of human faecal manure. Farmers indicated that they were willing to use human faecal manure on condition that it is certified by the Government, is well packaged, and does not produce odour. The biggest concern of farmers regarding the use of human faecal wastes was that it is unhygienic and might cause diseases.

The results also indicate that irrigation significantly *(p=0.033)* reduces variability in yield. Irrigation is a complementary input to fertilizer and thus plays an important role to stabilize crop yield (Ackello-Ogutu, 2011; Alila and Atieno, 2006). The results further indicate that distance to the market significantly (*p=0.084))* increases variability in yield. An increase in the distance travelled to the market by one kilometre increases variability in yields by 30%. Distance constrains market access which affects input use due to the increase in costs of accessing the input. Munyua *et al.* (2010) argues that transaction and transport costs increase with increase in the distance travelled to the market and consequently constrain market access.

The results further indicate that education significantly *(p=0.015)* reduces yield variability. Human capital enables farmers to distinguish more easily technologies whose adoption provides net economic gains from those that do not. Hence education increases the speed of adoption of technologies. Wanjiku *et al.* (2003) also found that education influences adoption of soil fertility enhancing technologies such as biomass transfer.

Farmers' membership to groups significantly *(p=0.029)* reduces variability in yields implying that farmers who belong to producers and marketing groups are likely to obtain stable yields. Group membership reduces transaction costs by allowing information sharing, bulk buying, and bulk selling which allows farmers to exploit economies of scale (Wambugu *et al.*, 2009). Moreover, membership in farmer groups increases the chances for increased interaction among farmers thus facilitating the flow of information and learning for farmers. The results further indicate that a unit increase in years of experience significantly *(p=0.041)* reduces variability in yields by 27%.

5.0 Summary, conclusions and policy recommendations

Farmers face production risks in making decisions to adopt agricultural technologies. Whether a farmer will adopt or not a particular technology will thus depend on the degree of risk aversion based on the perceived benefits and risks associated with the technology. This study investigated the relationship between yield variability in smallholder kale production in Kenya and farmers' attitudes towards integrated soil fertility management (ISFM) as well as the relationship to a domain-specific risk-benefit preference scale. Attitudes for ISFM were measured according to a behavioural cost approach in line with the recent developments which posits that behaviour is a direct reflection of attitudes instead of attitudes being considered as a latent construct while emanating from a planned behavioural process.

The study finds a significant negative relationship between individual farmers' attitudes and yield variability indicating that farmers with strong attitude in favour of integrated soil fertility management (ISFM) experience reduced variability in yields. Farmers' perception of expected benefits both from the use of conventional technologies (such as crop rotation, intercropping, use of crop residues, leaving the farm fallow, livestock manure, and applying chemical fertilizer) and nonconventional soil fertility management practices (such as the use of human faecal manure) significantly reduce variability in yields. Moreover, farmers' perception of the risks associated with not using the conventional soil fertility management practices decreases yield variability. However, risk perception associated with not using nonconventional soil fertility management practices significantly increases yield variability.

The domain-specific risk-benefit measure recognizes that farmers' degree of risk-taking in one domain (a set of related soil fertility management practices) may not correlate with their risk-taking in another domain. Rather, the same farmer may be more risk-averse in one domain, and risk-taking in another domain. In this study farmers were risk takers in the domain of conventional practices and risk averse in the domain of nonconventional soil fertility management practices. The study further revealed that full-time farming, education, irrigation, and group membership significantly reduce variability in yields.

Improving soil fertility remains an important goal of the Government of Kenya. Policies geared towards promoting the flow of balanced information on soil fertility enhancing technologies should be encouraged. Enhancing information flow through effective communication of the true level of risk and the probabilities of being exposed to risk content by farmers could promote use of ISFM technologies. Since the benefit domain associated with the use of nonconventional technologies potentially reduce variability in yields focus should be placed on the ways that enhance the promotion of the manures. In Central Kenya, farmers are exposed to a wide range of traditional soil fertility management practices and majority keep livestock hence are able to obtain livestock manure. Development and subsequent dissemination of non-conventional technologies such as human faecal manure requires that attention be placed on addressing the concerns of farmers regarding the risks associated with the technologies. For successful adoption of such technologies, it is imperative to assure farmers of their health safety. Focussing on the extrinsic cues such as price, packaging and certification coupled with intrinsic cues such as odour, sanitation, and nutrient contents of the manures will promote the use of the manures.

Furthermore, stimulating agricultural growth and reducing yield variability requires complementary investment in irrigation, human and social capital, and infrastructure.

References

Abrahamsen, E.B. and Aven, T., (2008). On the consistency of risk acceptance criteria with normative theories for decision-making. *Reliability Engineering and System Safety* 93: 1906– 1910

Ackello-Ogutu, C. (2011) Managing Food Security: Implications of Food Price Shocks in Africa. *Journal of African Economies*, 20: i100–i141.

Ahsan, D.A. (2011) Farmers' motivations, risk perceptions and risk management strategies in a developing economy: Bangladesh experience. *Journal of Risk Research*, 14(3): 325-349

Ahsan, D., and Roth, E., (2010). Farmers' Perceived Risks and Risk Management Strategies in an Emerging Mussel Aquaculture Industry in Denmark; *Marine Resource Economics*, 25: 309–323

Akcaoz, H., Ozcatalbas, O., Kizilay, H., (2009) Analysis of Energy Use for Pomegranate Production in Turkey. *Food, agriculture and environment*; 7(2): 475-480.

Akinola, A., Arega, D., Adeyemo, R., Sanogo, D., and Olanrewaju, A., (2009). Economic Impacts of soil fertility management research in West Africa. AfJARE**,** 3(2)

Alila, P.O. and Atieno, R., (2006). Agricultural Policy in Kenya: Issues and Processes. *A paper for the Future Agricultures Consortium workshop, Institute of Development Studies.*

Anderson, D.R., Sweeney, D.J., Williams, T.A., Freeman, J. and Shoesmith, E., (2007). Statistics for business and economics. Thomson Learning, London.

Barrett, C.B., Moser, C.M., Oloro, V. M. and Barison, J., (2004). Better Technology, Better Plots or Better Farmers? Identifying Changes in Productivity and Risk among Malagasy Rice Farmers; *American Journal of Agricultural Economics*, 86(4): 869-888

Binici, T., Koc, A., Zulauf, C., and Bayaner, A., (2003). Risk Attitudes of Farmers in Terms of Risk Aversion: A Case Study of Lower Seyhan Plain Farmers in Adana Province, Turkey. *Turk J Agric For* 27: 305-312

Buschena, D.E., and Zilberman, D., (2001) Generalized Expected Utility, Heteroscedastic Error, and Path Dependence in Risky Choice. *Journal of Risk and Uncertainty*, 20: 67-88

Buschena, D.E. and Zilberman, D., (1994). What Do We Know About Decision Making Under Risk and Where Do We Go from Here? *Journal of Agricultural and Resource Economics*, 19(2): 425-445.

Fischer, R.H., Frewer, L.J. and Nauta, M.J., (2006). Toward Improving Food Safety in the Domestic Environment: A Multi-Item Rasch Scale for the Measurement of the Safety Efficacy of Domestic Food-Handling Practices. *Risk Analysis*, 26(5)

Frewer, L.J., Howard, C., and Shepherd, R., (1998). Understanding public attitudes to technology, *Journal of Risk Research*, 1(3): 221-235

Henao, J. and Baanante, C., (2006). Agricultural Production and Soil Nutrient Mining in Africa: Implications for Resource Conservation and Policy Development. *International Centre for Soil Fertility and Agricultural Development*: Alabama, USA.

Hair, J.F., Black, W.C., Babin, B.J. & Anderson, R.E. (2010), *Multivariate data analysis*, (7th edition), Prentice Hall, Upper Saddle River, New Jersey.

Hansson, H. and Lagerkvist, C.J., (2012). Measuring Farmers' Preferences for Risk: A Domain-Specific Risk Preference Scale; *Journal of Risk Research*, DOI:10.1080/13669877.2012.657217

Heerink, N., (2005). Soil fertility decline and economic policy reform in Sub-Saharan Africa. *Land Use Policy*; 22: 67–74

Kahneman, D. and Tversky, A., (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2): 263-292

Kalogeras, N., Odekerken-Schröder, G., Pennings, J.M.E., Gunnlaugsdottir, H., Holm, F., Leino, O., Luteijn, J.M., Magnússon, S.H., Pohjola, M.V., Tijhuis, M.J., Tuomisto, J.T., Ueland, Ø., White, B.C. and Verhagen, H. (2012). State of the Art in Benefit-Risk Analysis: Economics and Marketing-Finance. *Food and Chemical Toxicology*, 50: 56–66

Karugia, J.T., Kosura, W.O., Nyikal, R.A., Odumbe, M., and Marenya, P., (2006) Access to Land, Income Diversification and Poverty Reduction in Rural Kenya; *Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia.*

Kerlinger, F. N. (1978), *Foundations of behavioral research*, McGraw-Hill, New York.

Kimani, S.K., and Lekasi, J.K., (2001). Managing Manures throughout their Production Cycle Enhances Their Usefulness as Fertilisers: *A Review*

Knight, J., Weir, S. and Woldehanna, T. (2003): The role of education in facilitating risk-taking and innovation in agriculture. *Journal of Development Studies*, 39(6): 1-22

Legesse, B., and Drake, L., (2005): Determinants of smallholder farmers' perceptions of risk in the Eastern Highlands of Ethiopia, *Journal of Risk Research,* 8(5): 383-416

Lusk, J.L., and Coble, K.H., (2005). Risk Perceptions, Risk Preference, and Acceptance of Risky Food. *American Journal of Agricultural Economics;* 87(2): 393–405

Macharia, J.M., Kimani, S.K., Kimenye, L.N., Nyikal, R.A., Ramisch, J.J., and Esilaba, A.O., (2004). Characterization of smallholder farm typologies in maize-based cropping systems of central Kenya: use of local and technical soil quality indicators. *Soil Science Society of East Africa (SSSEA) conference, Arusha, Tanzania.*

Munyua, B., Jon, H., Nyikal, R. and Mburu, J., (2010) Determinants for Use of Certified Maize Seed and the Relative Importance of Transaction Costs. *Contributed Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa.*

Nyikal, R.A., and Kosura, W.O., (2005). Risk Preference and Optimal Enterprise Combinations in Kahuro Division of Murang'a District, Kenya. *Agricultural Economics,* 32: 131-140

Odendo, M., Obare, G., and Salasya, B., (2010) Determinants of the Speed of Adoption of Soil Fertility enhancing Technologies in Western Kenya; *Contributed Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September*

Odendo, M., Obare, G., and Salasya, B., (2010) *Farmers' Perception of Soil Fertility Depletion and Its Influence on Uptake of Integrated Soil Nutrient Management Techniques: Evidence from Western Kenya; KARI*

Okello, J.J., Lagerkvist, C.J., Ngigi, M. and Karanja, N., (2012) Role of Farmers' Personal Values in Soil Fertility Management Decisions: Evidence from Means-End Chain Analysis of Peri-urban Leafy Vegetable Production in Kenya; *Selected paper prepared for presentation at the International Association of Agricultural Economists Triennial Conference, Foz do Iguacu, Brazil.*

Olarinde, L.O., Manyong, V.M., Okoruwa, V. O., (2008) Analysing Optimum and Alternative Farm Plans for Risk Averse Grain Crop Farmers in Kaduna State, Northern Nigeria. *World Journal of Agricultural Sciences* 4(1): 28-35

Pang, W.K., Yu, B.W., Troutt, M.D. and Hou, S.H. (2008). A simulation-based approach to the study of coefficient of variation of dividend yields. *European Journal of Operational Research;* 189: 559–569

Place F., Christopher B.B., Ade Freeman H., Ramisch J.J. and Vanlauwe B., (2003). Prospects for integrated soil fertility management using organic and inorganic inputs: evidence from smallholder African agricultural systems. *Food Policy,* 28: 365–378.

Pennings, J., and Garcia, P., (2001) Measuring Producers' Risk Preferences: A Global Risk-Attitude Construct. *American Journal of Agricultural Economics;* 83(4), 993-1009

Rabin, M., and Thaler, R.H., (2001) Anomalies: Risk Aversion; *Journal of Economic Perspectives,* Volume 15(1): 219-232

Sanchez, P.A., Shepherd, K.D., Soule, M.J., Place, F.M., Buresh, R.J. and Izac, A.N., (1997) Soil Fertility Replenishment in Africa: An Investment in Natural Resource Capital *International Centre for Research in Agroforestry Nairobi, Kenya.*

Sanginga, N. and Woomer, P.L. (2009) Integrated Soil Fertility Management Practices in Africa: Principles, Practices and Developmental Process. *Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture (TSBF-CIAT)*

Sjoberg, L., Moen, B., and Rundmo, T., (2004) *Explaining risk perception: An evaluation of the psychometric paradigm in risk perception research.* Trondheim: Rotunde.

Teklewold, H., and Kohlin, G., (2010). Risk Preferences as Determinants of Soil Conservation Decisions in Ethiopia. *Environment for Development; Discussion Paper Series.*

Ueland, Ø., Odekerken-Schröder, G., Pennings, J.M.E., Gunnlaugsdottir, H., Holm, F., Leino, O., Luteijn, J.M., Magnússon, S.H., Pohjola, M.V., Tijhuis, M.J., Tuomisto, J.T., Kalogeras, N., White, B.C. and Verhagen, H. (2012). State of the Art in Benefit–Risk Analysis: Consumer Perception. *Food and Chemical Toxicology* 50: 67–76

Wambugu, S.N., Okello, J.J., Nyikal, R. and Shiferaw, B., (2009) Effect of Social Capital on Performance of Smallholder Producer Organizations: The Case of Groundnut Growers in Western Kenya. *Contributed Paper prepared for presentation at the International Association of Agricultural Economists Conference, Beijing, China.*

Wanjiku, J., Ackello – ogutu, C., Kimenye, N., and Place, F., (2003). Socio-economic factors influencing the intensity of use of bio mass transfer in food crop production in western Kenya. *African Crop Science Conference Proceedings*; vol. 6, 661-667

Weber, E.U. , Shafir , S. , and Blais , A.R. (2004). Predicting risk sensitivity in humans and lower animals: risk as variance or coefficient of variation. *Psychological Rev.* 111, 430 – 445.

Weber, E.U., (2004). On the coefficient of variation as a predictor of risk sensitivity: Behavioral and neural evidence for the relative encoding of outcome variability. *Journal of Mathematical Psychology* 54: 395-399

Weber, E.U., Blais, A.R., and Betz, N.E., (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviours. *Journal of Behavioral Decision Making* 15: 263–90.