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Risk perceptions and management strategies by smallholder farmers in KwaZulu-Natal Province, South Africa

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ABSTRACT

Risk is a central issue in rural areas that affects many different aspects of people's livelihoods in the developing world. Unless well managed, risks in agriculture can slow development and hinder poverty reduction. Farmers' perceptions of and responses to risk are therefore important in understanding their risk behaviour. This paper examines risk perceptions and management strategies using field data collected from 200 smallholder rural farmers. The relationships between various socioeconomic characteristics and perceived sources of risk were also examined. In general, price, production and financial risks were perceived as the most important sources of risk. Using Principal Components Analysis, seven principal components (PCs) that explained 66.13% of the variation were extracted. Socio economic factors identified to have a significant relationship with the various sources of risk are age, gender, education, location, information access and risk-taking ability. The most important traditional risk management strategies used by the surveyed farmers were identified as crop diversification, precautionary savings and participating in social networks. The result of this study provides useful insights for policy makers, advisers, developers and sellers of risk management instruments.

KEYWORDS: Risk; Risk management; principal components analysis; smallholder farmers; social networks

1. Introduction

Smallholder agriculture is the key to local and global food security and is the engine for development and economic growth for most developing countries (Fan, 2011). World-wide, there are about 500 million smallholder farms supporting almost 2 billion people (International Fund for Agricultural Development, 2010). In much of Africa and South Asia, small farms still account for the largest share of agricultural output. Africa has approximately 33 million small farms, representing 80 percent of all farms in the region (International Fund for Agricultural Development (IFAD), 2011). The majority of African farmers (many of them women) who are smallholders with farms below two hectares, produce a significant amount of basic food crops with virtually no or little use of fertilizers and improved seed (IFAD, 2011; Altieri, 2009; Altieri and Koohafkan, 2008). They instead rely mainly on nature and natural processes, agricultural biodiversity, local resources and local knowledge to farm.

Agriculture is by nature a risky activity and agricultural enterprises, most especially in developing countries, operate under a situation of risk and uncertainty (Akcaoz and Ozkan, 2005). Risk and uncertainty are therefore pervasive characteristics of agricultural production (Adesina and Quattara, 2000). Farmers' perceptions and responses to risk are important in understanding their risk behaviour (Alimi and Ayanwale, 2005). Risk could arise due to several biophysical factors such as highly variable weather events, diseases or pest infestations. Other factors such as changing economic environment, introduction of new crops or technologies and uncertainties surrounding the public institutions and their policy implementation also combine with these natural factors to create a plethora of production, institutional, price, human and financial risks for farmers (Adesina and Brorsen, 1987). This risk situation affects the fortunes of the majority smallholder agricultural producers in sub-Saharan Africa. According to Wenner (2002), in the absence of institutional innovations (for example, crop insurance, disaster payments, and/or emergency loans) to cushion the impact of risk and uncertainty, risk-management is a critical part of farmer's decision making.

IFAD's (2011) rural poverty report shows that there are nearly 1.4 billion people living on less than US$1.25 a day. At least 70% live in rural areas where they depend on agriculture, but where they are also at risk from recurrent natural disasters. Natural disasters have a devastating impact on the food security and overall social and economic development of poor rural households. Rural economies remain some of the most vulnerable areas to climate change in Africa in terms of declines in agricultural production and uncertain climate that significantly affect food security (Armah, Yawson, Yengoh, Odoi and Afrira, 2010). The global crisis of 2008 led to the incidence of agrarian upheaval

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and inadequacy of staple food supplies which was most acute in Sub-Saharan Africa. According to Banerjee (2009), the financial crisis of 2008 resulted in the intensification of constraints on the production systems of the rural economy through plummeting product prices of agricultural commodities, declining availability of credit to small-scale agriculture, and shrinkage of non-farm employment opportunities in the secondary and tertiary sectors and increasing pressure of the work force on the primary sector.

Agriculture's inherent dependence on the vagaries of weather leads to production risks, and affects the farmers' ability to repay debt, to meet land rents and to cover essential living costs for their families. Ultimately, the precariousness of farmers and producers translates into macroeconomic vulnerability (Benson and Clay, 1998). Unless well managed, risk in agriculture slows development and hinders poverty reduction, ultimately resulting in humanitarian crises. Poor farmers have few options for coping with significant losses, and in order to reduce their exposure to risk, they often forgo opportunities to increase their productivity (Kanwar, 2005).

In the empirical literature, many researchers have found that risks cause farmers to be less willing to undertake activities and investments that have higher expected outcomes, but carry with them risks of failure (Alderman, 2008). The failure to cope with agricultural risk is not only reflected in household consumption fluctuations but also affects nutrition, health and education and contributes to inefficient and unequal intra-household allocations (Dercon, 2002). Households therefore habitually adopt diverse strategies to cope with or reduce risks to the maximum extent practicable. Traditional risk reducing strategies, however incomplete, help to cope with risky incomes (Morduch, 1999). There is vast literature documenting strategies employed by rural households to offset the adverse effects of income shortfalls and entitlement failures (Alderman, 2008). These efforts are however hampered by the absence of formal credit and insurance markets which often creates the impression that these households do not have strategies for dealing with income uncertainties.

According to Dercon (2007), in their daily lives, farmers experience at the same time "*fear and fate*". Out of the numerous risks they fear, at least one shock happens per day. Organic farmers particularly are faced with additional and different sources to risk due to limitations on their farming methods and practices (Flaten, Lien, Koesling, Valle and Ebbesvik, 2005). Restrictions on the use of chemicals influence production risk. Smaller organic markets influence price stability (Winter and Davis, 2006). Relatively recent studies that identified the sources of risk in agriculture include Tru and Cheong (2009); Salimonu and Falusi (2009) and Meuwissen, Huirne, and Hardaker (2001), but they largely refer to large scale commercial farmers.

In South Africa, there are few studies where farm-level data sets have been used to identify the perceived importance of multiple risk sources. These include MacNicol, Ortmann and Ferrer (2006) who identified sources of risk that commercial sugarcane farmers in the province of KwaZulu-Natal (KZN), South Africa, perceived to pose the greatest threat to the viability of their businesses. The most important risk sources were found to be the threat posed by land reform, minimum wage legislation and the variability of the sugar price. These findings confirm that government legislation risks (particularly relating to agrarian reform) have become increasingly important relative to price and production risks. Concerns among respondents regarding the land reform process in South Africa have become more pertinent with the shifting views on the willing-seller-willing-buyer principle to consideration of possible expropriation as per the Restitution of Land Rights Act 22 of 1994 (Nailana and Gotte, 2006). Stockil and Ortmann (1997) identified changes in the cost of farm inputs, government legislation (tax, labour, and land redistribution), the Rand exchange rate, and product prices as the most important sources of risk. Factor analysis of risk sources showed that various dimensions to risk exist, including changes in government policy, enterprise gross income, credit access and cost changes.

While these studies have established farmers sources of risk and shown how farmers behave under uncertainty, less work has been done to examine how smallholder farmers perceive risk and manage it in practice. Risks faced by smallholder farmers in rural settings have not received sufficient attention. The relative lack of information about (especially organic) farmers' risky environment and their approach to it means there are few useful practical insights for policy makers, researchers, extension officers and advisers. This paper seeks to explore smallholder rural farmers' perception of risk and risk management strategies.

2. The state of organic farming in South Africa

The South African organic sector has a long history dating back to the 1970s. The sector had about 50 small scale organic farmers in 1990 and the first group of farmers was certified by the United Kingdom Soil Association in 1993 (Moffet, 2001). While there is no consensus on the exact number of smallholder farmers and on the number of organic farms (Rundgren, 2006), there is evidence of substantial growth over the years. The available statistics focus on large commercial farms and mask the extent of the communal and subsistence farmers' involvement in organic farming (Auberch, 2003). South Africa has very few cases of documented smallholder organic growers and groups. According to Rundgren (2006), South Africa has begun to appreciate the role of organic agriculture in creating incomes and generating foreign exchange for the national economy, but like many other African states, the non-financial benefits of organic farming are rarely acknowledged and recognised.

Grolink (2002) notes that the potential for organic growth in South Africa is huge, not only driven by exports, but by a growing substantial domestic organic market unlike in many other African states. The Department of Agriculture, Forestry and Fisheries' (2006) National Policy on organic farming estimates that the value of the organic produce in South Africa is estimated to be between R200 million and R400 million, of this less than half is certified. This is across all categories of produce, a testimony to the rapid growth of this agricultural sector over the last 15 years. Grolink

(2002) further states that many large retail chains are also actively promoting organic products, particularly those supplied by smallholders who are given very little support despite being extensively used in the retailers' advertising campaigns. Mahlanza, Mendes and Vink (2003) emphasize that the growth in organic agriculture has been paralleled and promoted by the public's increasing awareness of health and lifestyle issues. Following the major global trends in food consumption, consumers' focus on health, convenience and the growing impact of private supermarket labels are taking stance in the South African context (ACNielsen 2005, 2006).

There are two distinct classes of organic agriculture observable in South Africa, namely certified organic production and non-certified or agro-ecological production (Parrott *et al.,* 2006). Certified production is earmarked mainly for export markets in Europe and North America, while agro-ecological farming is practiced to address challenges faced by smallholders. Arnold (1997) and Millstone and Lang (2002) argue that organic approaches have to make a trade-off between market oriented commercial production and increasing the productive capacity of marginalized communities. According to Byerlee and Alex (2005) organic agriculture is one of the sustainable approaches to farming and offers insights towards a paradigm shift in food and nutritional security. The UNEP-UNCTAD (2007) indicates that organic agriculture offers developing countries a wide range of economic, environmental, social and cultural benefits and it is well-suited for smallholder farmers, who comprise the majority of the world's poor.

The identification of organic agriculture as a development pathway, leading to improved livelihoods, is based on a central assumption that decreased use of external inputs, combined with price premiums for products will provide economic gain which can improve aspects of farmer's livelihood, for example food access, health, or education (Kilcher,2007). Organic agriculture is generally considered to reduce external input costs due to the cessation of use of pesticides and mineral fertilizers and increased internal nutrient recycling using green manures, composts and animal manures. However the farm scale effects of the adoption of organic agriculture in developing countries and the associated sources of risk are under-researched. In South Africa, to the best of the author's knowledge, there is no such study. Bakewell-Stone, Lieblein and Francis (2008) investigated the potential of organic agriculture to sustain livelihoods in Tanzania and found that, whilst there may be benefits for farmers, there are also a number of risks associated with the production and marketing of organic crops.

3. Materials

The selected study area is in the rural Umbumbulu magisterial district, uMgungundlovu District Municipality, Mkhambathini Local Municipality of KwaZulu-Natal Province. This province has the largest concentration of people who are relatively poor, and social indicators point to below average levels of social development (Statistics South Africa, 2006). According to the mid-year population estimates by Statistics South Africa (2010), the province has a population of 10.6 Million people 67% of whom reside in communal areas of the former KwaZulu-Natal homeland (Statistics South Africa, 2010). The land use pattern in Umbumbulu is predominantly agricultural in nature and has been characterized by small-scale subsistence farming and some marginal sugarcane cultivation. Smallholder agriculture is an important livelihood option for many rural families contributing a significant portion of their household income at a time when the population pressure is increasing and urban incomes are diminishing (Agergaard and Thomsen, 2006).

A survey was conducted during October-December 2004 to obtain socio-economic, demographic, institutional and household data via questionnaires through interview sessions with the principal decision maker in the participating households. The survey farmers were stratified into three groups: fully-certified organic farmers, partially-certified organic farmers and non-organic farmers. The fully-certified farmers are those who have been certified by the accreditation body Africa's Farms Certified Organic (AFRISCO) and are selling through the formal supply chain, the partially-certified are in the process of getting organic certified, while the non-organic group are not certified and are not entirely following organic practices. A total of 200 farmers were surveyed consisting of a census survey of 151 organic farmers and 49 non-organic farmers that were randomly selected from a sample frame constructed for each of the five neighbouring wards. The 151 organic farmers consisted of 48 fully-certified and 103 partially-certified organic farmers.

The 200 farmers were asked in the survey to give their perceptions of the main sources of risk that affect their farming activity by ranking the set of 20 perceived sources of risk on a 3-point Likert-type scales ranging from 1 (no problem) to 3 (severe problem) were employed. The listed perceived sources of risk used in the questionnaire were developed from findings of the research survey, past research on the perceived sources of risk in agriculture and challenges that smallholder farmers face in trying to access formal supply chains. The farmers were also requested to score any other perceived source(s) of risk(s) that they wanted to add to the list of hypothesized sources of risk. The additional sources of risk mentioned were crop damage by wild pigs, wild rabbits, moles, red ants and millipedes. However, less than 0.01% of the respondents cited these and they were therefore excluded as a category of risks for purposes of this analysis. These perceived risks are ranked from 1-being the most important/ having most impact to 20-being the least important/having the least impact. The ranking was done by averaging the scores on each source of risk and assigning a rank accordingly in ascending order. The farmers were also asked hypothetical questions designed to elicit their risk attitudes. The risk aversion of the sampled farmers was measured using the Arrow Pratt Absolute Risk Aversion (APARA) coefficient. The application of the Principal Component Analysis to quantify these preferences is described in detail in section 4 below.

4. Methods

All computations were conducted using the Statistical Package for Social Scientists (SPSS) version 19. Descriptive statistics were applied to analyze the general characteristics of the respondents as well as to evaluate the farmer's perceptions to risk and risk management decisions. The statistical analysis in this paper is based on the Principal Components Analysis (PCA) model using STATA 11. The general purpose of factor analytic techniques is to find a way of condensing the information contained in a number of original variables into a smaller set of new composite factors with minimum loss of information. The PCA is the most successful method under the factor analysis approach (Rao, 1964). Given a dataset with P numeric variables, one can compute PC principal components. Each principal component is a linear combination of the original variables, with coefficients equal to the eigenvectors of the correlation or covariance matrices. Principal components have a variety of useful properties (Rao, 1964; Kshirsagar, 1972). The implicit form for computing the first principal component (PC_n) is:

$$PC_n = f(a_{ni}X_i, \ldots\ldots\ldots a_{1k}X_k) \quad (1)$$

This simply means that, where there are a number of principal components, say n which represents any number greater than 1, each principal component will be a continuous variable or quantity related to the products of the values of the constituent variables and their respective weightings or component loading (a). As is well known, the relationship is an additive one and it is conventional to add up the products to obtain a value for the principal component. This is given by the following expression, for the first PC:

$$PC1 = a_{11}X_1 + a_{12}X_2 + \cdots a_{1k}X_k \quad (2)$$

Where:

PC_1 is the first principal component,

a_{1k} is the regression coefficient for the kth variable, that is the eigenvector of the covariance matrix between the variables, and

X_k is the value of the kth variable. This general model can be re-written as a functional equation.

The indication from equation (2) above is that a linear additive model is required to derive the principal components. Thus, if there are n principal components then a series of n equations can be written, each of them representing the linear combinations of component loadings and variable values and can be shown as equation (3) below:

$$\begin{aligned} PC_1 &= a_{11}X_1 + a_{12}X_2 + \ldots + a_{1k}X_k \\ PC_2 &= a_{21}X_1 + a_{22}X_2 + \ldots + a_{2k}X_k \\ &\vdots \quad\quad \vdots \quad\quad \vdots \quad\quad\quad \vdots \\ PC_n &= a_{n1}X_1 + a_{i2}X_2 + \ldots + a_{ik}X_k \end{aligned} \quad (3)$$

Where:

$n = 1\ldots.7;$

$k = 1 \ldots 20;$

$a_{i1} \ldots a_{ik}$ = the component loadings; and

$X_1 \ldots X_k$ = the sources of risk

In this study, seven principal components have been extracted while 20 sources of risks have been identified. The coefficients $a_{i1}, a_{i2},\ldots a_{ik}$ were chosen such that the first PC (PC1) will have a large variance as possible, the second PC *(PC2)* was chosen to be uncorrelated with the first, and to have as large variance as possible, etc. The PCs thus provide measures of the amount of common variation as well as magnitudes and nature of divergences in the farmers' scores for their perceptions of sources of risk.

There are various methods for determining the optimum number of factors, such as the Scree test, proportion of variance, analysis of residuals and a priori hypotheses. In this paper, the Kaiser–Guttman rule, which has been most commonly used due to its simplicity and availability in various computer packages (Kaiser, 1960). The Kaiser–Guttman rule states that "the number of factors to be extracted should equal the number of factors having an Eigen value greater than one". The rationale for choosing this particular value is that a factor must have variance at least as large as that of a single standardized original variable.

Note that the assumption of PCA is that interval data that is multivariate normally distributed should be used, but Kim and Mueller (1978) justify the use of ordinal data like Likert-type scales under two conditions: firstly, if the PCA is used to find general clustering of variables for exploratory purpose and secondly, if the underlying correlations among variables are believed to be moderate – say less than 0.6 or 0.7. The principal components (PCs) in this study are estimated using the covariance matrix as the scores are of the same units, implying that no source of risk is likely to have an undue influence on the principal components (PCs) due to a much larger relative variance (Manly, 2005).

The relationships between the perceptions of risk sources against farm and farmer socioeconomic characteristics were explored using factor analysis and multivariate regression methods. In regression analysis, the standard factor scores achieved from the factor analyses of the sources of risk were regressed on farms' and farmers' socioeconomic characteristics to identify the impact of these characteristics on the farmers' perceptions of risk sources. Specifically, the regression models can be represented in the form of equation 4 and 5:

$$\begin{aligned} \mathrm{FSR_{it}} = f(&\text{Age, Gender, Education, Geography,} \\ &\text{Land size, Information access, Household size,} \\ &\text{Household Income, Risk taking, } \varepsilon_t) \end{aligned} \quad (4)$$

$$\begin{aligned} \mathrm{FSR_{it}} = {} & \beta 0 + \beta\mathrm{Age} + \beta\mathrm{Gender} + \beta\mathrm{Education} \\ & + \beta\mathrm{Geography} + \beta\mathrm{Land}\,\beta\mathrm{size} + \beta\mathrm{Information} \\ & + \beta\mathrm{access} + \beta\mathrm{Household\ size} \\ & + \beta\mathrm{Household\ Income} + \beta\mathrm{Risk\ taking} \end{aligned} \quad (5)$$

Where:

$\mathrm{FSR_{it}}$ = standardized factor scores for sources of risk factors (I = 1, 2, 3, . . . , 10), achieved from the factor analyses of sources of risk.

Age, Gender, Education, Geography, Land size, Information access, Household size, Household Income, Risk taking = Explanatory variables

ε_t = Error term

All of the regression models were tested for possible violations of the basic assumptions of a linear regression model. Specifically, a simple correlation matrix and collinearity diagnostics were inspected to detect any potential multi-collinearity. The first order autocorrelation problem was tested using the Durbin-Watson statistics.

A Herfindahl index (DH) is used to calculate enterprise diversification and represents the specialization variable. Although this index is mainly used in the marketing industry to analyze market concentration, it has also been used to represent crop diversification (Llewellyn and Williams, 1996; Bradshaw, 2004). Herfindhal index is the sum of squares of the proportion of individual activities in a portfolio. With an increase in diversification, the sum of squares of the proportion of activities decreases, so also the indices (DH). In this way, it is an inverse measure of diversification. The Herfindhal index is bound by zero (complete diversification) to one (complete specialization). Herfindhal index $(\mathrm{DH}) = \sum_{i=1}^{N} s_i^2$ where N is the number of enterprises and s_i is the value share of each *i-th* farm enterprise in the farm's output. $s_i = {x_i}/{\sum_1 x_i}$ is the proportion of the *i-th* activity in acreage / income.

5. Results and discussions

General characteristics of respondents

The summary statistics of the enumerated smallholder farmer groups are presented and compared in Table 1[2].

The average age of respondents in the study area was generally high (around 51 years) with most farmers being female. These findings were consistent with previous studies in the province that estimated the average rural household head to be 60 years of age (Matungul, 2001) and found that most *de facto* heads were female (Marcus, MacDonald, Maharaj, Manicon and Phewa, 1995). The literacy level in the study area was low while the household sizes were above the national average of 4.83 (PROVIDE, 2009). Fully-certified organic farmers appeared to farm more intensively with smaller farm sizes (0.59 hectares), more family labour (9.49), highest farm income (R973.17) per annum and the highest proportion of income from farming (0.62). This latter is an indication that fully-certified organic farming and its commercialization has brought economic benefits to these otherwise poor rural households and is an important contributor to household income, albeit the high input costs.

A majority of the fully-certified and partially-certified organic farmers are located in the Ogagwini and Ezigeni sub-wards while non-organic farmers reside in Nungwane sub-ward. The estimated Arrow Pratt Absolute Risk Aversion coefficient shows that non-organic farmers are more risk averse than the organic farmers. Fully-certified organic farmers had the highest number of chicken (15.3 per household) as chicken manure is the main source of fertilization among smallholder rural farmers. The fully-certified organic farmers had more assets wealth than the other farmer groups. Smallholder farmers in rural KwaZulu-Natal have access to land through permission to occupy with allocation done by the traditional chief of the tribe (*inkosi*) and his headman (*induna*). On average the respondents across the farmer groups acknowledged that the household had rights to exercise on its own cropland the following: build structures, plant trees, bequeath to family members or lease out.

Perceptions of sources of risk

The identified risk sources and their ranking in order of importance are presented in Table 2.

The fully-certified organic farmers cited uncertain climate (mean 2.96), lack of cash and credit to finance inputs (mean 2.78) and tractor unavailability when needed (mean 2.76) as main sources of risk. These risks have a direct bearing on production. The key ranking for uncertain climate while beyond the control of the farmer, probably reflects the farmers' concerns about

Table 1: Summary statistics of respondents

	Fully-certified organic (n= 48)		Partially-certified organic (n= 103)		Non-organic (n =49)	
Variable	**Mean**	**std. dev.**	**Mean**	**std. dev.**	**Mean**	**std. dev.**
Age (years)	52.60	1.90	48.60	1.41	52.7	2.11
Gender (%female)	82	0.05	71	0.05	84	0.05
Education (years)	4.98	4.24	4.37	4.49	3.38	0.61
Household size(number)	9.49	5.23	7.72	3.68	6.60	3.46
Land size (hectares)	0.59	1.22	0.71	1.16	0.67	1.43
Input costs (rands)	812.90	884.91	309.30	343.40	318.20	302.90
Farm income (rands)	973.17	1074.51	417.26	471.50	400.28	429.53
Farm income (proportion of income from farming)	0.62	0.79	0.38	1.04	0.39	0.63
Location (Ogagwini /Ezigoleni =1; Other =0)	2.56	0.60	1.91	0.54	4.00	0.00
Risk attitude(Arrow Pratt Absolute Risk Aversion Coefficient)	0.522	0.29	0.581	0.307	0.756	0.29
Land rights (1= full access to land; 0=otherwise)	1.98	0.14	1.75	0.56	1.93	0.33
Chicken(number)	15.29	13.16	9.25	8.69	6.40	6.62
Asset ownership (index)	0.98	0.59	0.56	0.58	0.67	0.75

Table 2: Identification of risk sources and rank

Constraint	Fully-certified organic (n=48)			Partially-certified organic (n=103)			Non-organic (n=49)		
	Mean	Std dev.	Rank	Mean	Std dev.	Rank	Mean	Std dev.	Rank
Livestock damage crops	2.56	.744	7	2.82	.488	4	2.80	.539	**2**
Uncertain climate	2.96	.189	**1**	2.83	.409	**3**	2.82	.486	**1**
Uncertain prices for products sold to pack house	2.21	.793	13	2.13	.591	16	–	–	–
Uncertain prices for products sold to other markets	1.94	.811	17	2.02	.595	18	2.17	.761	10
More work than the family can handle	2.58	.599	6	2.32	.688	12	2.53	.649	4
Lack of cash and credit to finance inputs	2.78	.567	**2**	2.58	.615	6	2.78	.468	**3**
Lack of information about organic farming	2.02	.687	15	2.20	.632	14	2.16	.717	11
Lack of information about alternative markets	2.38	.623	10	2.29	.602	13	–	–	–
Lack of proper storage facilities	2.56	.660	7	2.46	.543	9	2.41	.643	7
Lack of affordable transport for products	2.72	.492	4	2.42	.560	11	2.06	.852	**12**
Lack of telephones to negotiate sales	2.69	.509	5	2.55	.633	8	2.22	.771	8
Inputs not available at affordable prices	2.52	.642	9	2.80	.447	5	2.51	.545	5
Tractor is not available when I need it	2.76	.501	**3**	2.89	.416	**1**	2.46	.713	6
Cannot find manure to purchase	1.92	.778	**18**	2.56	.660	7	2.20	.645	8
Cannot find labour to hire	1.73	.764	**20**	1.76	.816	**20**	2.00	.764	**13**
Cannot access more cropland	1.95	.753	16	1.98	.805	**19**	1.92	.794	**14**
Delays in payment for products sent to pack-house	2.22	.723	12	2.89	.315	**1**	–	–	–
Lack of bargaining power over product prices at the pack-house	2.16	.672	14	2.20	.704	14	–	–	–
Lack of information about consumer preferences for our organic products	2.23	.654	11	2.44	.604	10	–	–	–
Pack-house does not reward me fully for my own product	1.86	.780	**19**	2.02	.866	17	–	–	–

[1]*mean score (1 (no problem) to 3 (severe problem)*
[2]*Rank is in ascending order; 1 means most important and 20 least important.*

the effects of recent drought in rural KwaZulu-Natal, which impacted negatively on crop yield. Due to communal land tenure system and collateral required for credit, farmers have limited options to obtain credit from financial institutions for farming. Tractor unavailability can be attributed to the fact that the one tractor available in the area, has been allocated to the local farmer group. This tractor is leased out at a rental fees to members and poses a challenge during land preparation when demand is at peak. Similarly, partially-certified farmers' also ranked tractor not available when needed (mean 2.89) and uncertain climate (mean 2.83) as identified sources of risk. The risk of delays in payment for products sent to pack house (mean 2.89) are attributed to the long value chain processes. Non-organic farmers also cited uncertain climate (mean 2.82), livestock damage to crops (mean 2.80) and lack of cash and credit to finance farm inputs (mean 2.78).

It is evident from the rankings in Tables 2 that some of the perceived sources of risk were common across the farmer groups. These include the uncertain climate and lack of cash and credit to finance inputs. Through better communication, joint-problem solving and commitment, these specific risk sources can be made known to both downstream and upstream players. Investment in water harvesting technologies may alleviate the problem of drought whose occurrence is uncertain. Access to credit however will need the support of government and other role players in the financial sector to address lack of collateral among smallholder farmers. All the farmer groups ranked ''cannot find labour'' lowest. This is a clear indication that labour is not a constraining factor and is relatively. Similarly, lack of access to land was not a major risk as land is readily available through the communal system of allotment.

The optimal number of components was obtained by the Kaiser-Guttman rule. Table 3 below represents the Eigen value proportions of variance for selecting the optimal number of components. The correlation matrix shows that all of the estimated correlation coefficients between the sources of risk scores are less than 0.7 as required (see Kim and Mueller 1978). Seven principal components (PCs) that explained 66.13% of the variance in the original scores were extracted from the covariance matrix (see Table 3). Koutsoyiannis (1987) suggests retaining principal components (PCs) that meet Kaiser's criterion. The Eigen values for the seven principal components (PCs) are all above one. Varimax rotation did not improve the interpretation of these PCs and the reported PCs are thus unrotated as explained by Norusis (2008).

According to the factor loadings in Table 3, the factors 1 to 7 can best be described as 'financial and incentives index', 'input-output index', 'crop production index', 'labour availability index', 'lack of production information index', 'lack of market opportunity index', and 'input availability index' respectively. The first principal component (PC1) explained 18.37% of the variance in the explanatory variables with all six estimated coefficients above 0.3 being positive. This

Table 3: Estimated principal components for the perceived sources of risk

Sources of risk	Financial and Incentive	Input-output	Crop production	Labour availability	Production information	Market opportunity	Input availability
Proportion of variance explained	**18.37**	**12.74**	**8.94**	**7.66**	**7.43**	**5.77**	**5.21**
Eigen Values	**3.6748**	**2.5483**	**1.7874**	**1.5325**	**1.4866**	**1.1538**	**1.0417**
	Factor Loadings						
Livestock damage crops	0.1100	−0.1156	**0.3452**	0.2196	0.2857	−0.0013	−0.2347
Uncertain climate	0.0757	0.0462	0.0187	−0.2487	**−0.4786**	−0.1421	0.2498
Uncertain prices for products sold to pack house	**0.3281**	−0.0683	−0.0500	0.0549	**−0.3858**	−0.0258	0.2812
Uncertain prices for products sold to other markets	**0.3690**	−0.1476	−0.0176	−0.0476	−0.0498	0.1235	−0.1389
More work than the family can handle	0.1083	0.0648	0.2948	**0.5425**	0.0253	0.1286	−0.0136
Lack of cash and credit to finance inputs	0.0279	**0.3881**	**0.3753**	−0.0694	0.1017	0.1417	0.0874
Lack of information about organic farming	0.1746	−0.0545	−0.0123	0.0754	**0.3494**	−0.1293	0.1272
Lack of information about alternative markets	0.2371	0.0901	0.1686	0.1849	0.0141	**0.5791**	−0.1677
Lack of proper storage facilities	−0.0776	**0.3881**	−0.2332	−0.0969	0.2711	−0.1649	−0.0234
Lack of affordable transport for products	0.0498	0.1455	**−0.4236**	0.2461	0.2707	0.1866	0.2077
Lack of telephones to negotiate sales	0.2397	−0.1594	0.0795	−0.2056	0.2309	**0.3997**	0.2935
Inputs not available at affordable prices	0.0256	0.2961	**0.4164**	0.1253	−0.1322	0.1380	**0.3008**
Tractor is not available when I need it	0.0195	0.2949	0.0251	−0.2040	0.2671	−0.2627	**0.4099**
Cannot find manure to purchase	0.0410	**0.4545**	−0.0444	0.0499	−0.2645	0.1226	−0.2108
Cannot find labour to hire	**0.3307**	−0.0497	0.2221	0.0955	−0.0049	**−0.3651**	−0.1058
Cannot access more cropland	0.1567	0.1187	0.2744	**−0.5214**	0.1259	0.0288	−0.1877
Delays in payment for products sent to pack-house	0.1748	**0.4314**	−0.1998	0.2250	−0.1263	−0.0296	−0.2235
Lack of bargaining power over product prices at the pack-house	**0.3734**	0.0006	−0.0859	−0.1015	0.0098	−0.1224	−0.2903
Lack of information about consumer preferences for our organic products	**0.3706**	0.0829	−0.0977	−0.0456	0.1177	**−0.3165**	−0.0481
Pack-house does not reward me fully for my own product	**0.3594**	−0.0640	−0.1541	0.1723	−0.0063	0.0119	**0.3410**

Note: Factor Loadings >|0.3| are in bold and underlined

index suggests that respondents who were concerned with uncertain prices for the formal and informal market options are also faced with the risk of labour unavailability as well as lack of bargaining power. These farmers are also concerned about the lack of information on consumer preferences and the ability of the pack house to give farmers incentives for production.

According to Hough, Thompson, Strickland III, and Gable (2008), buyers have a stronger competitive advantage when they can exercise bargaining leverage over price, quality, service or other terms of sale. This component seems to capture risks associated with financial or farmer liquidity and incentives. It is important to note these risks are associated with production and marketing by the organic farmers. These farmers by targeting the niche of health conscious consumers may obtain premium prices associated with certified organic produce. The fully-certified organic and partially-certified organic farmers through their farmer association could exercise their bargaining power as a social network entity in order to influence better prices for producers.

Similarly, contract farming may limit the risk associated with unreliable market and prices for producers while buyers will have a guaranteed supply of organic produce. Information on consumer demand and preferences may enable the farmers better understand how to meet market demand. It is important to

note that while information on organic production and marketing is readily available at the South Africa's Department of Agriculture, Forestry and Fisheries, and through various economic bureaus, the challenge remains accessibility, packaging and dissemination to smallholder farmers.

The second principal component (PC2) accounted for 12.74% of the variance in the explanatory variables, and shows that fully-certified and partially-certified farmers who rank lack of cash and credit to finance inputs as a source of risk, are also concerned with the lack of proper storage facilities to store their crops. These farmers also experience challenges to purchase manure for organic farming and experience delays in payment for produce sent to the pack house. This component could be interpreted as reflecting Input-output risk. Lack of liquidity may remain a risk in the short and medium-term as the rural farmers do not have collateral required by the financial institution for access to credit. The indigenous communal land tenure system in the rural areas is a further hindrance to access to credit and finance.

The third principal Component (PC3) accounted for 8.94% of the variation and shows that farmers who strongly perceive livestock damage to crops as a major source of risk are also concerned about inputs not being available at affordable prices. Across the three farmer groups, lack of cash and credit to finance inputs was identified as a source of risk. However, these farmers did not perceive lack of affordable transport for products as a major risk. The latter could be attributed to the fact that the produce is collected at the farm gate and transport costs are limited to produce sold in the local market or surrounding farms. This dimension reflects a crop production risk.

The fourth component (PC4) explained 7.66% of the variance in the explanatory variables and implies a labour availability risk. More work than the household can handle was identified as a major risk. However lack of crop land was not perceived as a risk. The latter is due to the fact that land in the area is not a constraining factor and expansion of cropland is available at the request of the local headman. Organic farming is a labour intensive technology and would require more labour than conventional farming however the returns may be higher if farmers access the niche markets as is currently the case with the fully-certified and partially-certified smallholder farmers who are supplying an up market food retail store in KwaZulu-Natal. The labour bottlenecks experienced could also be attributed to increasing disability and ailments due to HIV/AIDS and outmigration of the youth.

The fifth principal component (PC5) displays a variation of 7.43% in the farmers' rankings, and captures a lack of production information. This risk is closely linked to weak support for extension services and advice to enable smallholder farmers to improve and increase production. The South Africa Government is in the process of revitalizing extension services to ensure access to rural advisory services and improved agricultural practices among smallholder farmers especially in rural areas. The sixth principal component (PC6) refers to a lack of market opportunity and accounted for 5.77% of the variation in the farmers' scores for the sources of risk. What both established and emerging black smallholders have in common is that they farm mainly to add to household food security. Surplus production has remained rare in the rural context. Moreover, the limited excess farming output is usually sold in local markets. Their access to established markets is limited by infrastructure and related transactional costs. Finally the seventh principal component is an input availability risk. The farmers perceived lack of inputs at affordable prices and tractor not available when needed as major risk sources. Lack of access to inputs and incentives is a deterrent to the development and growth of smallholder farming. According to the Southern African Trust (2009), Malawi is a great example of how government intervention and support prioritized smallholder farmers to overcome chronic hunger and achieve national food security.

Relationship between perceptions of risk sources against farm and farmer socioeconomic characteristics

Relationships between ''perceptions of sources of risk'' and ''farm and farmer socioeconomic'' variables were assessed using multiple regressions, the results of which are shown in Table 4. For each of the independent variables, the table depicts the partial regression coefficients and the levels of significance for the two-tailed t-tests. The goodness-of-fit of the models is indicated by adjusted R^2.

In the regression analyses, multi-collinearity between the independent variables was not found to be a problem (i.e. no variables have been omitted): Correlations were low, nonlinear principal components analysis (Gifi, 1990) for socioeconomic variables did not show strong relationships, and variance inflation factors (Hair *et al*., 2006) had all values around 1. As shown in Table 4, the regression models for Financial and Incentive, Input-output and Labour availability are statistically significant at a 1%, 1% and 5% level of significance respectively. All Durbin-Watson statistics for the six regression models ranged from 1.5 to 2.5, suggesting that autocorrelation is not a problem for these models. The goodness-of-fit is low as is often the case for discrete choice models (Verbeek, 2008).

An analysis of the socio economic factors identified the following variables to have a significant association with the various sources of risk: age, gender, education, location, information access and risk taking ability. Older farmers were concerned about the availability of labour while female farmers considered input-output risk and crop production risks as significant and relevant. Farmers residing in the non-organic areas of Hwayi and Numgwane sub-wards were more concerned about financial and incentive risk as well as input availability. These farmers have limited access to financial resources and incentives for production while farmers residing in the pioneer organic areas of Ogagwini and Ezigoleni considered input-output risk as less relevant. Farmers with access to information perceived input output risk and crop production risks as less relevant but financial and incentive risk are significant and more relevant. Farmers who were more

Table 4: Results of multiple regressions for sources of risk against socio-economic variables

Independent Variables	Sources of risk													
	Financial and Incentive	*p*-value	Input-output	*p*-value	Crop production	*p*-value	Labour availability	*p*-value	Production information	*p*-value	Market opportunity	*p*-value	Input availability	*p*-value
Constant	−1.35**	0.041	−0.362	0.564	−0.674	0.251	−1.202*	0.087	0.291	0.643	−0.638	0.255	0.1	0.893
Age	−0.004	0.594	0.008	0.29	−0.009	0.177	0.017**	0.039	−0.001	0.89	0.007	0.294	−0.01	0.281
Gender	−0.321	0.196	0.626***	0.01	0.52**	0.022	−0.127	0.63	−0.019	0.937	0.024	0.911	−0.194	0.493
Education	−0.013	0.612	0.065***	0.009	0.002	0.922	−0.046*	0.088	0.022	0.364	0.02	0.36	−0.026	0.376
Geography	0.243***	0.001	−0.114*	0.085	0.074	0.231	0.073	0.316	−0.049	0.453	0.004	0.95	0.18**	0.023
Land Size	0.101	0.282	−0.084	0.356	0.086	0.31	−0.208**	0.041	−0.028	0.753	−0.079	0.326	−0.115	0.286
Information	0.089***	0.001	−0.051***	0.01	0.021	0.253	0.03	0.179	−0.05**	0.013	−0.007	0.698	−0.008	0.742
Household size	0.032	0.211	0.029	0.231	0.028	0.226	−0.007	0.805	0.02	0.409	−0.012	0.598	−0.017	0.56
Household Income	0.045	0.222	0.005	0.878	0.013	0.691	−0.004	0.918	−0.001	0.966	0.035	0.265	−0.008	0.849
Risk taking	0.05	0.666	−0.135	0.231	0.057	0.588	0.191*	0.128	0.064	0.572	0.002	0.981	0.117	0.383
R2 adj	0.223***		0.188***		0.048		0.12**		0.003		−0.070		0.028	
p-value	0.002		0.005		0.196		0.036		0.428		0.906		0.287	
Durbin watson statistics	1.464		1.785		1.632		1.642		2.147		2.447		1.779	

****, **, * represents statistical significance at 1%,5% and 10% respectively*

likely to take risk perceived labour availability risks as much less relevant.

Risk management strategies

The production, financial, market and institutional risk, along with a farmer's attitude toward risk, have a major impact on the choice of risk management strategies and tools. Risk sources cause adversity in yield, prices and production units. Each or any combination of the outcomes of the risk sources may lead to low or declining farm income. There are several strategies that farm operators can use to reduce the farm exposure to risks. The strategies can be classified into modern and traditional risk management tools. The modern instruments include crop insurance, forward contract, and futures among others. In the absence of modern risk management tools especially among rural smallholder farmers, farmers can rely on some traditional strategies to deal with risk. This section summarizes the most important traditional risk management strategies used by the surveyed farmers. These are crop diversification, precautionary savings and participating in social network.

Diversification is a frequently used risk management strategy that involves participating in more than one activity. The rationale for diversifying is that returns from various enterprises do not move up and down in lockstep, so that when one activity has low returns, other activities likely would have higher returns. The extent to which a farmer uses on-farm diversification as a risk management strategy was measured using the Enterprise Diversification Index (EDI) also referred to as the Herfindahl Index (DH). Enterprise diversification is a self-insuring strategy used by farmers to protect against risk (Bradshaw, 2004).

The estimated Herfindahl index was 0.72, 0.89 and 0.23 for fully-certified organic, partially-certified organic and non-organic farmers (Table 5), an indication that the cropping system is relatively diverse. These results are consistent with previous findings in this study measuring farmers risk attitudes, that established that non-organic farmers are more risk averse than organic farmers. These results also confirm previous findings by Rahman (2009) who obtained an estimated DH of 0.49–0.69 among smallholder farmers in three regions in Bangladesh. The proportions of farmers using different risk management strategies are presented in Table 5.

Similarly, 69.1% of fully-certified farmers practised crop diversification compared to 96.8% of the non-organic farmers. A total of 81.2% of the partially-certified farmers practised crop diversification. The common crops grown by the organic farmers are *amadumbe*[3], potatoes, sweet potatoes and green beans while non-organic farmers grew *amadumbe*, potatoes, sweet potatoes, green beans, maize, sugarcane, bananas, chilies and peas. Precautionary saving occurs in response to risk and uncertainty (Feigenbaum, 2011). The smallholder farmers' precautionary motive was to delay/minimize consumption and save in the current period due to their lack of crop insurance markets. According to Cunha, Heckman and Navarro (2005) the

[3] This is a starchy, herbaceous and perennial tuber crop identified scientifically as *Colocasia esculenta,* and important as a famine reserve crop among smallholders.

Table 5: Risk management strategies used by the different farmer groups

Risk management strategy	Fully-Certified organic (n=48)	Partially-certified organic (n= 103)	Non-organic (n= 49)
Enterprise diversification index(DH)	0.7220	0.8962	0.2303
Practice crop diversification (% of respondents)	69.1	81.2	96.8
Savings (% of respondents)			
• Savings bank account	60.9	48.9	46.8
Current level of savings (% of respondents)			
• less than R500	27.27	37.84	35.29
• R501 – R1000	45.45	29.73	41.18
• R1001 – R5000	21.21	29.73	17.65
• More than 5000	6.07	2.70	5.88
Social networks (% of respondents)			
Membership of farmer associations	100	100	10
Others(burial clubs, *stockvel*[1])	33	25	25

[1]*A Stokvel is a club serving as a rotating credit union in South Africa where members contribute fixed sums of money to a central fund on a weekly, fortnightly or monthly basis.*

quantitative significance of precautionary saving depends on how much risk consumers face. Whereas 60.9% of the fully-certified farmers had savings bank accounts, only 46.8% non-organic farmers had bank accounts. The current level of saving in the study area was low with savings ranging from less than R500 to over R5000 per month. Among the fully-certified organic group, most of the respondents (45.45%) saved between R1000-R5001 whereas most of the of partially-certified farmers(37.84%) saved less than R500 per month. Most of the non-organic farmers (41.18%) saved between R501-R1000 per month. Across all groups, however the level of saving greater than R5000 was minimal.

The farmers also engage in social networks as a risk sharing strategy. There were two main categories of social networks that the farmers engaged in. These are farmers' associations and other social networks, most notably burial clubs and *stockvels*. The farmers' association is used as a vehicle for the organic farmers for purposes of production and access to markets for their organic produce while the burial clubs and *stockvels* are a source of access to credit and or loans. In the latter instance, farmers do not have to produce collateral. The burial clubs and *stockvels* are common in most rural areas and a means for mitigating liquidity and financial risk where possible.

6. Conclusion

The study seeks to establish the smallholder farmers' perception of risk and risk management strategies in rural KwaZulu-Natal and to contribute towards ongoing research into risk and risk management by smallholder farmers in developing countries. Summary statistics analysis shows that farming in rural KwaZulu-Natal is generally done by older female smallholder farmers with low literacy levels. Fully-certified organic farmers appeared to farm more intensively with the proportion of income from farming also recorded as higher than the other farmer groups. The majority of the organic farmers are located in the Ogagwini and Ezigeni sub wards locations and were found to be less risk averse than non-organic farmers. Chicken manure was the main source of fertilization and fully-certified organic farmers also had more asset wealth. Access to land for these smallholder farmers is through permission to occupy allocated by the traditional authority.

In general price, production and financial risks were perceived as the most important sources of risk. These were identified across the farmer groups as: uncertain climate, lack of cash and credit to finance inputs; tractor is not available when needed, delays in payment for products sent to pack house and livestock damage to crops. Seven principal components (PCs) that explained 66.13% of the variance in the original scores were extracted from the covariance matrix. These were labeled as follows: 'financial and incentives index', 'input-output index', 'crop production index', 'labour availability index', 'lack of production information index', 'lack of market opportunity index', and 'input availability index'.

Using multiple regression analysis, age, gender, education, location, information access and risk taking ability were found to have a significant association with the various sources of risk, the most important traditional risk management strategies used by the surveyed farmers in rural KwaZulu-Natal are crop diversification, precautionary savings and participating in social network. The findings are consistent with economic theory which postulates that in the absence of insurance markets, poor farm households tend to be risk averse and are reluctant to participate in farm investment decisions that are uncertain or involve higher risk. Risk research in agricultural economics and farm management has placed more emphasis on production and market risks (Musser and Patrick 2002). The result of this study provides useful insights for policy makers, advisers, developers and sellers of risk management strategies. It recommends that attention should be paid to studying and understanding price, production and financial risks common among smallholder rural farmers. Similarly, policy makers, researchers and advisers should use decision analysis tools that incorporate these identified risks.

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