

# Integration of Crops and Livestock in the Smallholder Farming System of the Former Homelands of South Africa

Ajuruchukwu Obi<sup>1</sup>

<sup>1</sup> Department of Agricultural Economics & Extension, University of Fort Hare, Alice Private Bag X1314, Alice, South Africa

Correspondence: Ajuruchukwu Obi, Department of Agricultural Economics & Extension, University of Fort Hare, Alice Private Bag X1314, Alice, South Africa. Tel: 27-0-73-313-1865. E-mail: aobi@ufh.ac.za

Received: March 18, 2013 Accepted: May 30, 2013 Online Published: September 15, 2013

doi:10.5539/jas.v5n10p183

URL: <http://dx.doi.org/10.5539/jas.v5n10p183>

## Abstract

Available evidence suggests that sub-saharan Africa as a group has suffered serious setbacks in recent years, culminating in the stagnation of farm production and productivity amidst sustained and sometime escalating poverty rates. At the same time, increases in human population levels have resulted in rising demand for food as well as for arable land. The growing intensification of farming has been accompanied by degradation of wild lands, including tropical forests and wetlands, at an alarming rate. Further pressure on fragile land has come from associated urbanization. Recent increases in food prices have drawn attention to this problem even more strongly. Integrating crops and livestock into existing farming systems is being recognized as a means to address these problems. The main objective of this paper was to investigate farmer's perception of the relative importance of crop-livestock integration in the small holder farming systems. Data collected from 70 emerging and smallholder farmers Nkonkobe Municipality were analyzed by means of descriptive statistics, multiple linear regression models and the binary logistic regression model. The results reveal that the smallholder farmers have the possibility of realizing immense benefits from the integrated systems. The most feasible option for enhancing productivity of the farming system and achieving sustainable livelihood improvements seems to be augmentation of existing and locally available inputs which will undoubtedly be less costly than their wholesale replacement with new and exotic inputs. It is recommended that collective action to identify innovative practices as part of innovation platforms comprising diverse rural and agricultural stakeholders be encouraged to enable farmers learn from one another and optimize the positive effects of a better targeted extension exposure.

**Keywords:** Integrated rural development, crop-livestock interaction, collective action, farmers' perception, rural livelihood

## 1. Background and Problem Context

The importance of agriculture in the socioeconomic development of countries, especially those in Sub-Saharan Africa, has long been recognized. According to the Food and Agriculture Organization of the United Nations (FAO), agriculture is the dominant contributor to the Gross Domestic Product (GDP) of these countries as well as their exports (FAO, 2003; Cervantes-Godoy & Dewbre, 2010). In addition, the bulk of job creation in the rural areas of the majority of the countries in Sub-Saharan Africa, as is the case with many other developing countries, occurs in agriculture which is believed to account for generally more than half of the active labour force (FAO, 2003; Cervantes-Godoy & Dewbre, 2010). Despite evidence of diverse occupational options in the rural areas of these developing countries, it is estimated that as much as 63% of rural households depend on agriculture for their income, especially in Africa (Afronline, 2011). There is a strong belief that agriculture will remain the driving force for rural transformation in Africa since no country is known to have managed to reduce poverty without commensurately improving agricultural productivity (United Nations Development Group, 2010; Christiaensen, Demery, & Kuhl, 2010; Afronline, 2011). In fact, according to Christiaensen, Demery and Kuhl (2010), agriculture lies at the heart of the battle against poverty and is normally seen as the driving force for poverty alleviation, food security and economic growth, given that it reduces poverty more effectively than non-agricultural employment.

As a result, the status of agriculture is a good predictor of the pace and pattern of economic development in these countries. This explains the focus of South African policy on agriculture as the main vehicle for poverty alleviation (Perret et al., 2005). The main thrust of such policy has been to promote public investments in the generation of improved technologies and developing procedures to encourage their adoption by the smallholder farmers who have often proved highly resistant to change. While considerable room exists for improvement in the mix of technologies and innovations on offer, the few that have shown promise have not been enthusiastically embraced by the vast majority of smallholders with the result that farm-level production and productivity have stagnated and poverty rates remain high for the most part (Sterve, 2010; Muzari, Gatsi, & Muvhunzi, 2012). In some areas, especially in the more remote former homeland areas, the situation seemed to have actually worsened (Obi, Schalkwyk Van, & Tilburg Van, 2012).

Since 1994, the South African government has been supporting small farmer development through a wide range of policy initiatives. But by the end of the first decade of the reforms, in 2005, the Department of Agriculture and Land Affairs, in a report produced for the Land Summit, observed that while overall poverty headcount has remained unchanged, the poverty gap which measures the severity of poverty and inequality, has escalated (DLA/DoA, 2005). Similar indications had been given by the UNDP (2003) whose South African Human Development Report for 2003 shows that unemployment rate could be anything from 25-40%, being worse for rural than urban areas, and more so for blacks than any of the other races in the country. The situation is not different in the second decade either. An indication that conditions may be worsening in the country in respect of poverty levels is the fact that since 2006, the country has witnessed incessant strikes and protests as workers demand higher wages and residents of poor districts demand improvements in living conditions and service delivery. During 2006, for several months, workers, including security personnel, undertook prolonged strike actions which turned violent in a number of instances, leading to immense loss of lives. No less an organization than the International Monetary Fund (IMF) had in September 2006, expressed concern about the high levels of unemployment in South Africa which it says poses “major challenges”, a concern that it has since repeated and which has been echoed by even the government (International Monetary Fund, 2006 and 2012; BDLive, 2013). The UNDP Human Development Report for 2006 shows that the Gini Coefficient for South Africa stood at 0.59 which confirms the country’s status as having one of the most unequal income distributions in the world (UNDP, 2006). Such a result is consistent with the fact that among the Medium Human Development countries to which South Africa is placed by the UNDP, it is one of the few whose Human Development Indices actually deteriorated since the early 1990s, having fallen from 0.735 in 1990 to 0.653 in 2004 (UNDP, 2006). The further decline of this index to 0.629 in 2013 indicates the considerable stress to which the economy is subjected (UNDP, 2013). The OECD’s third economic survey for South Africa equally concludes that progress towards reducing inequality in the country has been negligible (OECD, 2013).

At the local/rural level, the picture is even more disturbing. Poverty and livelihood studies carried out over the years suggest that the poverty rates may be higher in the Eastern Cape province than elsewhere in the country. Department of Labour data suggest that unemployment rates in the Eastern Cape in 2003 were in the order of 30-70% probably because the province ranks as the most rural province, with an estimated 63.4% of its population living in the rural areas, compared with a national average of 54% (May et al, 1998; Department of Labour, 2003). As might be expected, these situations have been worse in the former “independent homelands” where the infrastructure profile and services have remained basic and 13 years of democratic dispensation in South Africa has made little difference. In looking for the reasons for the persistent pauperization of the area, it is unavoidable to examine the agricultural sector and smallholder farming.

The experiences of small-scale citrus growers in the Ciskei homelands illustrate the declining fortunes of agriculture quite vividly. In the closing years of the Apartheid regime a programme was launched to establish a black entrepreneurial class in agriculture. Pursuant to this goal, the government of the former Ciskei homeland (now part of the Eastern Cape Province) introduced a scheme in 1988 to resettle a total of 22 black farmers on land expropriated from former white farmers with emphasis on citrus production. This programme has since evolved into a low-equilibrium trap characterized by under-production arising from a wide range of technical and institutional constraints. Of the 22 farmers resettled at the inception of the programme, only about 14 are operational today.

Among the reasons given for this situation, poor fruit quality limiting the market access of the emerging farmers has been mentioned as a major one (Kat River Water Users Association, 2007). In turn, the poor fruit quality on these farms has been attributed to the predominance of aging trees, planting of mixed cultivars, non-uniformity of spacing that hampers the application of plant protection and soil fertility enhancement technologies, among other reasons. The farmers also complain about the poor road network which causes the fruits to deteriorate in quality

due to friction during transportation. Another serious problem relates to the fact that these farmers have been waiting in vain to receive title deeds to the land they operate and this means that they are unable to use the land to raise much-needed capital to finance improvements and expand production. Other farmers who are less well-organized than this group of emerging farmers equally face serious challenges in respect to access to land and other productive resources. For instance, despite years of implementation of the land reform programme, a good number of farmers are still unable to secure land for arable farming and several land claims are yet to be resolved in a manner that guarantees the livelihoods of a large majority of the rural population in the area. Within the Kat River Valley area for instance a number of small farmers have been compelled to narrowly focus on semi-subsistence small stock production because they are unable to secure land for arable farming.

There is therefore urgent need to tackle these issues, especially in respect of rural areas where the majority of the population, mostly the previously disadvantaged blacks, still reside. In recent years, this segment of the population has been the target of a large number of policy interventions to redress past wrongs. Among these measures are those that aim to redistribute land to the black population who were previously denied access to this vital asset and were consequently effectively excluded from the nation's agricultural economy. In the time since the all-inclusive elections in 1994, a major land reform programme has been established with complementary programmes for economic empowerment through credit assistance, subsidization of farm infrastructure development, and other forms of support included under schemes like the Comprehensive Agricultural Support Programme (CASP), the Micro Agricultural Financial Institutional Scheme of South Africa (MAFISA), among several. However, apart from numerous internal contradictions in these programmes that make them ineffective for poverty targeting, the current interventions have continued within existing farming systems which have been developed around the circumstances of the established white farmers. For instance, the conventional farming system is the intensive monoculture system in which single enterprise specializations are the norm. One feature of the intensive monoculture system is its reliance on equipment-intensive technologies and the substantial use of agro-chemicals generally not affordable by small-scale and emerging farmers. These groups of farmers who are only just beginning to enter the farming industry therefore experience rising production costs which they are unable to meet due to lack of access to institutional finance for which collaterals are required. At the same time, they are unable to explore alternatives due to lack of experience. The result is that these groups of farmers are unable to compete on price with the established farmers and are therefore effectively excluded from the nation's agricultural economy. While the permanent resolutions of these problems must happen at the political and institutional levels, they traditionally take time to implement and will ultimately require technical solutions to be effective. It is therefore imperative that a sustainable farming system be developed that fits the circumstances of the small-scale and emerging farmers and simultaneously addresses their credit constraints, market access difficulties, profitability, as well as promote sustainable natural resource management practices. While full commercialization may seem too ambitious for this group in the medium term, especially without a massive injection of production capital and far-reaching institutional reforms, including more inclusive land reform strategies, it is possible to introduce transitional schemes, representing a subset of tested farming systems technologies, to more specifically target food security and poverty reduction in the households and provide these poor farmers with diversified options for generating income through access to alternative crops, new varieties with marketing potential, and through organizational and institutional development.

To meet the rapidly increasing demand for food both globally and for the region (estimated at 2.5% annually), by an ever-expanding human population, production from crop agriculture must expand by 4% annually while the production of food from animal agriculture must expand by more than 3% annually, by the year 2025 (World Bank, 2007). Efforts to raise agricultural productivity in the farming systems of the developing countries have dominated recent policy interventions. In South Africa, the government has promoted several programmes to enhance the productivity of small farms that now have to compete with the established commercial farms which have always been better able to withstand the harsh past and current socio economic environment.

Crop and livestock productivity is greatly hampered by inadequate availability of nutrients (i.e. metabolizable energy, protein and phosphorous for livestock production; and organic matter, nitrogen and phosphorous for crop production) in most of the Third World countries (International Fund for Agricultural Development, 2008). Growth in human and livestock populations has led to an expansion of cultivated land and shortened fallow periods. This, in turn, has accelerated land degradation and decreased soil fertility. Under these conditions, full integration of crop and livestock production offers the greatest potential for increasing agricultural productivity, especially in the sub humid and wetter parts of the semi-arid zones (International Livestock Centre for Africa, 1998). While crop-livestock integration systems have been practiced for a long time, especially by marginal farmers, no evaluation exists as to how these contribute to household income or how they compare to the mono or single

enterprise systems. What support is available to small farmers to deal with the associated complexity? Can integrated crop-livestock systems generate adequate income relative to the alternative? Why is crop-livestock integrated farming system not widely used when it seems that it makes sense? What are the factors that detract it from its widespread use? What are factors and obstacles that policy makers need to be aware of to ensure their widespread adoptions?

## 2. Objectives

The purpose of this paper is to gain deeper understanding of the farming systems as it pertains to the integration of crops and livestock. As a starting point, the perception of farmers regarding its relative value would be assessed and understood as a basis for judgment as to the viability of the system over the long term. The main objective of the study is therefore to investigate the farmer's perception of the relative importance of crop-livestock integration in the small holder farming systems. The specific objectives of the research are to:

- assess the perception of farmers about the relative value of crop-livestock integration and the extent to which they consider that it can be a viable path out of poverty for them.
- make recommendations on how the system can promote optimal crop – livestock integration to achieve sustainable economic empowerment of smallholder farmers in the former Ciskei homeland of South Africa.

## 3. A Brief Review of the Literature on Crop-Livestock Integrated Farming System

Continuous agricultural activity which is the main manifestation of agricultural specialization has been blamed for much of the environmental problems experienced today across the globe (Clark, 2004). According to Clark (2004), "enterprise diversity was the norm", and mankind only developed single-enterprise agriculture and specialization in the early decades of the 20<sup>th</sup> century. While specialization initially resulted in dramatic increases in yields and overall output of the farm, it is now known that it has also contributed to the deterioration of land resources, which has contributed to environmental degradation and is probably subsequently leading to low agricultural productivity. In order to address these issues, a large body of problem-solving and adaptive research reported in the literature since the 1940s have tended to advocate for a different approach to farming based on the harnessing of the positive aspects of both crop and livestock systems (Clark, 2004). Other studies have also suggested quite explicitly that integrated crop-livestock farming is preferable because it is said to be a way of enhancing agricultural productivity (Block & Webb, 2001). According to the contemporary literature, the renewed interest in crop-livestock integrated farming is a response to the disappointing results of the specialization approach and is motivated by a belief that the system improves the output of both crops and livestock products. In other words, in situations where the approach has been adopted within a systematic setup, the main goal has been to improve the efficiency of the farming systems. However, in order to optimise productivity, crop-livestock interaction needs to be enhanced through development and dissemination of appropriate crop-livestock technologies and management practices that take account of the technical, economic, social and environmental dimensions. This has been the approach followed by the Future Harvest centres as the members of the Consultative Group on International Agricultural Research (CGIAR) are now known. In this paper, the focus is on a number of specific questions around characterizing the approach and clarifying its constraints and opportunities.

## 4. The Model and Analytical Framework

This study has several dimensions, all of which have informed the analytical model adopted. As the specific objectives suggest, there is an initial attempt to profile and characterize the farming system and understand the importance of the crop-livestock integration in the study area. Following that, a test of associations between pairs of independent variables will be undertaken.

In the profile carried out, a number of variables that are crucial to understanding of the farmers and the farming environment are matched with one another to see if there are important relationships that can be followed up. This called for the adoption of systematic procedures so that valid predictions about future behaviour change can be made. To further strengthen the reliability of these predictions, variables that revealed significant associations were tracked through a series of multiple linear regression analyses. Finally, the major research question concerning the main reasons for farmers to integrate or otherwise was examined by means of a binary logistic regression. The specific procedures followed in this study are described in the next sub-sections that follow:

### 4.1 Descriptive Analysis

Descriptive statistics was applied on the basic characteristics of the sampled households. This employed both frequencies and means to describe the data which included age, education, gender, marital status of head of household, land size owned and cultivated, and importance of integrating crops and livestock. Frequencies and

mean values are useful in analyzing household characteristics as well as analyzing the relationship of variables. The results were cross-tabulated and where necessary, charts, graphs, and other diagrams were used to summarize and interpret the data.

#### 4.2 Inferential Analysis

It was necessary to also carry out inferential analysis on the data. For this purpose, three distinct analyses were carried out, namely a correlation analysis, the multiple linear regression (step-wise) and the logistic regression. The broad reasons for the multilayered analysis have been given in the introduction above but will be revisited in the subsections below within which they are elaborated and specified.

This study enumerated the farming households in the study area with respect to a range of standard perceptions associated with crops and livestock integration. The preliminary investigation that precedes the field survey revealed that the community members are pushed into practising integrated crops and livestock farming because of their perceived benefits with associated farming system. These perceptions were divided into nine distinct cases namely, source of milk production, production of meat, source of income, wealth status, food security, cultural reasons, draught power, source of manure and feed. Specifically, farmers were asked to rate these perceptions using a five-point Likert-type scale from 1 to 5 as follows: 1= very low, 2= low, 3= intermediate, 4= high, and 5= very high. A correlation matrix was drawn to explore the association between the household demographic and socio-economic characteristics and the above set of perceptions.

#### 4.3 Multiple Linear Regression

A linear regression model was used to test and analyze several relationships. One set of relationships was between a chosen index of successful crop-livestock integration and a number of variables that might affect it one way or the other. Regression analysis is a statistical technique that attempts to investigate and model the relationship between two or more variables such relationship may be linear or non-linear (Gujarati, 1992). A linear regression attempts to model the relationship between two or more variables by fitting a linear equation to a data set. In such a case, a direct relationship is assumed and the variables appear with a power of 1 only (Gujarati, 1992). In a linear equation, the variable that is influenced by other variables is known as the dependent variable. The other variables that have an influence on the dependent variable are known as explanatory or independent variables (Gujarati, 1992).

Economic theory predicts directional relationships between socio-economic and community variables and the willingness or otherwise of economic actors to participate in the process of exchange. It is therefore possible to fit a simple linear regression model of the type:

$$Y = f (X_1, X_2, \dots, X_n) \quad (1)$$

Where;

Y is the dependent variable representing some measure of adoption of crop-livestock integrated farming system, while X's are the explanatory variable and livestock.

Following conversion, the model can be specified as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + \mu_i \quad (2)$$

Where:

$\beta_0$  = the intercept or constant term

$\beta_1, \beta_2, \dots, \beta_n$  = slope or regression coefficient

$X_1, X_2, \dots, X_n$  = explanatory or independent variables

$\mu_i$  = error or disturbance term.

The model was estimated to identify the perception of farmers about integration of crops and livestock in the farming system under investigation.

Two diagnostic tests to detect (i) Heteroskedasticity, and (ii) Multicollinearity, were performed in SPSS Version 19 and the tests are described below:

#### 4.3.1 Heteroskedasticity

To test for the presence of heteroskedasticity in time series regression, the same method for cross-sectional applications could be used. This test requires that error terms  $V_t$  be serially uncorrelated. Heteroskedasticity is calculated as follows:

$$\hat{U}_t^2 = \delta_0 + \delta_1 X_{t1} + \dots + \delta_k X_{tk} + V_t \quad (3)$$

The null hypothesis is  $H_0: \delta_0 = 0, \delta_1 = 0, \dots, \delta_k = 0$ .

Then the decision can be made using F statistics (Gujarati, 2003).

#### 4.3.2 Multicollinearity

Given the rather large number of variables enumerated, the likelihood of correlation among independent or predictor variables is high. For this reason, the test of multicollinearity was applied. Assuming two variables,  $X_1$  and  $X_2$ , collinearity is suggested if:

$$X_1 = fX_2 \quad (4)$$

However, the equation (2) demands that a more robust function be developed to cater for the several predictor variables in the model, leading to the following relationship:

$$f_1 X_{1i} + f_2 X_{2i} + \dots + f_k X_{ki} = 0 \quad (5)$$

Where  $f_i$  are constants and  $X_i$  are the explanatory variables that might be linearly correlated.

The speed with which variances of an estimator is inflated by the presence of multi-collinearity. A formal detection tolerance or the variance inflation factor (VIF) for multi-collinearity as illustrated by Gujarati (2003) can be as follows:

$$VIF_j = \frac{1}{1 - R_j^2}$$

Where tolerance =  $1 - R^2$

Tolerance of less than 0.21 or 0.10 and / VIF of 5 or 10 and above indicates multicollinearity of variables. Where multi-collinearity was detected on the basis of these values of the VIF, the highly collinear variable, that is those with very high VIF, were detected from the model.

#### 4.4 Logistic regression

Following Gujarati (2003), the cumulative logistic distribution function for factors affecting the perception of farmers was specified as,

$$P = \frac{1}{1 + e^{-Z}} \quad (6)$$

Where P was the probability of integrating crops and livestock by a farmer and Z is a function of m explanatory variables (X) and was expressed as

$$Z = B_0 + B_1 X_1 + B_2 X_2 + \dots + B_m X_m \quad (7)$$

The probability of not integrating crops and livestock was given by

$$1 - P = \frac{1}{1 - e^Z} \quad (8)$$

The conditional probability of the outcome variable follows a binomial distribution with probability given by the conditional means P<sub>(i)</sub>. The logistic model in terms of logs is

$$\log\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k \quad (9)$$

Where

$$\log \frac{p}{1 - p} = Z$$

the log of odds ratio is not only linear in X but also linear in the Bi variable and as a result, OLS is used. Taking the stochastic term  $\mu$  into account, the logit econometric model to be used will be

$$Z = B_0 + B_1X_1 + B_2X_2 + \dots + B_mX_m + \mu \tag{10}$$

To evaluate how well the logistic regression equation predicts outcomes of whether a small scale farmer will integrate livestock and crops given the variables in the model, the Hosmer and Lemeshow Goodness of Fit was used.

Data analysis was implemented by means of the SPSS software version 19.

#### 4.4.1 Variables Used in the Model

The questionnaire was designed to capture data on production, marketing and factors that influence integration of crops and livestock. The data included demographic data, factors affecting farm productivity, amount of crop and livestock sold at the market, distance to market, institutional arrangements for marketing and difficulties associated with selling of produce. Importantly, the questionnaire captured information pertaining to farmers’ perception on livestock and crop integration. The key variables used in the model were divided into dependent and independent variables and are summarized in Table 1, showing the direction of their expected relationship with one another.

Table 1. Definition and units of measurements of key variables modeled

Dependent variable	Definition	Anticipated sign
(i) Total asset	Continuous	+
(ii) Integration (integr)	Dummy: Yes =1, 0 otherwise	+/-
(iii) Perception scores	Determinants of farmers perception on crop-livestock integration e.g. meat, milk, manure etc.	+/-
Total income	Continuous	+/-
Independent Variable	Description	Anticipated sign
Age	Discrete (years)	+/-
Gender	Categorical: Male =1, Female=0	+/-
Marital Status	Dummy: married =1, 0 otherwise	+/-
Household size (Hhsize)	Discrete (number)	+/-
Highest educational level (Educat)	Discrete (years of school attendance)	+
Religion	Categorical	+/-
Land size	Discrete (ha)	+
Arable	Discrete (ha)	+/-
Communal grazing	Dummy: Yes =1, 0 otherwise	+/-

#### 4.4.2 Impact of Farmers Perception on the Adoption of Crop-Livestock Integration

An important specific objective of this study is to assess the extent to which farmers’ perception influences the adoption of crop-livestock integration among smallholder farmers. The first step towards achieving this aim was the implementation of a correlation analysis. The purpose of the correlation analysis as has been explained is to test the strength of the linear association between the demographic and socio-economic variables and the indicators of

perception so that the variables to be included in a multiple regression analysis can be identified. On the basis of those results seven separate regressions were run as follows:

- (i) Total Asset on demographic and socio-economic characteristics
- (ii) Total Asset on the farmers perception scores
- (iii) Food security on demographic and socio-economic characteristics
- (iv) Farmers' perception about feed value on demographic and socio-economic characteristics
- (v) Farmers' perception about draught power on demographic and socio-economic characteristics
- (vi) Farmers' perception about milk value on demographic and socio-economic characteristics.
- (vii) Farmers' perception about culture value on demographic and socio-economic characteristics.

In the sections below, the relationships revealed by the foregoing regressions are presented and explained.

#### 4.4.3 The Total Assets and Demographic and Socio-economic Characteristics

The results are presented in Table 2. The assertion here is that a household's belongings in terms of total assets reflecting the family's socio-economic standing will be influenced by the household head's demographic and socioeconomic background. While this is rather obvious, the purpose of this regression is to demonstrate the more omnibus impacts of the socioeconomic/demographic characteristics which are going to be subsequently used to explain differences in the perceptions about the value of crop-livestock integration.

Table 2. Total Asset on demographic and socio-economic characteristics

Variables	Unstandardized Coefficients		Standardized Coefficients <i>Beta</i>	<i>t-statistics</i>	Level of significance	Collinearity Statistics	
	<i>B</i>	Standard Error				Tolerance	VIF
Constant	.612	1.741		.352	.726		
Gender	.587	.256	.064	2.295	.025*	.808	1.237
Marital Status	-.105	.091	-.032	-1.159	.251	.793	1.260
Age	-.008	.011	-.022	-.722	.473	.677	1.477
Education	.159	.152	.033	1.043	.301	.637	1.570
Religion	.231	.599	.022	.386	.701	.183	5.457
Landsize	.076	.032	.271	2.339	.023*	.047	21.502
Arable	.413	.054	.697	7.597	.000**	.074	13.518
Communal Grazing	.111	1.060	.003	.105	.917	.682	1.466
Integration	.351	.230	.042	1.528	.132	.842	1.188
Total Income	-9.850E-5	.000	-.034	-1.132	.262	.674	1.483

Dependent Variable: TOTASST

R<sup>2</sup>= 0.963, Adjusted R<sup>2</sup>= 0.957

\*Significance at 10%

\*\*Significance at 5%

According to the results, a good deal of the variations of Total Assets from one household to the other is explained by the demographic and socio-economic characteristics of the household head interviewed in this study. The results show that the most important determinants of the level of Total Assets could be gender of the household

heads and their land holding. A positive and significant relationship was found between land size (both grassland holding and cultivated land) and total assets, implying that as household belongings increase there are higher chances of household assets being substantially enhanced, a fact which can hardly be disputed. The gender variable was positively significant. As the results indicate that male farmers were more numerous in the sample, this result suggests that men were likely to command more assets in the project area than women which is also consistent with most viewpoints on the impact of gender on livelihoods in the area (Gibbs *et al.*, 2012). Alam *et al.* (2011) have also shown that socio-economic characteristics of farmers and productivity are related in important ways. The tests of model adequacy confirm that the regression analysis throws reasonable light on the determinants of wealth differences among households. For instance, the  $R^2$  of 96% and adjusted- $R^2$  of 95% suggest a reasonable part of the variations are explained by the model.

#### 4.4.4 Effects of Farmers Perception on Total Assets of Household

An important objective of this study was to determine how farmers' perception influenced decision to adopt integrated farming systems of crop and livestock enterprises. In order to address this question, it was decided to regress total assets on a number of indicators of farmers' perception. As already indicated, a Total Asset score was derived by assigning values to the durable assets owned by the household and observed by the researcher. This indicator was deemed more reliable as a measure of household socioeconomic status than reported income or production data which are often difficult to verify and may tend to be either overstated or understated. What is being examined here is to what extent the perceptions held by farmers about the relative value of crop-livestock integration influence their socio-economic standing measured by their Total Asset score. The perceptions found to be highly influential at this stage would then be followed up by investigating what socio-economic/demographic features of the respondents are consistent with such views about the relative values of crop-livestock integration. Investigating the relationships between perception and socio-economic and demographic characteristics is useful as a basis for designing appropriate policy responses which may involve interventions to enhance access of the affected population to education, resources, etc within the context of existing socio-cultural setups.

The study revealed that local farmers hold several views about the value of crop-livestock integration, the most of which are that:

- (i) It leads to enhanced profit from the crop enterprise
- (ii) It leads to increased meat output
- (iii) It leads to increased milk output
- (iv) It is a source of draught power
- (v) It is a source of manure for regenerating soil fertility
- (vi) It is a source of increased farm revenue.
- (vii) It is a status symbol to have diverse farm operations
- (viii) It is part of the culture to diversify into crops and livestock
- (ix) It is a source of food security
- (x) It is a source of feed for livestock.

The results of the regression analysis are presented in Table 3. According to the results, perception in respect to crop-profit, manure, food security and feed production seemed to strongly influence the total assets. The indication is that respondents who consider making more profit from the crop enterprise as a legitimate reason to embark on crop-livestock integration are likely to be those with substantial total assets relative to their neighbours. This is an intuitively appealing finding given that such people are also more likely to be more confident to try new practices in order to explore the possibility of obtaining enhanced earnings.

For the other perception in respect to the usefulness of crop-livestock integration for providing manure, livestock feed, and for addressing food security, the results indicate significant negative relationships. These are very crucial findings that are also consistent with intuition. For instance, respondents who are likely to be impressed with the capacity of the alternative practice to fill gaps in the availability of manure and livestock feeds are those who are unable to meet those needs under current conditions probably because of their weaker asset base, in relative terms. So a negative relationship with total assets makes a lot of sense. This is also true for food security where it is expected that desperation to address food security goals will be more intense for people currently experiencing deprivation in one way or the other which can be manifested in low asset holding.

Table 3. Total Asset on the farmers perception scores

Variables	Unstandardized Coefficients		Standardized Coefficients <i>Beta</i>	<i>t</i> -statistics	Level of significance	Collinearity Tolerance	Statistics VIF
	<i>B</i>	Standard Error					
Constant	15.597	3.819		4.084	.000		
Crop profit	1.245	.495	3.819	2.517	.015*	.800	1.251
Meat	.244	.277	.495	.881	.382	.703	1.421
Milk	.194	.269	.277	.719	.475	.785	1.274
Draught power	.412	.482	.269	.855	.396	.654	1.528
Manure	-.701	.318	.482	-2.202	.032*	.796	1.256
Revenue	-.082	.244	.318	-.336	.738	.875	1.142
Status	-.057	.288	.244	-.200	.842	.551	1.815
Cultural	.629	.317	.288	1.983	.052	.880	1.136
Food security	-2.511	.565	.317	-4.444	.000**	.803	1.246
Feed	-1.954	.455	.565	-4.290	.000**	.854	1.172

Dependent Variable: TOTASST.

$R^2 = 0.473$ , Adjusted  $R^2 = 0.384$ .

\*Significance at 10%.

\*\*Significance at 5%.

#### 4.4.5 Relationships between Farmer's Perception and Demographic and Socio-economic Characteristics

On the basis of the results of the regression analyses presented and described in Table 3, it is concluded that the most important perceptions in respect to crop-livestock integration in the project area, for the survey period, were the importance of the practice for crop profits, manure, feed, and food security. For this reason, further regressions were run to determine the socio-economic and demographic characteristics that best explain their variations from household to household. The purpose of regressing farmers' perception is crucial for adopting crop-livestock integration on the demographic and socio-economic characteristics was to find out which factors could be manipulated by policy to achieve a desirable response in respect to the approach. The results are presented in Table 4.

As indicated above, food security was shown to be a significant motive for a sizeable number of households choosing to integrate crop and livestock enterprises in the farming system under investigation. The purpose here is to find out which socio-economic and demographic characteristics of the farmers most closely explain the differences between households in terms of the perception that crop-livestock integration enhances food security of the household. The results appear in Table 4.

As Table 4 shows, the significant variables in this analysis were education ( $p=0.041$ ), household size ( $p=0.017$ ), land size ( $p=0.000$ ) and arable land ( $p=0.002$ ). These results suggest that these demographic and socio-economic characteristics influence the particular perception of farmers on whether to integrate or not. The implication is that respondents who are likely to consider food security an important reason to integrate would be those with larger household sizes and arable land while they may be those with less education than others. There was also a negative significant relationship with overall land size which may be consistent with a situation where respondent does not face the constraint to obtain adequate feed for the livestock. It is possible that persons owning large land areas are those who have access to communal grazing land and therefore can always obtain feed for their livestock whenever they need to.

Table 4. Food security on demographic and socio-economic characteristics

Variables	Unstandardized Coefficients		Standardized Coefficients <i>Beta</i>	<i>t-statistics</i>	Level of significance	Collinearity Statistics	
	<i>B</i>	Standard Error				Tolerance	VIF
Constant	3.580	.721		4.964	.000		
Gender	.227	.167	.132	1.360	.179	.860	1.163
Marital Status	-.012	.060	-.020	-.203	.840	.817	1.223
Age	.003	.007	.050	.479	.634	.755	1.325
Education	-.199	.095	-.220	-2.089	.041	.735	1.360
Religion	.686	.404	.358	1.699	.094	.183	5.463
Household size	.060	.025	.240	2.443	.017*	.840	1.191
Total land Size	-.083	.021	-1.581	-3.895	.000**	.049	20.290
Arable Landholding	.106	.032	.956	3.253	.002**	.094	10.635

Dependent Variable: food security.

$R^2 = 0.505$ , Adjusted  $R^2 = 0.440$ .

\* Significance at 10%.

\*\*Significance at 5%.

The perceptions regarding the importance of obtaining feed for livestock as a reason for integrating crop and livestock on farms were investigated by regressing that farmers' perception on demographic and socio-economic characteristics. The results are presented in Table 5. However, the analysis failed to reveal any meaningful patterns in the relationships between this variable and the set of socio-economic and demographic variables included in the model. The results show that the only significant variable in this analysis was gender ( $p=0.020$ ), while very little of the total variations are explained by the model.

Table 5. Farmers perception about feed value on demographic and socio-economic characteristics

Variables	Unstandardized Coefficients		Standardized Coefficients <i>Beta</i>	<i>t-statistics</i>	Level of significance	Collinearity Statistics	
	<i>B</i>	Standard Error				Tolerance	VIF
Constant	2.741	1.021		2.685	.009		
Gender	-.564	.237	-.272	-2.382	.020*	.860	1.163
Marital Status	-.023	.085	-.031	-.267	.791	.817	1.223
Age	.009	.010	.103	.843	.403	.755	1.325
Education	.267	.135	.245	1.979	.052	.735	1.360
Religion	-.039	.572	-.017	-.069	.945	.183	5.463
Household size	.041	.035	.137	1.185	.240	.840	1.191
Total land Size	-.004	.030	-.057	-.119	.906	.049	20.290
Arable Landholding	-.051	.046	-.386	-1.117	.268	.094	10.635

Dependent Variable: Feed.

$R^2 = 0.315$ , Adjusted  $R^2 = 0.225$ .

\* Significance at 10%.

\*\*Significance at 5%.

As indicated in the foregoing, there are perceptions that crop-livestock integration is valuable for its contribution in generating organic manures for purposes of restoring and enhancing soil fertility. The extent to which this particular perception was important and what factors determine such views were interrogated by regressing that perception on the same set of demographic and socioeconomic characteristics. The results are presented in Table 6.

Table 6. Farmers perception about manure on demographic and socio-economic characteristics

Variables	Unstandardized Coefficients		Standardized Coefficients	<i>t-statistics</i>	Level of significance	Collinearity Statistics	
	<i>B</i>	Standard Error	<i>Beta</i>			Tolerance	VIF
Constant	.010	1.734		.006	.995		
Gender	.073	.403	.024	.182	.856	.858	1.166
Marital Status	.023	.145	.022	.161	.873	.824	1.214
Age	.014	.018	.112	.800	.427	.753	1.327
Education	.319	.231	.197	1.383	.172	.731	1.367
Religion	1.328	.977	.224	1.360	.179	.551	1.816
Household size	-.075	.060	-.166	-1.239	.220	.833	1.201
Total land Size	.008	.033	.091	.256	.799	.118	8.447
Arable Landholding	-.037	.069	-.189	-.540	.591	.122	8.206

$R^2=0.106$ ; Adjusted  $R^2= -0.014$

\*Significance at 10%

\*\*Significance at 5%

The analysis shows that regressing farmers' perception about soil fertility/manure on demographic and socio-economic characteristics does not help in clarifying the picture. The results show that none of the regression coefficients associated with the explanatory variables showed any significance. Expectedly, the proportion of the variations explained by the model is quite insignificant, especially when the sample size is considered (see the negative adjusted R-squared). Thus, much as some households who integrated may have done so because of their expectation of obtaining adequate amounts of manure to maintain or restore soil fertility, this was not statistically significant and may have been important only in a limited number of cases.

As was noted earlier, the possibility of realizing increased profits from the crop enterprise as a result of tapping the synergies between crop and livestock enterprises was mentioned in a few cases. Since this variable showed some significance as a determinant of the total assets scores of the household, it was decided to follow up on the analysis by investigating the factors that may exert important influence on such perceptions. The results are presented in Table 7.

Table 7. Farmers perception about crop profit on demographic and socio-economic characteristics

Variables	Unstandardized Coefficients		Standardized Coefficients <i>Beta</i>	<i>t</i> -statistics	Level of significance	of Collinearity Statistics	
	<i>B</i>	Standard Error				Tolerance	VIF
Constant	0.559	.976		.573	.569		
Gender	0.018	.227	.010	.081	.935	.858	1.166
Marital Status	-0.084	.081	-.123	-1.027	.309	.824	1.214
Age	0.037	.010	.460	3.680	.001*	.753	1.327
Education	0.237	.130	.231	1.822	.073	.731	1.367
Religion	0.677	.549	.180	1.232	.223	.551	1.816
Household size	-0.062	.034	-.217	-1.823	.073	.833	1.201
Total land Size	0.022	.019	.367	1.163	.249	.118	8.447
Arable Landholding	0.002	.039	.016	.051	.959	.122	8.206

Dependent Variable: Crop Profit.

$R^2=0.294$ ; Adjusted  $R^2=0.199$ .

\*Significance at 10%.

\*\*Significance at 5%.

The analysis shows that regressing farmers' perception about crop profit on demographic and socio-economic characteristics does not help a great deal in clarifying the picture. The results show that the only significant variable in this analysis was age of the household head ( $p=0.001$ ), while very little of the total variations is explained by the model which shows  $R^2$  of 29% and adjusted  $R^2$  of 20%.

#### 4.5 Results of the Logistic Regression Analysis

A key objective of this study was to determine the major factors influencing the decision of the households to engage in crop-livestock integration and what obstacles they confront in the process. Given the dichotomous nature of the dependent variable in this case, this required that a binary logistic regression model be fitted alongside the other analyses already undertaken and discussed. The results of the analysis are presented in Table 8. The procedure began with the inclusion of all the variables identified in the correlation analysis and follow up multiple linear regressions as potentially key explanatory variables. The initial runs exhibited very high levels of insignificance. As a result, the variables were deleted by backward elimination to achieve parsimony in the model. All 70 cases were included in the analysis. The Nagelkerke R Square value of 0.50 shows that about 50% of the variation in the outcome variable (integration of crops and livestock) is explained by this logistic model with the Cox & Snell R square indicating that this is not likely to fall below 35%. These indications in respect of the model adequacy are supported by the results shown in Table 8 for both the Wald estimates and the p-values. For instance, p-values of 0.002, 0.049, 0.07 and 0.049 are associated with the variables age, perceptions of high milk and meat yield and total income, respectively (Table 8). Interestingly, the Total Income predictor which was hardly helpful in the linear model came out to be highly significant in the binary choice model which may reflect the non-linearity of this particular variable rather than a reflection of the nature of the overall model fitted.

Table 8. Effect of socio-economic factors on participation in the integration of crops and livestock

Variable	B	S.E.	Wald	Sig	Exp (B)	95% C.I. for EXP(B)	
						Lower	Upper
Constant	-12.517	3.901	10.296	0.01	0.000	-	-
Age	0.140	0.045	9.705	0.002**	1.151	1.053	1.257
Arable land	-0.157	0.296	2.386	0.122	0.633	0.355	1.131
Meat	0.483	0.246	3.859	0.049*	1.622	1.001	2.627
Milk	0.621	0.231	7.218	0.007**	1.861	1.183	2.928
Manure	0.207	0.299	0.481	0.488	1.230	0.685	2.210
Total Assets	0.786	0.497	2.501	0.114	2.195	0.828	5.814
Total income	0.001	0.000	3.887	0.049*	1.001	1.000	1.001

Overall, of the seven variables hypothesized to explain the farmers' adoption behaviour of an integrated livestock and crop farming system, four were found to be significant at 5% probability level. There are a few interesting implications that can be drawn from these results. Taking the continuous variables first, the evidence from the values of the odds ratios can be examined in the case of age and total income. In the case of age, there is the suggestion that the odds of a farmer adopting crop-livestock systems are 1.151 times higher for an older person than for one who is younger. This implies that the older a person is, the more likely s/he will adopt crop-livestock integration. According to the values shown in Table 8, an increase in age by one year can produce a positive response towards adoption by as much as 15% on the average, with a 5% probability that this such a response can range from as low as 5% to nearly 26% (95% CI 5.3% to 25.7%) of adopting integrated livestock and crop farming system.

The odds ratios can also be interpreted in a straightforward manner in the case of the total income predictor. According to Table 8, the odds ratio associated with this variable is 1.001. Since this is a positive value greater than 1, there is an implication of an increase in the odds of the respondent adopting crop-livestock integration for every one unit increase in total income. Such a result is consistent with the expectation that smallholder farmers will be less eager to adopt a practice with uncertain outcomes when they have difficulty financing the initial investment in the first place. Households with higher income and existing wealth are undoubtedly more likely to take risks and embark on exploratory investments than those households with weaker resource bases, all things being equal. It must be noted, however, that in this case, the range over which the income predictor influences adoption decisions is quite narrow when assessed at the 5% alpha level (95% CI 0.0% to 0.1%). This result with respect to the rather narrow confidence interval in the smallholder setting being evaluated in this study probably reflect the multiple influences that these farmers are subject to, including cultural considerations which can sometimes exert stronger influences on the decision process than other factors.

For the variables that have been based on the 5-point Likert Scale, namely the farmers' perception of the importance of meat and milk as motives for integration, the interpretation is similar to the case of categorical variables with more than two categories, in this case five categories. The perceptions of respondents in this respect have been ranked according to the strength of their perceptions from weak (ranked 1) to very strong (ranked 5). In the case of the respondents who are of the opinion that more meat production is a reason for integrating, the results suggest that the odds of a household integrating crops and livestock increases the stronger the views of the respondent in respect to the meat value of the farming approach. Thus, households whose heads think that crop-livestock integrated system yields higher meat output are more likely to adopt the approach than households whose heads hold less strong views in that regard. The stronger the perception of the household the more likely is the household to adopt crop-livestock integration. In numerical terms, the results suggest that the odds of adopting integrated crop-livestock system is 1.6 times higher between successive ranks on the scale as we move from the weakest viewpoint of 1 to the strongest viewpoint of 5, all things being equal (i.e. if farmers' perceptions were the only determinants of adoption of crop-livestock integration). Given the results, it seems that this influence of perception may be even stronger at higher rankings of the perception in view of the relatively wide range of values indicated at 95% confidence interval (95% CI 1.0 to 2.6). The results in the case of the perceptions about the contribution of crop-livestock integration to milk production lead to similar conclusions, with the likelihood of integration being estimated at 1.9 times higher for those with stronger views compared to those with less strong

view. Again, in the case of milk, there seems to be a possibility that stronger views will elicit much larger responses in terms of the adoption of the practice than weaker views given the observed confidence interval (95% CI 1.2 to 2.9).

## 5. Conclusions and Recommendations

The results of the study reveal that small farmers in the Nkonkobe municipality have the possibility of realizing immense benefits from the integrated systems which also have the potential to lead to substantial improvements of the physical, chemical and biological soil properties. There is clear evidence of widespread interest to experiment with the practices based on the strong positive perceptions that a majority of the survey farmers exhibited. But the farmers face challenges in coping with the associated complexities especially in respect to access to land which must be used efficiently for the desired results to be achieved. This calls for entrepreneurial skills and management capabilities to identify and take advantage of marketing opportunities. Whether or not the current agrarian reform efforts succeed will depend crucially on how these issues are addressed.

## Acknowledgments

The original research on which this paper was based was funded by the South Africa Netherlands Research Programme on Alternatives in Development (SANPAD) to whom the author expresses immense gratitude. The research assistance for data collection was largely provided by the author's numerous research students, particularly Miss Feziwe Peter, Miss Sibusisiwe Matanda, Miss Vuyo Ngxetwane, and Mr Bulelani Mnduze whose inputs are gratefully acknowledged.

## References

- Afronline (2011). "Agriculture: Job Creation and Rural Growth". Retrieved from [www.afronline.org](http://www.afronline.org)
- Alam, M. M., Siwar, C., Talib, B., & Toriman, M. E. (2011), "The relationships between the socioeconomic profile of farmers and paddy productivity in north-west Selangor, Malaysia.", *Asia-Pacific Development Journal*, 18(1), 161-173.
- BDLive (2013). IMF Slashes South Africa's Economic Growth Forecast. Retrieved from [www.bdlive.co.za/economy/2013/07/09/](http://www.bdlive.co.za/economy/2013/07/09/)
- Block, S., & Webb, P. (2001). The dynamics of livelihood diversification in post-famine Ethiopia. *Food Policy*, 26, 333-350. [http://dx.doi.org/10.1016/S0306-9192\(01\)00015-X](http://dx.doi.org/10.1016/S0306-9192(01)00015-X)
- Cervantes-Godoy, D., & Dewbre, J. (2010). Economic Importance of Agriculture for Poverty Reduction. OECD Food, Agriculture and Fisheries Working Papers, No. 23, OECD Publishing. <http://dx.doi.org/10.1787/5kmmv9s20944-en>
- Christiaensen, L., Demery, L., & Kuhl, J. (2010). *The (Evolving) Role of Agriculture in Poverty Reduction*. UNU-WIDER, Working Paper No. 2010/36.
- Clark, E. A. (2004). Benefits of Re-Integrating Livestock and Forages in Crop Production Systems, *Journal of Crop Improvement*, 12(1), 405-436. [http://dx.doi.org/10.1300/J411v12n01\\_06](http://dx.doi.org/10.1300/J411v12n01_06)
- FAO, (2004). Changing patterns of agricultural trade. The evolution of trade in primary and processed agricultural products. Retrieved 21 July, 2009 from <http://www.fao.org/docrep/007/y5419e/y5419e05.htm>
- Gibbs, A., Willan, S., Misselhorn, A., & Mangoma, J. (2012). Combined structural interventions for gender equality and livelihood security: a critical review of the evidence from southern and eastern Africa and the implications for young people. *Journal of the International AIDS Society*, 15(1), 1-10.
- Gujarati, D. (1992). *Essentials of Econometrics*. McGraw-Hill, Boston.
- Gujarati, D. N. (2003). *Basic Econometrics* (4th ed.). New York: McGraw Hill.
- Hebinck, P., & Lent, P. C. (Eds.) (2007). *Livelihoods and Landscapes – the people of Guquka and Koloni and their resources*. Leiden, Koninklijke Brill NV, The Netherlands. Retrieved from <http://www.ifad.int/lrkm/events/cops/papers>
- International Fund for Agricultural Development. (2008). Improving Crop- Livestock Productivity through Efficient Nutrient Management in Mixed Farming Systems of Semi-arid West Africa. Retrieved from <http://www.ifad.org/lrkm/tags/384.htm> (accessed 8 June 2009).
- International Fund for Agricultural Development. (2009). Integrated Crop-Livestock Farming Systems, Communities of Practice for pro-poor livestock and Fisheries/aquaculture development, Rome.

- International Livestock Centre for Africa. (1998). *Crop-Livestock Interactions. A Review of Opportunities for Developing Integrated Models*. Llangefni, United Kingdom: Stirling Thorne Associates.
- Muzari, W., Gatsi, W., & Muvhunzi, S. (2012). The impact of technology adoption on smallholder agricultural productivity in sub-Saharan Africa: A Review. *Journal of Sustainable Development*, 5(8), 69-77. <http://dx.doi.org/10.5539/jsd.v5n8p69>
- Obi, A., Van Schalkwyk, H. D., & Van Tilburg, A. (2012). Market Access, Poverty Alleviation and Socio-Economic Sustainability in South Africa. In H. D. Van Schalkwyk & A. Obi (Eds.), *Unlocking Markets for Smallholders: Lessons from South Africa*, Wageningen, Wageningen Academic Publishers and Mansholt Publications Series. [http://dx.doi.org/10.3920/978-90-8686-168-2\\_1](http://dx.doi.org/10.3920/978-90-8686-168-2_1)
- Perret, S., Anseeuw, W., & Mathebula, N. (2005). *Poverty and livelihoods in rural South Africa*. Investigating diversity and dynamics of livelihoods. Case studies in Limpopo. Pretoria, University of Pretoria, Kellogg.s Foundation, Unpublished Project report num.05/01, 64p.
- Sharma, S. (2012). Rising inequality in South Africa: Drivers, Trends and Policy Responses. *Consultancy Africa Intelligence*. Retrieved from <http://www.consultancyafrica.com>
- Sterve, H. (2010). *Factors restricting adoption of sustainable agricultural practices in a smallholder agro-ecosystem: a case study of Potshini community, upper Thukela region, South Africa*. Masters Thesis, Stockholm Resilience Centre, Stockholm University.
- United Nations Development Programme. (2003). *South African Human Development Report 2003*, Pretoria, United Nations Development Programme.
- United Nations Development Programme. (2013). *Human Development Report 2013 – The Rise of the South: Human Progress in a Diverse World*, New York, United Nations Development Programme.
- World Bank. (2007). *Rural women in the Sahel and their access to agricultural extension. Sector Study: Overview of Five Country Studies*. Washington, DC: World Bank.

### Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).