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Full Length Research Paper

Factors and risks associated with integrated, conventional and sustainable agribusiness farming

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A multinomial logistic regression was used to estimate the impact and risks associated with integrated, conventional and sustainable agribusiness farming. The results of the study suggested that farmers operating on conventional and sustainable agribusiness farming were more likely to be those with knowledge of technology and diversified agribusiness farming. Compared with integrated agribusiness farming, these farmers were those with low levels of education and less access to information with higher business risks. In conclusion, the study suggested that in developing areas dominated by farmers with low levels of education and access to information, integrated agribusiness farming would be appropriate.

Key words: Sustainable, integrated and conventional agribusiness farming, risks, multinomial logit model.

INTRODUCTION

Sustainable Agribusiness Farming (SAF) has been observed to take into the account topography, soil characteristics, climate, pests, local availability of inputs, and the individual grower's goals. Ashby (2001) defines sustainable agribusiness farming as the type of agricultural agribusiness farming that can meet the demands for food and fibre for a fairly long time at socially acceptable economic and environmental costs. Sustainable agriculture has also been defined in terms of its philosophy as well as agribusiness practices. For example, Francis and Youngberg (1990) define SAF system as a philosophy that guides farmers to develop integrated, resource conserving, and equitable agribusiness farming based on previous experience and current knowledge. Besides this appealing philosophy, there are risks involved in SAF practices. Various negative effects result when different geographical regions, background, economic and social characteristics of farmers are considered. According to Debertin (1994), SAF consists of a collection of agricultural production practices that can be continued, or "sustained" over a period of time. Ikerd (1990) also defines SAF as the type of agribusiness system whereby farmers are able to keep farms both ecologically sound and economically viable.

On the other hand, an integrated agribusiness farming (IAF) has been defined as consisting of a range of resource-saving agribusiness practices that aim to achieve acceptable profits with high and sustained production levels, while minimizing the risks involved in intensive agribusiness. Based on the principle of enhancing natural biological processes above and below the ground, IAF represents an agribusiness system that reduces erosion and increases crop yields. Soil biological activity and nutrient recycling, intensified land use and improved profits are also enhanced. IAF also helps to reduce poverty and malnutrition and eventually strengthen environmental sustainability. The definition of IAF varies depending on the context in which it is considered. According to Agbonlabor et al. (2003) IAF is the concept and type of mixed agribusiness system that combines crop and livestock enterprises in a supplementary and/or complementary manner. However Prato (2000) defines IAF as a mixed agribusiness system that consists of at least two separate but logically interdependent parts of a crop and livestock enterprises. Contrasting these definitions, Radhammani et al. (2003) describe IAF as a component of agribusiness farming

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which takes into account the concept of minimising risks, increasing production and profits whilst improving the utilization of organic wastes and crop residues. Research has showed that continuous production of crops and livestock without external inputs reduces the ability of the soil resource base to both provide and retain nutrients which often results in a decline in productivity (Bailey et al., 1999).

A comparison can be made with Conventional Agribusiness Farming (CAF) which has been defined by Comer et al. (1999) as “capital intensive, large-scale, highly mechanised agriculture with monoculture of crops and extensive use of artificial fertilizers, herbicides, and pesticides with intensive animal husbandry”. According to Coiner and Polansky (2001), the use of conventional agriculture has increased food production, but risks in the form of increase in costs have been observed in the process. The costs have been observed to be both economic and ecological in nature. For example, persistent soil erosion has been associated with substantial site damages, contamination of surface and ground water, loss of genetic diversity, cost-price squeeze and degradation of resources in agribusiness communities (Schierre et al., 2002). Increased use of agro-chemicals has also increased the perceived risks among consumers about food safety. Consequently, reasonable support is growing towards the type of agribusiness system that will continue indefinitely to be productive and profitable, conserve resources, protect the environment and reduce the risks in the health and safety of the entire population. Schierre et al. (2002) have proposed an ideal agribusiness system that will accomplish these goals and refers to this type of agribusiness system “sustainable agribusiness system”. Against this background, it was hypothesised in this paper that a good understanding of farmers’ choices in the selection of the appropriate agri-business farming with its associated risks would assist policy makers to formulate strategies that will enhance the adoption of agribusiness farming suitable in a particular area.

OBJECTIVES AND HYPOTHESES

Empirical evidence indicates that adoption of integrated, conventional or sustainable agricultural farming is influenced by several socio-economic factors. The general purpose of this study was to investigate the relative importance of selected socio-economic factors that affect the selection of conventional or sustainable agricultural agribusiness farming compared to integrate agribusiness farming. Based on previous studies, the following hypotheses were tested:

1. Farmers with prior knowledge in recommended technology and diversified agribusiness farming are more likely to choose conventional and sustainable agribusiness farming and not integrated compared with integrated agribusiness system;

2. Low levels of input costs are associated with conventional and sustainable agribusiness farming compared with integrated agribusiness system;

3. Farmers with high levels of education and access to information on new agribusiness practices are more likely to prefer conventional or sustainable agribusiness system compared with integrated agribusiness system.

METHODOLOGY

This study was carried out in the Limpopo province of South Africa, which comprises six districts: Capricorn, Vhembe, Mopani, Bohlabela, Sekhukhune and Waterberg. The study covered emerging farmers operating on diverse enterprises involving crops, livestock, fruits and vegetables. A list of emerging agribusiness farmers was obtained from the Limpopo Department of Agriculture. A sample of 400 farmers covering six districts was included in the survey. The cohort included farmers operating on integrated agribusiness, conventional and sustainable agribusiness farming. Following face-to-face interviews 382 out of 400 questionnaires were analysed. This number represented 95.5% response rate.

Farmers were asked to choose the description of an agribusiness system that best suited their agribusiness operations in their areas. The three categories considered were:

i) Integrated agribusiness system: a resource-saving agribusiness practice that aims to achieve acceptable profits with high and sustained production levels, while minimizing the negative effects of intensive agribusiness by preserving the environment.

ii) Conventional agribusiness system: a capital intensive, large-scale, highly mechanised agriculture with monoculture of crops and extensive use of artificial fertilizers, herbicides, and pesticides with intensive animal husbandry.

iii) Sustainable agribusiness system: an agribusiness system that can meet the demands for food and fibre for a fairly long time at socially acceptable economic and environmental costs.

Multinomial logit model

A multinomial logit regression analysis was used to determine the impact of selected socio-economic factors towards integrated, conventional and sustainable agribusiness farming. In this study where categories were unordered, multinomial logistic regression (MLR) was the most appropriate method. The dependent variable in this study had three categories: integrated, conventional and sustainable. Integrated with the highest frequency was designated as the reference category. The probability of membership in other categories was then compared with the probability of membership in the reference category.

In general for such a dependent variable with M categories, this required the calculation of M-1 equations, one for each category relative to the reference category, to describe the relationship between the dependent variable and the instrumental variables. The first category, integrated, was the reference, so, for m=2... M,

$$ln \frac{P(YI = M)}{P(YI = 1)} = \alpha_M + \sum_{K=1}^{K} \beta_{MK} X_{IK} = Z_{MI}$$

Hence, for each case, there were M-1 predicted log odds, one for each category relative to the reference category. For more than two groups: m= 2… M,

Table 1. Dependent variable classified by three categories.

Category	Description	Number of cases (%)
1	Integrated agribusiness system	244 (63.9)
2	Conventional agribusiness system	118 (30.9)
3	Sustainable agribusiness system	20 (5.2)

Total sample size = 382.

$$P(Y_I = M) = \frac{\text{EXP}(Z_{MI})}{1 + \sum_{H=2}^{M} \text{EXP}(Z_{HI})}$$

For the reference category, integrated, (M=1),

$$P(Y_I = 1) = \frac{1}{1 + \sum_{H=2}^{M} \text{EXP}(Z_{HI})}$$

(Note that when m =1, In (1) = 0 = $Z_{11,}$ and exp (0) = 1). Similarly, for conventional, (M=2),

$$P(Y_I = 2) = \frac{\text{EXP}(Z_{1I})}{1 + \sum_{H=2}^{M} \text{EXP}(Z_{HI})}$$

and for sustainable, M=3,

$$P(Y_I = 3) = \frac{\text{EXP}(Z_{2I})}{1 + \sum_{H=2}^{M} \text{EXP}(Z_{HI})}$$

The multinomial logistic regression that was used to predict the logit of case i (L_i) was specified as:

$$Li = \alpha + \beta_1 \text{ Var} + \beta_2 \text{ Div} + \beta 3 \text{ Cost} + \beta_4 \text{ Edu} + \beta_5 \text{ Info}$$

The logit was the natural log of the odd ratio. Farmers' knowledge of planting and of recommended maize species and variety variable (Var), was included to capture the effects of the selection of species and varieties of maize that were well suited to the site and conditions of the farm. When site selection is an option, factors such as soil type and depth, previous crop history and location are taken into account before planting (Jayanthi et al., 2000). This variable was expected to have positive impact on agribusiness farming. Diversified maize/livestock agribusiness variable (Div) was expected to highlight the positive effect of the biological and economic stability of the farm. Diversified farms are thought to be more economically and ecologically resilient hence expected to impact positively on agribusiness farming (Panell and Glen, 2000). Estimated cost on inputs per season variable (Cost) was included in the model to determine the efficient use of inputs by farmers. Many inputs and practices used by conventional farmers are also used in sustainable agriculture.

The goal in sustainable agriculture is to develop efficient biological farming which does not need high levels of material inputs which in turn should have positive effect on agribusiness farming (Tegegne et al., 2001). Years of formal education variable (Edu) was hypothesised to enhance management decision which eventually translates into proper management of the soil to enhance and protect soil quality and also for efficient use of inputs (Rosby and Caceres, 2001). Hence lower levels of education of farmers were likely to have negative effects on agribusiness farming. Farmer's access to information on new and recommended agribusiness practices through years of agribusiness experience (Info) was likely to have positive effects on all agribusiness operations. For example, the adoption of some technologies or practices that promise profitability may require several years of access to information and practices. Research has shown that low levels of access to information are likely to impact negatively on agribusiness farming (Halberg, 1999).

RESULTS

Based on the choice of the above three descriptions of agribusiness farming, 382 of the respondents were classified as integrated (63.9%), conventional (30.9%) and sustainable (5.2%) (Table 1). The description of the independent variables used in the multinomial logistic regression was presented as in Table 2. Farmers were asked questions on knowledge of planting of recommended maize species and variety, diversified maize/livestock agribusiness, costs of inputs, level of education and access to information on new agribusiness practises acquired through years of agribusiness experience. Analysis of their responses was presented in Table 3 using the analysis of variation (ANOVA) method.

Three variables (variety, diversification and access to information) showed significant differences among the three categories of agribusiness farming while two variables (input costs and level of education) did not. The results indicated that farmers in the three categories (integrated, conventional and sustainable) view knowledge of planting of recommended maize species and variety, diversified maize/livestock agribusiness and access to information on new agribusiness practices differently.

The results of the multinomial logistic regression model specification presented in Table 4 was statistically significant (Chi-square = 45.447; $p < 0.00$). The significance of the coefficients and their accompanying relative risks are indicated by the *P*-values and the Exp (B) values respectively. Table 4 had two parts, labelled with the categories of the outcome variable, farm category. They correspond to two equations:

$$\text{Log [P (category =2)/ P (category=1)]} = \beta_{10} \text{ Var} + \beta_{11} \text{ Div} + \beta_{12} \text{ Cost} + \beta_{13} \text{ Edu} + \beta_{14} \text{ Info}$$

Table 2. Description of variables.

Variable	Description
Variety (Var)	Knowledge of planting of recommended maize species and variety (Scale: No Knowledge =1 to Excellent=5)
Diversity (Div)	Diversified maize/livestock agribusiness (Maize only =1; Maize/other crops=2; Maize/livestock=3; Maize/livestock/crops= 4)
Cost on inputs (Cost)	Estimated total cost on inputs per season (water, nutrients, pesticides, and/or energy for tillage) (00'Rand) (5-10=1; 11-15=2; 16-20=3; 21-30=4)
Education (Edu)	Years of formal education for management decisions (21-30 = 4; 11-20=3; 1-10 =2; No education = 1)
Information (Info)	Access to information on new agribusiness practices through agribusiness experience (Years) (>10=1; 11-20=2; 21-30=3; 31-40=4; > 40=5)

Table 3. ANOVA (mean values).

Variable	Integrated	Conventional	Sustainable	*P*-value
Variety	2.43	2.98	3.65	0.00
Diversity	1.60	2.07	1.75	0.09
Cost on inputs	2.69	2.83	3.15	0.48
Education	2.89	3.03	3.15	0.23
Information	2.43	2.10	2.35	0.08

N=382, n_1=244, n_2=118, n_3=20.

Table 4. Parameter estimates.

Conventional	B	Se	Wald	P-value	Exp(B)
Intercept	-1.486	0.481	9.551	0.002	--------
Variety	0.234	0.075	9.867	0.002	1.264
Diversity	0.318	0.090	12.573	0.000	1.374
Cost on inputs	0.197	0.149	1.744	0.187	1.218
Education	-0.297	0.105	7.971	0.005	0.743
Information	-0.153	0.056	7.629	0.006	0.858

Sustainable	B	Se	Wald	Sig.	Exp(B)
Intercept	-4.629	1.237	14.010	0.000	-------
Variety	0.422	0.128	10.880	0.001	1.525
Diversity	0.116	0.180	0.418	0.518	1.123
Cost on inputs	0.405	0.341	1.416	0.234	1.500
Education	-0.145	0.208	0.487	0.485	0.865
Information	-0.086	0.112	0.590	0.443	0.918

-2 Log Likelihood = 429.326 (P<0.00), Chi-Square =45.447 (P<0.00). The reference category is: Integrated.

$$\text{Log}\,[P\,(\text{category}=3)/\,P\,(\text{category}=1)] = \beta_{20}\,\text{Var} + \beta_{21}\,\text{Div} + \beta_{22}\,\text{Cost} + \beta_{23}\,\text{Edu} + \beta_{24}\,\text{Info}$$

With the β's being the raw regression coefficient estimates from the output.

The results indicated that for one unit change in the variable *Var,* the log of the ratio of the two probabilities, P (category=2)/P(category=1), be increased by 0.234, and the log of the ratio of the two probabilities P(category=3)/P(category=1) increased by 0.422.

Therefore, it could be interpreted that in general, the more the knowledge of planting of recommended maize species and variety of farmers (Var), the more they are likely to prefer conventional agribusiness or sustainable agribusiness compared with integrated agribusiness. The same interpretation can be attributed to diversification (Div), and cost of inputs (Cost), but the opposite was true for education (Edu), and information (Info).

The relative risks of choosing integrated agribusiness system were displayed in the column labelled Exp (B) in the Table 4. For example, for one unit change in the variable *Var,* it was expected that the relative risk of choosing integrated agribusiness system (category 2) over integrated (category 1) increased by exp(0.234) = 1.264. Hence the relative risk for choosing integrated agribusiness system was higher for farmers with knowledge of planting of recommended maize species and variety. The multinomial logistic regression was employed to estimate the impact and risks associated with farmers who had knowledge of planting recommended technology, diversified agribusiness practices, high input costs, high years of formal education, and high levels of access to information on Conventional Agribusiness Farming (CAF) and Sustainable Agribusiness Farming (SAF). Four variables out of the five were significant. The variables with positive signs in both equations suggested that farmers operating on Conventional Agribusiness Farming (CAF) were more likely to have knowledge of recommended technology and diversified agribusiness farming. The impacts were however, significant only in CAF compared with SAF at least at the 1% level of significance. Furthermore, the risks involved were all higher in both CAF and SAF compared with IAF. The findings supported the first hypothesis stated above. The results showed that high farm inputs costs did not significantly affect farmers' affinity for IAF or CAF compared to IAF.

The variables with negative signs indicated that CAF and SAF were associated with farmers with low levels of education and less access to information on agribusiness practices compared with integrated agribusiness farming (IAF). The results did not support the third hypothesis stated above. However, the risks associated with this choice were estimated to be lower than in IAF.

SUMMARY AND CONCLUSION

The study indicated that the small-scale maize farmers interviewed in the area were operating mostly on integrated agribusiness system (63.9%). This result has good implications for agribusiness farming in the area.

However, for farmers with knowledge of planting of recommended species and varieties, diversified maize/ livestock agribusiness farming and low cost of inputs per season, the risk attached to their selection of integrated agribusiness system was relatively high. Farmers need to have sufficient access to knowledge, assets and inputs to manage the agribusiness farming in a way that they could be economically and environmentally sustainable over the long term. On the other hand, farmers with more years of formal education for management decisions and access to information on new agribusiness practices who preferred conventional and sustainable agribusiness farming, the risk compared to conventional and sustainable was lower. In conclusion, the study suggested that in areas where integrated agribusiness system is not practicable, conventional and sustainable agribusiness farming which have low risks are recommended. This is also true for farmers with low education and less or no access to agricultural information as can be found in less developed countries.

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