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Economic Analysis of Factors Responsible for the Attainment of Food Security Levels among Beneficiaries of Selected Agricultural Cooperatives in the Limpopo Province of South Africa

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ABSTRACT This study determined factors responsible for the determination of four levels of food security: never, seldom, sometimes and often or always among beneficiaries of two farmer cooperatives in the Limpopo Province of South Africa using the ordinal regression approach. A sample size of 178 respondents was used for the analysis. Respondents were purposively selected from beneficiaries of two cooperatives which had vegetable production as their main enterprise. Semi-structured questionnaires were used to collect information from respondents during the 2014/5 farming season. Data were analyzed using the SPSS version 22. Predictors which included, educational level, perceived high impact of cooperatives on food security, farming experience and ownership of equipment were identified as being positively associated with the odds of being food secure. It was recommended that for policy development and appropriate interventions in food security, factors identified to be positively associated with the attainment of high food security levels be considered as crucial.

INTRODUCTION

Food security exists when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life (Bajo 2014). Food security can be observed on three dimensions: food availability, food access and food use. Most definitions of food security do not distinguish between different levels of food security, durations and intensities (Hart 2009). Food security has a temporal as well as intensity dimensions. Temporal dimensions can be chronic, long-term or persistent, or transitory, referring to short periods of extreme scarcity of availability and access to food, as well as cyclical. This study investigates the levels of food security and three dimensions, never, seldom, sometimes and often or always. An understanding of the levels of food security is necessary for policy development and interventions.

In this study, focus is on food security levels among beneficiaries of agricultural cooperatives where farmers jointly own land and other farm equipment like tractors, irrigation pumps but individuals establish and control their own farming enterprises, operations on the jointly owned piece of land and infrastructure. Like other cooperatives, profit and needs of the communities are taken into account. Agricultural cooperative models differ in many countries. In the Limpopo Province of South Africa, agricultural cooperatives are formed through agreement by members to share a demarcated piece of land jointly owned by them. Individuals own plots allocated to them for as long as they remain cultivating on the jointly owned land. Different enterprises can be established on each piece of land, normally between 2-3 hectares. Joint production is not the mode as seen in other cooperatives, but individual production on different sizes of land.

Objectives

The main objective of this study was to determine factors responsible for the determination of four levels of food security among beneficiaries of two farmer cooperatives in the Limpopo Province of South Africa namely: never, seldom, sometimes and often or always, using the ordinal regression approach.

METHODOLOGY

Data Collection

A total of 178 sample size was used for this study. The respondents were purposively selected from beneficiaries of two cooperatives, Ratanang Cooperative and Dimammorako Agricultural Cooperative in the Limpopo Province of South Africa. The two cooperatives have vegetable production as their main enterprise. Since the two cooperatives were not of the same size, a proportional representative sample method was employed to select a sample size of 98 from Ratanang Cooperative and 80 from Dimammorako Agricultural cooperative. In all, a sample size of 178 was used in the analysis. Semi-structured questionnaires were used to collect information from respondents during the 2014/5 growing season. The data were analyzed using the SPSS version 22, available at the University of Venda.

Data Analysis

The Ordered Logistic Regression Model was considered appropriate in the analysis of the data. This regression model extends the proportional odds assumption by assuming that the predictor variables can be estimated freely across different categories of the dependent variable. The model can be expressed as (Bender and Benner 2000; O'Connell 2006):

$$= \alpha_j + \sum_{k=1}^{k} \beta_k X_{ik} \quad (1)$$

Equation (1) can be expressed as:

$$Logit\left[P(Y > j|X_1, X_2, ..., X_k\right] = Ln\left[\frac{P_i(Y_i > j|X_1, X_2, ..., X_k)}{P_i(Y_i \le j|X_1, X_2, ..., X_k)}\right] \quad (2)$$

$$\alpha_j + \sum_{k=1}^{k} \beta_k X_{ik}$$

In both equations (1) and (2) aj are the intercepts or cut-points, and β1j, β2j …, βpj are the logit coefficients. To simplify assumptions, the effects of the instrumental variables (IV) are assumed to be invariant across splits. The model predicts cumulative logits across K-1 response option categories. For K=4, (here, Y = 0 to 3) these cumulative logits can be used to make predictions for the K-1 cumulative probabilities, given the collection of explanatory variables can be expressed as a latent variable model (Powers and Xie 2000; Wooldridge 2001; Agresti 2002; Greene 2003). Assuming a latent variable, Y^* exists, as in this study, the estimated model can be specified as:

$$Y^* = x\hat{a} + \mathring{a} \quad (3)$$

In general, let Y^* be divided by some cut points (thresholds): α1, α2, α3… αj, and α1<α2<α3…< αj. The observed ordinal outcome, y, ranging from 0 to 4, then by definition: Y=0, if $y^* \le \alpha 1$; Y=1, if $y^* \le \alpha 2$; Y=2, if $y^* \le \alpha 3$; Y=3, if $y^* \le \alpha 4$;

The probability of attaining each achievement level can then be computed as:

$$P(y=0) = P(y^* \le á1) = P(x\hat{a} + \mathring{a} \le á1) = g(á1 - x\hat{a});$$
$$P(y=1) = P(á1 < y^* \le á2) = g(á2 - x\hat{a}) - g(á1 - x\hat{a});....$$
$$P(y=4) = P(á4 < y^* \le á5) = g(á5 - x\hat{a}) - g(á4 - x\hat{a});$$
$$P(y=5) = P(y^* > á5) = 1 - g(á5 - x\hat{a}). \quad (4)$$

The cumulative probabilities can be computed using the form:

$$P(Y \le j) = g(áj - x\hat{a}) \quad (5)$$

It is assumed that each of these comparisons yields the same odds ratio. A positive coefficient indicates that an individual is more likely to be in a higher category as opposed to a lower category of the outcome variable (Agresti 2002).

In this study, the outcome variable was respondents' food security status levels. An ordinal variable with three levels were constructed. The three food security levels were hierarchically structured and the proportional odds model was used to determine factors responsible for the ordered levels of food security.

$$Ln Y = Ln\left[\frac{P_i(Y_i = 1)}{1 - P_i(Y_i = 1)}\right]$$

RESULTS

The results of the analysis are presented in Tables 1, 2 and 3. Table 1 presents the description of the explanatory variables and their expected signs. In Table 2, the food security categories and their proportions are tabulated. In all, out of 178 respondents, 24.7 percent indicated that they had never experienced hunger during the 2014/5 growing season, 27.5 percent mentioned that they seldom went hungry or were food secure, 39.3 percent sometimes hungry and a comparatively small percentage of 8.5 percent indicated that they often or always went hungry or were not food secure. The full proportional odd model with all nine predictor variables fitted are presented in Table 3. The -2 Log likelihood (404.193), Chi-square (131.251) df (9), P<0.001, indicated that the model with nine predictors provided a good fit. The logit effects of all nine

Table 1: Description of explanatory variables and expected signs

Variable	*Description*	*Expected Sign*
X1	Educational level (1= higher than high school; 0 otherwise)	+
X2	Perceived distance to the nearest agricultural extension office (Km)	-
X3	Perceived high impact of cooperative on food security (1-6)[a]	+
X4	Percentage of income spent on food (1= >50%; 0=<50%)	-
X5	Age (years)	-
X6	Farming experience of beneficiary (years)	+
X7	Ownership of a tractor (1=yes; 0 otherwise)	+
X8	Household size (number)	-
X9	Off-farm income (1=yes; 0 otherwise)	+/-

a= Strongly disagree; 2= Disagree; 3= Slightly disagree;

predictors of food security levels were significant. The predictors, Educational level (X1), Perceived high impact of cooperative on food security (X3), farming experience of beneficiaries (X6) and ownership of tractors (X7), were all positively associated with the odds of being at higher food security levels. Other predictor variables, increase in distance to the nearest agricultural extension office (X2), percentage of income spent on food (X4), age (X5), household size (X8) and engagement in off-farm income (X9) were negatively associated with the odds of being food secure. The model also estimated three cut points which were used to differentiate adjacent categories of food security status levels. Cumulative logistic model for Y>0; cut point $\alpha 1 = 0.366$, Cumulative logistic model Y>1; cut point $\alpha 2 = 2.513$, and cumulative logistic model Y>2; cut point $\alpha 3 = 5.853$.

DISCUSSION

This study was aimed at determining factors responsible for the determination of four levels of food security (never, seldom, sometimes and often or always) using the ordinal regression approach.

Table 2: Food security categories and proportions

Level	*Description*	*Frequency*	*% of total sample*
0 (high)	Never hungry (food secure)	44	24.7
1	Seldom hungry	49	27.5
2	Sometimes hungry	70	39.3
3 (low)	Often/always hungry (food insecure)	15	8.5
Total		178	100.0

Table 3: Results of the full proportional odds model

Variable		*β*	*Std. error*	*Wald*	*P (β =0)*
Y>0:	α1	0.366	1.462	0.063	0.802
Y>1:	α2	2.513*	1.456	2.979	0.084
Y>2:	α3	5.853***	1.55	14.257	0
	X1	0.783***	0.266	8.677	0
	X2	-0.399**	0.184	4.724	0.03
	X2	1.399***	0.335	16.397	0
	X4	-1.325***	0.229	33.379	0
	X5	-1.893**	0.607	9.714	0.002
	X6	0.817***	0.179	20.868	0
	X7	0.805***	0.251	10.253	0.001
	X8	-0.351*	0.21	2.788	0.095
	X9	-1.124**	0.376	8.932	0.003
Model fit statistics:					
		-2Loglikelihood		304.193	
	Chi-square		131.251		
	Df			9	
	Sig.		0		

***P<-.001; **P<0.05; *P<0.10; N=178

The results indicated that the ordered log-odds estimate for a one unit increase in educational level (X1), on the expected food security seldom group and not in the sometimes or often group level given, all other variables held constant, in the model was 0.783. An indication that if a respondent were to increase his educational level score by one, his ordered log-odds of being food secure would increase by 78.3 percent. This result is in line with a study by Leyna et al. (2007), who found out that people living in rural areas with high educational levels were more food secure compared with those with less educational levels. Again, a study by Ngongi (2010) on food security in Tanzania showed that high formal education was resulted in the likelihood of households adopting agricultural technologies which improved their crop production resulting in high food security levels. Urassa (2010) also indicated that households with more education stood a better chance of accessing credit to afford farm inputs resulting in higher yields and food security.

The results indicated that the ordered log-odds estimate for a one unit increase in distance to the nearest agricultural extension office (X2), on the expected food security seldom group and not in the sometimes or often group level given all other variables held constant in the model was -0.399. An indication that if a respondent were to increase his distance score by one, his ordered log-odds of being food secure would decrease by 39.9 percent or almost forty percent. The finding is in line with that of Matchata and Chilonda (2012) who also found a negative relationship between long distance of farms from agricultural services and food security.

The results indicated that the ordered log-odds estimate for a one unit increase in perceived high impact of cooperative on food security (X3), on the expected food security seldom group and not in the sometimes or often group level given all other variables held constant in the model was 1.358. An indication that if a respondent were to increase his perception score by one, his ordered log-odds of being in the food secure group would increase by 135.8 percent. The result indicates farmers have a high perception that the formation of cooperatives results in high levels of food security. The findings are in conformity with other studies on the impact of cooperatives on food security. For example, Biru (2014) on a study of the role of agricultural cooperatives in promoting food security in Ethiopia found a high correlation between cooperatives and food security. Similar studies by Yamusa and Adefila (2014) also confirm high positive relationship between cooperatives and food security.

The results indicated that the ordered log-odds estimate for a one unit increase in percentage of income spent on food (X4) on the expected food security seldom group and not in the sometimes or often group level given all other variables held constant in the model was -1.325. An indication that if a respondent were to increase his percentage score by one, his ordered log-odds of being food secure would decrease by 132.5 percent. The inference from this finding is that farmers who spend more of their income on food are likely to be food insecure. A plausible explanation could be that since household size in negatively correlated with food security, it would mean that those household who spent more of their income on food may also have high household size. The result is however in contrast with that of Smith et al. (2006) who found out that in Sub-Saharan Africa households who spent more than sixty percent of their income on food were food secure.

The results indicated that the ordered log-odds estimate for a one unit increase in age (X5), on the expected food security seldom group and not in the sometimes or often group level given all other variables held constant in the model was -1.893. An indication that if a respondent were to increase his age score by one, his ordered log-odds of being food secure would decrease by 189.3 percent. This finding is consistent with the outcome of a study by Aidoo et al. (2013). Babatunde and Qaim (2010) explain that the negative effect may be due to the risk averse nature of old people to change from old farming practices to modern methods where the use of new technologies are employed. As a result, food availability from farm produce become limited.

The results indicated that the ordered log-odds estimate for a one unit increase in farming experience (X6), on the expected food security seldom group and not in the sometimes or often group level given all other variables held constant in the model was 0.817. An indication that if a respondent were to increase his farming ex-

perience by one, his ordered log-odds of being food secure would increase by 81.7 percent. Studies by Amaza et al. (2009) reveal that farming experience have a positive effect on productivity resulting in high food security levels. However, studies by Stats SA (2009) shows that after a long period in farming experience, which is correlated with age, negative effect on productivity resulting in low food security levels may occur.

The results indicated that the ordered log-odds estimate for a one unit increase in ownership of a tractor (X7), on the expected food security seldom group and not in the sometimes or often group level given all other variables held constant in the model was 0.805. An indication that if a respondent were to increase his age score by one, his ordered log-odds of becoming food secure would increase by 80.5 percent. The finding is in line with the results of a study by Babatunde and Qaim (2010) who found out that productive assets of farmers had positive effects on farm productivity resulting in high yields and high food availability. Again, in the estimation of effects of constraints on food security in Malawi, Matchaya and Chilonda (2012), found a positive effect of household assets on food security.

The results indicated that the ordered log-odds estimate for a one unit increase in household size (X8), on the expected food security seldom group and not in the sometimes or often group level given all other variables held constant in the model was -0.351. An indication that if a respondent were to increase his household size score by one, his ordered log-odds of being food secure would decrease by 35.1 percent. The implication of the outcome is that an increase in household size results in more people to feed in the family resulting in food insecurity. The finding is in line with studies by Aidoo et al. (2013) who found a negative significant correlation between household size and food security. Sikwela (2008) also found similar results in a study conducted in Zimbabwe.

The results indicated that the ordered log-odds estimate for a one unit increase in access to market information (X9), on the expected food security seldom group and not in the sometimes or often group level given all other variables held constant in the model was -1.124. An indication that if a respondent were to increase his age score by one, his ordered log-odds of being food secure would decrease by 112.4 percent. The finding is in contrast with the results from a study by Aidoo et al. (2013) who showed that off-farm income had a positive relation with food security. However, a study by Babatunde and Qaim (2010) on the impact of off-farm income on food security and nutrition in Nigeria found out the percentage share of off-farm income to calorie supply of households was low.

CONCLUSION

Predictors, educational level, perceived high impact of cooperatives on food security, farming experience and ownership of equipment for example, a tractor were positively associated with the odds of being beyond food secure level. Those respondents never went hungry during the past growing season and could be considered as being food secured. Comparatively, increased distance to the nearest agricultural extension office, increase in the percentage of farm income spent of food, age, household size, and engagement in off-farm income were negatively associated with food security. These were respondents who sometimes or often went hungry during the growing season or were not food secure.

RECOMMENDATIONS

For policy development and appropriate interventions in food security, the factors identified to be associated with the different levels of food security will be crucial. These factors include the provision of high educational levels through short-term training of farmers, perceived high impact of cooperatives on food security, farming experience and ownership of equipment.

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