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Abstract

A Tobit model censored at zero was selected to examine factors explaining differences in production efficiency amongst resettled farmers. Efficiency scores obtained from Data Envelop Analysis (DEA) were used as the dependent variable. From the factors inputted in the model, age of household head, excellent production knowledge and level of specialisation affected technical efficiency. Allocative efficiency was only affected by good production knowledge, farm size, arable land owned and area under cultivation. Factors which affected economic efficiency of the resettled farmers were secondary education, household size, farm size, cultivated area and arable land owned. None of the included socio-economic variables had significant effects on the allocative and economic efficiency of the resettled farmers. Thus, the allocative and economic inefficiencies of the farmers might have been accounted for by other natural and environmental factors which were not captured in the model. Efficiency of the resettled farmers can be improved significantly if the government focuses on increasing the education level of farming communities. The promotion of large farms through the establishment of co-operatives could also improve efficiency of the resettled farmers.

Keywords: farm size; inefficiencies; production knowledge; resettled farmers; Tobit model

1. Introduction

In a predominantly agricultural country such as Zimbabwe, the problem of land reform has naturally been one of the most important subjects of political campaign and economic problems (Shaw, 2003; Sachikonye, 2005). Zimbabwe's land distribution was racially highly skewed towards whites before land invasion and the status quo was not politically, socially or economically sustainable (Sibanda, 2001; Utete, 2003). This has been the state of affairs since the British invasion of 1890. It is this inequitable distribution of land that prompted the black people to take up arms and fight for independence (Government of Zimbabwe, 2000; Moyo, 2004).

After gaining independence from Britain on 18 April 1980, Zimbabwe adopted land reform programmes. There has been a widespread criticism of some of the programmes implemented to redistribute land in Zimbabwe, especially the Fast-Tract land reform programme also termed *jambanja* or *the Third Chimurenga* in Zimbabwe. The Fast-Track approach to resettlement was officially launched on 15 July 2000 to speed up the pace of land acquisition and resettlement (Utete, 2003). After the implementation of the *Third Chimurenga*, Zimbabwe's national crop production has been affected badly (World Bank, 2007). Areas under cultivation have decreased substantially between 1999/2000 and 2007/2008. Maize plantations reduced from 850.000ha to 500.000 ha, soya plantations from 220.000 ha to 60.000 ha and tobacco from 180.000 to 60.000ha (World Bank, 2007). In the beef sector, Zimbabwe has failed to meet its export quota to the European Union (EU) for a number of years (Richardson, 2005).

Most land reform beneficiaries are failing to feed themselves (Richardson, 2005). According to a Zimbabwe Vulnerability Assessment Committee (ZimVAC) Report (2009), the number of households consuming three meals a day declined from 54 % in 2006 to 23 % in 2009, and many households had to sell their assets, including livestock, to purchase food. Lower food production and failure of agriculture led to dependency on food aid.

These macro-economic figures suggest a very unattractive state of affairs, but do not tell us about the performance of resettled farmers who now occupy much of the productive land. Are these reductions in land area cultivated and yield a result of lack of efficiency on the part of resettled farmers? Jill (2005) even stated that the present land reform programme had, in several cases, negative effects on poverty alleviation. This, therefore, implies that the Zimbabwean land reform programme has not lived up to some its objectives which include

combating poverty and revitalizing the rural economy. If land reform is to meet its wider objectives, efficiency has to increase amongst the beneficiaries of the land reform programme.

The main objective of the study was to determine the efficiency of the resettled farmers using DEA. However, production efficiency scores from DEA would not provide evidence regarding factors that cause variation in efficiency (Coelli et al., 2005; Bojnec and Latruffe, 2008). To guide extension agents, researchers and policy-makers, it is essential to identify factors that influence production efficiency. The study therefore also determined the factors that affect technical, allocative and economic efficiency of the resettled farmers in Zimbabwe in the production of field crops.

2. Materials and methods

2.1 The study area

The study was conducted in the Shamva District of Zimbabwe. Shamva is one of seven districts in the Mashonaland Central Province of Zimbabwe. It is located 90km North-East of Harare, the capital city of Zimbabwe. The province mostly lies in the Agro-Ecological Region II, which is good for cropping and intensive livestock production. Rainfall is confined to summer and is moderately high (750-1000 mm) in this region (Vincent and Thomas, 1960; Campbell 2003).

The main economic activities in Shamva district are farming and illegal gold mining. The majority of the people live in rural areas where formal employment opportunities are minimal. The main crop grown is maize due to the fact that it is the staple food. Most farmers in the district also keep cattle and goats. However, due to the persistence of droughts in Zimbabwe since 1992, most households in the province now depend on gold panning, remittances, grain loans extended by the government and food relief provided by Non-Governmental Organisations (NGOs) to meet the shortfalls (Utete, 2003). As at the end of

July 2002, 1 851 households in Shamva District had been settled under the A1 Model[1], while 378 had been allocated land under the A2 Model[2] (Utete, 2003).

2.2 Sampling procedure

Two hundred and forty five households that benefited from land reform were randomly selected in the District. Respondents were stratified according to the model of land reform. The following models of land reform were used:

- Resettlement scheme: beneficiaries of land reform before 2000[3]
- Fast-Track A1 model
- Fast-Track A2 model

The reason for this type of stratification was that the land reform programme was implemented using different models and in most cases these models differed on how they were implemented and supported thus might have led to different efficiencies of the resettled farmers. Sample sizes varied according to the total number of beneficiaries that benefited from each of the three models of land reform. Selection of respondents was based on being a land reform beneficiary and the farmer's willingness to participate in the research. From the A1, A2 and the old resettlement scheme, 79, 67 and 99 respondents were selected, respectively and interviewed at their homesteads by trained enumerators (extension officers) under the supervision of a researcher from June to September 2010. Respondents were household heads. In the absence of household heads, any adult member of the household was interviewed. Data on farm output and output prices, input and input prices and household socio-economic characteristics were comprehensively collected.

[1] Model A1 was intended to decongest communal areas and targeted at land-constrained farmers in communal areas. This model was based on existing communal area organization, whereby peasants produce mainly for subsistence.

[2] Model A2 is a commercial settlement scheme comprising small, medium and large scale commercial settlement, intended to create a cadre of black commercial farmers.

[3] Old resettlement model was intended to decongest communal areas and beneficiaries mainly produced for family consumption and sale the surplus. Beneficiaries were given 3ha of arable land and access to communal grazing land.

2.3 Data analysis and description of variables used in the analysis

The efficiency of a farm consists of two components namely, technical and allocative efficiency. Technical efficiency is the ability of a farm to produce maximum output from a given set of inputs. By contrast to technical efficiency, allocative efficiency accounts for the respective prices of inputs. Allocative efficiency reflects the ability of a farm to choose the inputs in optimal proportions, given their input prices. The product of technical and allocative efficiency is called economic efficiency. In this study, input-oriented DEA model under the assumption of constant return to scale was used to estimate technical efficiencies in this study. It addresses the issue of 'by how much' can the amounts of inputs be proportionally reduced without changing the quantities of outputs produced.

Data Enveloped Analysis was adopted mainly because it has the ability to incorporate technical parameters that may not be captured by parametric production efficiency methods and its capability of handling multiple inputs and outputs (Coelli et al., 2005). Analysis of production efficiency scores would not provide evidence regarding factors that cause variation in efficiency (Llewelyn et al., 1996; Coelli et al., 2005; Bojnec and Latruffe, 2008). To guide extension agents, researchers and policy-makers, it is critical to identify factors that influence efficiency of these resettled farmers. A Tobit model was therefore used to determine the factors that affect technical, allocative and economic efficiency of the resettled farmers in Zimbabwe in the production of field crops

Efficiency scores lie between 0 and 1. Formulation of a regression equation with a truncated continuous dependent variable (efficiency score) may have resulted in a predicted output that lay beyond the interval 0-1. In addition, the dependent variable in regression model does not have normal distribution (Dhungana et al., 2004). As Wooldridge (2002) noted, traditional methods of regression are not suitable for censored data, since the variable to be explained is partly continuous and partly discrete. In this situation, ordinary least squares (OLS) analysis might have generated biased and inconsistent estimates of the model parameters. This implied that ordinary least squares (OLS) regression was not appropriate. Evaluation with an OLS regression might have led to a subjective parameter estimates as noted by Krasachat (2003). A Tobit model was therefore adopted in this study.

A Tobit model is a statistical model proposed by James Tobin (1958) to describe the relationship between a non-negative dependent variable y_i and an independent variable (or

vector) x_i. It is also called a censored regression model, designed to estimate linear relationships between variables when there is either left or right-censoring in the dependent variable (also known as censoring from below and above, respectively). Censoring from above takes place when cases with a value at or above some threshold, all take on the value of that threshold, so that the true value might be equal to the threshold, but it might also be higher (Bruin, 2006). In the case of censoring from below, values that fall at or below some threshold are censored. Greene (1993) argues that it is more suitable to have data censored at 0 than at 1. A Tobit model censored at zero was selected to examine factors explaining differences in production efficiency. The model used was:

$$E = E^* = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_{26} Z_{26} + \mu$$

$$If\ E^* > 0 \qquad E = 0\ if\ E \leq 0$$

Where:

E is the efficiency measures representing technical, allocative and economic efficiency.

E^* is the latent variable.

β are unknown parameters,

μ is a disturbance term.

Z_1 Dummy variable showing male household heads =1, female headed household=0

Z_2 Dummy variable showing married household heads=1, otherwise zero

Z_3 Age of the farmer in years

Z_4 Dummy variable showing poor production knowledge=1, otherwise zero

Z_5 Dummy variable showing fair production knowledge=1, otherwise zero

Z_6 Dummy variable showing good production knowledge=1, otherwise zero

Z_7 Dummy variable showing very good production knowledge=1, otherwise zero

Z_8 Dummy variable showing excellent production knowledge=1, otherwise zero

Z_9 Dummy variable showing no education=1, otherwise zero

Z_{10} Dummy variable showing primary level of education =1, otherwise zero

Z_{11} Dummy variable showing secondary level of education=1, otherwise zero

Z_{12} Dummy variable showing tertiary level of education=1, otherwise zero

Z_{13} Dummy variable showing Christianity =1, otherwise zero

Z_{14} Household size (number of household members)

Z_{15} Dependence ratio-the ratio of independent to the number of dependent members of the family

Z_{16} Dummy variable showing full time farmer =1, otherwise zero

Z_{17} Farming experience in number of years

Z_{18} Total farm area in hectares

Z_{19} Arable land used in hectares

Z_{20} Arable land owned in hectares

Z_{21} Herd size (number of cattle owned)

Z_{22} Dummy variable showing clay soil =1, otherwise zero

Z_{23} Dummy variable showing silt soil=1, otherwise zero

Z_{24} Dummy variable showing sandy loam =1, otherwise zero

Z_{25} Dummy variable showing clay loam=1, otherwise zero

Z_{26} Dummy variable showing sand soil=1, otherwise zero

Z_{27} Number of extension visits per season

For the Tobit model, efficiency scores obtained from DEA were used as the dependent variable. The model was used separately for economic, technical and allocative efficiency. Variables that were anticipated to cause variation in efficiency included years of farming experience, level of education, number of visits by extension agents, farm size, dependence ratio, region, production knowledge and household characteristics (age of head of household, religion of head of household, household size and gender of head of household) and level of specialization (whether a farmer was doing farming full time or part).

To measure production knowledge and skills related to current production technologies and practices, problem-solving tests were constructed. Studies in cognitive psychology have demonstrated the usefulness of measuring knowledge using problem solving tests or comprehension ability (Charnes et al., 1978; Eisemon 1988). The tests were intended to examine the kinds of solutions households provide to crop production problems based on their agricultural knowledge. For instance, farmers who plant maize were presented with the following problem solving task: Your maize plants are stunted exhibiting yellowish colour on leaves. What are the possible causes of this problem? How may it be prevented? Answers obtained from problem-solving tests were scored to compare variations in knowledge of farmers within and between land reform models. A score of 1 to 5 was prepared and individual farmers' response was ranked relative to their answers.

3. Results

The frequency distribution of technical, allocative and economic efficiency scores of sampled households are presented in Table 1. The results clearly showed that given the level of output with a minimum quantity of inputs under certain technology, the majority of the farmers who benefited from the A2 Fast-Track land reform model in Zimbabwe were clustered around 0.9 to 1. The minority of A1 farmers had the ability to produce a given level of output with a minimum quantity of inputs under certain technology lower than 50 % that was 42%. For A2 farmers, 6% scored above 50% whilst 94% scored below 50%. For the old resettled farmers the percentage of land reform beneficiaries with a technical efficiency score below 50% was 17% whilst the majority (83%) of these old resettled farmers had efficiency scores above 50%.

The results on the frequency distribution for allocative efficiency showed that the majority of the A1 and the A2 farmers had efficiency scores above 50% whereas for the old resettled farmers, the minority scored above 50%. For the A1 and A2 farmers, 44 and 45 % of these farmers that benefited under these two models of land reform had allocative efficient scores below 50%. On aggregate the majority of the sampled farmers have an allocative efficiency below 50%. As for economic efficiency, most of the sampled farmers in all the studied models of land reform had efficiency scores below 50%. The A1 beneficiaries led in this regard with 98 % of the sampled farmers who benefited under this model having less than 50% efficiency scores closely followed by the old resettled farmers with 97 %. The A2 land reform beneficiaries had the least percentage of 63% having economic efficient score of less than 50%.

Table 1: Frequency distribution of efficiency scores

Efficiency level Frequency												
	Technical Efficiency				Allocative Efficiency				Economic Efficiency			
Scores	A1	A2	OR	Total	A1	A2	OR	Total	A1	A2	OR	Total
0.01 – 0.10	0 (0)	0(0)	0(0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
0.11 – 0.20	0 (0)	0(0)	0(0)	0 (0)	3 (4)	0 (0)	6 (6)	9 (4)	7 (9)	3 (4)	13 (13)	23 (9)
0.21 – 0.30	0 (0)	0(0)	1(1)	1 (0)	10 (13)	4 (6)	20 (21)	40 (16)	47 (60)	11 (17)	48 (48)	106 (44)
0.31 – 0.40	3 (4)	1(1)	2(2)	6 (2)	9 (11)	14 (21)	5 (5)	28 (11)	20 (25)	19 (29)	34 (34)	73 (30)
0.41 – 0.50	30 (38)	3(5)	14(14)	47 (20)	13 (16)	12 (18)	19 (19)	44 (18)	3 (4)	9 (13)	1 (1)	13 (5)
Sub Total	33 (42)	4 (6)	17 (17)	54 (22)	35(44)	30(45)	50(51)	121(49)	77 (98)	42(63)	96 (97)	215 (88)
0.51 – 0.60	10 (13)	4(6)	41(42)	55 (22)	19 (24)	10 (15)	26 (26)	55 (21)	1 (1)	9 (13)	2 (2)	12 (5)
0.61 – 0.70	12(15)	11(16)	11(11)	34 (14)	23 (30)	16 (24)	20 (20)	59 (24)	0 (0)	10 (15)	0 (0)	10 (4)
0.71 – 0.80	8 (10)	8 (12)	5(5)	21 (9)	1 (1)	9 (13)	3 (3)	13 (5)	0 (0)	4 (6)	1 (1)	5 (2)
0.81 – 0.90	4 (5)	6(9)	3(3)	13 (5)	0 (0)	2 (3)	0 (0)	2 (1)	0 (0)	2 (3)	0 (0)	2 (1)
0.91 – 1.00	12 (15)	34(51)	22(22)	68 (28)	1 (1)	0 (0)	0 (0)	1 (0)	1 (1)	0 (0)	0 (0)	1 (0)
Sub Total	46 (58)	63 (94)	82 (83)	191(78)	44 (56)	37 (55)	49 (49)	124 (51)	2 (2)	25 (37)	3(3)	30 (12)
Total	79 (100)	67 (100)	99 (100)	245 (100)	79 (100)	67 (100)	99 (100)	245 (100)	79 (100)	67 (100)	99 (100)	245 (100)
Minimum	0.33	0.39	0.29	0.29	0.18	0.23	0.19	0.18	0.12	0.16	0.11	0.11
Maximum	1.00	1.00	1.00	1.00	1.00	0.90	0.75	1.00	1.00	0.90	0.75	1.00

Results obtained from the Tobit analysis are presented in Table 2. Technical efficiency was significantly affected by age of household head, excellent production knowledge and level of specialisation positively ($p \leq 0.05$).

Table 2: Sources of Technical, Allocative and Economic efficiencies

Variable	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Constant	0.366	0.009	0.673	0.000	0.293	0.001
	(0.140)		(0.111)		(0.083)	
gender	0.097	0.172	-0.062	0.267	-0.006	0.878
	(0.071)		(0.056)		(0.042)	
marital status	-0.075	0.259	-.004	0.946	-0.036	0.361
	(0.066)		(0.053)		(0.039)	
age	0.003	0.047*	-0.001	0.605	0.001	0.147
	(0.002)		(0.001)		(0.001)	
Poor production (prod)	-0.119	0.141	-0.114	0.076	-0.050	0.300
knowledge	(0.080)		(0.064)		(0.048)	
Fair prod knowledge	0.144	0.082	-0.117	0.075	-0.038	0.440
	(0.082)		(0.065)		(0.049)	
Good prod knowledge	0.113	0.177	-0.134	0.044*	-0.073	0.140
	(0.083)		(0.066)		(0.049)	
Very good prod	0.130	0.126	-0.127	0.061	-0.059	0.247
knowledge	(0.085)		(0.067)		(0.050)	
Excellent prod	0.119	0.048*	-0.080	0.120	-0.020	0.598
knowledge	(0.065)		(0.051)		(0.038)	
No education	-0.011	0.947	-0.023	0.855	0.025	0.788
	(0.158)		(0.125)		(0.094)	
Primary education	-0.008	0.903	0.065	0.239	0.061	0.140
	(0.069)		(0.055)		(0.041)	
Secondary education	0.106	0.110	0.020	0.705	0.093	0.019*
	(0.066)		(0.052)		(0.039)	

religion	0.014	0.687	-0.027	0.327	-0.009	0.652
	(0.034)		(0.027)		(0.020)	
Household size	0.002	0.491	0.004	0.131	0.004	0.035*
	(0.003)		(0.003)		(0.002)	
Dependence ratio	0.006	0.941	0.021	0.760	0.022	0.666
	(0.087)		(0.067)		(0.052)	
Specialisation	0.103	0.041*	0.043	0.323	0.024	0.463
	(0.055)		(0.044)		(0.033)	
Experience	0.001	0.739	-0.002	0.341	-0.001	0.317
	(0.002)		(0.002)		(0.001)	
Farm Size	0.001	0.975	0.004	0.026*	0.003	0.014*
	(0.002)		(0.002)		(0.001)	
Arable land owned	0.004	0.645	0.014	0.023*	0.009	0.046*
	(0.008)		(0.006)		(0.005)	
Cultivated area	0.008	0.254	0.010	0.045*	0.012	0.007*
	(0.007)		(0.006)		(0.004)	
Herd size	0.001	0.476	0.001	0.608	0.001	0.195
	(0.001)		(0.001)		(0.001)	
Clay Soil	-0.037	0.436	-0.018	0.634	-0.045	0.113
	(0.047)		(0.038)		(0.028)	
Silt Soil	-0.010	0.852	-0.065	0.127	-0.065	0.060
	(0.053)		(0.042)		(0.032)	
Sandy Loam Soil	-0.014	0.715	-0.042	0.179	-0.041	0.080
	(0.039)		(0.031)		(0.023)	
Sand Soil	0.038	0.512	0.010	0.831	0.005	0.880
	(0.058)		(0.046)		(0.035)	
Extension visits	-0.008	0.483	-0.002	0.974	-0.004	0.595
	(0.012)		(0.009)		(0.007)	
Prob > chi2	0.000		0.032		0.000	
Pseudo R^2	-1.021		-0.196		-0.437	

*Significant at 5%

Good production knowledge significantly affected allocative efficiency negatively. Farm size, arable land owned and cultivated area had a positive significant effect on allocative. Economic efficiency was positively affected by household size, secondary education, farm size; arable land owned and cultivated area considerably.

4. Discussion

The low economic efficiency scores imply that there is a wide room for improving efficiency among all the land reform beneficiaries. Improving efficiency amongst the resettled farmers would be important because most of the productive land in Zimbabwe is now in the hands of the newly resettled farmers and there is heavy grain shortage and consequently food insecurity in the country (Richardson, 2005). The only way grain shortage could be reduced is through improving the efficiency of the resettled farmers.

The average technical, allocative and economic efficiency scores for the sampled households were less than 60%, which is relatively low indicating a heterogeneous sample. This suggests that although the sample contained very different production systems in terms of farm size, farms had different management practices and made use of the existing technology differently, with A2 farmers utilizing available technology better than the small land holders (A1 and the old resettled land reform beneficiaries). The finding that large land owners were more technically efficient corresponds with the findings of Philip (2007) in his study on efficiency of farmers in the production of crops used in bio-fuel production in Tanzania. The study conducted in Tanzania observed that farms measuring more than nine hectares had higher DEA technical efficiency scores than those that had farms measuring between three and six hectares. The higher efficiency scores for farms with areas of more than nine hectares could be attributed to improvements in supervision of hired labourers. Large farms which hire many labourers are likely to employ field officers or hired labourers' supervisors. The employment of hired labour supervisors is likely to increase the productivity of hired labour and hence improving the efficiency of the farm as a whole. Furthermore, since the number of supervisors does not change with slight changes in the number of hired labourers, farmers who employ many hired labourers are likely to benefit from scale economies in hired labour supervision[4].

[4] Increasing the number of hired labourers from say 5 to 10 would not necessarily require an increase in the number of hired labourers' supervisors.

The finding of the study that age affected technical efficiency of the resettled farmers positively and significantly implies that older farmers were more efficient than younger ones and this is consistent with findings of previous studies (Chen and Tang, 1987; Lundvall and Battesse, 2000; Dhungana *et al.*, 2004). This was probably because of growing stock of experience farming. In addition older farmers had more resources at their disposal, which included capital in form of livestock, agricultural implements and assets.

As expected, excellent production knowledge significantly affected technical efficiency of the sampled households. Having excellent knowledge on agriculture information on topics ranging from agriculture production, marketing, and post-harvest handling of agricultural products and management of natural resources, new research and technology, government programs and services, and farm business management were very essential in improving efficiency in agriculture. None or poor provision of agricultural information is a key factor that has greatly limited agricultural development in developing countries (Chimonyo *et al*., 1999). The farmers' information needs are those that enable them to make rational, relevant decisions and strengthen their negotiating ability during transactions with product buyers and sellers of agricultural inputs and consequently prevent possible exploitation by better informed buyers and sellers (Coetzee *et al*., 2004).

The lack of timing and reliable information is severe, particularly in the resettled areas of Zimbabwe. Although, considerable progress has been observed in the provision of communication systems such as telephone and cellular phone network facilities, resettled farmers still remain uninformed in terms of new production techniques, market prices, trends and weather patterns (Utete, 2003). The poor transfer of knowledge, skills and information is mainly a result of limited interaction of the farmers with extension officers due to poor road networks and resources as well as misunderstanding between the two groups (Utete, 2003). Extension manuals are in most cases available in English version which most of the resettlement farmers do not understand. This therefore calls for agricultural manuals and handbooks to be focused on visual aid materials and adequate illustration. In addition, agricultural manuals must be written in local languages as well. Agricultural information directed at developing farmers' negotiating skills during the settlement of transactions, crop production and basic farm management tools such as marketing, record keeping and financial management should be regularly made available to farmers by all stakeholders.

Household size, according to Montshwe (2006), is a useful unit of analysis given the assumptions that within the household resources are pooled, income is shared, and decisions

are made jointly by responsible household members. Household requirements are many and one person in most cases cannot handle them alone and small-holder farmers depend on family labour for most of the agricultural activities. Results from the study, however, reveal the importance of household size in enhancing the overall efficiency of the farm business. Large families were more economically efficient than smaller families who depended on hired labour. This is in line with the findings of Mushunje *et al.* (2003) amongst cotton producers in Zimbabwe. According to Feder (1985), family labour is more efficient than hired labour mainly because family labour is more motivated than hired labour.

Degree of specialisation captures any advantages related to specialisation such as the ability to gain more in-depth knowledge about a single activity or the ability to capture economies of size by increasing the relative size of a single activity. This therefore, may be the major reason why farmers who specialised in farming only achieved higher technical efficiency scores than those that practised farming as part time. This therefore means specialisation has a positive and significant effect on technical efficiency ($p<0.05$). Coelli *et al.* (2002) also found a similar result that farmers doing less off farm work were more efficient.

The parameter estimate of secondary level of education dummy variable carry a positive sign and is statistically significant at 5 % level. This result evidently demonstrates that secondary education emerges as an important factor in enhancing agricultural productivity and is in line with Hussain (1999), Battese *et al* (1996) and Hassan (2004). Rauf (1991) also found that the effect of higher education on efficiency was higher compared to that of primary education during the Green Revolution in the entire irrigated areas of Pakistan. Educated farmers usually have better access to information about prices, and the state of technology and its use. Better-educated people also have a higher tendency to adopt and use modern inputs more optimally and efficiently (Ghura and Just, 1992).

According to Nkhori (2004), education increases the ability of farmers to use their resources efficiently and the locative effect of education enhances farmers` ability to obtain, analyse and interpret information. It is more likely that the farmers with higher educational status are more perceptive to agriculture expert advice as noted by Mushunje *et al* (2003). In addition, education enhances the acquisition and utilization of information on improved technology by the farmers as well as their innovativeness (Dey *et al.*, 2000; Effiong, 2005; Idiong, 2006). The results from this study suggest that primary education had a negative but insignificant effect on efficiency for the sampled households. On the other hand, Hussain

(1989) argue that there is no association between education and agricultural efficiency. For the Indian village of Kanzara, Coelli and Battase (1996) found that the farmers with more years of schooling were more technically inefficient.

From the results, farm size, size of arable land and cultivated area do not affect technical efficiency significantly. These factors only affected allocative and economic efficiency positively. This positive relationship was also observed in several other studies (Kumbhakar *et al* 1989; 1991; Bravo-Ureta and Rieger, 1991; Ngwenya *et al*, 1997; Handri and Whittaker, 1999; Hazarika and Alwand 2003). It may be the case that the smaller-sized farms are populated heavily by young and inexperienced people and therefore, they are expected to have lower average efficiency levels than large and more experienced farmers.

The large scale and experienced farmers may also have an easier access to cheaper or superior quality of inputs or may enjoy greater economies of scale. The coefficient of farming experience and extension visit variables had the expected positive sign and negative sign for technical efficiency, respectively and unexpected negative signs for allocative and economic efficiency but was not significant. This means being an experienced farmer or having as many extension officers' visits was not enough to significantly cause a farmer to attain higher levels of technical efficiency if he cannot rearrange his inputs to obtain higher output levels with a given technology or increase levels of allocative and economic efficiency if he cannot use his inputs correctly at the prevailing input prices.

5. Conclusion

None of the included socio-economic variables had significant effects on the allocative and economic efficiency of the resettled farmers. Thus, the allocative and economic inefficiencies of the farmers might have been accounted for by other natural and environmental factors which were not captured in the model. These factors include, among others, land quality, weather, labour quality, diseases and pest infestation and so on. It is also clear from the results of the study that secondary education was positively related to economic efficiency of the resettled farmers in Shamva District. This therefore means that, efficiency of the resettled farmers can be improved significantly if the government focuses on increasing the education level of farming communities through conducting crop production informal training in resettlement areas. Government should design policies to attract more educated people into farming by providing incentives to the educated people. The promotion of large farms

through the establishment of co-operatives could also improve efficiency of the resettled farmers.

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