

Effect of Irrigation on Poverty among Small-Scale Farmers in Limpopo Province of South Africa

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Abstract

Despite the strength and stability of South African economy, poverty and inequality remain a glaring and persistent issue in the country. About 40% of the population live in outright poverty or continuing vulnerability to being poor, with poverty being more persistent in rural areas. The Forster-Greer-Thorbecke index and a Logit econometric model were used to measure the dynamics of poverty among irrigation and non-irrigation individuals and households.

The poverty incidence, depth and severity were found to be higher among non-irrigation household than among irrigation households. In term of poverty depth, it will cost R51.08 per capita to eliminate poverty among small-scale farm families that practice non-irrigated, while R48.00 per capita will be needed to eliminate poverty among small-scale irrigation families. There was significant correlation between income poverty and capability and deprivation poverty. This implies that policies aimed at mitigating income poverty may also mitigate capability and deprivation poverty.

Keywords: Poverty, Irrigation, The Forster-Greer-Thorbecke index, Small-scale agriculture, Limpopo Province

1. Introduction

A consistent policy priority for the post - apartheid led government in South Africa is to reduce poverty and inequality. However since their inception more than a decade ago, poverty and inequality remain a glaring and persistent issue in the country.

Despite the strength and stability in the economy brought by the macroeconomic reforms (OECD 2006), it is estimated that more than 40% of South Africans live in outright poverty or continuing vulnerability to being poor, with poverty being more persistent in rural areas particularly in the former homelands (Nesamvuni et al. 2003; Van der Berg et al. 2007). In rural development literatures, agriculture is considered one of the best vehicles to reduce rural poverty (DFID 2004; Christiaensen and Demery 2007). The Government of South Africa is using this premise with the intention to reduce poverty by increasing the competitiveness of the small and medium scale farmers. As part of this plan, they intend to revitalize the existing irrigation schemes in order to increase productivity which will intend increase income and consequently mitigate poverty (NDA 1996).

Historically poverty has been viewed as lack of income, expenditure or consumption, and these money-metric approaches were used by economics for quantitative analyses to measure poverty and are still at the core of today's concept. People were said to be in poverty when they are deprived of income and other resources needed to obtain the conditions of life - the diets, material goods, amenities, standards and services - that enable them to play their roles, meet their obligations and participate in the relationship and customs of their society. The use of subsistence to define poverty has been criticized because it implies that human needs are mainly physical rather than also social (Edward 2006; Townsend 2006).

Over the decades, new perspectives on poverty have challenged the focus on income, expenditure and

consumption as the condition for defining poor people. For instance poverty has been viewed as a state of lack of entitlement and deprivation of some minimum fulfilment of elementary capabilities, this then shifted to issues such as lack of “entitlement” and “Inaccess” to basic resources (Bhattarai 2002).

Studies on the problems of poor people and communities, and of the obstacles and opportunities to improving their situation, have led to the understanding of poverty as a complex set of deprivations. These alternative perspectives have refocused the concept of poverty as a human condition that reflects failures in many dimensions of human life - hunger, unemployment, homelessness, illness and health care, powerlessness and victimization, and social injustice; they all add up to an assault on human dignity (Fukuda-Parr 2006).

Many factors have been cited to explain why poverty occurs, from which it is perceived as a complex multi-dimensional phenomenon, generally characterised by the inability of individuals, households or communities to command sufficient resources to satisfy a socially acceptable minimum standard of living (Viljoen 2006). Therefore for any effective plan to reduce poverty, the poverty dynamics of the population has to be understood.

This study aimed at understanding the poverty dynamics among small scale farmers and how irrigation affects poverty. This was done by estimating the degree of poverty among small scale farmers, identifying the types of poverty and determining the impact of irrigation on poverty among small scale farmers in Limpopo province.

2. Methodology

2.1 Data Source

The study was carried out in Limpopo Province, one of South Africa’s nine provinces found in the northernmost part of the country. It covers an area of 12.46 million hectares accounting for 10.2 percent of the total area of South Africa. The provincial population of 5.56 million is divided into five districts of Capricorn, Mopani, Sekhukhune, Vhembe and Waterberg. The population is predominantly rural consisting of about 89 percent of the total with the main occupation of the people being agriculture (M’Marete 2003; LDA 2007).

2.2 Data Collection

Using semi-structured questionnaire, data was collected from 312 sampled households containing 1674 individuals in the study using a stratified random sampling. 248 of these households belong to an irrigation scheme with the remaining 65 cultivating on dry land.

2.3 Data Analysis

Poverty is a multidimensional concept, extending from low levels of incomes and expenditures to lack of education and poor health, and includes other social dimensions, such as powerlessness, insecurity, vulnerability, isolation, social exclusion and gender disparities. Similarly, the concepts of livelihoods, basic capabilities and entitlements have broadened the concepts of poverty. For the purpose of this study, three dimensions of poverty were considered; the monetary, capability and deprivation poverty.

Monetary poverty: Using presidential poverty line of R250 per capita in 2000 Rand value, the Forster-Greer-Thorbecke index was used to measure the incident (Headcount), depth (Gap index) and severity (squared Gap index) of income poverty.

Foster-Greer-Thorbecke measures

$$P_{\alpha} = \frac{1}{n} \sum_{i=1}^q \left(\frac{z - y_i}{z} \right)^{\alpha} | (y_i \leq z)$$

Where;

P_{α} = measure of poverty

q = number of poor individuals

n = total number of individuals

z = poverty line

y_i = income of the i th individual

α = 1 for poverty incidence, 2 for poverty depth and 3 for severity.

Capability poverty: Educational level was used as a measure for capability poverty. Grade 7 educational level was used as the minimum for persons older than 15 years of age. At household level, a household was considered

capable if there are more than 50% of persons older than 15 years of age.

Deprivation poverty: For deprivation, household lacking more than 5 items identified by 50% of the respondents as necessity will be considered as poor.

Logit Model

To measure the effect of irrigation on poverty, a logistic regression model was run using the Statistical package for Social Science software (SPSS).

Logistic regression is used in predicting a dichotomous outcome. Because the dependent variable is not continuous, it takes the value 0 or 1. Logistic regression makes no assumption about the distribution of the independent variables, therefore the independent or predictor variables in logistic regression can take any form. A logistic regression formula is thus used to predict the relationship between the predictor and response variables. This formula computes the probability of the selected response as a function of the values of the predictor variables.

The predictor variables, X_1, X_2, \dots, X_n are related to the dependent variable Y by the following equation:

$$\text{Logit } (P) = \ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n$$

Where; β_1 is the regression coefficient of X_1 and p = probability ($Y = 1$),

The value of p can be calculated by taking the inverse of the Logit (p) as shown in the following equation:

$$p = \frac{\exp(\beta_0 + \beta_1 X_1 + \dots + \beta_n X_n)}{1 + \exp(\beta_0 + \beta_1 X_n + \dots + \beta_n X_n)}$$

Odds ratio; commonly used to interpret the effect of independent variables on the dependent variable which is estimated by $\exp(\beta_i)$. For example, if β_i is the coefficient of a variable, then $\exp(\beta_i)$ is the odds ratio corresponding to a one unit change in the variable.

There are many goodness of fit indices used in logistic regression. Some tested significance means fit and others significance means lack of fit.

Hosmer-Lemeshow Test is the test of lack of fit. It tests the null hypothesis that there is a linear relationship between the predictor variables and the log odds of the criterion variable. A non-significant chi-square indicates that the data fits the model well.

Nagelkerke R^2 , and Cox and Snell R^2 ; unlike the linear regression models, logit regression does not have intuitive measures like the R^2 to predict the quality of the model. However, pseudo R^2 test like the Nagelkerke R^2 and the Cox and Snell R^2 are used. They, like the R^2 explain the proportion of variability in a data set that is accounted for by the statistical model. Due to their pseudo nature, they are best complemented by other fitness measures.

Likelihood-Ratio Test:

The likelihood-ratio test uses the ratio of the maximized value of the likelihood function for the full model (L_1) over the maximized value of the likelihood function for the simpler model (L_0). The likelihood-ratio test statistic equals:

$$-2\log\left(\frac{L_0}{L_1}\right) = -2[\log(L_0) - \log(L_1)] = -2(L_0 - L_1)$$

This log transformation of the likelihood functions yields a chi-squared statistic. This is a measure of the goodness of fit for a logit regression model.

Coefficients, their Signs and Interpretations

A positive significant coefficient on a variable for a particular equation indicates that the variable is associated with a higher probability of being in that group choice relative to the reference group.

A negative significant coefficient on a variable for a particular equation means that the probability of the bank deciding on that outcome or placing the borrower in that group is smaller than the probability of him being in the reference group.

Coefficients which are not significantly different from zero whether positive or negative indicate that the

particular predictor variable does not affect the utility or the probability of the state to which it applies relative to the reference state.

3. Results and Discussion

As shown on Table 1, income poverty incidence among small scale farming families on per capita basis was found to be 47.0% resulting from 46.6% of household with irrigation farming and 48.7% of household with dry land agriculture. There is no unique poverty line in South Africa therefore the outcome of a lot of studies with different poverty lines cannot be compared. However, Van der Berg et al (2007) conducted a poverty study with the same presidential poverty line of R250 in year 2006, and find poverty incidence among the South African population to be 44%, which is lower than the 47.0% poverty incidence among the small-scale farmers. This is consistent with literatures which indicate that poverty is more prevalence in rural areas.

Poverty gap index which measures the depth of poverty was found to be 0.1943 among small-scale farmers lower than that of South Africa, calculated by Van der Berg et al. (2007), which is 0.2114. For non-irrigation families the poverty gap index was 0.2043, which was slightly higher than that of irrigation families (0.1920). This implies that small-scale farm families who practiced non-irrigation farming on an average had an income shortfall of 20.42 % of the poverty line of R210, while small-scale irrigation families on an average had a shortfall of 19.20% of the poverty line. In other words, it will cost R51.08 (Poverty gap index multiply by poverty line) per capita to eliminate poverty among small-scale farm families that practice non-irrigated, while on an average it takes R48.00 per capita to eliminate poverty among small-scale irrigation families.

The squared poverty gap index was found lower (0.1087) among small-scale farmers than that for South Africa (0.1265) calculated by Van der Berg et al. (2007). Likewise the square gap index for irrigated farm families was lower than that for the non-irrigated farm families. This means there is high severity of poverty among the non-irrigated farm families than among the irrigated farm families.

The result of poverty incidence using different poverty measures on per household basis is reported on Table 2. It showed income poverty to be the most prevalent of all. The analysis found capacity poverty (22.98%) to be more predominant among irrigated farm families, while deprivation (26.56%) and income (42.34%) poverty were more associated with non-irrigated farm families.

Chi square statistic showed significant relationship between income and capacity poverty ($P = 0.003$) at 99% statistical level of significance, income and deprivation poverty ($P = 0.072$) was significant at 90% statistical level of significant, while there was no significant relationship between capacity and deprivation poverty ($P = 0.24$). Since there is a link between income poverty and both capacity and deprivation poverty, it may imply that policies targeting income poverty may also be dealing with capacity and deprivation poverty. Whereas targeting capacity poverty may have no effect on deprivation poverty and vice versa.

Table 3 above shows the basic statistic of the dependent variables and the predictor variables used in the models. The number of households using traditional irrigation technology for farming was the highest with 57.7% and only 3.8% household used modern irrigation systems. There are more male headed households (68.6%) than female (38.4%) with a mean age of about 60 years. The average number of people per household was 5.36 with a minimum of 1 and a maximum of 22 persons. An alarming 68.6% of households earn less than R25000 per annum of non-agricultural income which is the minimum category, while 20.5% of the households earned more than R10000 for agricultural income which is the maximum earning category.

Shown in Table 4, the test of the full model was found to be significant for all the models, implying that all variables were different from zero. The Models also all had non-significant values for the Hosmer-Lemeshow Test, indicating a goodness of fit for the models. Complementing the Hosmer-Lemeshow Test with the Nagelkerke Pseudo R^2 , showed variability of more than 50% in both the income poverty (50.9%) and capability poverty (73.4%) models brought by the change in the predictive variables. Only 38.3% variability in the model for deprivation was accounted for by change in the predictive variables.

Almost all predictive variables in the income poverty model were significant using the 5% statistical level of significant with the exception of traditional irrigation system, sex of household head and secondary education for household head (Table 4). For capability poverty, the partial coefficients of drip irrigation, sex of household head, age of the household head and number of people living in a household were found to be significant, while only the age of the household head and household heads with secondary education were found to affect deprivation poverty. These indicate that, farming households using modern irrigation systems are less likely to be poor than those doing dry for both income and capability poverty.

For income poverty, the higher the number of people in the household, the more likely the household is poor

while for capability poverty the higher the number of people in the household the less likely the household is poor. The case of capability poverty could be explained in the fact that the higher the number of people in the house, the higher the number of younger people whom after apartheid were encouraged to go to school.

In terms of the age of the household head, the higher the age the less likely the household is poor. This may be due to the fact that older parents may have matured children who may also contribute to household income. The higher the age of the household head the less likely the household is poor due to the fact that as people grow older, they accumulate more assets. On the other hand for capability poverty, the older the household head, the more likely the household is poor. This could be explained by discrimination of the apartheid regime.

4. Conclusion

Poverty is a complex multi-dimensional phenomenon. What it means depends on who asks the question, how it is understood and who responds. In other words, it means different things to different persons. Therefore, the way it is measured may also affect people differently.

Income poverty was more sited in the non-irrigation families than in the irrigation families and people who are income poor seem to be also capability and deprivation poor. Therefore for any policy intervention to reduce poverty, targeting income poverty may also result in the reduction of capability and deprivation poverty.

The South African government intends to increase the competitiveness of the small-scale farmers by rehabilitating existing irrigation systems. This could be a step in reducing poverty because like other studies, this study concludes that irrigation has some poverty reducing potentials, especially in the use of modern technologies. However as Anderson et al., (2006) puts it, empirical evidence on the links between public investment and economic growth is somewhat inconclusive and that although there is more evidence that public capital is productive in the sense that it complements private capital and other factors of production, there is a clear need for caution with the choice of the optimal investment level and allocation across sectors.

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Table 1. Poverty Indicators among Small-scale Farmers in the Limpopo Province using the R250 Poverty Line of 2000 Rand value

Population group	Literacy rate	Unemployment	Income poverty		
			Poverty incidence	Poverty depth	Poverty severity
All	68.91(N=1261)	37.86(N=1103)	47.0(N=1674)	0.1943	0.1087
Irrigation	69.39(N=1003)	39.51(N= 882)	46.6(N=1325)	0.1920	0.1069
Non-irrigation	67.05(N=258)	24.43(221)	48.7(N=349)	0.2043	0.1159

Table 2. Prevalence of Poverty among Small-scale Farming Household in the Limpopo province

Population group	N	Capacity poverty	Deprivation poverty	Income poverty
All	312	21.47%	24.68%	41.34%
Irrigation	248	22.98%	24.19%	41.5%
Non-irrigation	64	15.62%	26.56%	42.2%

Table 3. Basic Statistic for Independent and Predictor Variables

Variable and Description	Coding	Distribution	Statistics
Dependent Variable			
Income Poverty	Non poor (Base)	58.7	
	Poor	41.3	
Capability Poverty	Non poor (Base)	78.5	
	Poor	21.5	
Deprivation Poverty	Non poor (Base)	75.3	
	Poor	24.7	
Independent (Predictor) Variables			
Type of Irrigation system	Dry land farming (Base)	20.2	
	Modern Irrigation = 1	57.7	
	Traditional Irrigation = 2	22.1	
Age of Household head			Mean = 60.05 Min = 20 Max = 91
Number of people in the household			Mean = 5.36 Min = 1 Max = 22
Sex of Household head	Male (Base)	61.8	
	Female = 1	38.2	
Yearly non agricultural income	< R25000 (Base)	68.6	
	R25001-R75000 = 1	22.1	
	> R75001 = 2	9.3	