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*Full Length Research Paper*

# Assessing the contribution of smallholder irrigation to household food security, in comparison to dryland farming in Vhembe district of Limpopo province, South Africa

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**The aim of this study was to assess the contribution of irrigation to household food security, in comparison to dry-land farming. This study used both primary and secondary data to analyse the factors. The primary data was collected by using a pre-tested questionnaire administered to selected farmers in the study area. A probability sampling method (that is pure or simple random sampling technique) was used to select the respondents. From a total population of 3,236 small-scale irrigators in Vhembe District, 147 irrigation farmers were randomly selected while 43 dry-land farmers were selected adjacent to the selected irrigators. A logistic regression model was used to analyse the variables in the model, selected from factors identified by previous researchers that affect food security in rural areas. A comparison of the variables in the model was carried out between irrigators and dry-land farmers. The results obtained showed that the proportion of food secured households was higher among farmers who were on the irrigation projects (86.3%) compared to dry-land farmers (53.0%). From the analysis, irrigation and per capita aggregate production were found to have a positive influence on the probability of households being food secure. This means that the likelihood of food security increases when farmers increase agricultural output and have access to a piece of land on the irrigation project. The food security of households is also dependent on other factors such as household size and farm size. These two variables were found to have negative and significant effects on household food security. The implications of these findings are that the likelihood of a household being food secures decreases with an increase in household size and farm size. Water has obvious advantages in that it increases farmer's yields, promotes diversified farming enhances household food security and increases household incomes. Farmers who are on irrigation projects are more likely to be food secure than dry-land farmers. With concerted support from government, and all stakeholders, food security can be enhanced at the household levels. In addition education and extension training are essential for farmers to adopt new technologies. The study suggests that households that need to be targeted for food aid are those with large families, without access to irrigation water, families with few assets, and those without access to agricultural land and implements.**

**Keywords:** Household food security, rural livelihood, smallholder irrigation, dry-land farming.

## INTRODUCTION

Agricultural growth offers possibilities for reducing risks of food shortages at all levels, increasing overall supply of food, creating economic opportunities for vulnerable people and improving dietary diversity and the quality of food consumed by farm households (Lyne et al., 2009). In South Africa, food security is not a failure of agriculture to

produce sufficient food at the national level, but it is a complex failure of households to access guaranteed sufficient food.

Food insecurity and malnutrition are highest in provinces with large rural populations, such as KwaZulu-Natal, Limpopo, Eastern Cape and the Free State (Department of Agriculture, 2007). The demands of the colonial and apartheid eras for male labour in urban areas have resulted in the erosion of the fundamentally agrarian existence of Black Africans, and a subsequent increased reliance on non-farm and non-rural incomes. There is a greater reliance on purchased food as opposed to own-produced food which exposes vulnerable households to the adverse effects of price fluctuations. For example, the 17% inflation on food prices between 2001 and 2002 had a disproportionate and devastating impact on the living standards of the predominantly rural ultra-poor, which spent more than 50% of their income on food (Stats SA, 2004). The food availability in any household had a pattern within a time frame which was either increased, decreased or was at a constant level (Obadire et al., 2010).

Food insecurity and poverty are locked into the same destructive cycle. Poverty is the leading cause of food insecurity, and food insecurity is a major contributor to the continuity of poverty. Several studies have been carried out to assess household food insecurity in the semi-arid areas of Southern Africa. Most of these studies have shown that there are many factors that are involved in enhancing food security such as irrigation, land quality, incomes, size of household, wealth of farmers and land size. In Obadire et al. (2010), low level of managerial and technical skills and inadequate training were identified as the major determinants of low level of productivity and household food insecurity. Among these factors water has been highlighted as the most limiting factor to food security in rural communal areas (FAO, 1997a). Thus, this study concentrated on selected irrigation projects and dry-land farming in the Vhembe District of Limpopo Province with the aim of assessing the contribution of irrigation to household food security, in comparison to dry-land farming.

The outlook for the food security of many developing nations is cause for serious concern. Widespread denudation and accelerated erosion diminish the productivity of both cultivated and grazed rain-fed lands. Semi-arid regions are especially vulnerable to climatic instability and frequent droughts. At the same time, depletion and pollution of limited freshwater resources and competing demands for water - among neighbouring states as well as between different sectors within each state - constrain further expansion of irrigation.

South Africa is a net agricultural exporter with an agri-food and seafood trade surplus of $2 billion (Berry, 2007). In 2005, the country exported $5.4 billion of agri-food and seafood. Agricultural products make up 8% of South Africa's total exports. South Africa is the world's top exporter of avocado, tangerine, and ostrich products. It is also ranked as the world's second largest exporter of grapefruit, third for plums and pears, and fourth for table grapes. Other major export commodities include wine, citrus, sugar, grapes, maize, fruit juice, wool, and deciduous fruit (Berry, 2007).

Projections indicate that should current production trends hold, domestic wheat production would be outstripped by domestic consumption by nearly 60% in 2010 and by over 100% in 2020 (Limpopo Department of Agriculture, 2002). Maize and beef is expected to increase by about 130% if production trends continue. The demand for poultry products has already outstripped domestic production by an estimated 22% in 2000, and is expected to increase to 92% in 2010 and to 192% in 2020 (Limpopo Department of Agriculture, 2002).

The erratic fluctuations in the value of the Rand have also underlined the close relationship between macroeconomic or economy-wide factors and food security in South Africa. The tariff policy is also significant, and needs to be constantly examined in the light of its effects on national food security policies. Lowered tariffs on poultry products from the USA in the late 1990s caused a severe crisis in the South African poultry industry. South African consumers, on the other hand, enjoyed more affordable poultry products. In order to appease both producer and consumer interests, the Government intervened to raise tariffs on US poultry to a level, acceptable to both sides (Limpopo Department of Agriculture, 2002). Food security can be said to have two components:

1. Ability to be self sufficient in food production through own household production.
2. Accessibility to markets and ability to purchase food items.

Irrigation has long played a key role in feeding expanding populations and is undoubtedly destined to play a still greater role in the future (FAO, 1997a). It not only raises the yields of specific crops, but also prolongs the effective crop-growing period in areas with dry seasons, thus permitting multiple cropping (two or three, and sometimes four, crops per year) where only a single crop could be grown otherwise. With the security provided by irrigation, additional inputs needed to intensify production further (pest control, fertilizers, improved varieties and better tillage) become economically feasible (FAO, 1997a). Irrigation reduces the risk of these expensive inputs being wasted by crop failure resulting from lack of water.

The practice of irrigation consists of applying water to the part of the soil profile that serves as the root zone, for the immediate and subsequent use of the crop (FAO, 1997b). Well-managed irrigation systems are those which

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control the spatial and temporal supply of water so as to promote growth and yield, and to enhance the economic efficiency of crop production. Such systems apply water in measures and at frequencies calibrated to answer the time-variable crop needs. The aim is not merely to optimize growing conditions in a specific plot or season, but also to protect the field environment as a whole against degradation in the long term. Only thus can water and land resources be utilized efficiently and sustainably (FAO, 1997a).

More recent assessments of the sector have all come to the conclusion that the success of smallholder irrigation has been limited (Bembridge, 2000; Crosby et al., 2000). Factors that contributed to their modest performance were poor infrastructure, limited knowledge of crop production among smallholders, limited farmer participation in the management of water, ineffective extension and mechanisation services and lack of reliable markets and effective credit services (Bembridge, 2000; Crosby et al., 2000).

Another factor that constrained the economic impact of smallholder irrigation was the predominance of subsistence-oriented farming. Backeberg et al. (1996) reported that 37% of farmers on smallholder irrigation schemes were commercially oriented, whilst the remaining 63% were mainly engaged in subsistence production. The results of the recent survey by Arcus (2004) painted a similar picture. It needs pointing out that economic success through market-oriented production has not always been the objective of these projects (Van Averbeke et al., 1998), nor should the measuring of success ignore the importance of food security through own production. As Perret (2002) points out, food security remains the major objective for many plot holders and subsistence-oriented crop production patterns have never been changed. For this reason it is important to also assess the success of smallholder irrigation from the perspective of plot holders and their livelihoods.

When viewed from this livelihood perspective, smallholder irrigation schemes represent assets or resources. They can be used to increase and diversify the livelihood activity of plant production, resulting in improved livelihood outcomes, either directly in the form of food or income for plot holders, or indirectly by providing full or partial livelihoods to people who provide goods and services in support of irrigated agriculture on these schemes. Determining the value of the irrigation plot as an asset and the importance of irrigated agriculture as a livelihood activity has not received much attention from South African researchers.

A case study of livelihood and farming among plot holder homesteads conducted during the period 2003 to 2006 at Dzindi (Van Averbeke and Mohamed, 2007), a smallholder canal irrigation scheme of 132 ha in Thulamela, Limpopo Province, showed that livelihood and farming at this scheme were highly diverse. Using principal source of income (cash and kind), which was defined as the source of income that contributed at least 50% to total homestead income, to categorise livelihood among plot holder homesteads, five livelihood categories were identified. It was significant was that only 20% of the homesteads had a farmer livelihood type, meaning that they derived at least half of their income from agriculture. The others also farmed, but they derived most of their income from sources other than farming.

Backeberg et al. (1996) developed a comprehensive policy proposal aimed at assisting the development of the smallholder irrigation sector. This proposal recognised that smallholder irrigation and associated livelihoods are affected directly by three policy domains, namely irrigation policy, agricultural policy and rural development policy.

In the domain of irrigation policy, the proposal called for (i) the review and reform of water resources development and irrigation policies and strategies; (ii) the creation and empowerment of Water User Associations (WUAs), with the state facilitating the formation of these organisations and providing technical and management training; (iii) the assessment of present irrigation technologies to identify their suitability and sustainability for smallholders; (iv) the consideration of active farmer participation in the re-planning of existing and future smallholder irrigation projects; (v) the transformation of public extension services to cope with issues related to water use and irrigation; and (vi) the assignment of the responsibility for the maintenance of water storage and primary reticulation systems to the state, and the responsibility for maintaining and operating in-field distribution systems to WUAs or the private sector (Van Averbeke and Mohamed, 2007).

The overall economic performance of smallholder irrigation schemes were identified as institutional developments to improve access to land and water, the reintroduction of animal draught in land preparation, collaboration among smallholders in relation to markets, and the incorporation and integration of animal production into irrigated farming systems. Western technology should be adapted or redesigned to be flexibly so as to suit the prevailing conditions and requirements. Government, private agencies and the farming communities should be geared towards achieving a sustainable smallholder irrigation scheme that will enhance food security.

## MATERIALS AND METHODS

### Data types, sources and collection

Both primary and secondary data collection methods were used in the study. The secondary data was collected from various government official reports which included Department of Agriculture, the Agricultural Service Centres in Thohoyandou, Makhado, Musina and Mutale; Statistics South Africa 2000 to 2008 census reports and mid-year estimates; private and public institutions including local farmers' organisation in the district; policy documents; journals, research papers on internet and related books in the University of Venda library and elsewhere. Primary data was

collected using a pre-tested questionnaire administered among selected farmers in the study area.

### Sampling procedures

A probability sampling method involving simple random sampling technique was used to select the respondents. Vhembe district has a total of 3,236 small-scale irrigators. A desired sample of 147 irrigators was randomly selected using simple random sampling techniques while 43 non-irrigators of dry-land farmers were selected adjacent to the selected irrigators. The data collection tool was the questionnaire which was designed and used to obtain the required data needs of the study. The questionnaire elicited household characteristics such as demographic information (name, sex, age, level of education, etc), farm specific characteristics (number and class of livestock, crops grown, hectarage and output), food and non-food expenditures, remittances, employment and income, agricultural activities and finally the nature and risks of farming. The questions were designed in such a way as to avoid ambiguity, sensitivity and provocativeness. The questionnaire included a few open-ended and numerous close-ended questions. Face-to-face interview method between the researcher together with the enumerators and the respondents was used to administer the questionnaires.

### Data analysis

A combination of quantitative and qualitative design methods was used. However, the study was based more on quantitative (survey), complemented with food recalls using qualitative data collection method. In the quantitative approach, the investigator primarily used post-positivist claims for developing knowledge (that is cause and effect thinking, reduction to specific variables, hypotheses and questions, use of measurement and observations, and the testing of theories) and collects data using pre-determined instruments that yield statistical data. A logistic regression model was used to analyse the impact of smallholder irrigation on household food security. This model was complemented by eleven factors which influence food security, (the dependent variable).

In this study, the selected independent variables are sex of the household head, the age of household head, the household size, the education level of household head, the technology adoption level (water frequency), farm size, per capital aggregate income, land quality, aggregate production, marital status, physical access to markets and physical access to irrigation. These factors could have positive or negative impact on household food security. The model was specified as follows:

$Y = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11})$

Where,
Y = Dependent variable (food security)
$x_1$ = Household size
$x_2$ = Water frequency
$x_3$ = Household farm size
$x_4$ = Irrigation technology
$x_5$ = Access to market
$x_6$ = Per capital aggregate income
$x_7$ = Age of the household head
$x_8$ = Sex of the household head
$x_9$ = Educational level of the household head $x_{10}$ = Marital status
$x_{11}$ = Land quality

The above model was estimated using cross sectional data collected from the respondents. The data analysis was carried out on 147 irrigators and 43 dry-land farmers, making a total of 190 respondents. The logistic regression was carried out on two separate groups and on a combination of the two groups. The variables were grouped into farm specific (irrigation technology, water frequency, land size, per capital aggregate income, land quality, access to market) and demographic variables (sex, age, marital status, education level, household size). The food security was measured based on whether or not the household produced enough food from their farm in the last one year (Table 1).

A logistic regression model was used to analyze the impact of smallholder irrigation projects on household food security. A comparison of the variables in the model was made between irrigation and dry-land farming to establish whether they produce enough food or not in order to ascertain the variables impact on the household food security of Vhembe District Municipality farmers. These variables showed significant signs after analysis.

## RESULTS AND DISCUSSION

### Logistic regression results of the study

The logistic regression result together with the probabilities result were used to identify the impact of smallholder irrigation on household food security in the study area. There were 190 cases used in the analysis. Given the base rates of the two decision options (147/190 = 77.4% using irrigation technology, 22.6% are on dry-land farming), and no other information, the best strategy is to predict, for every case, that the subject will use irrigation technology. Using that strategy, it would be correct 77.4% of the time. Under Variables in the Equation, the intercept-only model is on (odds) = 1.229. If we exponentiate both sides of this expression we find that our predicted odds [Exp (B)] = 3.419. That is, the predicted odds of using irrigation technology are 3.419. Since 147 of the respondents were using irrigation technology and 43 were in the dry-land farming, the observed odds are 147/43 = 3.419 (Table 2).

In Table 3, the irrigation and dry-land farmers were compared in terms of their household food security status. Selected parameters were presented to show the percentages of households that were food secure and those that were food insecure relative to the type of farming practiced. Using the logistic regression model, the researcher was able to determine which households more food was secured than the others. This was based on whether or not the household produce enough food to last one year. The analysis revealed that out of the 190 observed households in the study area, 141 households were food secured (86.3 and 53%) of irrigators and dry-land farmers respectively while 49 households representing (48.5 and 41.6%) of irrigators and dry-land farmers respectively were food insecure.

The age of the household head, has a negative coefficient that was significant at 10% level (Table 4). This probably indicates that the older the household head, the lower the chances of the household being food secured. Hofferth (2003) argued that older people have better experiences in agricultural activities than younger people in that they know the social and physical

**Table 1.** Household demograp hics in the study area.

| Characteristics | Irrigators | | Dry-land | |
|---|---|---|---|---|
| | Number | Percentage (%) | Number | Percentage (%) |
| **Sex** | | | | |
| Male | 65 | 52.4 | 32 | 48.5 |
| Female | 59 | 47.6 | 34 | 51.5 |
| **Household age** | | | | |
| Less than 18 | 1 | 0.8 | 0 | 0.0 |
| 18-50 | 39 | 31.5 | 13 | 19.7 |
| 51-65 | 38 | 30.6 | 32 | 48.5 |
| 66 plus | 46 | 37.1 | 21 | 31.8 |
| **Household size** | | | | |
| 1-5 | 73 | 58.9 | 26 | 39.4 |
| 6-10 | 45 | 36.3 | 35 | 53.0 |
| More than 10 | 6 | 4.8 | 5 | 7.6 |
| **Marital status** | | | | |
| Single | 9 | 7.3 | 3 | 4.5 |
| Married | 92 | 74.2 | 53 | 80.3 |
| Divorced | 6 | 4.8 | 1 | 1.5 |
| Widowed | 11 | 8.9 | 7 | 10.6 |
| Living together | 6 | 4.8 | 2 | 3.0 |
| **Education level** | | | | |
| No formal education | 24 | 19.4 | 18 | 27.3 |
| Up to grade 7 | 42 | 33.9 | 35 | 53.0 |
| Grade 8-12 | 44 | 35.5 | 10 | 15.2 |
| Post secondary | 14 | 11.3 | 3 | 4.5 |
| **Irrigation** | 147 | 77.4 | 43 | 22.6 |
| **Tenure status** | | | | |
| PTO | 79 | 63.7 | 42 | 63.6 |
| Title deed | 10 | 8.1 | 6 | 9.1 |
| Rented | 9 | 7.3 | 5 | 7.6 |
| Others | 26 | 21.0 | 13 | 19.7 |
| **Farming year** | | | | |
| Less than 1 yr | 2 | 1.6 | 1 | 1.5 |
| 1-5 yrs | 11 | 8.9 | 3 | 4.5 |
| Over 5 yrs | 111 | 89.5 | 62 | 93.9 |

Source: Computed from field survey, 2009.

environments better than younger people. This result shows that these households are headed by people who are economically active and are able to make household farm decisions as they have acquired more knowledge about farming. This variable has a negative coefficient that is significant at 5% level, implying that as the household size gets larger, and the probability of food security decreases. In other words, large size households are more likely to be food insecure than small size households. Small-scale farming heavily depends on its family for labour. Household size is significantly larger for households that are food insecure as compared to food secure households. Thus, there is a negative correlation between household size and food security. This follows

Paddy (2003) that as household size increases it puts pressure on available food for the household to be food secured. This variable was found to be positive and significant at 5% level (Table 4). It can be concluded that the farmers were able to understand information given to them that is written in their own language. This implies that households with an educated head are more likely to be food secured than uneducated head.

For this study, households that are food insecure have on average more than 1 to 5 ha of land on the irrigation projects while dry-land farmers have as much as 10 ha of land. For dry-land farmers, this contradicts Estudillo et al. (2006) findings, in that as farm sizes increase, households tend to be more food secured as they are able to get better yields from their fields in the absence of major technological advancement that can further increase yields. For irrigation farmers it could be that they lack management skills or do not have access to certain inputs required on the irrigation projects. Per capita aggregate production was higher for irrigation farmers that have 62.1% of maize while dry-land households have 37.9%. Food insecure households have per capita aggregate production of 56.8% for irrigation farmers and 43.2% for dry-land farmers. From the analysis in Table 3, per capita aggregate income was higher for farmers on irrigation projects than those on dry-land. This could be due to high intensive crop production on irrigation projects and also that irrigation farmers have access to water and seeds and inputs that increase their productivity.

The shortest distance to the market was used in this study to determine how often the farmers went to the market to sell their produce. This study revealed that the shortest distance to the market was 5 km for irrigation farmers and about 1 km for dry-land farmers. Those who did not market their crop either produce only enough for household consumption or sold at the farm gate. Feleke et al. (2005) used amount of time taken to reach the nearest market to assess if households were food secured or not but, for this study distance was used because of lack of transportation in the rural areas.

Eleven variables were all initially fitted in the binary logistic model. Six variables were found to have a significant impact in determining household food security. These are irrigation technology, household size, farm size, per capita aggregate income, education, marital status. The data set was combined for both irrigation and dry-land farmers to investigate which determinants had a significant impact on household food security (Table 4). The results showed an anomaly with land size. A positive sign for land size was expected but in this case it was negative. The data was then split into irrigation and dry-land farmers to verify if land size still had a negative and significant sign between the two groups of farmers. The result was still negative even after splitting the irrigation and dry-land farmers but the other variables showed some consistency.

Based on the results in Table 4, most of the variables had a positive impact on household food security while household size and farm size had a negative impact on household food security. The expected signs were irrigation (+), per capita aggregate production (+), farm size (+) and household size (-). From the analysis, irrigation and per capital aggregate income were found to have a positive relationship to the probability of households being food secured, meaning that the likelihood of food security increases when farmers have increased agricultural output and have access to a piece of land on the irrigation project. However, household size and farm size had a negative and significant effect on household food security meaning that the likelihood of a household being food secured decreases with an increase in household size and farm size.

This study revealed that the proportion of food secured households was higher among farmers who were on the irrigation projects (86.3%) than those on dry-land farming (53.0%). However, households that was on the irrigation farming and food insecure were (48.5%) while (41.6%) were households that were food insecure on dry-land farming (Table 5). Irrigation was found to be significant at 10% level meaning that irrigation plays an important role in enhancing food security in the study area. A dummy variable was set for non-irrigation farmers to assess if irrigation contributes to household food security or not. The results confirmed that irrigation is significant in ensuring that households achieve food security.

Irrigation promotes crop production throughout the year and also crop diversification because of the availability of water. Thus, the development of irrigation has been advocated in these areas with insufficient rainfall for crop yields to meet minimum food requirements. The perception of irrigation in enhancing food security in rural areas has also been acknowledged by Crosby et al. (2000). This has seen an increase in the development of small-scale irrigation projects in a bid to ensure food security in these areas. Irrigation reduces the risk of crop failure and the increment can be substantial. However, realizing the potential requires not only good irrigation (water) but also a range of complementary agricultural support (for example, improved agricultural research and extension). Despite the large investments, the performance of some small-scale irrigation projects has been poor and the goal of achieving food security has not been realized (Bembridge, 2000). Also with irrigation farming, there is a tendency to produce cash crops which are sold so that they can generate income for the households.

**Insights from the analysis**

From the results obtained from this study, it has been found that irrigation farmers gain high income from the crops they grow and were relatively more food secure

**Table 2.** Distribution of total household income category of farmers (R000,000 for the 2008-2009) .

| | Irrigation | | | | Dry-land | | | |
|---|---|---|---|---|---|---|---|---|
| **Income sources** | **N** | **Amount (R)** | **Average amount** | **%** | **N** | **Amount (R)** | **Average amount** | **%** |
| Maize | 81 | 2,044,087 | 25,235 | 64.02 | 10 | 52,030 | 5,203 | 50 |
| Vegetables* | 48 | 1,135,651 | 23,659 | 35.9 | 7 | 48,110 | 6,872 | 46.3 |
| Livestock** | 4 | 2,300 | 575 | 0.08 | 5 | 3,900 | 780 | 3.7 |
| Total | 133 | 3,182,038 | 23,925 | 100 | 22 | 104,040 | 4,729 | 100 |

*Vegetable - include tomatoes, onions, spinach, cabbage, etc. **Livestock – include cattle, goats, sheep, chickens, donkeys, etc.

**Table 3.** Marketing problems.

| | Irrigation | | Dryland | |
|---|---|---|---|---|
| | **Frequency** | **%** | **Frequency** | **%** |
| Storage facilities | 25 | 62.5 | 6 | 85.7 |
| Transport | 37 | 77.1 | 4 | 66.7 |
| Sourcing inputs | 16 | 55.2 | 5 | 83.3 |
| No market around | 28 | 63.6 | 6 | 85.7 |
| Market information | 14 | 42.4 | 3 | 60.0 |
| Other marketing problems | 10 | 90.9 | 6 | 85.7 |

**Table 4.** Coefficient of the Logistic analysis for irrigation and dry-land farming.

| **Variable** | **Coefficient (B)** | **Std. error** | **Wald statistic** | **Significant level** | **Exp(B)** |
|---|---|---|---|---|---|
| Constant | 1.229 | 0.169 | 10.849 | 0.000 | 3.419 |

**Table 5.** Descriptive results of the study.

| **Variable** | | **Food secure (%)** | | **Food insecure (%)** | |
|---|---|---|---|---|---|
| | **Number** | **Irrigation** | **Dry-land** | **Irrigation** | **Dry-land** |
| **Sex** | | | | | |
| Male | 97 | 52.4 | 51.6 | 48.5 | 50.5 |
| Female | 93 | 47.6 | 48.4 | 51.5 | 49.5 |
| **Per capital aggregate income** | | | | | |
| Yes | 93 | 62.1 | 37.9 | 24.2 | 75.8 |
| No | 97 | 45.3 | 54.7 | 56.8 | 43.2 |
| **Irrigation** | | | | | |
| Yes | 147 | 75.0 | 97.9 | 81.8 | 56.8 |
| No | 43 | 25.0 | 2.1 | 18.2 | 43.2 |
| **Access to market** | | | | | |
| Yes | 82 | 50.0 | 50.0 | 30.0 | 69.7 |
| No | 108 | 61.1 | 38.9 | 52.6 | 47.4 |
| **Food security** | | | | | |
| Yes | 141 | 86.3 | 53.0 | 51.5 | 58.4 |
| No | 49 | 13.7 | 47.0 | 48.5 | 41.6 |

**Table 6.** Parameter estimates of the determinants of food security.

| Variable | Coefficient (B) | Std. error | Wald statistic | Significant level | Exp (B) |
|---|---|---|---|---|---|
| Constant | 0.557 | 0.169 | 10.849 | 0.001*** | 1.745 |
| Household size | -0.350 | 0.968 | 0.131 | 0.018** | 0.705 |
| Food security | 1.736 | 0.625 | 7.714 | 0.005*** | 5.673 |
| Water frequency | 1.130 | 0.819 | 1.905 | 0.078* | 3.404 |
| Farm size | -0.889 | 1.039 | 0.731 | 0.393 | 2.432 |
| Per capital aggregate income | 1.822 | 0.564 | 10.437 | 0.001*** | 6.182 |
| Irrigation | 1.289 | 1.388 | 0.862 | 0.053** | 3.276 |
| Access to market | 1.176 | 0.602 | 3.816 | 0.051** | 3.243 |
| Enough food | 1.736 | 0.625 | 7.714 | 0.005*** | 5.673 |
| Age | -0.659 | 0.609 | 1.172 | 0.079* | 0.517 |
| Sex | 0.748 | 0.563 | 1.767 | 0.184 | 2.113 |
| Education | 3.296 | 1.306 | 6.372 | 0.012** | 0.037 |
| Marital status | -3.832 | 1.802 | 4.524 | 0.033** | 0.022 |

*Statistically significant 10% level, ** statistically significant 5% level, *** statistically significant 1% level, Number of observations = 190, Restricted log likelihood value [Log($L_0$)] = -1.378, Unrestricted log likelihood value [Log($L_0$)] = -121.581[a], Log likelihood value $(\chi^2_{(df=6)} - 2[Log(L)_0 - \log(-(L))_1] = -1.378.$

than dry-land farmers. Most of their income came from vegetables that are grown on the irrigation projects. Vegetables and maize contribute the larger percentage of income as compared to other crops and off-farm incomes. Communal farmers receive less income from off-farm activities because a few people were employed and they received fewer remittances from their urban relatives. As was highlighted in Table 5, vegetables contribute about 35.6% of total income in irrigation farming as compared with 46.3% in dry-land farming. Livestock income was very low as farmers sell their livestock only in time of pressing financial needs and animals were not usually kept for commercial purposes by farmers in the study area.

The analysis shows that irrigation farmers get higher income from on-farm activities as opposed to dry-land farmers. On the other hand, dry-land farmers realize higher off-farm incomes than irrigation farmers. This is due to the fact that irrigation farmers do not depend much from family members employed elsewhere like dry-land farmers. Irrigation farmers get better incomes from crop sales. Farmers also pointed out that they had marketing problems especially with perishable crops. Some of the problems included lack of storage facilities, unavailability of transport, exploitation by middlemen and failure to get inputs on time (Table 6). These problems were affecting the profits they could realize if they had their own transport to get to profitable markets.

## RECOMMENDATIONS

Having thoroughly synthesised the findings from this study, it is recommended that the following medium-long term measures be introduced to assist the government and the stakeholders concerned with agricultural development at both local, district and nationally level:

1. There should be improved access to production resources through enabling policies that will ensure access to land and improved tenure support. To improve production, smallholder farmers need access to inputs and output markets which require them to have access to credit facilities and be able to market their produce.

2. The results from the study have shown that access to irrigation by rural farmers has a greater impact in enhancing food security at the household level. With increased agricultural production from irrigation projects, food security can be achieved both at household and national levels provided the farmers get the necessary support from government, non-governmental organisations (NGOs), farmers' support groups and parastatals. The kind of support that the farmers will need include information from extension services, agricultural inputs and price policy interventions that protect farmers from frequent fluctuations in market prices.

3. Stabilization of agricultural prices or producer prices can promote increased production in the short and long term. Such conditions can encourage farmers to produce more and sell surplus produce to profitable markets. An intervention like irrigation can bring employment to local people, increase household incomes, reduce rural to urban migration, reduce the level of malnutrition, increase per capita aggregate production and also promote crop diversification.

4. In addition, own food production among farmers should be encouraged by the government and other stakeholders so as to break the dependency syndrome.

5. Government and other stakeholders should provide support through the establishment of more irrigation projects and other income generating projects that can assist farmers to produce their own food and be food secured.

6. Policy makers need to promote irrigation development so that farmers can irrigate more crops, fruits, vegetables and other fresh produce.

7. Farm size is one other important factor that contributes to household food security. An increase in farm size is likely to increase food security in rural areas without employing advanced technologies. In this study, farm size had a negative relationship to household food security. This suggests that farmers with small farms are more efficient than farmers who own large pieces of land. The reason could be the presence of irrigation projects which allows farmers to produce more on their irrigated land than dry-land farms.

8. Government should improve rural infrastructure to boost household income through the provision of better roads, water, electricity and telecommunications. This could increase the possibility of off-farm activities that could generate more income for the households.

9. Education and extension training is essential for farmers so that they are able to adopt new technologies. Farmers need to be enlightened on programmes such as health education. This will assist them to know more about HIV/AIDS pandemic and programs that assist them to deal with these challenges.

10. Marketing, especially through contract farming, has proven to be a problem for smallholder farmers. Most of the contracts are verbal and farmers usually are cheated by unscrupulous dealers. The terms are always in favour of the buyers and farmers lack bargaining power. Training in contract marketing is hereby recommended as a means of safeguarding the farmers against some unscrupulous people.

11. A suitable local agricultural base is key to a community responsive food system. Farmers need increased access to markets that pay them a decent wage for their labour, and farmland needs planning protection from suburban development. By building stronger ties between farmers and consumers, consumers gain a greater knowledge and appreciation for their food source.

12. It has been observed that when production goes beyond subsistence requirements, agricultural growth does drive food consumption demand and leads to beneficial dietary changes. Incentives to increase production and education on proper nutrition will help farmers make the right food choices and improve their quality of life. Nutrition should be part of the agricultural extension programme to promote a paradigm shift in the eating habit of the farmers.

13. The stakeholders should invest in collaborative learning and knowledge development for sustainable food security, through the strengthening of the agriculture,

14. Rural development and food security networking and collaborative work with external partners.

## Improving food security

Increased production of food for own consumption and for the market has helped to reduce the need for coping strategies. Most of the households in dry-land farming were engaged in more erosive-coping strategies than did irrigation farming households. Adopting erosive-coping strategies undermines future resilience. Agricultural production for markets reduced consumption expenditure and helped households to accumulate cash savings or invest in assets.

Improved nutrition is clearly a positive externality for increased agricultural production in South Africa's rural areas. However, the scale of agricultural production strongly determines the magnitude of these nutritional benefits. To have a significant impact on the food security and nutritional status of rural populations, agricultural production must develop beyond the subsistence level. While production for home consumption increases the availability of vegetables and increases micronutrient intake, the income 'savings' derived from home production seems to have more positive influences on the nutritional status of rural productions. Income replacement leads to increased purchases of energy-dense foods as fats, oils and meat.

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