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Characterization of Farming Households and Assessment of Economic Viability of Water Users Association at Mafefe Irrigation Schemes in Limpopo Province of South Africa

A.E. Nesamvuni[1,4], K.A. Tshikolomo[2,4], A. Belete[3] & M.Z. Motaung[3]

Abstract

The study characterized farming households at three irrigation schemes in Mafefe Area at Lepelle-Nkumpi Municipality under Capricorn District of Limpopo Province and assessed the economic viability of their Water Users Association (WUA). The irrigation schemes were Mashushu, Fertilis and Mantlhane. Heads of household were older at Mashushu (average age=68) followed by Fertilis (59) and finally Manthlane (56). Household sizes ranged between 5 and 6. Some 21.7% of heads of household (37.5%-Mashushu, 20%-Fertilis and 7.7%-Manthlane) had no formal education, half (55%-Fertilis, 50%-Mashushu, and 53.8%-Manthlane) had primary while 25.3% (38.5%-Manthlane, 25%-Fertilis and 12.5%-Mashushu) had secondary education. Household income varied (average R26,991-Manthlane, R24,780-Mashushu, R21,807-Fertilis) across the schemes. The majority (88%) of farmers had ≤ 40% of income from farming. On average, individual farmers made profit in all schemes (R6,654.50-Mashushu, R4,565.59-Fertilis, R5,938.78-Manthlane). Production increased with cost of tillage ($p<0.01$)and marketing ($p<0.05$). The cost for operating the WUA was estimated at R15 500 / annum while the income was estimated at R16 700 / annum. The WUA for farmers in the study irrigation schemes would therefore be economically viable.

Keywords: Characterization, irrigation scheme, Mashushu, Fertilis, Manthlhane, Water Users Association

1. Introduction

Close to 6 million people do not have access to a reliable source of safe drinking water in South Africa (Manase *et al.,* 2009).

[1]University of Venda, Private Bag X5050, Thohoyandou, 0950, South Africa.
[2]Limpopo Department of Agriculture, Private Bag X9487, Polokwane, 0700, South Africa.
Phone: +2782 806 8762, Email: tshikolomo@gmail.com
[3]Deaprtment of Economics, University of Limpopo, Polokwane, 0700, South Africa.
[4]Centre for Sustainable Agriculture, University of the Free State, Bloemfontein, 9300, South Africa.

Water demand forecasts especially at household level are difficult to make partly because of the general lack of empirical data on domestic water consumption (Tshikolomo *et al.,* 2012a). The challenge of lack of data on domestic use of water is more serious in rural areas where households rely on common sources such as river wells and street taps for their water.

The amount of water fetched is influenced by the demand the household has for the resource. The household water demand is determined by a range of socio-economic and demographic variables. Obvious variables such as occupancy and subtle ones such as occupant age determine the demand for water by households (Fox *et al.,* 2009). Accordingly, increased social and economic development of a country would be accompanied by a continued increase in the demand placed on its water resources (Tshikolomo et al. 2012b).

In South Africa, the supply of water resources was distorted along racial lines as determined by apartheid policies. The democratic government therefore had a difficult task of correcting the past distortions in water allocations, and this had to be through equitable allocations of the resource (Dent, 2000). Accordingly, the South African water policy sets out a far-reaching vision of making sustainable, equitable and efficient water resource management a reality (RSA, 1997).

According to RSA (1998), the water resources are managed through two management organizations which are driven by users in the long term, the Catchment Management Agency (CMA) and Water User Association (WUA). The CMAs were established to manage, conserve, control and develop water resources at the broad catchment level. As stated in Faysse (2004), a CMA is responsible for developing a catchment management strategy and for allocating water licenses and would be critical for promoting equitable access to the resource.

At a local level, WUAs are created to coordinate day-to-day management of different uses of water, including irrigation use (Faysse, 2004). The importance of WUAs is better understood if one considers the scarcity of water in irrigation schemes and the inefficiencies associated with its use. According to Bembridge (2000), water availability and management is a serious constraint in irrigation schemes in Limpopo Province, a situation that is exacerbated by farmers' lack of irrigation techniques and their subsequent low efficiency of water use.

While CMAs are necessary for promoting equitable access to water, WUAs are important for improving the efficiency of use of the resource.

To address the challenges of scarcity of irrigation water and the inefficient uses of the resource, water committees in Mafefe Irrigation Schemes launched a process to become a WUA in 2005. In order to be sustainable, the WUA should be able to pay for the cost of water supply and related services when the resource is physically available. The purpose of this study was to characterize the smallholder farmers in Mafefe Irrigation Schemes and to determine the effect of selected socio-economic and production variables on the production of maize as a major crop. Subsequently, the study will conduct a profitability assessment to determine whether the farmers would afford to pay for the running of the established WUA or not.

2. Research Methods

2.1 Description of Study Area

The study was conducted at the Mafefe Area of the Lepelle Nkumpi Municipality of Capricorn District in Limpopo Province of South Africa (Figure 1). In this area, there are three gravity irrigation schemes located on the upper part of the Mohlapitse River, namely: Mashushu (42 hectares for 45 farmers), Fertilis (92 hectares for 88 farmers), and Mantlhane (30 hectares for 34 farmers).

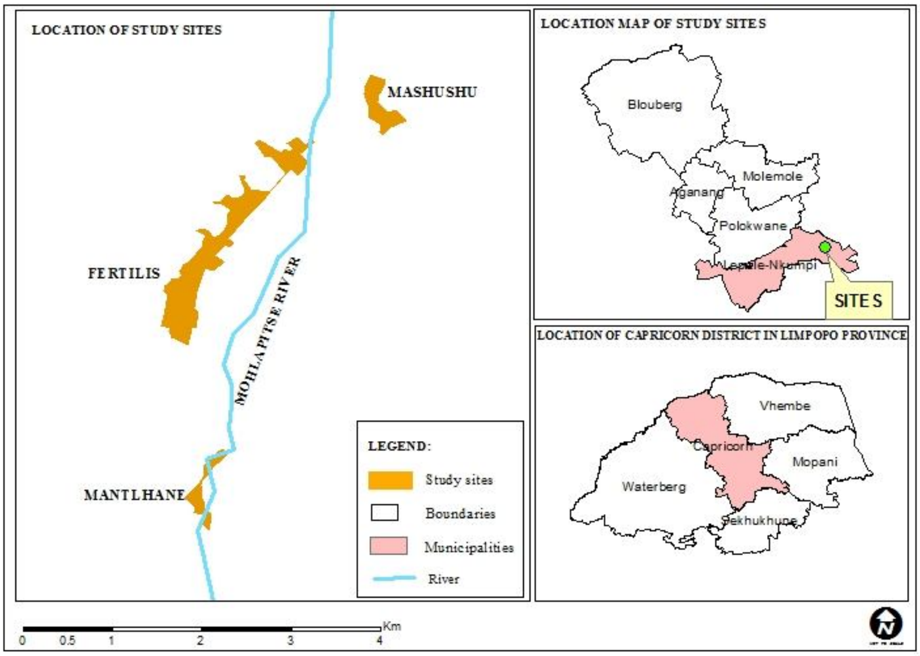

Figure 1: Map of the location of the study sites in Lepelle-Nkumpi Municipality under Capricorn District of Limpopo Province

All the three schemes receive water from the Mohlapitse River through diversion weirs. The river is perennial with a flow that fluctuates according to seasons. As a result of the heavy rains and floods experienced in the year 2000, the riverbed is low and consequently the water level is often lower than the required level for outflow to the Mantlhane Irrigation Scheme.

2.2Sample Frame and Sampling Procedure

(A) Sample Frame

A sampling frame was defined by Welman *et al.* (2005) as a complete list of units of analysis in which each unit is mentioned only once. The sampling frame for this study was at four levels: (1) district, (2) municipality, (3) irrigation scheme and (4) plot holder. At the district level the sampling frame was made up of five districts of the Limpopo Province, and those are (a) Capricorn, (b) Mopani, (c) Sekhukhune, (d) Vhembe and (e) Waterberg with Capricorn selected for the study.

The sampling frame for municipalities consisted of the five municipalities in the sampled Capricorn District, namely: (i) Aganang, (ii) Blouberg, (iii) Lepelle-Nkumpi, (iv) Molemole, and (v) Polokwane. The Lepelle-Nkumpi was selected for the study and accordingly the irrigation schemes located in this municipality comprised the sampling frame.

A total of 21 main irrigation schemes were identified in this municipality, namely: (1) Mashushu, (2) Fertilis, (3) Manthlane, (4) Success, (5) Zebediela, (6) Devonia, (7) Grootklip, (8) Adriansdraai, (9) Badfontein, (10) Canyon, (11) Gemini, (12) Gompies, (13) Grootfontein, (14) Koedoeskop, (15) Lucerne, (16) My Darling, (17) Praque, (18) Haffendon Heights, (19) Moletjie, (20) Sepitsi, and (21) Slaaphoek. The first three irrigation schemes were selected for the study and accordingly plot holders in those schemes comprised the sampling frame with 45 in Mashushu, 88 in Fertilis and 34 in Manthlane.

(b) Sampling Procedure

In order to ensure proper selection of study units at all levels, multistage sampling was used as described by Leedy and Ormrod (2010) and included primary area selection of municipalities (both district and local municipalities), location selection of irrigation schemes and respondents' selection of plot holders. Purposive sampling was used to select the municipalities (district and local municipality) and the irrigation schemes. In purposive sampling, study units are chosen, as the name implies, for a particular purpose. The researcher should always provide a rationale explaining why he or she selected the particular sample of study units (Leedy and Ormrod, 2010).

Capricorn District and Lepelle-Nkumpi Local Municipality were sampled for their proximity to the place of residence of the enumerator. Also, the irrigation schemes were purposively sampled for their close proximity to the place of residence of the enumerator and hence Mashushu, Fertilis and Manthlane Irrigation Schemes were selected. Plot holders in each of the three selected schemes were randomly sampled and accordingly 16 plot holders were sampled from Mashushu, 20 were sampled from Fertilis, while 13 were selected from Mantlhane Irrigation Scheme.

2.3 Data Collection and Analysis

Studies on the identification of the attributes and characteristics of potential successful and unsuccessful farmers relied primarily on the prior knowledge of extension officers about the farmers (Nicholson and Bembridge, 1991; Nel *et al.*, 1998). Insufficient knowledge about the farmers would have made it difficult for the correct attributes and characteristics to be identified.

Primary data used in this study were collected using a structured questionnaire that covered a number of variables. As stated by Lussier (1995), there is no generally accepted list of variables for use in forecasting business success or failure. This view affirmed Ray (1993) who had revealed that there is no ideal-type personality that guarantees success for a business. The questionnaire was structured in such a way that the first part covered the demographic variables such as the age of the farmer and the size of the household; the second part dealt with the farming methods in respect to the sizes of the plots and amounts of crops produced. The third part of the questionnaire covered issues such as input and output prices, and the fourth part dealt with farmer willingness to pay water use charges .

The questionnaire had two major types of questions, the closed-ended questions that collected quantitative data and the open-ended questions collecting qualitative data (Leedy and Ormrod, 2010). The interviews were more structured when dealing with closed-ended questions and provided limited opportunities for respondents to give more insight on the aspects covered by the questions. As for open-ended questions, the interviews were less structured and probed respondents to give more insight on the aspects covered. The study therefore fit into Hurmerinta-Peltomaki and Nummela (2006)'s description of a mixed research.

Secondary data were also used and these were obtained from the Department of Water Affairs and Forestry (DWAF), Department of Agriculture, Forestry and Fisheries (DAFF) and from Limpopo Department of Agriculture (LDA). The information was obtained through reports and interpersonal communication with relevant officers. Also, information was obtained from relevant literature that included books and journals, both the print and electronic literature search.

For analysis the data were captured into the Statistical Package for Social Sciences (SPSS 14.0), and relevant analyses were carried out.

Microsoft excel programme was also used to calculate the profitability of the farmers at farm level. The Cobb-Douglas production model was used to determine the variables that had some effect on maize production. This model helped in investigating the profitability of the farmers and their ability to pay for water use charges.

3.Results and Discussions

Information on farmer characteristics and attributes for farming potential will influence the design and implementation of policies on farmer selection and development (Randela *et al.,* 2006). The discussion in this study focused on socio-economic characteristics of farmers in the study area, namely: age, educational status and incomes as well as farming attributes such as production costs. Also included in the discussion is the extent to which farming households in the area are dependent on crop production.

3.1Characterization of Farming Households in Mafefe Irrigation Schemes

Studies addressing the characteristics of small-scale farmers with the potential of becoming commercial farmers, including personal factors, decision making, access to agricultural information, socio-economic variables and the sociocultural milieu have been limited (Bembridge and Tshikolomo, 1998). This study focuses on these important characteristics with the objective of obtaining more information on smallholder farmers, specifically plot holders at irrigation schemes.

The characterization of farming households is very important for development of relevant strategies for increased farming productivity. This was affirmed by Mazuze (2004) who revealed that adoption of orange-fleshed sweet potato in the Gaza Province of Mozambique was mostly dependent on the farmers' characteristics that included their socio-economic conditions. Important characteristics influencing effectiveness in farming include age of household head, his / her education, size of household and household income (Table 1).

Table 1: Characteristics of Farming Households in Three Schemes Under Mafefe Irrigation Scheme in Limpopo Province

Variable	Descriptive statistics of farmers across schemes								
	Mashushu			Fertilis			Mantlhane		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Age of household head (Years)	49	78	68	44	75	59	39	73	56
Size of house hold (number of people)	2	11	5	1	11	6	2	13	6

3.1.1Age of Household Head

The age of the head of household has a strong effect on the family's agricultural productivity, and this could be a result of the influence of age on such variables as education and farming experience. A negative correlation (Pearson r = -0.272; p = 0.037) was found between age and the level of education indicating that older farmers tended to have lower levels of education (Mphinyane and Terblance, 2005). As stated by Mphinyane and Terblanche (2005), a highly significant correlation exist between different age categories and farming experience (r = 0.450; p = 0.001) and this means that older farmers were more experienced.

The distribution of heads of household in Mopani and Vhembe District of the same province was such that the least were children (1.3% <18) with the number increasing through youth (23.3% aged 19-35) to the middle aged (34.8% aged 36-50) category (Tshikolomo *et al.,* 2012a). As stated by Tshikolomo *et al.* (2012a), the number declined through the elderly (26.6% aged 51-65) to those of retirement age (14% aged > 65).

The households of smallholder farmers in the study area were all headed by adults with the youngest heads of household for the three schemes being 49 for Mashushu, 44 for Fertilis and 39 for Manthlane (Table 1). The heads of household were oldest at Mashushu (mean age=68) followed by Fertilis (59) and finally Manthlane (56). As stated by Tshikolomo (1996), decision making is a key factor in farm management. The fact that the heads of household were mostly elderly suggests that they were experienced in various issues of life and this could include farming.

3.1.2Size of Household

Agricultural production is influenced by the size of farming household. Larger households provide more farming labour resulting in increased production. Also, the quantity of resources demanded for household consumption increases with an increase in the number of people living in the household and this may result in less availability of resources for agricultural production (Tshikolomo *et al.,* 2012a).

As shown in Table 1, the mean size of household was 5 at Mashushu and was 6 at both Fertilis and Manthlane irrigation schemes. Considering the prospects of provision of more labour by larger families, it would be expected for agricultural production at Fertilis and Manthlane irrigation schemes to be slightly higher than that at Mashushu Irrigation Scheme.

The sizes of households in the study irrigation schemes were larger than the sizes reported for households in selected villages in the nearby Mopani and Vhembe districts. According to Tshikolomo *et al.* (2012a), the largest household in these villages was composed of four members. This figure differed with the reported household size by Stats SA (2009) who suggested a membership of four to be the mean and not the maximum size of households in the area. As stated by Tshikolomo *et al.* (2012a), the respondents could have deliberately reported lesser numbers of people in their households for some reason.

Contrary to the result for the study by Tshikolomo *et al.* (2012a), the mean sizes of households reported by respondents at the three study irrigation schemes were larger than those reported by Stats SA (2009). The report for larger households by the respondents at the study irrigation schemes compared to sizes reported for villages in Mopani and Vhembe District reveals a wide variation of household sizes from one district to another.

3.1.3Education of Household Head

The level of education attained by a head of farming household plays an important role in agricultural productivity. Allied to the problem of low levels of education and literacy, print media has played a minor role as a source of information in the smallholder farming industry (Bembridge, 1995).

However, the print media has an important role to play in disseminating agricultural information. Media such as radio and television broadcasts (on farming) may be more accessible to smallholder farmers, but the information communicated tends to be of general interest with little technical content (Bembridge and Tshikolomo, 1998).

According to Diale (2011), farmers with more years of schooling in the Sekhukhune District of Limpopo Province had more use of hybrid seed technology, and this resulted in increased crop yield. This affirmed the findings by Ekoja (2004) that the rate of adoption of new technology is positively related to the level of education. Educated farmers were able to read and understand the contents of the print media that is rich in technical information for the agricultural sector; hence they used hybrid seed technology more than their less schooled counterparts. The educational status of heads of farming household in the study area is shown in Table 2.

Table 2: Distribution of Heads of Farming Households in Mashushu, Fertilis and Manthlane Irrigation Schemes According to Level of Education

Scheme	**Level of education of heads of household (%)**			
	None	**Primary**	**Secondary**	**Total**
Mashushu	37.5	50.0	12.5	**100.0**
Fertilis	20.0	55.0	25.0	**100.0**
Mantlhane	7.7	53.8	38.5	**100.0**
Mean	**21.7**	**52.9**	**25.3**	**100.0**

One in five (21.7%) heads of farming households in the study area had no formal education with almost two in five (37.5%) at Mashushu, one in five (20%) at Fertilis and one in thirteen (7.7%) at Manthlane Irrigation Scheme. Half (52.9%) of the heads of household had primary education with more or less the same number at the three irrigation schemes, namely: Fertilis (55%), Mashushu (50%) and Manthlane (53.8%). Only one in four (25.3%) heads of the farming household had secondary education with two in five (38.5%) of them at Manthlane, one in four (25%) at Fertilis and one in eight (12.5%) at Mashushu Irrigation Scheme. None of the heads of the households had tertiary education. The educational status of the heads of farming households in the study area was low.

Allied to the problem of low levels of education and literacy, the print media would play a minor role as a source of information (Bembridge, 1995). A study focused on fruit growers in the Phaswana Area in Vhembe District of the Limpopo Province revealed that only 46% had access to written information, mainly in the form of popular journals with little research based information (Tshikolomo, 1996), and the situation in the study irrigation scheme could be worse.

3.1.4Household Income

Household income is a strong determinant of the access and use of agricultural resources (Tshikolomo *et al.,* 2012a) and subsequently of agricultural productivity. It was argued for instance, that people could be water poor not because there is no water in their area but because they are income poor. In other words, despite water being available within their area, people may fail to access it because they cannot afford the cost of doing so (Dungumaro, 2007).

The success of any agribusiness enterprise is highly influenced by finance as this determines the enterprise's ability to access important resources such as water. As affirmed by Steiner and Solem (1988), a successful farmer is someone likely to have access to adequate financial services and competitive advantage.

From the above assertion, it may be inferred that the level of household income is a strong determinant of success in crop farming, and this may be a result of improved access to production inputs, including irrigation water. For households with low incomes, the costs of inputs may impede adoption of new technologies (Hassan and Karanja, 1997; Mazuze, 2004). This was affirmed by Diale (2011) who revealed that hybrid seed was more costly for low income farmers to procure and transport compared to open pollinated varieties.

Table 3: Income Distribution of Farming Households in Mashushu, Fertilis and Manthlane Irrigation Schemes

Income category	Descriptive statistics of farmers across schemes								
	Mashushu			Fertilis			Mantlhane		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Total annual farm income (R)	2 719	9 789	7 365	725	8 701	5 076	4 169	8 520	6 582
Total annual non-farm income (R)	10 440	25 680	17 415	5 640	43 200	16 731	10 200	54 000	20 409
Total annual household income (R)	**13 159**	**35 469**	**24 780**	**6 365**	**51 901**	**21 807**	**14 369**	**62 520**	**26 991**

The household income in the study area was highest at Manthlane Irrigation Scheme with a mean income of R26 991 comprised of a farm income of R6 582 and a non-farm income of R20 409. The household income at Manthlane was followed by that at Mashushu Irrigation Scheme with a mean household income of R24 780 comprised of a farm income of R7 365 and a non-farm income of R17 415. The household income was low at Fertilis with a mean income of R21 807 of which R5 076 was farm and R16 731 was non-farm income (Table 3). According to the findings by Hassan and Karanja (1997) and by Mazuze (2004), farming households at Manthlane Irrigation Scheme would better afford technologies and production inputs and would likely be more successful farmers. The households at Mashushu Irrigation Scheme would likely come second and those at Fertilis third in their prospects for success in farming.

3.2Profitability of Maize Farming and Reliance on Farm Income

3.2.1Profitability of Maize Farming

The level of profitability of farming among rural households has a strong influence on farming income. In order to assess the level of profitability of crop farming at the irrigation schemes under study, determination was made of farming costs and income based on which profits were calculated. Farmer averages were determined for the two assessed variables and based on the averages the profitability of crop farming in the study area was calculated (Table 4).

Table 4: Farmer Profitability of Maize Farming at the Three Irrigation Schemes Comprising the Mafefe Irrigation Scheme

Irrigation Scheme	Average farmer production costs	Average farmer income	Average farmer profit
Mashushu	710.00	7 364.50	6654.50
Fertilis	510.25	5 075.84	4 565.59
Manthlane	643.08	6 581.86	5 938.78
Average: Mafefe	**621.11**	**6 340.73**	**5 719.62**

Maize was the major crop annually produced at the irrigation schemes and was therefore used for profitability analysis. Although the schemes were supplied with irrigation water, the plot holders only produced summer crops, mainly maize, and the land was mostly left fallow in winter.

The average maize production cost per farmer at Mafefe Irrigation Scheme was R621.11. The average maize production cost for the three irrigation schemes comprising the Mafefe Irrigation Schemes were high for Mashushu (R710.00) followed by Manthlane (R643.08) and was low for Fertilis Irrigation Scheme (R510.25). The difference in the production costs for the three irrigation schemes suggests variation in the type or level of use of production inputs. Irrigation schemes with high production costs may have used either the better quality more expensive types or larger quantities of production inputs.

The average maize farming income for Mafefe Irrigation Scheme was R6 340.73. The farming incomes for the three irrigation schemes that make up the Mafefe Irrigation Scheme followed the same trend as the costs, and accordingly the income was high for Mashushu (R7 364.50) followed by Manthlane (R6 581.86) and was low for Fertilis Irrigation Scheme (R5075.84). The fact that the farming incomes followed the same trend as production costs affirms the assertion that high production costs were either associated with application of quality expensive types or use of high levels of production inputs.

The average farmer profit for maize farming at Mafefe Irrigation Scheme was R5 719.62. This average profit was calculated from the profits of the three irrigation schemes comprising this larger scheme, namely: Mashushu (farm profit=R6 654.50), Fertilis (R4 565.59) and Manthlane Irrigation Scheme (R5 938.78).

It was interesting to note that the amount of profit derived for the three irrigation schemes comprising the Mafefe Irrigation Scheme followed the same trends as production costs and farm incomes. The results reveal that more profits were derived in schemes where more investments were made in production inputs. It may therefore be inferred that increased investment in production inputs resulted in increased performance of the maize farming in study irrigation schemes under the Mafefe Irrigation Scheme.

3.2.2Reliance on Farm Income

The extent of reliance of farming households on farm income is estimated by the contribution of the farm income to total household income. The farming households may be regarded reliant on farm income when their farm income comprises major proportions of total household income. The relative reliance of farming households in the study area on farm income is as shown in Table 5.

Table 5: Relative Reliance on Farm Income Across the Schemes

Proportion of farm income on total household income	**Proportion of farmers falling within the category (%)**			**Mean**
	Mashushu	**Fertilis**	**Mantlhane**	
0-20%	6	35	15	**18.7**
21-40%	88	50	70	**69.3**
41-60%	6	15	15	**12.0**
Total	**100**	**100**	**100**	**100.0**

Source: Field Survey (2008)

One in five (18.7%) farming households at Mefefe Irrigation Scheme derived at most 20% of their income from farming. These households were mostly in Fertilis Irrigation Scheme (35%) and were fewer in Manthlane (15%) and Mashushu (6%) irrigation schemes. With this low contribution of farm income to household income, the households in this category may be regarded less reliant on farm income.

A farm income contribution of 21-40% to household income represents a high level of household reliance on farm income. The majority (69.3%) of households in the study area had this high level of reliance on farm income.

Of the 69.3% farming households with farm income contributing 21-40% of their total income, four in five (88%) were at Mashushu Irrigation Scheme, seven in ten (70%) were at Manthlane and half (50%) were at Fertilis Irrigation Scheme.

The contribution of 41-60% of farm income to total household income represents a higher level of household reliance on farm income. Only one in eight (12%) of the farming households in the study area belonged to this category, suggesting that only a few households were heavily reliant on farming for their livelihoods. Of the 12% of households heavily reliant on farm income, 15% were at Fertilis, the same proportion (15%) was at Manthlane and only 6% was at Mashushu.

The majority (88%) of farmers in the study area derived a smaller portion ($\leq$ 40%) of their income from farming activities and hence the farmers were not heavily dependent on farming for their livelihoods. These farmers who were less dependent on farming could survive without success in their farming enterprises and hence the low dependence served as a disincentive to farming success.

3.3Effect of Selected Variables on Maize Production

The variables analyzed for effect on maize production were selected socio-economic (household size, education level and non-farm income) and production (costs of tillage, seed and marketing) variables (Table 6) and the analysis was done using Cobb-Douglas Production Model. The majority of the variables showed a positive effect on maize production even though the effects were mostly insignificant. Adjusted R^2 is 0.566, indicating that the independent variables included in the model explain about 56.6 percent of the variation in the maize production in the area, meaning that some explanatory variables were not included in the model.

For constant returns to scale, the sum of the technical coefficient β must be equal to one (1); for increasing returns, it must be greater than one; and for decreasing returns to scale it must be less than one. The regression statistics, as shown on Table 6, show that the sum of β's is greater than one (1) and this shows increasing returns to scale. The results for individual socio-economic and production variables are also discussed.

Table 6: Effect of Selected Socio-Economic and Production Variables on Maize Production in Mafefe Irrigation Scheme Using Cobb-Douglas Production Model

Variable category	**Variable**	β	**t-statistic**
Socio-economic	Household size	0.045	-0.367
	Education level	0.145	1.234
	Non-farm income	-0.008	-0.069
Production	Cost of tillage	0.693	5.144**
	Cost of seed	0.282	2.337
	Cost of marketing	0.384	3.128*
	Sum β's	1.541	
	Adjusted R^2	0.566	

*Significant at 5% level, ** significant at 1% level.

3.3.1 Socio-Economic Variables

(a)Size of the Household

The size of the household had a positive effect (β=0.045) on the production of maize at the irrigation schemes under study although this was not statistically significant. The positive effect may be explained based on the fact that rural farm production is dependent on household labour. The labour intensive activities include ploughing, weeding and harvesting. As a result of the dependence of farm production on labour, larger households will have the advantage of having more people to provide the labour and will therefore likely produce more from their agricultural enterprises.

(b)Level of Education

Although there was no significance statistically, the level of education of maize producers also had a positive effect (0.145) on maize yield. The more the farmers were educated, the better their chance was of making informed production and marketing decisions. Literate farmers are able to access all kinds of information stretching from written information in their own languages to that in other languages such as English.

(c)Non-farm Income

Again without the effect being statistically significant, there was a negative relationship between non-farm income and maize production. This might be true, considering the fact that an increase in non-farm income may decrease household's dependence on farming. This would then lead to a decreased participation in farm production.

Apart from incomes earned from non-farm employment, some of the non-farm income may have been received from social grants. With the reported larger sizes of households, some of the members of these families were likely to be of pensionable age while others could still be young children, both of which might qualify for some social grant. The receipt of the social grants by the farming households in the study area would therefore serve as a disincentive to maize production.

3.3.2Production Variables

(a)Cost of Tillage

The results showed a statistically significant ($P<0.01$) positive relationship between the cost of tillage and the level of production. Farmers who paid more for tillage obtained higher yields. The farmers who paid for tillage had their soils well prepared and this is necessary for proper planting of maize. The maize crop planted in well prepared soils therefore produced higher yields.

(b)Cost of Seed

The access to improved seed technology appears to be one of the major challenges in the subsistence farming sector (Diale, 2011). The major improved seed technology is the hybrid seed. According to Mphinyane and Terblanche (2005), about three in five (57%) maize farmers in the Vuwani Area of Vhembe District in Limpopo Province used hybrid seed, and the adoption of the hybrid seed was heavily promoted by extension services and salespersons of seed companies.

The results showed a positive relationship between the cost of seed and the level of production although the relationship was statistically not significant. Farmers who spent more on seed probably procured the improved types of seeds. The study irrigation schemes are located about 130km from both Polokwane and Tubatse which are the nearest towns from which seeds may be bought. A reasonable portion of the cost of seed was therefore likely spent on transport to and from the town where the seed was bought.

(c) Cost of Marketing

There was a statistically significant ($p<0.05$) positive relationship between the cost of marketing and maize production. The maize producers in the area had only one market and this was Progress Milling which they accessed through the office of the extension officer. The maize crop was transported to a collection point (depot) from where it was transported to Polokwane for milling as the Progress Mills are located there. As was the case with the cost of seed, the marketing cost also included a large portion for transport. The producers did not always have direct monetary gains from their production; they were sometimes given maize meal in exchange for the maize delivered to the market.

Access to marketing information gave farmers an added incentive to produce for the market. The access to market played an important role in increasing maize production and farming profitability. Farmers who had access to the market had an incentive to produce since they knew where and when they would sell their maize crop. This cannot be said about the farmers without access to the market as they did not know how much to produce; and this decreased their level of maize production.

3.4Economic viability of Water Users Association

Assessment of economic viability of the WUAs requires knowledge of the costs for running the WUA and the income the WUA would be able to raise.

3.4.1 Costs for running a WUA

The study identified the main activities that would serve as cost drivers for running WUAs, namely: (1) compensation of administrator of the WUA, (2) compensation of workers for monitoring of the state of infrastructure in the irrigation schemes, in this case this would be mostly canals, and (3) procurement of stationery (Table 7). The economic viability of the WUA will depend on its ability to pay for the costs of these activities.

Table 7: Costs for running a Water Users Association for Mafefe Irrigation Schemes

Activity	**Cost (R / annum)**
Compensation of Administration Officer	7 800
Compensation for monitoring of canals (3 people each paid R50 / week)	7 200
Procurement of stationery	500
Total	**15 500**

Of the three main activities, compensation of the administration officer had the largest portion of the cost (R7 800 per annum) followed by compensation for monitoring of the state of canals (R7 200 per annum) and finally the procurement of stationery (R500 per annum) for the WUA (Table 7). Based on the costs of these three main activities, the total cost for running the WUA was R15 500 per annum.

3.4.2 Income of Water Users Association

The income of the WUA would mainly be paid by the member farmers and would therefore be affected by the farmers' ability and willingness to pay for water and related services. On average, the farmers across the three schemes indicated that they were prepared and willing to pay R100 / annum for the water and water related services. Based on the average R100 / annum that a farmer would be prepared to pay, the 167 farmers in the study area would be able to pay R16 700 / annum for water and related services. With the income of R16 700 / annum for the WUA, the costs of R15 500 / annum would be easily covered and a net income of R1 200 / annum would be obtained. This result suggests that a WUA for the Mafefe Irrigation Scheme would be economically viable.

4. Conclusions

The households of smallholder farmers in the study area were all headed by adults with heads of household oldest at Mashushu (mean age=68) followed by Fertilis (59) and finally Manthlane (56). The mean size of household was 5 at Mashushu and was 6 at both Fertilis and Manthlane irrigation schemes.

One in five (21.7%) heads of farming households had no formal education with almost two in five (37.5%) at Mashushu, one in five (20%) at Fertilis and one in thirteen (7.7%) at Manthlane Irrigation Scheme. Half (52.9%) of the heads of the households had primary education with more or less the same number at the three irrigation schemes, namely: Fertilis (55%), Mashushu (50%) and Manthlane (53.8%). Only one in four (25.3%) heads of household had secondary education with two in five (38.5%) of them at Manthlane, one in four (25%) at Fertilis and one in eight (12.5%) at Mashushu Irrigation Scheme.

The household income was highest at Manthlane Irrigation Scheme with a mean income of R26 991 (farm income = R6 582; non-farm income = R20 409) followed by Mashushu with a mean household income of R24 780 (farm income= R7 365; non-farm income = R17 415). Household income was low at Fertilis with a mean income of R21 807 (farm income= R5 076; non-farm income= R16 731). The majority (88%) of farmers in the study area derived a smaller portion ($\leq$ 40%) of their income from farming activities and hence the farmers were not heavily dependent on farming for their livelihoods

The average farmer profit for maize farming was R5 719.62. This average profit was calculated from the profits of the three irrigation schemes, namely: Mashushu (farm profit=R6 654.50), Fertilis (R4 565.59) and Manthlane Irrigation Scheme (R5 938.78).

Maize production was positively influenced by size of household (β=0.045), level of education of maize producers (0.145) and the cost of seed although the influence was statistically not significant. Maize production was statistically significantly positively influenced by the cost of tillage ($P<0.01$)and by the cost of marketing ($p<0.05$).

With the income of R16 700 / annum for the WUA, the costs of R15 500 / annum would be easily covered and a net income of R1 200 / annum would be obtained. This result suggests that a WUA for the Mafefe Irrigation Schemes would be economically viable. However, farmers were only willing to pay the R100 per annum each provided the canals were in proper working conditions. Should the canals not be working, farmers would stop paying and the WUA would then not be economically viable.

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