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# Rural Farmers Participation in Smallholder Irrigation: Analytical Stance of Selected Shiloh Scheme Beneficiaries in Eastern Cape, South Africa

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**ABSTRACT** The paper examined households' participation and decision making in smallholder irrigation practice with specific reference to Shiloh irrigation scheme. The objectives of the study were to investigate the determinants of participation and decision making among smallholder irrigation farmers; to survey the association between household and farm characteristics in Shiloh scheme. A survey design, quantitative and qualitative research methodologies were employed in the study. Data was analysed using the Statistical Package for Social Science (SPSS version 21). Frequencies, percentages, bar and pie chart was also used for data description. Seven variables were discovered to have positive correlation on households' participation and decision making. The paper concludes that it is appropriate to enact an effective policy programme to address the diversity of smallholders' circumstances and recognise their major constraints.

## INTRODUCTION

Sufficient weight has been laid on recognising the role played by agriculture in the process of economic development in Sub-Saharan Africa (SSA); but its performance in the last two decades has been inauspicious with the sector's growth been exceeded by rapid increases in population. In Sub-Saharan and Eastern Africa, per capital food production and employment have deteriorated over the past decades, while food demands continues to increase due to speedy population increases of 2-3 percent (World Bank 2014). Meanwhile majority of the African population are involved in sustenance agriculture with their state of hunger and paucity unswervingly reflects the poor performance of traditional agricultural systems. The weakening agricultural productivity has been contributing to growing poverty among smallholder farmers' and timely recovery may bring enviable prospects for rural population to reduce poverty. Consequently, the development of smallholder irrigation beneficiaries is important for ensuring the production of sufficient food, steady growth in arable and cash crop production. Farming is very important to the South Africa economy and remains the main occupation of the majority of the rural communities. Agricultural decisions are made at every stage of agricultural production and the process is behavioural hence, appreciating the decision making process requires an understanding of human behaviour (Johnson 1976). Participation in decision making is a proccess that entails categorizing the choice to be made, collection of information about the choices and the selection from amongst the alternatives (Caroll and Johnson 1990). Overall, decisions of farmers in a stated period are expected to be derived from the maximization of expected utility (or expected profit) subject to land availability, labour and credit (Feder et al. 1985). The Organisation for Economic Co-operation and Development (2006) asserted that the long period solution to poverty alleviation requires involving the majority of the rural poor in agricultural activities. In generally, the smallholder irrigation schemes in South Africa have been achieving below expectation and have been unsuccessful in delivering on their development mandate of increasing food production (Fanadzo et al. 2010). In pursuing a

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successful rural development objectives that involve food production, needs a clear understanding of the level of participation and decisions making' and livelihood patterns and policy environment of the rural communities. And so, there is need to discover the potentials of raising rural farmers' productivity through more active use of the accessible labour, land and water resources. The study explicitly discussed participation and decision making of irrigation scheme beneficiaries.

**Objectives of the Study**

The study aimed at investigating the determinants of decision making among smallholder irrigation farmers, and to examine the relationship between household and farm characteristics of smallholder irrigation scheme in Shiloh. Therefore, the objectives of this paper were:

(1) To investigate the determinants of decisions making process amongst smallholder irrigation scheme beneficiaries in Shiloh.
(2) To examine the relationship between households in the irrigation scheme and farm characteristics.

**Conceptual Framework of the Study**

Majority of household's farming decisions are influenced by age, gender and level of education (Pattanyak et al. 2003). The study by Tafesse (2007) on the impact of irrigation project on farming efficiency in Ethiopia, also discovered that characteristics such as education, years of farm experience, income of households, farm size were the main characteristics that influences household decision making. The readiness of farmers to use irrigation facilities in farming were also discovered to be dependent on their attitudes and risk discernments (Pannell 1999). In his study Shiferaw (2006), observed that farmers are discouraged to participate in most agricultural activities especially crop farming because of prevailing land rights and the length of tenure. Shorter period of tenure does not allow farmers to engage in long term farming investment like the farming on permanent crops. Tenure uncertainty may be linked to how farmers make use of their land in terms of short-term and long-term crops cultivation. The security of tenure influences household's ability to either remain in production at subsistence level or increase productivity. Wherever farmers observe uncertainties in land tenure arrangements, they display little interest in investment in farming. Farm characteristics includes size of available land; labour availability, household income, the number of livestock and crops available; and distance from farm to the market. Commonly, farm characteristics are positively linked with participation and decision making of household.

The institutional policies which entails land holding rights, secure property rights, credits and insurance generates inducements for positive investment decisions making process (Shiferaw 2006). The delivery of proficient extension services to smallholder irrigation scheme beneficiaries assist in decision making process. Solidification of farming through investment in irrigation infrastructure will assist in increased food production in rural communities. Majority of the smallholder farmers cannot afford on-farm storage facilities to store water for use in time of water stress. The smallholder farmers' decision to acquire and utilise a large area of land for farming will definitely be affected by the irrigation scheduling arrangement that may be in place. Norris and Batie (1987) observed that farmer's awareness of the biophysical features in their environment is clearly linked with farmers' decisions making process. The slope of a field, rainfall pattern and other soil physical features are essential indicator for chances of erosion in an area (Lapar et al. 1999). The decision to adopt irrigation technology will depend on returns from land that is used for previous farming. Therefore, it bears noting that biophysical features are capable of influencing decision making at household level. Marketing reforms introduced in South Africa is an integral part of institutional arrangements which also has influence on production decisions (Fig. 1). The issuance of credits and fluctuations in yield price prompted by imperfect markets are also anticipated to make smallholder face very low prices of their products (Janvry and Sadoulet 2010).

## METHODOLOGY

**Selection and Description of the Study Area**

Shiloh smallholder irrigation scheme is located in Lukhanji Local Municipality which is situated within the Chris Hani District of the Eastern Cape Province. The scheme is situated on the R67 road to Fort Beautfort, about one

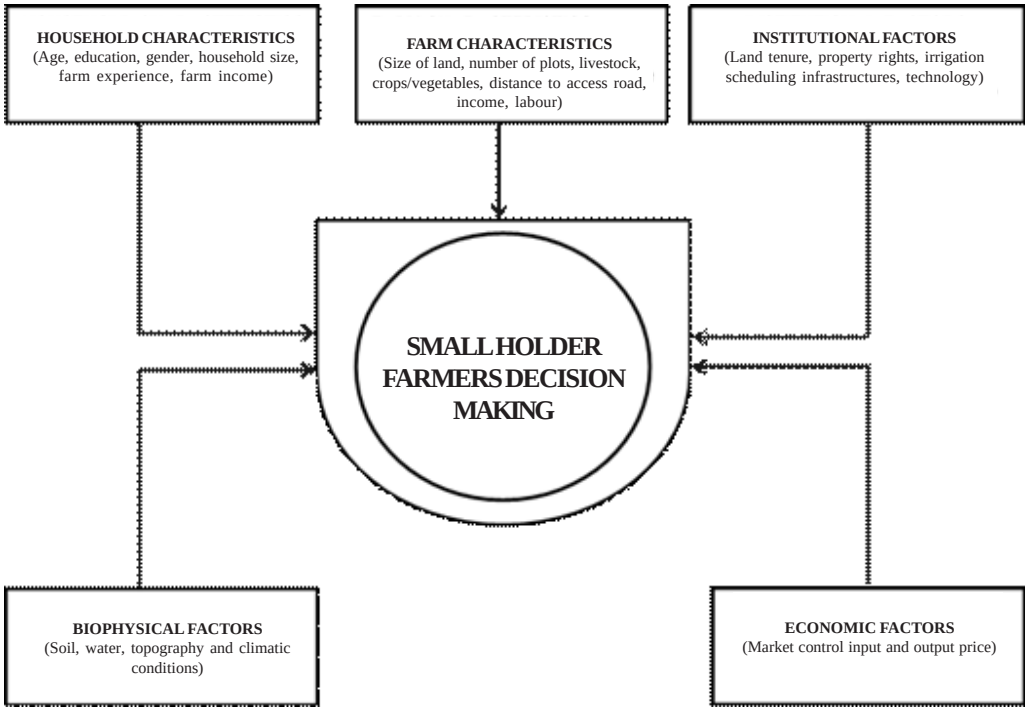


**Fig. 1. Conceptual framework of factors influencing smallholder decisions' in irrigation practices**
*Source:* Author compilation 2012

kilometre from Whittlesea. It is also 40km from Queenstown and 102km from Fort Beautfort on both sides of the road. The total area of the scheme is 455 hectares. Lukhanji Local Municipality where the Shiloh irrigation scheme is located comprises of Queenstown and neighbouring communities (Fig. 2).

## Sampling of Respondents

The survey gathered information on socio-economic background which includes: income, consumption and expenditure of households, decision making process, household farming activities and marketing. Shiloh smallholder irrigation scheme has 450 hectares of irrigated plots divided amongst 338 beneficiaries. Nevertheless, of the 450 plots, 318 hectares were used for dairy farming and 96 hectares were used for crop production. The farmers involved in crop farming were considered in the sampling. The list of farmers in the scheme were used and all farmers were allocated serial numbers for ease of identification and analysis.

## Sampling Size

Farming households were considered as a unit for analysis and the sample size for the study site was determined using 5 percent margin of error at 95 percent confidence interval, and 60 households as finite population. With the set values, a sample size of 52 households were used. This study used 60 households as the samples size. These samples were collected randomly from the study areas.

## Instrument for Data Collection and Method

Some enumerators who understands the local language (Isi-Xhosa) were informally trained on the ways of approaching the respondents, the way to arrange the interview and how to record information accurately. However, the main survey was then carried out in the study area involving the researcher, stakeholders and enumerators. Structured and semi-structured questionnaires, interviews, personal observation and some field measurement were used in collecting


**Fig. 2. Map of Chris Hani Local Municipality**
*Source:* Chris Hani District Municipality (2012).

data. Focus group discussion were also used to ensure proper investigation.

**Data Analysis Method**

Descriptive statistical tools such as, mean, standard deviation, and SPSS were used to analyse data collected from the sample households. Data were compared and carefully examined for clarity and relevance. The determining variables for decision making of household were quantified using the binary logistic regression. The method was adopted because it estimates probabilities of events as a function of a set of explanatory variables that are hypothesized to influence the outcome or result (Pohlmann and Leitner 2003). Logistic regression method is a more popular approach used to classify individual into one or two populations when only predictor variables are known and to predict which characteristics best determine decisions. In this case, no assumptions made with respect to the distributions of the predictor variables (X) and that X variables may be discrete or continuous (Afifi et al. 2004). The logistic regression method is an established approach applied in empirical studies focused on finding the determinants of investment decisions of smallholder agriculture (Mercer et al. 2005; Neupane et al. 2002). The conceptual framework developed were used as the basis for the analysis.

**The Adopted Model**

Agricultural household model was used to analyse smallholder farmer's decision making. In subsistence circumstances, production and consumption decisions of smallholder households are often mutually dependent primarily because household labour is employed as an input in agricultural activities and the income generated from the household's agricultural activities denotes an important share of the income used for consumption purposes (Amacher et al. 2010). Agricultural household model is hinged on the literature of adoption and farm household (Singh et al. 1996). Household theory illustrates that household maximizes utility ($U$) over a set of consumption items produced by a set of home grown agricultural product ($C_{f}$,)

a set of consumption goods ($C_{nf}$), and leisure *(l)*. The utility obtained from household consumption levels depends on the preferences of its members ($\Omega_{HH}$), formed by the main characteristics of the household, for example the age, education and wealth status of its members.

$$MaxU\ (C_f, C_{nf}, l; \Omega_{HH}) \quad (1.1)$$

$C_f, C_{nf}$

Quantities of farm produce to be consumed at farm level *(Cf)* or sold *(Q – Cf)* are taken or chosen from a vector *Q* of farm outputs. The decision making processes are constrained by a constant technology that combines purchased inputs *(X)*, labour *(L)*, with the allocation of a fixed plot or land area ($A = A^o$) among *m* crops, given the physical conditions of the farm ($\Omega F$),

$$Q = F(\alpha, X, L, \backslash A, \Omega_F) \quad (1.2)$$

Every set of area shares $(\alpha i)$ among *m* crops sum up to 1, $m$

$$\Sigma \alpha i = 1, i = 1 \text{ ——— } mi$$

Objective function in Eq. (1.1) can then be rewritten as:

$$Max\ V\ (C_f, C_{nf}, l; \Omega_{HH}) \quad (1.3)$$

$h$

Where $h = ((\alpha 1,..., \acute{a}^m) \geq 0; C_f, C_{nf}, X, and\ L)$.

The preference of household in terms of labour are constrained by the total time *(T)* available for farm production and leisure *(l)*, and by the full income of the household. However, the total income in a single decision making period comprises of the net farm earnings that is, profit from crop farming and income that is realised from outside and different choices $(Y^o)$, such as stocks carried over, remittances, pensions and other transfers from the past seasons:

$$T = H + l \quad (1.4)$$

$$Pf(Q - C_f) - p_x X - wL + Y^O = p_{nf} C^{nf} + wH \quad (1.5)$$

$P_f$ *is* the price of farm produce sold, *px* is the average price of variable inputs, *w* is labour wage, and $P_{nf}$ is the average price of purchased goods.

Other problems like market, institution and cultural factors affecting production and consumption decisions can be explained as exogenous features *(M)*. In the event that consumption and production decisions are not separable, the household's best possible choice $(h^* = \alpha^*, Cf^*, Cnf^*, X^*, L^*)$ can be expressed as a reduced function of farm size, income from outside sources, and household, farm and market characteristics:

$$h^* = h^* (A^O, Y^O, \Omega_{HH}, \Omega_F, \Omega M) \quad (1.6)$$

Equation (1.6) above is the basis for econometric approximation to examine the factors affecting household decision-making.

**Determinants of Farmers Decision-making**

Binary logistic regression model was used to evaluate factors that influence households' decision to participate or move out of the scheme. The dependent variable was binary with a value of 1 if a household indicates that he/she would remain in the scheme and 0 otherwise. By applying screening questions based on the readiness of farmers to remain in the scheme or not to remain in the scheme, two homogeneous mutually exclusive groups were created.

Pohlmann and Leiter (2003) observed that logistic regression models estimates the probabilities of events as a function of a set of explanatory variables that are hypothesized to influence an outcome. The model is used to categorise individuals into either one or two populations when only one set of predictor variables is known and to decide which features or characteristics best predict decision making. There are no assumptions made with respect to the distribution of the predictor variables (X); however, X variables may be discrete or continuous (Afifi et al. 2004). Logistic regression method is well entrenched in empirical studies that seek to establish the determinants of decisions making in agricultural production (Mercer et al. 2005). Subsequent to Mercer et al. (2005), let $R_i$ represent a dichotomous variable that would equal 1, if households' decide to remain in the scheme and 0 if they did not. The probability of the choice to remain in the scheme, $Pr\ (R_i=1)$, or not $Pr\ (R_i=0)$ is derived as follows:

The probability of choice to remain in the scheme is

$$P=Pr\ (Ri=1) = \frac{1}{1+_e\text{-}(\beta_0+\beta_1 X_{1i}+...+\beta_k X_{ki})} - \frac{e\ (\beta_0+\beta_1 X1i+...+\beta_k X_{ki})}{1+e(\beta_0+\beta_1 x_{1i}+...+\beta_k X_{ki})} \quad (1.1)$$

On the other hand, the probability of choice not to remain in the scheme,

$$P=Pr\ (Ri=0)=1\text{-}Prob\ (Ri=1) = \frac{1}{1+e\text{-}(\beta_0+\beta_1 x_{1i}+...+\beta_k X_{ki})} \quad (1.2)$$

Dividing [1.1] by [1.2], we obtain

$$\frac{Pr\ (Ri=1)}{Pr\ (Ri=0)} = \frac{Pi}{1\text{-}Pi} = e(\beta_0+\beta_1 x_{1i}+...+\beta_k X_{ki}) \quad (1.3)$$

Taking the log in both sides of Eq. [1.3], results

$$In \frac{Pr\,(Ri = 1)}{1 - Pr\,(Ri = 0)} = ß_0 + ß_1 X_{1i} + \ldots + ß_k X_{ki} \quad (1.4)$$

Where:

Subscript *i* represent *the* $i^{th}$ observation in the sample

*Pr* is the probability of the outcome

$ß_0$ is the intercept term

$ß_1, ß_2 \ldots, ß_k$ are the coefficients associated with each explanatory (independent) variable $X_1$, $X_2 \ldots X_k$

The independent variables $(X_i)$ included in the model were gender of household (GENDER), age of household (AGE), level of education (EDUC), farm experience (FARMEXP), land size (LANDSIZ), distance of household to the nearest access road (ROADDIS), land rights (LANRITS), farm infrastructure/asset (FARMASET), water sufficiency in the scheme (WATSUFC), access to extension service (EXTACES), marketing information (MKTINFO), and produce variation and yield gap (PRODVAR). While the dependent variable used in this logistic regression analysis was whether or not the plot holders decides to participate or remain in the scheme (DECREM), where DECREM = 1 if plot household remain and 0 if they do not.

Subsequent to the above explanatory variables (independent), the general form of Equation [1.4] was rewritten below to represent the probability of remaining in the scheme by sampled households' in the study area.

$$\ln\left(\frac{Pr\,(Ri=1)}{1-Pr\,(Ri=0)}\right) = \beta_0 + \beta_{1GENDER} + \beta_{2AGE} + \beta_{3EDUC} + \beta_{4FARMEXP} + \beta_{5LANDSIZ} + \beta_{6ROADDIS} + \beta_{7LANRITS} + \beta_{8FARMASET} + \beta_{WATSUFC} + \beta_{10EXTACES} + \beta_{1MKTINFO} + \beta_{12PRODVAR} \quad (1.5)$$

## RESULTS

### Characteristics of Household in the Study Area

#### *Gender of Household*

Findings of the study (Table 1) shows that the respondents in Shiloh consisted of 41.7 percent males and 58.3 percent females. There were more females plot holders than males. Findings further revealed that 43.3 percent of farmers in the irrigation scheme were married while 3.3 percent were widowers (Table 1). The divorce rate were 10.5 percent.

### Age of Household

Household ages ranged from 44 to 71 years. Youths who were actively participating in the scheme were not very encouraging. Only 1.7 percent of the population sampled was 44years old with an average age of 55.7 percent (Table 1). Farming in the area is in the hands of old men and women while the able-bodied youths often travel to cities for white collar jobs.

**Table 1: Socio-economic characteristics of households**

| *Irrigation scheme* / *Household characteristics* | *Shiloh (N=60)* | |
|---|---|---|
| | *Number* | *Percent* |
| *Gender* | | |
| Male | 25 | 41.7 |
| Female | 35 | 58.3 |
| Total | 60 | 100 |
| Average age | 60 | 55.7 |
| *Marital Status* | | |
| Married | 26 | 43.3 |
| Single | 17 | 28.3 |
| Widow | 9 | 15.0 |
| Widower | 2 | 3.3 |
| Divorcee | 6 | 10.0 |
| Total | 60 | 100 |
| *Education Level* | | |
| No school | 13 | 21.7 |
| Primary school | 14 | 23.3 |
| Junior school | 20 | 33.3 |
| High school | 10 | 16.7 |
| Tertiary | 3 | 5.0 |
| Total | 60 | 100 |
| *Employment Status* | | |
| Yes | 5 | 8.3 |
| No | 55 | 91.7 |
| Total | **60** | **100** |

### Level of Education of Household

About thirty three percent of farmers had junior school education in the study area and were more than any other educational level. Though, 16 percent of respondents had high school education while farmers with no formal education in the study area was 21.7 percent (Table 1). The percentages of farmers with a tertiary education in the entire scheme were 5.0 percent.

### Farm Experience of House

Farm experience of beneficiaries in the scheme was investigated and responses show

that 1.7 percent of the total number of respondents had a minimum farm experience of five years. In the scheme, 4.2 percent of farmers had 10 years farm experience. The longest farm experience was 20 years in the schemes. Conversely, the majority of respondents that had farm experience ranging from nine to 17 years. In agriculture, the number of years of experience has implication for the decision making. As observed by (Polson and Spencer 1992) farmers with longer years of experience are likely to access better information.

### Employment of Household Head in the Study Area

Findings reveal that 45.83 percent were unemployed while 4.17 percent of the farmers were employed. The regular off-farm activities such as running Spaza shops, hawking, and engaging in unskilled jobs exist in the area.

## DISCUSSION

### Logistic Regression Results

The binary logistic model, show that seven variables (farm experience, size of farmland, land rights/PTO, water sufficiency, farm asset, market information and production variation) out of the twelve predictor variables were found to have significant impact on household decision making. Whereas five variables (gender, age, education, road distance and extension access) were not significant (Table 1). From the seven significant variables, four had positive signs (land rights/PTO, water sufficiency, size of farmland and market information); which means that an increase in either of these variables may be associated with an increase in household decision making in Shiloh. The other three predictor variables (farm experience, farm asset and product variation) had negative signs; this means an increase in either of these variables may be associated with a decrease in decision making as illustrated in Table 2.

### Farm Experience

The variable farm experience was significant with *p-value* of 0.038 but negatively related to decision making. The findings indicate that, for every unit increase in household farm experience there is 0.77 decrease in the log odds of decision making of households in Shiloh. The findings contradicts past report by Enete et al. (2002) who posited that experienced farmers are more informed and are better able to make quality decisions.

### Land Size

Sizes of land allocated to farmers was significant (*p-value* = 0.010) and positively related to decision making of households in Shiloh. The results suggest that, for every unit increase in land size there is 9.970 increases in the log odds for decision making of households in Shiloh. As indicated, 49.2 percent of the surveyed house-

**Table 2: Determinants of decision making for choice to remain in the scheme**

| *Independent variable* | *B* | *S.E* | *Wald* | *df* | *Sig.* | *Exp(B)* |
|---|---|---|---|---|---|---|
| GENDER | - .631 | .632 | .997 | 1 | .318 | .532 |
| AGE | -.004 | .054 | .005 | 1 | .946 | .996 |
| EDUC | -.165 | .274 | .361 | 1 | .548 | .848 |
| FARMEXP | -.077 | .089 | .748 | 1 | .038* | .926 |
| LANDSIZ | 9.970 | 20096.480 | .000 | 1 | .010* | 21366.965 |
| ROADDIS | -.53987 | .775 | .483 | 1 | .487 | .583 |
| LANRITS | .970 | .680 | 2.036 | 1 | .015* | 2.639 |
| WATSUFC | 1.299 | 1.096 | 1.404 | 1 | .023* | 3.667 |
| FARMASET | -1.430 | .678 | 4.444 | 1 | .035* | .239 |
| EXTACES | 1.076 | .720 | 2.232 | 1 | .135 | 2.933 |
| MKTINFO | .768 | .668 | 1.323 | 1 | .012* | 2.933 |
| PRODVAR | -1.390 | .598 | 5.400 | 1 | .020* | .249 |
| -2 Log likelihood | 44.819[a] | | | | | |
| Nagelkerke $R^2$ | .398 | | | | | |

Percentage correctly predicted 83.3
*Note:* Significant variables affecting decision making at 0.01(**), and 0.05 (*) levels of significance.

holds in Shiloh had less than 1ha irrigated food plot that was used for farming. The influence of land size agrees with the findings of Darr and Uirbrig (2004) and Emtage and Suh (2004). Small land sizes does not allow farm mechanization.

**Land Rights**

The views of farmer with respect to land rights was significant and positively related to the decision to remain in the scheme in Shiloh (*P-value* = 0 .015). These results imply that, for every unit increase in land rights there are 9.970 increases in the log odds for decision making of households in Shiloh. The findings agrees with studies by Bannister and Nair (2003) in Haiti who observed that farmers cultivated more trees on land where they had tenure security.

**Farm Asset**

Farm assets (*p-value* = 0.35) was significant but negatively related to decision making. The findings show that, for every unit increase in household farm asset there is 1.430 decrease in the log odds of decision making of households. The emerging theme from our focus group discussions was the inadequate farm assets and farmers observed that this was the main factor influencing decision making in the schemes.

**Water Sufficiency**

The availability and sufficiency of water was positive and significantly influences decision making with a *p-value* = 0.023. The result suggest that, for every unit increase in water there are 1.299 increases in the log odds for decision making. This findings also agrees with the study of Stephen (2007) who observed that decreased level of crop yield in many smallholder irrigation schemes in South Africa stems from inefficient water use.

**Market Information**

The results from market information suggest a significant and positive influence on decision making (*p-value*: 0.012) in Shiloh. AS per a unit increase in market information, the results propose a 0.768 increases in the log odds of decision making. However, information about market prices for farm produce is likely to motivate farm households. Besides, market information help households in the purchase of farm inputs at the right time and at reasonable cost.

**Produce Output Variation**

The variation of farm produce yield (*p-value*: 0.020) was significant but negatively related to decision making of households. This imply that for every unit increase in farm yield there are 1.390 increases in the log odds for decision making of households. The result is consistent with the study of Zeleke (2008) that farmers with higher crop output per unit area of land were more likely to continue growing trees in the Sodo Zuriya in Ethiopia.

## CONCLUSION

From the findings of the study, seven out of twelve independent variables were discovered to be weighty in illustrating the farmers' decision making. The significant variable as exemplified in the study were household farm experience, the distance of households to the closest access road, farm asset, water adequacy, household access to extension services, information about market, and yield gap. The study illustrated certain key determinants of decisions process of households and how these decisions impact on households' participation in smallholder irrigation schemes. A substantial number of households depend on farming as a means of livelihood. Nevertheless, many has been renting out their food plots because of inadequate farm infrastructures, inadequate training on the available infrastructure couple with low yield performance. In sum, the need for smallholder irrigation scheme in communities is enormous given that it does not only provide employment but also food security of households. Household food security will not be realized without recognizing the role played by smallholders' farmers in South Africa.

## RECOMMENDATIONS

The initiation of ideal policy that will encourage smallholder farmers should be develop to enhance a culture of regular maintenance of farm infrastructure. The average size of most household plots, should be increased for households to achieve food security. The planning and exe-

cution of regular seminars and workshops with specified time frames will enhance efficiency and participation in smallholder irrigation schemes. The paper also recommend that it is pertinent to promulgate an efficient extension policy programme to address the diversity of smallholders' situations and identify the main constraints on investment in smallholder farming.

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