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Small Scale Irrigation and Agricultural Commercialization in Tigray

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Abstract

This paper attempts to demonstrate how access to irrigation determines household's decision to the extent of market participation in irrigated compared to rainfed systems. By doing so the paper identifies the role of irrigation in share of land allotted to cash crop production, while at the same time highlighting its role in market participation decision of farm households. The results from the sample t-test indicate that irrigation contributes significantly to increase in cash crop production and market participation decision by inducing shifts in farmers cropping mix. Analyzing household data from Kilte-Awlaelo woreda in Eastern Tigray, the findings from the 2SLS model revealed that production value, amount of credit and means of transport by car and mule as reference to human power have positive and significant association with households' market participation decision. While, non-farm income and using donkey as a means of transport compared to human power have significant and negative association with households' market participation decision. Overall, this paper concludes with implication for policy to link irrigation development with road infrastructure development and improvements in other marketing services, thus, can help in the long-term transform traditional subsistence agriculture into more market oriented and modern agriculture.

Key words: *small scale irrigation, market participation, 2SLS and Kilte-Awlaelo woreda.*

Introduction

Ethiopia agricultural potential is believed to be quite substantial; it has a total land area of 1.13 M km^2 with an estimated 55 M ha arable which is approximately half of the total land mass. However, only about 20% of the total arable land is currently being utilized for crop production. The potential arable land encompasses both rain-fed and irrigable lands that are agro-ecologically suited to the production of a variety of crops, including cereals, pulses, oil crops, tree crops and vegetables. In addition, Ethiopia is said to have also an estimated irrigation potential of 3.5 million hectares (Awulachew et al. 2007). However, the total estimated area of irrigated agriculture in the country in 2005/2006 was 625,819 ha, which in total constitutes about 18 percent of the potential (MOWR, 2001). Particularly, in Tigray, based on secondary data from BoFED[1], the total cultivated area during the 2006 agricultural season was about 1.9 million hectares, of which only about 0.02 million hectares was irrigated (Gebre-egziabher, 2008).

As empirical evidences suggest that irrigation projects have positive impacts on agricultural production and reduction of poverty for farmers (von Braun, Puetz, and Webb 1989; Hussain and Hanjra 2004; Smith 2004; Lipton 2007; and Hussain 2007b), by providing farmers with a reliable water source to meet food self-sufficiency, generate export earnings, and provide raw materials for industry on a sustainable basis (MoWR, 2001). This strategy is also expected to increase market participation of producers (Rosegrant et al., 1995; MoFED, 2006). Higher yields, higher cropping intensity and all year round farm production leads to increased market-oriented production, implying a shift in supply (markeatable surplus production) and perhaps food security.

In risky environments such as Tigray, small holder farmers, who constitute the bulk of the population, are often caught in production of low- risk/low –return food grains. With insufficient cash funds, and unpredictable outcomes, they cannot afford to take the risk of diversifying from subsistence food production into potentially higher-return ventures (such as growing cash crops for market), or of spending their limited cash on purchased agricultural inputs, because if they fail – either because of crop failure, price collapse, or lack of demand – they will not have either the basic food they would otherwise have produced, nor the cash to purchase it, and their families will go hungry (MOFED, 2006). Furthermore, a smallholder farmer who allocates land to a commercial crop often has to depend on market purchases to meet food requirements, resulting in an additional source of risk. Some high-value agricultural commodities also require significant investments, including the use of specific inputs. Finally, the production and marketing of highly perishable high-value commodities benefit from the producing farm being located near markets and good marketing infrastructure (Torero and Gulati, 2004d cited in Brithal et al., 2007).

As Lapar et al. (2003) argue that, farmers in developing countries such as Ethiopia, particularly poor farmers in Tigray, have inadequate capita resources – including, physical and financial resources, but also human capital resources such as experience, education and extension – which limit their ability to diversify production portfolios. In addition, Brithal et al. (2007) further indicated that, small holder producers often do not have savings or credit access needed to make these investments and purchase the necessary inputs. However, high-value commodities like fruits and vegetables may become viable prospects when these constraints are relieved through intervention. In addition, poor infrastructure often increases the transaction costs of small holder's market participation (Hagos F. et al., 2007).

[1] BoFED = Bureau of Finance and Economic Development

Therefore, the development of small-scale irrigation schemes with the aim of producing high-value crops has a number of advantages. It helps to reduce the impact of erratic rainfall on household income fluctuations, promote intensive land use and thereby increases the likelihood of using purchased inputs due to the reduced risk of crop failure (Rahmato, 1999). In a nutshell, irrigation is expected to remove or ease risk so that farmers can venture into an inherently high risk-high return production pathway, which may have a significant effect on poverty reduction (MoFED, 2006). Hence, this paper attempts to explore empirically the impact of irrigation intervention on farm household's decision to market participation and to understand the factors affecting the extent and determinant factors to market participation decision of farm households' in Tigray.

Objectives of the Study

The general objective of the study is to assess the overall impact of small scale irrigation intervention on farm household's decision to agricultural commercialization using a quantitative approach.

Specific objectives of the study are:

1. To examine the impact of small scale irrigation on farm household's decision to market participation in irrigated systems in contrast to rain fed system in Tigray;
2. To analyze the determinants of farm households' decision in Market oriented development.

Methodology

Tigray is located in the northern part of Ethiopia. The Tigray national Regional State (TNRS) is divided into 7 administrative zones, 48 woredas (districts), 550 tabias more than 3500 kushets, and 74 towns. The zones are Eastern, Central, Southern, Western, North Western, South Eastern and Mekelle city. TNRS has an estimated total population of 4,448,997 consisting of 2,192,996 men and 2,256,001 women. Out of which 3,519,000 or 81.2% of the population are estimated to be rural inhabitants, while 816,000 or 18.8% of the population are estimated to be urban inhabitants (CSA, 2006).

This study uses a secondary data from a representative Survey of 101 households collected by Gebre-egziabher (2008) from a household and plot level survey. In the study area, Kilte-Awlaelo woreda, agriculture contributes much to meet major objectives of farmers such as food supplies and cash needs. The sector is characterized by its small scale and subsistence nature. Mixed farming is the major economic sector in the woreda, where crops are grown for food and cash, and livestock are kept for complementary purpose, as a means of security during food shortage, and to meet farmers' cash needs. Both crops and livestock production are important. River Birki, where the specific research place, is one of the small scale irrigation technologies among the upgrade diversion schemes located in Kilte-Awlaelo woreda, tabia Mesanu and kushet Laelay Agulae.

Model specification for market participation

The level of commercialization (market participation) needs to be measured in order to analyse the determinant factors of commercialization. There are a number of different ratios developed to measure the degree of household commercialization. These different indicators usually emanate from the way commercialization is conceptualized. Some authors use econometric models derived from the conventional non-separable agricultural household models to evaluate their resource allocation decisions for producing commodities consumed at home (staple crops) vs. those supplied to markets (cash crops). Others use simple indices (ratios) to look at the proportions of resources or income derived from the market. In some cases, these indices are focusing on either input or output side commercialization, whereas in others, they combine the two and look at overall market transactions of a farm household (Jaleta et al., 2009). In this thesis the index on output side commercialization is considered.

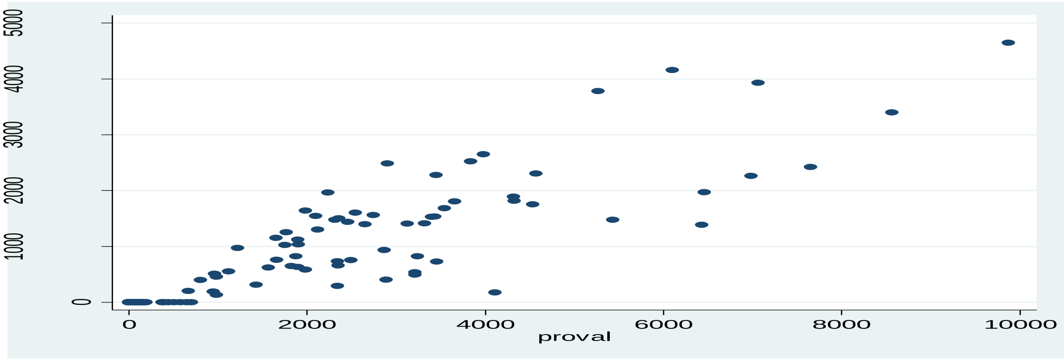
In this thesis, market participation is defined as Strasberg et al (1999) and Govereh et al (1999) and Gabre-Madhin et al. (2007) stated that, in terms of sales as a ratio of total output: Household Commercialization Index (HCI):

$$HCI = \frac{Gross\ value\ of\ Agricultural\ Sales}{Gross\ Value\ of\ All\ Agricultural\ Production}$$

This "sales index" would be zero for a household that sells nothing, and could be greater than unity for households that add value to their crop production via further processing and/or storage. The measure is intended to measure market orientation or commercialization in a scale-neutral manner, independently of the household's wealth or productivity (Govereh et al, 1999). A big advantage of this approach is that commercialization is treated as a continuum, there by avoiding crude distinctions between commercialized and non-commercialized farms (Leavy J and Pouliton C, 2007).

Obviously, the degree of farmers' participation in output markets could be measured in terms of the proportion of output sold i.e. HCI, but this is open to critics. One possible critic is that it makes no meaningful distinction between a farmer who produces just one bag of maize and sells that one bag, and one growing fifty bags of maize who sells thirty of them. Based on the HCI, the first farmer, with a HCI of 100, would appear to be more commercialized than the second, who has a HCI of 60 (Leavy J. and C. Poulton, 2007). Therefore, I used to follow value of output sold for analysis.

In addition, although the amount that farmers supply to the market increases as farm production rises, the relationship is far from one to one relationship. This implies that, for the same size of farm production, some farmers consume more on farm while others consume less and sell more. Therefore, to model the degree of market participation of farm households I assume that the quantity supplied to the market (measured in terms of cash earned from agricultural sales) is a linear function of a set of household's characteristics, after inspecting the distribution of sampled households on a scattered plot of total value of output sold. The graph below reflects that there is linear functional form relationship between the dependent and independent variables.



$y_i = x_i\beta + z_i\gamma + \mu_i$

It is possible to estimate equation 1 by OLS under the condition that the error term and the regressors are not correlated. Where y_i is the total vale of output sold, x_i and z_i are factors that affect quantity supplied to the market (i.e. the degree of households' participation in output market as a seller), β and γ are parameters to be estimated and μ_i is the error term. We assume that exogeneity of the vector x_i and z_i that implies both are uncorrelated with the disturbance term, μ_i. We think, however, that z_i may be endogenous and therefore (in general) correlated with μ_i, since, the value of output produced could be correlated with the error term and, if so, it is potentially endogenous. Therefore, we want to test for this.

Our null hypothesis is therefore

H0: $cov(z_i; \mu_i) = E(z_i, \mu_i) = 0$; and eqn. 2

The alternative hypothesis is

H1: $cov(z_i; \mu_i) = E(z_i, \mu_i) \neq 0$; eqn. 3

Assume that an instrument for z_i relative to (eqn. 1) is available. It is the scalar variable wi, i.e., wi is correlated with z_i and uncorrelated with ui:

$cov(w_i; u_i) = E(w_i, u_i) = 0$; eqn. 4

Both zi and wi may be correlated with xi. Assume that ui is non-auto correlated and has constant variance. We then know the following:

1. If zi is exogenous and H0 holds, then we know from Gauss-Markov's theorem that applying OLS on (11) gives the MVLUE (the Minimum Variance Linear Unbiased Estimators) of β and γ. These estimators, denoted as (b_OLS; γ_OLS), are therefore consistent.
2. If zi is correlated with ui and H0 is violated, then (b_OLS; γ_OLS) are both inconsistent.
3. Estimating (11) by two-stage least squares, using wi as an instrument for zi gives consistentnestimators of β and γ, denoted as (b_2SLS; γ_2SLS). Consistency is ensured regardless of whether H0 or H1 holds.
4. We then have two sets of estimators of β and γ:
   (i) (b_2SLS; γ_2SLS), is consistent both under H0 and H1, but inefficient under the former.
   (ii) (b_OLS; γ_OLS), is consistent and efficient under H0, but inconsistent under H1. Hence, (b_2SLS; γ_2SLS) is more robust to inconsistency than (b_OLS; γ_OLS). The price we have to pay when applying the former is, however, its loss of efficiency if H0 is in fact true. Intuition then says that the "distance" between (b_2SLS; γ_2SLS) and (b_OLS; γ_OLS) should "on average" be "smaller" under H0 than under H1.

Therefore, we formulate the assumed relationship between the instrument, the regressor vector xi and the instrument wi for zi in (11) as follows:

$z_i = x_i\delta + w_i\lambda + v_i$; eqn. 15

and assume that

$u_i = v_i\rho + \varepsilon_i$; eqn. 16

where

$cov(\varepsilon_i; v_i) = cov(\varepsilon_i; w_i) = cov(x_i; v_i) = cov(\varepsilon_i; x_i) = 0$: eqn. 17

Equation (15) may be the reduced form for zi in a multi-equation model to which (eqn. 11) belongs, yi clearly endogenous and zi potentially endogenous and determined jointly with yi. Then (xi; wi) are the exogenous variables in the model. It is supposed that (eqn. 11) is identified. It is perfectly possible that zi is a regressor variable affected by a random measurement error, where wi is an instrument for the true (unobserved) value of zi, and hence also for zi itself. In selecting instruments for the value of output produced, any 'exogenous' variables in the full system of equations were selected as instrumental variables for the total value of output produced. We subject these instrumental variables to a range of tests. The tests have limited power to reject weak or invalid instruments, however, so their value ultimately depends on our a priori knowledge of how they relate to household decisions. In this case, our candidate instruments for explaining the size of farm production are (i.e. Per capita land, labour, number of oxen, expenditure on farm inputs, age, sex, access to irrigation and literacy of the head) were considered as instruments to replace the value of output produced (which was found to be correlated with error term). The validity of these instrumental variables was tested using F-test. The F-test validates whether these instruments are themselves endogenous. The null hypothesis for the F-test was that the parameters associated with the selected instruments are jointly zero. The F-value with 12 and 88 df is 9.34(F (12, 88)=9.34, prob>F=0.0000), implying that all instruments are exogenous.

From (eqn. 14) - (eqn. 17) it follows that:

$cov(z_i; u_i) = cov(x_i\delta + w_i\lambda + v_i; v_i\rho + \varepsilon_i) = \rho\, var(v_i)$ eqn. 18

and therefore

H0 =) $\rho = 0$; eqn. 19

$H1 =) \rho \neq 0;$ eqn. 20

Inserting (16) into (11) gives

$y_i = x_i\beta + z_i\gamma + v_i\rho + \varepsilon_i$ eqn. 21

Let the OLS estimates of (δ , λ) in (15) be (δ_OLS; λ_OLS), and compute the residuals

vi = zi - xi δ_OLS - wi λ_OLS: eqn. 22

Replace vi with _vi in (21), giving

$y_i = x_i\beta + z_i\gamma + v_i\rho + \epsilon_i$ eqn. 23

Estimate the coefficients of (23), (β, δ, ρ) by OLS i.e., by regressing yi on (xi; zi; _vi). Test, by means of a t-test whether the OLS estimate of ρ is significantly different from zero or not.

This leads to the following prescription for performing a Wu-Hausman test and estimating (11):

Rejection of ρ = 0 from OLS and t-test on (23) =) rejection of H0, i.e., rejection of exogeneity of zi in (11). Stick to 2SLS estimation of (1). Non-rejection of ρ = 0 from OLS and t-test on (23) =) non-rejection of H0, i.e., non-rejection of exogeneity of zi in (1). Stick to OLS estimation of (11). Before proceeding with the 2SLS model, it is also important to check for simultaneous equation bias between output sold and produced. I estimated empirically whether the value of output produced is indeed correlated (asymptotically) with the disturbance term or not. I followed a three stage procedure and there is evidence in favour of the hypothesis that the value of output produced is correlated with the error term. Therefore, the 2SLS estimator is preferred.

Results and Discussions

The results of the findings from the quantitative as well as qualitative data are discussed thoroughly followed by the discussion of the respective issues of interest.

Description of the variables

The total impact of irrigation can be best assessed by comparing same agro-environments, which are similar in all aspects, including endowment of resources, except in access to irrigation infrastructure. Summary statistics (table 5.1) presented below shows distinct differences in the household's resource endowment and household characteristics. This indicates household characteristics and resource endowment that may affect their decision on crop choice and market participation.

The survey data indicate that about 77% of sampled households were irrigation users while 23% were purely rainfed cultivators. That is, irrigation enables producers to cultivate their land intensively and select high value crops for their production using continuous flow of water. The availability of such facilities affects cropping pattern and related cropping decision.

Household characteristics include those related to human capital, labor supply and the life-cycle stage of the household. The average age of the household head is computed to be approximately 41.67 years and the minimum and maximum age of the household head is computed to be 18 and 80 years respectively. Age of household head is expected to have a quadratic relationship with both inter and intra specific diversity, as younger households may be more willing to adopt new technologies including different crops and varieties, while older households may be reluctant to new technologies and less likely to try new crops and varieties (Abera, 2009).

Gender of the household head is one of the determinant factors for agricultural commercialization. From the sample survey, majority of the household heads are male-headed households (61%) which are quite higher than that of female-headed households (40%). Categorically, 64% of the male-headed households have access to irrigation while 36% of the female headed households have access to irrigation. Gender composition of the household (male-headed) is expected to have a positive effect, while household size is difficult to predict priori on commercialization through its effects on preferences and overall labor capacity. Family size is included as productive labour and dependency ratio, to capture the impact of consumption and productivity on crop choice and market participation. For the educational attainment of the head of the household, years of schooling by level (read a letter, write a letter, literacy program, attend to school, high grade completed and training/qualification in which the head attained) were considered.

Rural Ethiopia in general Tigray in particular is characterized by the practice of mixed farming except for certain areas known for their nomadic pastoralist life style. This is also the case in the context Kilte-Awlaelo woreda of Tigray. Oxen ownership is expected to contribute positively to diversity among cash crops through ensuring draught power for plowing and as a source of cash when it is needed. The effect of income that is exogenous to crop choice, such as remittances, gifts, aid, and pensions, is ambiguous. As table 5.1 demonstrates, household heads have income, on average, 1211 birr with minimum 0 birr and maximum 6000 birr. Credit take is also included to capture the impact of risk aversion on crop choice and market participation. Generally 65.35% (66) of the sample households heads in the survey have taken out loan in the production year, with a mean 1414 birr. Extension service is also included to capture its impact on getting integrated provision of market information.

In rural Africa many household obtain half or more of their income from non-farm sources (Reardon, 1997). Nonfarm activities refers both to self employment in nonfarm sectors and/or off farm employment. Participation in nonfarm activities is expected to have negative relationship with agricultural commercialization. Nonfarm income of the household are included to capture the impact of wealth on crop choice and market participation. Per capita land and expenditure on farm input are included, which are critical factors of production, to capture their impact on household's decision to produce surplus for market.

Finally access to radio is included to capture the impact of information asymmetry on crop choice and market participation. Access to radio has importance in accessing market information and in facilitating market transactions. It helps to transform from subsistence oriented farming into market oriented farming system. However, from the survey most of the household heads don't have radio, that is, 82 (81.19%), the remaining 19 (18.81) have radio. Means of transport and walking distance to market were also included to capture the impact of distance on market participation.

Variable	Description of the variables	Obs	Mean
Percapitaland	total cultivable land/family size	101	1.159 (0.82)
Plottype	1= irrigated, 0=otherwise	101	0.772 (0.421)
hhage	age of the head	101	41.67 (16.60)
hheadsex	1=male, 0=female	101	60.40 (0.491)
Education of the household			
edu1	read a letter	101	0.376 (0.486)
edu2	write a letter	101	0.306 (0.463)
edu3	litracy program	101	0.138 (0.347)
edu4	attend to school	101	0.118 (0.325)
edu5	highgrade completed	101	0.029 (0.17)
edu6	training/qualification	101	0.029 (0.17)
Family size			
depratio	members < 15 and > 64/family size	101	0.485 (0.249)
produlab	adult labor	101	2 (1.086)
income	income of the household head	101	1211.324 (965)
credittake(1=credit)	1=loan take, 0=otherwise	101	0.653 (0.478)
amountcredit	amount of credit taken	101	1414.03 (1304.056)
extenser(1=extension)	extension service	101	0.67(0.473)
expfarminput	expenditure on farm input	101	554.085 (551.949)
oxen	total number of oxen	101	0.95 (1.033)
nonfarm income	nonfarm income	101	163.811 (273.641)
Means of transport			
mode1	no transaction	101	0.079 (0.271)
mode2	on foot	101	0.841 (0.3669)
mode3	mule	101	0.019 (0.14)
mode4	donkey	101	0.009 (0.099)
mode5	by car	101	0.049 (0.218)
wdonfoot	walking distance on foot	101	1.316 (0.615)

Results from the descriptive and statistical analysis

In this section, the results of the impact of irrigation on market participation have been done on descriptive statistics. Apparently, the econometrics analysis conducted also reinforces the descriptive results.

Impact of irrigation on market participation

Irrigation is a rare phenomenon of agricultural production in most parts of Africa (World Bank, 2007). What is now covered by irrigation is but a very small portion of what is potentially irrigable area in most countries (World Bank, 2007). However, use of irrigation is one of important way to enhance agricultural production, switches farm use away from staples to higher-value, market-oriented products and increase market participation. In this sub-section I present descriptive results concerning the impact of irrigation on market participation decision by smallholder farmers in Eastern Tigray on market participation decision by plot type.

The statistical summary in table 5.2 depicts that a typical household head that uses irrigation in the study area marketed agricultural production that are staple crops include a significant proportion of the foodstuffs produced on small-scale subsistence farms. Such farms frequently sell much of their output to meet urgent cash needs and then seek to buy staple foodstuffs later in the crop year. Overall market participation of farm household under the survey is 29%. Categorically, to see the impact of irrigation on household's commercialization I use two sample t-test. From the two sample t-test result revealed that farmers who have irrigation scheme have higher market participation than rainfed users by 11.8% which is statistically significant at 5% level.

Table 5.3 Two-sample t test with equal variances

Variable	Mean (Std. Err.)
Rainfed	**0.20 (0.05)**
Irrigated	**0.32 (0.03)**
Combined	**0.29 (0.03)**
Difference	**-0.118 (0.06)**
t = -1.8737 **	**Obs = 101**
degrees of freedom = 99	

Finally, from the two-sample t test evidence we can suggest that; even though access to irrigation have positive impacts on farm households market participation, we might guess that this due to the fact that "distress sales", that is, agricultural sales by poor households straight after harvest because they are desperate for cash. Where it is food that is being sold, the household may then be forced to buy back the same (or indeed a greater) quantity of food later in the year when the price is much higher. In this case, the crop sale raises the HCI, but is in no way indicative of increasing household welfare. i.e., the rise in the HCI is not driven by a profit motive, but rather a short term survival need. Since, risk minimization rather than profit maximization is an important driver of subsistence production.

In summary, the descriptive statistics indicate that irrigators are better off in terms of market participation indicators. But this does not imply that the difference is solely due to access to irrigation. Other factors (both observable and unobservable) might have contributed to market participation difference between irrigators and non-irrigators.

Results for market participation model

At the household level, the proportion of household's market participation is explained positively by production value, amount of credit taken and means of transport, that is using mode of transport mule and car as reference to human power have positive values. The decision is explained negatively by non farm income and means of transport by donkey. All significant variables in the 2SLS model have the expected signs.

Economic evidence suggests that production value had positive and significant impact on market participation decision of farm households, confronting to my expectation. This might be due to the fact that as households produce more, they are likely to participate in output markets as seller.

Amount of credit taken increases the probability of Household's market participation. This might be due to higher amount of credit eases liquidity constraints of households that contributes to market orientation. In addition, it means higher capital to invest in livestock, in higher yielding crops, in seasonal inputs that boost yields, in purchase of fertilizer and improved seeds and invest in improved technologies.

The non farm income of the households surveyed has a negative and significant impact on market participation decision of farm household. This could explain getting more non farm income represents additional wealth which constrain farm household to transact due to cash desperate and might enable them to consume whatever they produce by supplying the cash required for other purposes.

Participation also increases with the use of mule and by car as a means of transport in reference to use of human power, which appears to be important and positive for sale value or market-oriented production because of its impact on marketing costs. The negative association of using donkey compared to human power with the sales value was not expected, especially since using donkey as a means of transport is associated with higher level of sale value. A closer investigation of the donkey as a transport is required to explain this unexpected result.

Finally, after estimating our results, we need to do model adequacy checks. Otherwise, the results may be misleading. Therefore, VIF (Multicollinearity), imtest (Hetroscdasticity), linktest (Model specification), ovtest (over identification test) and hausman test (endogeneity) are performed to see if the model suffers from such problems. These test show that the model is free from such problems.

2SLS Estimation of market participation decisions

Dependent variable: sales value	
Variables	Coefficients (SE)
Production value	0.461(0.062) ***
Dependency ratio	-178.95(144.5)
Income	0.028(0.093)
Credit take (1= yes, 0=no)	187.8(146.57)
Amount of credit	0.135(0.063) **
Nonfarm income	-0.628(0.259) **
Access to radio	102.4(239.9)
Means of transport	
No mode (reference=on foot)	-251.04(173.95)
Mule (reference=on foot)	528.6(273.25) *
Donkey (reference=on foot)	-468.4(207.58) **
By car (reference=on foot)	364.06(113.3) ***
Walking distance (on foot)	-120.8(92.9)
Intercept	158.4(162.9)
Instrumental variables (2SLS) regression	**Number of obs = 101** **F (11, 88) = .** **Prob > F = 0.0000** **R-squared = 0.8129** **Root MSE = 483.77**

*. ** and *** represent significance at 10%, 5% and 1% respectively.

Conclusions and Recommendations

Conclusions

With the aim of pin pointing attributes of the study area, such as impacts of having access to irrigation on household's market participation status, factors determining household's decision to market participation decision under irrigated systems in contrast to rainfed systems in Kilte-Awlaelo woreda and results achieved.

Irrigation development contributes to agriculture production and productivity improvement. This increase in agricultural production is due to agricultural expansion and intensification. Moreover availability of food is improved by product diversification. Irrigation development enables to bring uncultivated land under cultivation and enable multiple cropping within a year time (agricultural intensification).

Besides, irrigation made possible to diversify agricultural production by creating favourable condition to cash crop production. By irrigation, irrigators could produce more cash crops than non-irrigators.

In this paper, I investigate the interaction between access to irrigation and agricultural commercialization in Eastern Tigray. The findings from this study show that the majority of the households covered in the study are mainly dependent on agriculture for their livelihood. Most of them produce food crops for own consumption. The statistical findings showed that households having access to irrigation have positive impact on household's market participation decision than rainfed users which is more optimism and hope to generate benefits for poor rural communities.

Estimation results from the 2SLS analysis of the market participation function of rural households show that production value, amount of credit, non farm income and means of transport were the determinant factors to households to participate in markets.

In this work, therefore, the objective of investigating the role of irrigation in household decision to participate in markets are dealt, and were found that irrigation development can have positive cause and effect relationship with household market participation in the region. Factors those may retard the effectiveness and sustainability of such projects were also identified.

Recommendations

In order to bring a beneficial impact on rural living condition, policies ought to target at facilitating the increase in agricultural production and productivity; and ensuring their sustainable usage and performance status. With this recognition, a possible approach that could be recommended is to:

The study shows the impact of irrigation on agricultural commercialization is direct and immediate, therefore, given commercialization is positively associated with income and credit, policies targeting these variables might have a positive impact on smallholder's market participation decision. Combined with finding that higher non-farm incomes are associated with lower agricultural commercialization, this underlies the importance of developing sources on non-farm employment alongside intensification of agriculture, in order to provide favorable conditions of exit from farming for some less productive farmers and landless youth. The suggested direction of change is towards more diversified rural economy, aiming for higher returns from agriculture alongside a wider range of local income and livelihood options.

The study also found that having many oxen has positive impact on market participation, therefore, policies that encourage asset accumulation processes through promoting investments in animal traction will create virtuous circle between cash cropping and assets. In addition, the study founds means of transport by car and mule has market promoting effect in terms of increasing the probability of participation. Hence, there is a need to link irrigation development with road infrastructure development and improvements in other marketing services, thus, can help in the long-term transform traditional subsistence agriculture into more market oriented and modern agriculture.

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