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   HYPOTHESES

   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

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CONTRIBUTION OF IMPROVED AGRICULTURAL INPUTS USE ON VEGETABLE PRODUCTION: IMPACT ANALYSIS ON VEGETABLE PRODUCERS IN ALMATA, TIGRAY, ETHIOPIA

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ABSTRACT

To examine the impact of the project intervention in the study Wereda[1] and the trend of vegetable production starting 2005 to 2010 in the study area, randomly selected respondents interviewed to gather the data. Heckman treatment effect model and descriptive statistics were estimated (used) respectively. The result of Heckman treatment effect model estimation indicated that the dummy variable known as improved agricultural inputs use, cooperative membership, market information to the vegetable producers, market price expectation, marital status and household head gender were found significant variables for the profitability of smallholder farmers in the study area. The principal hypothesis that was designed as using an improved agricultural inputs have positive effect on the profitability of the input users and in return this profitability can affect the utility of the smallholder positively was confirmed by the Heckman treatment effect estimation.

KEYWORDS

improved agricultural inputs use, Heckman, profit, smallholder, vegetable

1. INTRODUCTION AND JUSTIFICATION

Ethiopia is a country with favourable climatic condition for growing different cereals and vegetables. But irrespective of these comfortable conditions, the country suffers through different challenges typically famine as a result of recurrent drought and food insecurity due to lack of enough domestic food consumption supply (Akalu, 2007). Vegetable production can be seen as one best solution to provide food supply to the growing food, especially vegetable consumption, demand in the country (Akalu, 2007). Because the country has promising resources like land with its comfortable climatic condition, to some extent, fertile soil contents and huge unskilled but able and till trying to produce vegetable output with backward hand tool, the country can have these comparative advantages when compared to neighbouring and the rest of the world especially the middle east and Europe through producing that item at enough amount of domestic supply and of course with the orientation of export when there exist excess product than the domestic demand (Akalu, 2007)

Vegetable is a plant or part of a plant that is eaten as food; potatoes, and onions are among others. Vegetables can broadly be categorized as *Root vegetables* for example carrots, *Green vegetables* like cabbage, and *vegetables oils*. Alternatively, vegetables can also grouped as leaf, root, tuber, bulb and fruit vegetables (Fekadu, Dandena, 2006).

Vegetable crops make significant contributions to the Ethiopian households and national economy. Potato and Sweet Potato are valuable food security crops for densely populated highland regions and drought prone areas respectively. Vegetable like hot pepper and onion are also used for flavouring local dishes and as well important as sources of vitamins and minerals which indicates that a considerable proportion of Ethiopians could derive their livelihood from growing vegetable (Fekadu and Dandena, 2006)

It is evident that these type of production needs large scale capital and expertise mobilization which is of course the major bottleneck for developing countries like Ethiopia. Although Vegetable production is practiced both in commercial enterprises and smallholder farmers, the later is taking the lion's share on production and its supply to the local consumers and traders.

Smallholder vegetable producers in the study area are farmers who produce and supply their vegetable produce with the traditional farming technology and traditional marketing system with incomplete market (market price) information and low price bargaining power. As a result, contrary to the expected benefits from vegetable output, smallholders are less beneficiaries of this type of production due to lack of modern farming technologies like adopting new farming system, productive organic and chemical fertilizers, extension consulting agents, knowledge of land use management, providing market information, providing transport facilities, store, infrastructure especially road. To this regard, government intervention aiming at solving such bottlenecks of Ethiopian smallholder vegetable producers is mandatory. The public intervention aiming at contributing in poverty reduction of the rural poor through market oriented agricultural development (IPMS Team, 2004).

As explained above, vegetable production plays the major role in food security of rural Ethiopian peasants and indeed supporting to the foreign currency earnings. As faced by capital and technology constraints and of course market access which can affect the smallholders' current and future outputs, smallholder vegetable producers farm output is insignificant compared to other producers in the nation which is contrary to the prevailing domestic as well as export demand and the need of food security.

To make smallholder vegetable producers self sufficient and beneficiaries from this area, it is commonly agreed that huge amount of capital with enough technical expertise regarding to market access like market prices information and adopting new technologies are the crucial intervention areas. But it is not surprising to raise some questions about the feasibility and impacts of these types of interventions because projects are accompanied with different problems such as challenges by farmers to adopt a new agricultural technology quickly. The final goal of the interventions is scale up farmers' productivity and output so that maximize farmers profitability from producing vegetables and other agricultural produces. Hence, making interventions in a particular economic area can result either positive or negative effect to the intended beneficiaries that really needs impact assessment while, as to the knowledge of the researcher, there is no such particular an assessment. As a result, this study intends to assess the impact of improved agricultural input use introduced by the government and other local cooperatives and unions on the farmers' production.

2. OBJECTIVE OF THE STUDY

The main objective of this study is to analyze the overall effects of the government and non government stakeholders' interventions on smallholder vegetable producers in Alamata Wereda.

Specifically, the study aimed to examine whether the improved agricultural input use have socio-economic impact on smallholder vegetable producers in that particular study area.

3. REVIEW OF LITERATURE

Public support for technology adoption in the rural sector is usually defined as an agricultural extension service. For this study extension services is define as a system and a set of functions that may induce voluntary change in the rural sector. The system includes private, public and semi-public agents and the functions

[1] Wereda is a local name given to an administration unit known as district

could be transfer of knowledge, information, technologies or managerial capacity. Overall, the aim of these types of services is to provide technical education to farmers or foster the flow of information between farmers and technology providers.

The evaluation of the impact of this type of services in the last years can be divided in four groups (Gonzalez et al, 2009).

The first includes studies that analyze the effect of extension services by estimating production functions which include extension as an input. This approach, however, assumes that farms operate at an inefficient level– which is likely due to the market inefficiencies that justify public intervention – and that there is a random assignment between controls and treated groups. The latter is rarely the case given that treated producers have, on average, different characteristics from controls. Thus, the results of this type of estimations could be biased by the observable and unobservable characteristics that might affect participation and the relevant outcome variable.

The second approach tries to overcome the problems of the production function technique by controlling for the observable variables available in the data. As Heckman (1979) explains, this correction reduces the estimation bias. One alternative would be regressing the outcome variable in an improved agricultural inputs use dummy and control for the observables (assuming they are the only ones that may affect the outcome). Other alternatives include the construction of a counterfactual of the experiment by surveying non-participant farmers and compare them with the treated through matching techniques.

For example, Gebregziabher, G. (2008) evaluated the impact of access to irrigation on household income. Gebregziabher, G. (2008) presents the non-parametric matching estimates of the average treatment effect of access to irrigation on the treated (ATT) and found a significant estimation result, that is, access to irrigation have a positive effect on the overall average household income generated.

The third body of literature utilizes a panel data approach to remove time invariant unobservable (e.g., farmers' skills or efficiency). A complete impact evaluation is offered by Gautam (2000) (as cited by Gonzalez et al, 2009) for the National Expansion Project I and II programs that were funded by the World Bank in the agricultural sector of Kenya. The extension services offered included trainings for farmers and visits. This complete impact evaluation develops a fixed effects estimation finding no evidence of a significant impact of the current extension system on farmer efficiency or crop productivity. One of the most interesting conclusions according to Gonzalez et al, (2009) is that there was a need for more efficient targeting given that many treated farmers did not need the technologies or could have implemented them without funding.

Specifically, the authors utilize a fixed effects panel model and a stochastic production frontier approach. Results from both models show that having contact with the advisory services through either a visit or a training course is significant in explaining the efficiency levels of farms.

Finally, the fourth group of studies deals with the time-variant unobservable using instrumental variables. For instance, Akobundu et al. (2004) utilize measures of access to extension services as instrument for program participation given that it is not related with the income of farmers (i.e., outcome variable). They found that the program had a positive impact on farmers' income only for the case of multiple visits from technical advisors.

Overall, two conclusions can be obtained from the revision of the literature. On the one hand, the choice for the adequate estimation technique that should be used in each case depends on the available data. Absent a well-thought experimental design, the ideal scenario would imply using panel data or a good instrument to control for biases generated by observable and unobservable. Yet, this type of data is rarely available for the agricultural sector. For cross sectional data the most recommended methodology is propensity score matching, however, this technique does not control for biases generated on the unobservable. On the other hand, results of the different evaluations suggest that the direction and magnitude of the impact of extension services depends on the type of intervention, on the characteristics of the market and on the producers.

4. METHODOLOGY

4.1. DATA SOURCE AND METHODS OF DATA COLLECTION

The data which was tested against the basic hypothesis was collected mainly through questionnaire in three Tabias in the Wereda both from the improved agricultural input users and one users by employing some interviewers. Besides, important information was gathered from MoARD's extension agents and some prior documents or collected data from the same office. The questionnaire was designed to be more closed type questions so that it enables to have specific answers to the specific research objective.

The sampling procedure is principally made based on the researcher's disposal on time and financial budget. The Wereda has fifteen Tabias. Of these, five Tabias are located in the highlands of the surroundings known as 'Dega' climate setup where the experience of vegetable production is uncommon. Ten Tabias are the low land 'Kola' climate environment part of the Wereda where vegetable production is commonly practiced.

As a result, of these ten Tabias, where this type of production is adapted by farmers in that Wereda, three Tabias namely, 'Gerjele', 'Tumuga', and 'Kulu Geze Lemlem' were selected using probability sampling technique. From 80796 or (17,564 household) (WBOA, 2009) total population of the rural inhabitants, 5800 households were using the improved agricultural inputs in their vegetable production and the remaining households of these rural Tabias were not using such inputs. Here, 150 population size was equally divided to the participant and non participant. (See Table 1)

As shown in Table 1, 25 sample respondents from both improved input users and non users were taken which was done using random sampling. Weights for both input users and non users were calculated as shown in the last row in the table 1 so that STATA can correct the proportion of the sample population which can make the sample a representative one.

4.2. METHOD OF DATA ANALYSIS

In many of the less developed agrarian economies the agricultural productivity is extremely low. Clearly, increasing agricultural productivity is critical to economic growth and development.

One important way to increase agricultural productivity is through the introduction of improved agricultural technologies and management systems. National research programs are activating in most countries, in Ethiopia named as Ethiopian institute of agricultural research, working with a network of international centers operating under the auspices of different international and local research institutions. These research institutions have worked to develop new agricultural technologies and management practices. A challenge for agricultural researchers, however, is to understand how and when new technologies are used by farmers in developing countries.

Over the years, researchers have worked to answer challenging questions about agricultural technology adoption. Initially, policy makers and researchers sought simple descriptive statistics about the use and diffusion of new seed varieties and associated technologies such as fertilizer and irrigation (Yohannes 1993, Doss, 2003). Concerns arose later about the impact of technology adoption mainly focusing on commodity production, on poverty and malnutrition, on farm size and input use in agriculture, on genetic diversity, and on a variety of social issues.

For further decision whether to introduce and diffuse new technology or not, impact assessment is important/mandatory then. Transforming the production culture in the study area is to mean increasing smallholders' income from their produce. The smallholder maximizes utility given the income at which income is the profit of the smallholder's production activities (own production) and off-farm employment (Ravalion, 2001)

Here, the study adopt smallholder profit maximization with the assumption that utility is an increasing function of profit with fixed capital and labour resources. For this concept, the researcher express the following functional relationships between utility and profit as below:

$$\pi_i(P_j, V_j, C_{iy,} C_{jx}, C_{it}) = \underset{xi \quad yi}{Max}\left(P_i V_i - W_i X_i - C_{iy} Y_i - C_{ix} X_i - C_{it} : T_j(X_i, Y_i, Z_i), P_j > 0, V_j > 0\right)$$

.... (1)

Where P_i vector of output prices of smallholder i, V_i vector of variable input prices of smallholder, and C_{iy}, C_{ix}, C_{it} are vectors of transaction costs for output, variable inputs and fixed transaction costs respectively.

Again, Y_i, X_i and Z_i are vectors of output, variable inputs, labour and capital for smallholder j. T(.) is the state of technology smallholder j.

From equation (1) the study can show the following terms as:-

$$P_i = P_i(K,H,L).......................(2)$$

$$V_j = V_i(K,H,L).......................(3)$$

$$C_{jy} = C_{iy}(K,H,L)....................(4)$$

$$C_{jx} = C_{jx}(K,H,L)....................(5)$$

$$C_{jt} = C_{jx}(K.H,L)....................(6)$$

Where K_j, H_j, L_j Represents vectors of smallholder characteristics, vectors of project intervention and aggregate benefit accrued to smallholder j due to access to markets, credit, and transport services respectively. From those identifications, equation (1) can be written as:

$\pi_i(K,H,L)..........................(7)$, which represents the reduced form of the profit equation. For the sake of capturing the impacts on smallholder profit through increasing income as a result of the intervention in the Wereda, the study has used Heckman treatment effect estimation method.

The main justification to apply the treatment effect model which is similar to Heckman two step model, as Heckman two step model overcomes the problems of linear regression (OLS) model of self selection bias, was to avoid the input use decision bias that could be affected through self selection bias where the estimation of linear regression model cannot correct this self selection bias and there by the estimated parameters become inconsistent and wrongly interpreted.

Further, the study chooses this model than the propensity score matching where again the sample size matters. Propensity score matching have the ability to correct the self selection bias by searching and matching the best matches of the respondents with having common support observable characteristics which may need, if not lucky enough, large amount of sample size.

The Heckman treatment effect model is applied by using two groups as smallholders using inputs(treatment) and smallholders not using improved inputs while both sharing similar observable characteristics. The mean effect (profit) of treatment is calculated (Ravalion, 2001) as the average difference in profitability between the treated and control group.

Let $D_j \in (0,1)$ indicates whether the smallholder j was using improved input from the intervention or not; that is, 1 if participating, 0 otherwise.

The profit can also be defined as $\pi_{(D_j)}$ for smallholder at which j=1, 2….N where N is indicating the total population (Sample size), in this case, 150 number of respondents

The effect (profit) of smallholder j participation then is going to be calculated as:

$$E_{i} = \pi_{i(1)} - \pi_{i(0)}................................(8)$$

However equation (8) cannot observe the smallholder's j profitability had she/he not using the improved input (Ravallion, 2001) and selection bias can result inconsistent parameter coefficient estimation.

Selection problems are pervasive in applied micro econometric research. For instance, a profit of improved input use, in this case, is observed only for those individuals who use the input while the profit of the non-users is not. Here the selection problem can be viewed as a problem of missing observations. Using Heckman treatment effect model can minimize such incidences because Heckman's approach to the selection problem is closely linked to economic theory. His key insight is that observations are often missing because of conscious (self-selection) choices made by economic agents (the decision to use improved agricultural inputs in this case).

In the regression context, self-selection bias occurs when one or more explanatory variables are correlated with the residual term of outcome equation or selection bias arises because the "treatment" was correlated with the error term in the outcome equation because the residual captures the effects of all omitted and imperfectly measured variables. Thus any explanatory variables that are correlated with the unmeasured or incorrectly measured factors will end up proxying for them where if any explanatory variable ends up proxying for those factors, its estimated coefficient cannot be directly interpreted as the effect of that explanatory variable for each, since it also captures part of the effect of the omitted or incorrectly measured variables.

The well-known Heckman correction (also called the two-stage method) has become part of the standard toolbox in applied micro-econometric work. The method may be described by means of the following two equations.

Profit equation:

$$\pi_{1i} = X_{1i}\beta_1 + \varepsilon_{1i} \text{ --- } (9)$$

Improved agricultural input use equation:

$$e^* = X_{2i}\beta_2 + \varepsilon_{2i} \text{ --- } (10)$$

Where Equation (9) determines the individual $i's$ profit (output equation), whereas (10) is a "participation selection equation" describing the individual's propensity to improved input use. Hence, π_i is the observed profit for improved agricultural input user individual i if she/he used inputs and e^* is a latent variable that captures the propensity to input use, X_{1i} and X_{2i} are vectors of observed explanatory variables, such as age and education, household size, distance from the market, etc; ε_{1i} and ε_{2i}, are mean-zero stochastic errors representing the influence of unobserved variables affecting π_i and e^*_i. The parameter (vectors) of interest are β_1 and β_2. Although the latent variable e^*_i is unobserved, it can be defined as dummy variable $e_i = 1$ if $e_i^* > 0$ and $e_i = 0$ otherwise; it thus can be observed the positive net profit only if $e_i = 1$, that is, if the individual used improved agricultural inputs. Here it is likely that the unobserved terms ε_{1i} and ε_{2i} are negatively correlated; that is, individuals with higher propensity to input use, given the characteristics X_{1i}

and X_{2i}, are presumably also more likely not to input. If this is true, the sample of individuals observed as participants will not accurately represent the underlying population, even in a large sample. Failure to correct or recognize this selectivity problem generally produces inconsistent estimates of the parameters in the net profit equation.

Here assuming the basic assumptions, specifically saying that, $\varepsilon_{1i} \sim N(0,1)$ and $\varepsilon_{2i} \sim N(0, \delta^2)$, that is, the error terms, ε_{1i} and ε_{2i}, are assumed to be bivariate, normally distributed with correlation coefficient (ρ), the conditional mean of ε_{1i} can be written as:

$$E(\varepsilon_{1i} / e_1^* > 0) = E(\varepsilon_{1i} / \varepsilon_{2i} > -X_{2i}\beta_2) \ldots\ldots\ldots(11)$$

Where equation (11) is indicating the mean error term given the farmer is using the improved agricultural inputs. And hence it can be put as:

$$E(\pi_i \mid X_{1i}; e_i = 1) = X_{1i}\beta_1 + E(\varepsilon_{1i} \mid \varepsilon_{2i} > -X_{2i}\beta_2) \ldots\ldots\ldots(12)$$

Where Equation 12 shows the average treatment effect (average profit of using improved agricultural inputs) which is the result of the differences in profits when the farmer is using the input and when she/he is not. Thus, the regression equation on the selected sample depends on both X_{1i} and X_{2i}. Omitting the conditional mean of ε_{1i} biases the estimates of β_1 (unless ε_{1i} and ε_{2i} are uncorrelated, in which case the conditional mean of ε_{1i} is zero). Selection bias can thus be regarded as a standard problem of omitted-variable bias. The problem is to find an empirical representation of the conditional mean of ε_{1i} and include this variable in the profit equation.

Assuming that ε_{1i} and ε_{2i} are drawn from a bivariate normal distribution, the regression equation can be derived:

$$E(\pi_i \mid X_{1i}, e_i = 1) = X_{1i}\beta_1 + \rho\delta_1\lambda_i \ldots\ldots\ldots(13)$$

In equation (13) ρ is the correlation coefficient between ε_{1i} and ε_{2i}, δ_1 is the standard deviation of ε_{1i}, and, λ_i – the inverse of Mill's ratio(hazard lambda), sometimes called a "control function" or estimated expected error - literally a function that controls for selection bias , can be also given as by

$$\lambda_i = \frac{\phi(X_{2i}\beta_2 \mid \delta_2)}{\Phi(X_{2i}\beta_2 \mid \delta_2)} \ldots\ldots\ldots(14)$$

Where λ_i is derived from the partial derivation of the inverse mills ratio with respect to, δ_2, the standard deviation of ε_{2i}, where ϕ and Φ are the density and distribution functions of the standard normal distribution respectively.

As shown in the Scientific Contributions of James Heckman and Daniel McFadden (Bank of Sweden, 2000), Heckman treatment effect procedure is conceptually as follows:

The first step involves estimating the parameters in equation (10) or the input use equation by the probit method, using the entire sample. These estimates can then be used to compute λ_i, for each individual farmer in the sample. Once λ_i is computed, the study can estimate equation(13) over the sample of input users by ordinary least squares (OLS) regression, treating $\rho\delta_1$ as the regression coefficient for λ_i. Here STATA provide the potion that calculates the treatment effect procedure at a time using the 'two-step treat' syntax. The sign of the selection bias depends on the correlation between the errors in the profit (outcome equation) and input use equations 'ρ' and the correlation between λ_i and the variables in the profit equation X_{1i}. Since λ_i is a decreasing function of the probability of sample selection, it follows that the β-coefficient on variables in X_{1i} that are likely to raise both profits and input use, such as education, will be biased downwards if the Heckman selection correction technique is not applied(provided $\rho > 0$).

5. RESULTS AND DISCUSSION

5.1 VEGETABLE PRODUCTION TREND IN THE WEREDA

Many types of vegetables could easily be grown in the study area because there is conducive climate and easy access to water. Among these vegetable the culture of growing pepper has a longer history in the area. As a result, farmers have developed own systems (IPMS, 2005)

Table 2 is the data from the documentations from the Wereda Bureau of agriculture and rural Development.

The limited expansion of vegetables in the pilot learning Wereda, according to the IPMS diagnosis 2005, has a lot to do with problems related to the development of water harvesting technologies (ponds and wells) and small scale irrigation schemes (river diversion, streams from the swampy area).

Currently the marketing of vegetables is done on individual basis. Since farmers harvest vegetables at about the same time, prices fall significantly at harvest (IPMS, 2005).

Table indicated that starting from the 2005, total production decrease continuously this might be due to the perishable nature of the product and the discouraging price at the harvest season. Cash liquidity problems, including repaying their loan they have taken from different source of loan, forced farmers to sale their output at the same time.

Pepper product indicated some fluctuations in output. It declines at the beginning and continues declining till to the production period of 2007, then rise up to some extent in the year 2008, and finally the last survey in the 2010 indicated a decline in the output.

Unlike the two vegetable outputs, onion indicated encouraging output. Though there was some output decline in the years 2006 to 2007, starting from the harvest season of 2007 registered a promising result. There is rapid output growth in the years between 2007 and 2008. When we see the production of 2008 to 2009, there was also output decline may be due to the then unbalance rainfall in the area. In the 2009/10 harvest season, the line-chart shows again a rapid output rise may be due to the product price rise and to some extent a balanced rain fall in the area.

Finally, number of producers using the improved agricultural input increases from 2005 to 2007; but, we see that the improved agricultural inputs use trend declined in the years 2008 and 2009 production seasons where the trend increased in the year 2010.

Because these vegetable products consume large amount of water where the farmers' water source for irrigation is partly the rain fall and river diversion, the balanced rain fall may be become the significant factor for the participation of farmers in this package.

5.2 IMPACT ON IMPROVED AGRICULTURAL INPUT USERS

To examine whether smallholder farmers are benefiting from using improved agricultural inputs where the improved agricultural inputs comprises of new agricultural farming technology sets, smallholder's utility maximization function is used to examine the impact of the input use. In my case, the new agricultural farming technology sets which are provide by the government intervention were use of improved seeds, farm technology like planting (spacing), supporting the vegetable (for Tomato), provision of pesticide, training on post harvest output management and provision of output market information from the project extension agents. For this study, improved agricultural input users are defined as those farmers who adopt at least one of the technology sets which are indicated above. Using these new agricultural technologies, the smallholders in the study area are expected to maximize their utility as where utility is assumed an increasing function of agricultural output profits. The agricultural output profits can be realized through producing varieties of farm outputs. To come up with the study's main concern here, sources of agricultural output profits are profits from vegetable (where vegetable in this case is Onion, Tomato, and Pepper) produce using at least one of the technology sets (improved agricultural input users profit from vegetable) and profits from vegetable produce without using improved agricultural inputs. The net profit is a continuous value which is the explaining factor to the utility of the smallholder. Heckman treatment effect is estimated to see the effect of improved agricultural input use. In the second stage of the two step treatment effect estimation, the control function, hazard lambda is included. That means the outcome equation estimation estimates the ordinary least square estimation(the second step estimation) where STATA software package results consistent and asymptotically normal estimators for the parameters in the outcome equation and consistent variance estimator or corrected standard errors automatically (Heckman 1979).

As shown in Table 3, the hazard lambda which is similar to inverse Mills ratio estimated as selection bias equation is significant at 10 percent level of significance showing the existence of selection bias. The selection equation taking the input use dummy variable estimated the probit regression for participation. Here, pre treatment variables are taken for the input use decision.

IMPROVED INPUT USE: as indicted in Table 3, smallholder farmer adopting at least one of the new agricultural technologies is better profitable than the ones who do not. The estimated coefficient of the input use dummy variable revealed that the null hypothesis which states using improved agricultural inputs does have zero effect on the profitability of a smallholder is rejected at 10 percent level of significance. Smallholder farmers taking at least one of the technology sets are able to enjoy the government and nongovernmental institutions intervention. Particularly speaking, the use of modern seeds, farm technology like planting (spacing), supporting the vegetable (for Tomato), protection from damage the vegetable using chemicals, post harvest output management, training were enabling farmers using the improved input better profitable than households who do not use these types of interventions.

Though the main interest of this study is to see the impact of those technology variables, in the treatment effect estimation, the result shows that cooperative membership is significant at 10 percent level of significance. This could probably be farmers who have the exposure to be member of any association may be familiar to the new innovations made at their surroundings. Besides, their association may help them on how to produce and sale their produce

Market information provided by the extension agents is another factor for profitability of the smallholder farmer. The result shows the alternative hypothesis is accepted at 10 percent level of significance where the estimated coefficient in Table 3 was indicating the variable for market information was positively and significantly affecting the profitability of a smallholder in the study area.

In reality, farmers expect their future earnings where these future earnings are dependent on different circumstances. Market price expectation of their output is among the various conditions that may have an influence on the farmer's productivity and thereby profitability. The finding of this study indicated that market price expectation has significant effect on net profit gain of the participants (at P-value <0.1; which indicates that the farmers who expect higher future price of their output were motivated to produce more marketable vegetable better than the ones who do not. This price expectation may help the smallholder farmers to be more productive and produce quality output in return help them to enjoy the market as well as the just price in their locality.

Current Marital status and household head gender were other factors that can affect the profitability of a smallholder vegetable producer. Here, the null hypothesis for these variables was rejected at 1percent and 5 percent level of significances respectively. The acceptance of the alternative hypothesis for the farmer being couple is more profitable than the single ones may be due to the resource sharing of the household. Husband can be devoted and exert all the time he has for caring and treating the vegetable production than the single ones because the remaining household tasks in the former case can be covered by his wife (since a woman is responsible in activating tasks at home). Male headed household is profitable than the women headed household may due to the farm distance in that study area which can require energy. Besides, male may have more exposure to market and all farm activities than women.

6. CONCLUSIONS

From the estimation to examine the impacts of using improved agricultural inputs on vegetable producers in study area, I concluded the following issues.

The Heckman treatment effect estimation result indicated that the improved agricultural inputs use dummy variable taken as dependent in the selection estimation and simultaneously as explanatory variable in the outcome equation is significant at 10% level of significance both in the selection equation and outcome equations. This result revealed that the new agricultural technology set have an impact on the profitability of the smallholder vegetable producer. Such agricultural intervention helps the smallholder's profitability. Because there is fertile land, huge underground water potential and culturally vegetable production is accustomed as the local consumption for food. Unlike these realities in the area, before the intervention, farmers producing vegetable in the study area were not as such profitable from vegetable production and thereby were not motivated to produce vegetable surplus than their direct consumption. Thanks to the intervention by stakeholders, the technical and other all rounded supports provided to the farmers brigs the farmers familiar with markets and benefits of vegetable production and of course the use of the improved agricultural inputs made the farmers more profitable than the ones who do not use.

Apart from its main interest here, the study found that, though not significant, age affects to the profitability of the smallholder negatively. For this regard, it can be concluded that younger farmers were more profitable than the older ones because besides the conservative behaviour of the older farmers, the younger ones were more active in the market interactions and farming activities than the older ones and as a result they were more profitable. Market information provided to the farmers, cooperative or any association membership, farmers' output market price expectation variables were both significant at 10 percent level of significance indicating positive effect on profitability of the smallholder vegetable produce. The dummy variable asked if the family head is coupled or not was significant at 1 percent level of significance showing that married farmers were more productive than the single ones, may be due to household resource sharing and allocation efficiency. Gender had also another contribution to profitability. Male sex variable is significant at 5 percent level of significance which can in broad be concluded as men were more energetic and productive than female. The frequency male visit to the farm and treat the vegetable may also be another factor of their profitability than women.

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TABLES

TABLE 1: THREE 'TABIAS" INPUT USERS AND NON USERS POPULATION AND SAMPLE TAKEN

Name of Tabia	Non users household size	Sample taken	users Household size	Sample taken
Gerjele	1059	25	522	**25**
KuluGeze Lemlem	562	25	277	**25**
Tumuga	1411	25	695	**25**
Sub Total	3032	75	1494	**75**
Total sample population		**150**		
Weight	Weight of input users= 1494/75			**19.92**
	Weight of non users =3032/75			**40.43**

Source: Own calculation from sample survey data (2010)

TABLE 2: ANNUAL INCOME FROM VEGETABLES PRODUCTION AND USERS TREND IN THE WEREDA

	2005	2006	2007	2008	2009	2010
Onion	17217.7	14446.98	10458	70780	65217.96	**119871**
Tomato	10856	6466.76	12070	13304	8030.5	**2504.2**
Pepper	6094	1084.32	1529.2	1073.6	2233.57	**924.2**
Users	**426**	**1205**	**4912**	**3892**	**3343**	**5800**

Source: Documentation: Alamata Wereda Bureau of Agriculture and Rural Development, 2010

TABLE 3: TREATMENT-EFFECTS MODEL -- TWO-STEP ESTIMATES

Variables	Coef.	Std. Err.
Outcome equation: Continuous dependent variable (Net profit)		
Respondent's age	-20.39113 (0.923)	211.5391
Respondent's Education level	607.6945 (0.454)	811.0818
Farming Experience of the farmer	256.6872 (0.753)	814.2511
Household Land holdings size	1800.927 (0.273)	1642.924
Market information by extension agents	5739.669 (0.091)	3399.467
Cooperative membership of farmer	7135.042 (0.082)	4096.946
Experience of employing man labour	3797.118 (0.523)	5944.355
Farmer's output market price expectation	6341.895 (0.060)	3367.31
Household Oxen ownership for farm	417.9894 (0.790)	1570.86
Current Marital status (couple=yes, single=no)	44209.61 (0.000)	9913.212
Household head gender	22563.88 (0.010)	8795.217
Improved agricultural input use	18860.16 (0.050)	9634.253
Constant	-41259.58 (0.008)	15547.9
Dummy dependent variable for Improved input use selection bias equation		
Respondent's age	0.0078915 (0.637)	0.0167159
Respondents Education level	0.0153433 (0.814)	0.0653304
Current Marital status (couple=yes, single=no)	-0.8678923 (0.208)	0.688941
Household Oxen ownership for farm	0.1133201 (0.354)	0.1223032
Comparison of technology sets	0.4076394 (0.151)	0.2838772
Equal access of the project to all farmers	0.3212764 (0.264)	0.2874741
Household Land holdings size	0.3638681 (0.000)	0.1013288
Different sources water for irrigation	1.286454 (0.000)	0.3627506
Constant term	-3.905218 (0.000)	1.089756
hazard lambda	-10276.58 (0.083)	5921.017
rho	0.55279	
sigma	18590.532	
lambda	10276.584	5921.017

Source: Own survey result (2010),

Number of obs = 150, Wald chi2(17) = 129.24,
Prob >chi2 = 0.0000, P>|z values are in brackets

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