Effect of Nonfarm Income on Household Food Security in Eastern Tigrai, Ethiopia: An Entitlement Approach

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Abstract

The study attempts to investigate the link between food security and nonfarm employment using the survey data collected from 151 randomly selected households from six villages of Woreda Gantafeshum, Eastern Tigrai, Ethiopia. Considering the objective of the study, given a household participated in nonfarm employments and its effect on food security, the Heckman selection model (two stage) is used.We examine first the household decision with respect to participation in nonfarm employment using pobit model. We found that land size, age, family size, special skill, electricity, credit, distance to the nearest market and access to irrigation are the most influencing variables in determining farmers to participate in nonfarm activities. Further we examine the effect of nonfarm employment on households' food security. Our study indicates that nonfarm employment provides additional income that enables farmers to spend more on their basic needs include: food, education, closing and health care. The result of the study implied that nonfarm employment has a role which is significant in maintaining household food security.

Key words: nonfarm employments; food security; probit model: Heckman selection model; Eastern Tigrai

1. Introduction

Ethiopia is one of the most food insecure countries in the world. Hunger and famine results of food insecurity have been always problems in the country. The country is renowned for its highly dependent on agriculture. According to the 2007 population census 83.8% of the population of the country derives its livelihood from agriculture, which is entirely dependent on rain fed. Of the 4.3 million hectares of the potential of irrigable agriculture only 5% is currently utilized (Kebede, 2003). Small peasants also dominate the sector. Smallholder farmers cultivate about 95% of the land (Adenew, 2006). Indeed agriculture is the main source of income and employment but it has been highly constrained by various constraints and thus leaves the country to remain food insecure. To address the food security problems, the government designed different interventions, among other things to improve agricultural productivity through irrigation schemes and food security packages. But in drought prone and degraded areas the government stand is non controversial as it clearly stated in its five year strategic plan (PASDEP), to promote non agricultural activities so as to sustain the rural livelihoods.

Likewise, agriculture is the main economic base of Tigrai region. About 80.5 % of the population earns their livelihood from agriculture. Despite the sector remains the main source of livelihood in the region, production is far from being adequate. The region has seven zones namely Eastern, Central, Western, Northwestern, Southern, Southeastern and Mekelle metropolitan zone. The Eastern zone is one of the zones known for its food insecurity. Agricultural production in the area is highly constrained by factors such as degraded environment, inadequate rainfall; lack of technology, capital, and credit. Besides, agricultural land in the area is characterized by fragile and fragmented smallholdings. In the area, agriculture production is viewed by many as marginalized.

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Farming, which is the main source of livelihood of the people, is largely dependent on rain fed, and the pattern of rainfall is erratic, short and one season (usually from June to September). In the absence or little rainfall farmers constantly faced with food shortages and crises. Even in a good season, the onetime harvest or produce is too little to meet the yearly household needs as a result the majority of these rural people remain food insecure.

Thus, focusing in agricultural production alone may not be enough to combat the food insecurity problem of the area and therefore engaging in non-agricultural or nonfarm activities might be of paramount importance to sustain the people's livelihoods.

The positive contribution of nonfarm activities in reducing poverty and improving household food security is a subject of discussion and has been rarely explored. The emphases of the earlier studies (cf: Reardon, 1998; Lanjouw and Lanjouw, 2001; Davis, 2003; Barrett et al 2001) have been on the role of nonfarm activities in poverty reduction, household income and wealth. Moreover, despite rural households tend to participate in such activities in order to fulfill their households need, their participation appear to be constrained by capital assets including human, social, financial, physical, and land property.

Hence, the contributions and determinants of involvement in nonfarm activities are issues that deserve investigation particularly in Easter Zone (the study area) which is viewed as the most food insecure zone comparing to the others zones of the region. In such area; merely depending on agriculture is not a panacea, therefore to reduce dependency on subsistence farming on fragile land, nonfarm employment could be an option and thus the study is aimed at investigating the potential of involvement in nonfarm activities to household food security in the woreda and its determinants.

The rest of the paper is organized as follows. In section two, we tried to present a brief review of role of nonfarm employments, reasons and determinants of involvement in nonfarm employments. Section 3 provides the theoretical framework and model specification. Section 4 presents results and discussions. Finally Section 5 ends up with conclusions and some policy implications.

2. Review of Related Literature

Over the last three decades, the non-farm economy has been gaining a wider acceptance in issues of rural development due to its positive implication in poverty reduction and food security (Reardon et al., 1998; Ellis, 1998; Lanjouw and Lanjouw, 2001; Davis, 2003). Participation in rural non-farm activities is one of the livelihood strategies among poor rural households in many developing countries (Mduma, 2005). Empirical research found that non-farm sources contribute 40-50% to average rural household income across the developing world. For example according to World Bank report (2008) non agricultural activities account for 30 percent to 50 percent of income in rural areas. In Ethiopia, according to Davis as cited in Deininger et al. (2003) some 20% of the rural incomes originate from non-farm sources. In Tigrai, in areas where study has been undertaken off-farm/nonfarm labor income accounts up to 35 percent of total farm household income (Woldehanna, 2000).

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The rural non-farm sector plays a vital role in promoting growth and welfare by slowing rural-urban migration, providing alternative employment for those left out of agriculture, and improving household security through diversification (Lanjouw and Lanjouw, 1995).

For example, in the study of Barrett et al (2001) nonfarm activity is typically positively correlated with income and wealth (in the form of land and livestock) in rural Africa, and thus appears to offer a pathway out of poverty if non-farm opportunities can be seized by the rural poor. Moreover, this key finding appears a double-edged sword. The positive wealth-nonfarm correlation may also suggest that those who begin

poor in land and capital face an uphill battle to overcome entry barriers and steep investment requirements to participation in nonfarm activities capable of lifting them from poverty (ibid).

Decisions by rural households concerning involvement in RNF activities depend on two main factors, i.e incentives offered and household capacity (Reardon et al., 1998). In poor rural areas, some households will make a positive choice to take advantage of opportunities in the rural non-farm economy, taking into consideration the wage differential between the two sectors and the riskiness of each type of employment. Rising incomes and opportunities off-farm then reduce the supply of labor on-farm. However, other households are pushed into the non-farm sector due to a lack of opportunities on-farm, for example, as a result of drought or smallness of land holdings (Davis, 2003).

One of the components of rural non-farm activities, in which the poor can participate because it does not require any complementary physical capital, is wage employment (Mduma and Wobst, 2005).

Different studies have investigated the factors that most influence rural household participation in nonfarm activities. For example in the study by Mduma and Wobst (2005) education level, availability of land, and access to economic centers and credit were the most important factors in determining the number of households that participate in a particular rural local labor market and the share of labor income in total cash income

3. Theoretical Model

The starting point of the theoretical framework of this study is the Farm Household Model (FHM). It is based on a simple non-separable household model where market is imperfect (Singh et al., 1986; Sadoulet and de Janvry, 1995).

Consider a household that drives utility from consumption of home produced goods(C), purchased goods (M), and leisure (L). Hence, the household utility function can be specified as (Sadoulet and de Janvry, 1995; Woldehanna, 2000):

$(1) \ U = U(C, M, L; Z^h)$

Note that the household utility (U) is a function of household consumption (C), (M) and leisure (L).The household is assumed to maximize utility subject to constraints imposed by 1) the production technology; 2) the total time endowment of the household; and 3) the households cash income (budget).

This model provides a theoretical framework for capturing and prediction of household's (farmer's) farm, off farm / nonfarm work participation and hours of work decisions. The intuition is that the farmer's labor supply decisions are determined by maximizing a utility function subject to technology, time and income constraints.

The production technology of the farm represents the constraint on the household's consumption possibilities. Farm output depends on the labor hours allocated to farm production, T_f, a vector of purchased input factors, X, capital employed on the farm, K, land, A, and farm specific characteristics, Z^q. The production function is assumed to be strictly concave.

The Production technology constraint can be specified as (Sadoulet and de Janvry, 1995; Woldehanna, 2000):

$(2) \quad Q = Q(T_f, X, K, A, Z^q) \geq 0$

The household allocates its total time endowment (T) among farm work (T_f), market work (T_m), nonfarm employment (T_n) and leisure (L). Hence, the time constraint is (in vector notation)**:**

$(3) \quad T = T_f + T_m + T_n + L$

Non-negativity constraints are imposed on farm work, market work, nonfarm work and leisure of household: $T_f \geq 0$, $T_m \geq 0$, $T_n \geq 0$ and $L \geq 0$.

Consumption is constrained by household income, composed of: (i) farm income (Y_f), which is a function of each household member's farm labor supply; (ii) off farm labor income, which is the sum of off-farm earnings of all household members (Y_{mi}); non farm labour income, which is the sum of non farm earnings of all household members (Y_{ni}); and (iii) other income (Y_o). The resulting budget constraint is:

(4) $C = Y_f(T_f ; Z_f) + Y_{mi}(T_m ; Z_m) + Y_n(T_n ; Z_n) + Y_o$.

The household optimization problem is to maximize $U(C, M, L; Z^h)$ subject to the time, budget, and non-negativity constraints, where Z_j are exogenous shifters of function j. The optimal solution is characterized by the Kuhn-Tucker conditions, which are the first-order conditions for maximizing the Lagrange function:

(5) $\xi = U(C, M, L; Z^h) + \delta(L_f, L_h, K, X, A, Z^q) + \lambda [Y_f (T_f; Z_f) + \sum_i Y_{mi} (T_{mi}; Z_{mi}) + \sum_i Y_{ni}(T_{ni} ; Z_{ni}) + Y_o - C] + \mu_t [T - T_f - T_m - T_n - L] + \mu_f . T_f + \mu_m . T_m + \mu_n . T_n$

Where, δ = the marginal utility of the production constraint
   μt = the shadow wage rate (value) of every job obtained in farm, off farm, and non farm
   λ = marginal utility of income (liquidity) constraint

The first order conditions for interior solutions imply:

(6) $\dfrac{\partial \xi}{\partial T_m} = -\mu t + \mu m = 0$ optimality condition for off farm labour

(7) $\dfrac{\partial \xi}{\partial T_n} = -\mu t + \mu n = 0$ optimality condition for non farm labour

(8) $\dfrac{\partial \xi}{\partial T_f} = \delta - \mu t + \mu f = 0$ optimality condition for farm labour

(9) $\dfrac{\partial \xi}{\partial L} = \dfrac{\partial U(.)}{\partial L} - \mu t + \mu l = 0$ optimality condition for liesure

   Assuming labor time is exhaustively used in the three activities.

4. Econometric model specification and data
4.1 Econometric model specification
Probit and Heckman selection model are used to empirically analyze and seek answers to the research questions. Probit model is used to determine the factors influence rural households to participate in nonfarm employments.

The probability of participation in nonfarm activities given the explanatory variables is captured by running a probit regression model. In this model, the response variable is binary, taking only two values, 1 if the household is participated in nonfarm employment, 0 if not.

The probit model is given by (Greene, 2005):

$$\text{(10)} \qquad pi* = F(Ii) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{Ii} e^{-z2/2} \, dz$$

$pi*$ Cannot be observed; it can only be observed if the farmer works nonfarm or not. Then pi = 1 if p* > 0, pi = 0 otherwise.

Considering the second objective of the study, given a household participated in nonfarm employments and its effect on food security, the Heckman selection model is used.

The Heckman selection model is specified as (Heckman, 1979):

(11a) $\qquad y_i = x'_i \beta + u_i$ $\qquad\qquad\qquad\qquad$ Outcome/regression equation

Assume that Y is observed if a second, unobserved latent variable exceeds a particular threshold

(11b) $\qquad z_i* = w'_i \alpha + e_i$

$$z_i = \begin{cases} 1 \text{ if } z_i* > 0; \\ 0 \text{ otherwise} \end{cases} \qquad\qquad \text{Selection equation}$$

Table 1 Definition and measurement of variables

Variable Specification	Measurement
Dependent variable:	
Participation in nonfarm activities	1 if the household is participated in nonfarm employment, 0 if not.
Explanatory variables:	
Age of household head	Age at time of interview in completed years
Sex of household	1 if male and 0 otherwise
Years of schooling	Years of schooling
Possession of special skill	1 for those with transferable skill, 0 otherwise
Marital status	1 if married, 0 otherwise
Household size	Number of household members
Landownership	1 if yes, 0 otherwise
Land size	Total land owned in *Tsimad*
Tenure security	1 if the household has fear of land redistribution, 0 otherwise.
Livestock holding	Number of livestock owned
Credit	1 if the household has taken credit in last year, 0 otherwise
Electricity	1 if the village has electricity, 0 otherwise
Irrigation	1 if the household has access to irrigated land, 0 otherwise
Distance to the nearest market	1 if close to the town, 0 otherwise
Distance to the main road	1 if close to the main road, 0 otherwise

4.2 Data set
Both primary and secondary data were used for the study. Primary data was gathered from 151 households via structured questionnaire. In addition to this, key informant, group discussion and informal interview were made so as grasp their perception on availability and constraints of nonfarm employments and food security status. Secondary data was collected to describe the area under study, its population size, village composition and major economic occupation of the woreda.

5. Results and Discussion

5.1 Descriptive analysis

The primary occupation of the majority of sample households is farming (see Table 2). Households whose primary occupation is crop production accounts for 7%, livestock rearing, 3% and both (crop and livestock) 77%.In general, farming constitutes the major economic occupation of the households as accounts 87 % followed by trade 9% ,2% civil servant and other 3%.

Table 2 Occupation of sample households

Primary occupation	Freq.	Percent
Crop	11	7.28
Livestock	4	2.65
Both (crop and livestock)	116	76.82
Trade	13	8.60
Civil servant	3	1.98
Other(such as daily labor)	4	2.64
Total	151	100.00

Farmers in the study area grow crops under rain fed condition. Farmers plant a mix of crops, of which the major ones are barley, wheat, *teff*, and maize. Irrigation is also practiced by some farmers in the area. Few of them earn some cash income through the sale of vegetables like cabbage, onion tomato and potato in the near market. Livestock production is also another important means of livelihood of the people. Farmers in the area are also widely undertaking non agricultural activities as agricultural income is seasonal and low.

Table 3 Descriptive Statistics of households' socioeconomic attributes

Household features	N	Mean	Minimum	Maximum	Std. Deviation
Household head sex (1= male, 0=female)	151	0.78	-	-	0.414
Household head education(years of schooling)	151	2.45	0	14	3.301
Household head age	151	44.53	25	71	11.690
Family size of the household	151	5.456	2	11	1.945

Landownership(1 = yes,0 = no)	151	0.927	0	1	0.260
Land holding size in *Tsimad*[3]	151	1.826	0	6	1.025
Oxen	151	1.278	0	3	.731
Cows	151	1.529	0	8	1.182
Total expenditure per year (birr)	151	4836.35	700	20670	3887.582

The survey result depicts that the average age of sample respondents is about 44.53 years with the minimum and maximum ages of 25 and 71 years, respectively (see Table 3). Further, the data revealed that that the majority of the respondents (78) percent are male headed households'. Of the respondents' also the average years of education is 2.45 which ranges from zero to maximum 14 years. The main activity of the majority of the household heads is farming. About 93% households in the study area have agricultural land. Though farming is the major source of livelihood, nonfarm activities are becoming additional source of income.

In the area the average land holding size is 1.826 tsimad (0.45 ha) ranges from zero (no land) to a maximum 6 tsimads. Household size ranges from minimum of two to a maximum of eleven individuals and the average household size 5.45. The household size of a family may suggest that the level of dependency in the household and or the labor force in the household. The average oxen and cows holding of the sample households are 1.28 and 1.53, respectively.

The results of the analysis showed that the annual average household expenditure (education, domestic household basic needs which include salt, sugar, soap, kerosene, edible oil, food etc, clothes and shoes and health care) totaled at 4836.358 birr per year ranges from minimum 700 to maximum 20670 birr.

Table 4 Nonfarm participation of sample households (No = 151)

Participation	Food for work	Other nonfarm (non food for work)
Yes	69.54	52.32
No	30.46	47.68
Total	100.00	100.00

Food for work (FFW) is the most common and widely observed nonfarm activity in the area (Table 4). As can be seen in the above table about 70 percent of the respondents participated in food for work activity. Food for work is more widespread than that of other nonfarm activities with numbers of household participated in food for work program being larger than those participated in other nonfarm activities both in the case of all village and individual households. Of the total 151 sampled households 79 (52.32%) households are participated in nonfarm employments (excluding food for work) while 72 (47.68%) households are not participated in nonfarm activities. Here it should be noted that the food for work activity is a government program and it is accessible to all households regardless of their endowments. Therefore, assuming food for work as nonfarm employment may not clearly show the possibility and constraints of household participation in the nonfarm activities. For this reason the study ignores the food for work activity in attempt to meet its objectives i.e. in this study the FFW is not considered and included as nonfarm activities.

Figure 1 Nonfarm employments participation by sex

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[3] 4 *Tsimads* are equivalent to one hectare
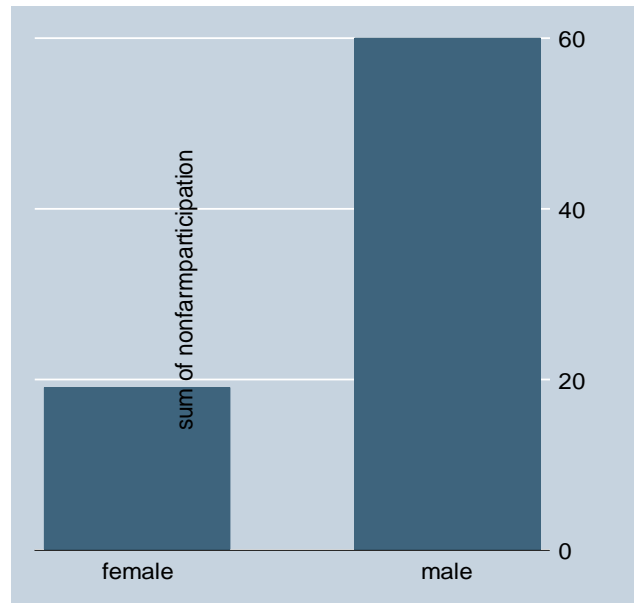
Of the nonfarm participant household heads 60 (76%) are male while from 19 (24%) are female (Figure 1). Though it seems male headed households participated more in nonfarm employments than female headed households. The Pearson chi2 (Pr = 0.494) showed that no significance difference in the level of participation in nonfarm employments between the male and female household groups.

Table 5 Ranking of reasons for participate in nonfarm employments

Reasons	Rank					
	1	**2**	**3**	**4**	**5**	**Total**
Insufficiency of income from agriculture	26(32.91%)	29	6	3	5	69(87.34)
Growing family size	3(3.79)	6	7	8	6	30(37.97)
Decline land size, soil fertility or productivity	13(16.45)	12	21	4	5	55(69.62)
Availability of credit	2(2.53)	8	7	1	2	20(25.31)
The presence of road, electricity and market in your village	6(7.59)	3	10	5	2	23(29.11)
Seasonal nature of agricultural labor	6(7.59)	11	8	9	2	38(48.11)
Shocks (rain failure, short rainy season, pests swarm, flood, etc)	11(13.92)	10	11	2	0	33(41.77)
Possession of special skill such as masonry, handcrafts, etc	3(3.79)	8	3	1	4	19(24.05)
Favorable demand for goods/services	4(5.06)	6	4	3	7	24(30.37)

Other	5(6.32)	4	3	12	6	30(37.28)

Though the economy of the household is depending on farming, substantial numbers of farmers are involved in nonfarm activities to supplement farm income. Non-farm income is the income derived from source other than farming, like petty trade, handicraft, daily labor, masonry etc. From data as shown above majority of farmers are involved in nonfarm employments because they believe that agricultural income is not sufficient enough to stand households food security. About 33 percent of the farmers participated in nonfarm employment tell that insufficiency income from agriculture is the major push factor for such involvement (see Table 5). In addition to this about 16 percent mentioned that decline land size, soil fertility or productivity is the other major reason, around 13 percent indicated shocks (rain failure, short rainy season, pests swarm, flood, etc) as the major reason. While 7 percent due to seasonal nature of agricultural labor, about 5 percent, 8 percent, and 2 percent as a result of favorable demand for goods/services, the presence of road, electricity and market in your village and availability of credit respectively. Only 3 percent involved due to possession of special skill. Our study points, among others, the three main reasons that explain the extent and involvement in nonfarm employments are insufficiency of income from agriculture, decline land size, soil fertility, productivity and shocks (rain failure, short rainy season, pests swarm, flood, etc). From this, one can observe that farmers in the area participated basically due to push factor. However, from the study it is interesting to note that farmers undertake nonfarm activities during the dry or slack season.

Table 6 Types of nonfarm activities

Nonfarm activities	Freq.	Percent
Petty trade	17	21.51
Masonry	21	26.58
Daily labor	16	20.25
Tannery	4	5.06
Craft work/Carpentry	3	3.79
Blacksmith	3	3.79
Pottery	2	2.53
Other activities(such as stone & mild selling, transportation etc)	13	16.45
Total	79	100.00

According to Table 6 above, as an alternative means of income smoothing strategy, other than food for work, more than half of the respondents are involved in nonfarm employments. More specifically, of the participant 27 % engaged in masonry, 20 % in daily labor, 22% run petty trade (like Brewery, tea and food, kiosks, Wood and charcoal, grain trading and other) and,5 %,   4%, 4% and 3% tannery, craft work/carpentry, blacksmith and pottery respectively. The remaining 16% of the farmers are engaged in other nonfarm activities to supplement their farm income.

Table 7 Nonfarm participation and food security

| Food security improved due to participation	No of households involved	Percent
Yes	64	81.01
No	15	18.98
Total	79	100.00

Respondents were asked to state whether their food security status has improved after participated in nonfarm activities and accordingly, about 81 % of the respondents perceived that their food status improved as a result of nonfarm participation while 19 % of the respondents said that their food security status has not been improved even after participation (See Table 7). Hence, it is evident that nonfarm employments improve households' food security status.

Respondents were also asked about perception of food habit change after participation in nonfarm activities. Accordingly, as shown in table below about 73 % of the respondents said that there has been an improvement in food habit. While 23% said there has been no change and about 4 % perceived as deteriorating (see Table 8).

Table 8 Perception of food habit after participation

Perception of food habit change after participation in nonfarm activities	Freq.	Percent
Improved	58	73.42
Unchanged	18	22.78
Deteriorated	3	3.79
Total	79	100.00

Figure 2 Nonfarm participation and livelihood change
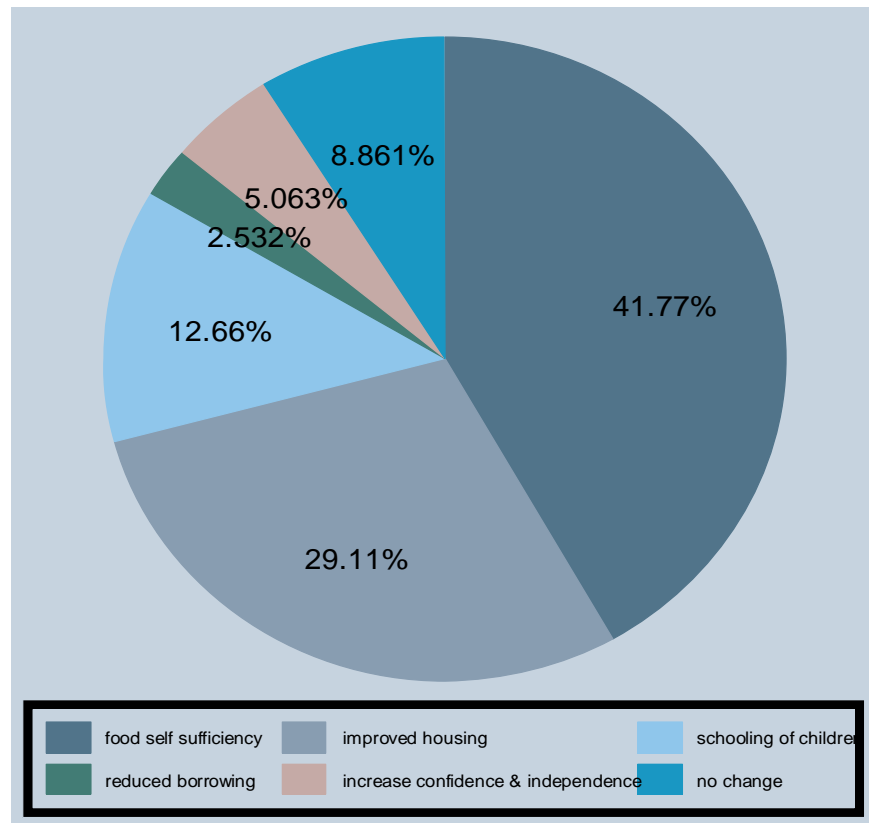
Among the respondents that are involved in the nonfarm activities it is indicated that nonfarm employment improve farmers' livelihood. Farmers participated in nonfarm employments have shown improvements in daily food self sufficiency, housing, schooling of children and other (See Figure 2). Accordingly, about 42% of the respondents mentioned that their households' daily food sufficiency improved as a result of participation in nonfarm activities. 29 % improved housing and 13%, schooling of children. About 5 % and 3% reported that involvement in nonfarm resulted in increase confidence and independence, and reduced borrowing respectively, while 9% of the participants reported no change.

An attempt has been made to see whether there is difference in total expenditures per year between the farmers participated in nonfarm employments and those that did not participate. As a result the average yearly total expenditure for households participated in nonfarm activities found to be as twice as non-participants. Households that participate in nonfarm activities are more likely to spend for education, food, closing and health care than those who do not participate at all. Statistically there is significant difference in total expenditure per year between the participants and the non participants group. A two-sample t-test confirmed that the differences at 5 % level.

Table 9 constraints to nonfarm employments

Constraints in accessing nonfarm activities	Freq.	Percent
Lack of employment opportunities	25	34.72
Lack of skill	14	19.44
Lack of nearby towns and transportation	11	15.27
Low level of demand for labor	5	6.94

Lack of credit	5	6.94
Low profitability of products	2	2.77
Other (being aged, health problems and time constraints)	10	13.88
Total	72	100.00

A frequently cited reason for the nonparticipation in nonfarm activities is absence of employment opportunities. As could be seen in Table 9 above, 35 % of the non participant mentioned that lack of employment opportunities is one and the major constraints in accessing nonfarm activities followed by, lack of skill 19 %. Lack of nearby towns and transportation 15%, low level of demand for labor 7%, lack of credit 7%, low profitability of products3% and other 14%.

5.2 Econometric results

In this section we present estimation/econometric results of nonfarm participation model and of the effect of nonfarm participation on food security. As it has been explained in the preceding section, the probability of participation in nonfarm activities given the explanatory variables is captured by running a probit regression model. Literature suggests that there are several factors which can influence farmers to participate in nonfarm activities many of these are socio-economic characteristics of the farm household. In the econometric model used, potential variables expected to influence nonfarm employment participation are included.Regression results for participation in nonfarm activities, the corresponding marginal effects and elasticities are presented in Tables 10 and 11 and 12, respectively, below.

Table 10 Probit estimates for participation in nonfarm employments

Variable	Coefficient	Standard Error	P>|z|
Age of household head	-.0344856	.6601097	0.005***
Sex of household	-.7228009	.6601097	0.274
Married	.6326218	.8105869	0.435
Divorced	-.3652991	.7491794	0.626
Years of schooling	.1486609	.0915144	0.104
Special skill	1.858289	.5360464	0.001***
Family size	.292024	.1050676	0.005**
Land ownership	1.707182	1.254839	0.174
Land size	-.4820135	.2783972	0.083*
Perception of tenure security	.3006271	.2993647	0.315
Cow	-.1179172	.1768825	0.505
Oxen	.0176708	.280086	0.950
Credit	.8328926	.3886724	0.032**
Electricity	.979403	.4948543	0.048**
Irrigation	-1.028937	.4173368	0.014**
Distance to the nearest market	.9558707	.369862	0.010***

Distance to the main road	.2990218	.4520805	0.508
Constant	-2.273986	1.60396	0.156

Notes:
* ** 1% significance level   ** 5% significance level * 10% significance level
LR chi2(17)   =   119.58
Prob > chi2   =   0.0000
Log likelihood : -44.711451
Pseudo R^2: 0.5722

As indicated in the Table 10 above, participation in nonfarm employments is influenced by variables age, family size, skill, land size, irrigation, credit, electricity, and distance to market.

All the above mentioned variables are found in line with our a priori expectorations. The variable age has significantly negative effect on participation in nonfarm employments. This may indicate that younger headed households tend to participate in such activities. Family size is found to be significant positive influence in participation in nonfarm employments. This is in line with expectations, in the sense that having more family size in a limited and marginalized land agricultural income alone could not meet food security/livelihood and hence farmers might tend to involve in activities that bring additional income. Land size is negatively and significantly influence the involvement in nonfarm employments. Possessing a special skill positively and significantly influences the nonfarm employment participation

The result of the regression shows that access to irrigation negatively influences participation in farm employments. This might be due to the fact that irrigation is labor intensive and hence farmers might not have labor time to be supplied in nonfarm activities.

Distance to the market influence positively farmers participation in nonfarm employments. This seems reasonable because the presence of opportunities for labor market in the town and being far away from the town increase the transaction costs of involving nonfarm activities.

Variables access to credit and availability of electricity are turned out to be significant and positive as far as the decision to participate in nonfarm employments is concerned. This could be due to the fact that access to credit and availability of electricity enables and promote households to engage in nonfarm self employment

Table 11 Marginal Effects for Probit Estimates of nonfarm participation[a]

Variable	Dy/dx	Standard Error	P>|z|	X
Age of household head	.1037776	.0075	0.102	44.5364
Sex of household	-.2255261	.17419	0.195	.781457
Married	.2385992	.3124	0.445	.807947

Divorced	-.136791	.29035	0.638	.119205
Years of schooling	-.0122553*	.03056	0.084	2.44371
Special skill	.5110921***	.09638	0.000	.331126
Family size	.1037776 ***	.03715	0.005	5.45695
Land ownership	.5922529 **	.28588	0.038	.927152
Land size	-.1712949*	.09899	0.084	1.82616
Perception of tenure security	.106835	.10614	0.314	.543046
Cow	-.0419047	.06287	0.505	1.5298
Oxen	.0062797	.09963	0.950	1.27815
Credit	.2759075**	.11518	0.017	.384106
Electricity	.3168532**	.14187	0.026	.370861
Irrigation	-.379891***	.14587	0.009	.298013
Distance to the nearest market	.3408428 ***	.12352	0.006	.612931
Distance to the main road	.1071878	.16197	0.508	.582781

[a] ***, **, *** represent significance at 10, 5 and 1 % levels, respectively**

Table 12 Elasticitities of nonfarm participation[a]			
Variable	**ey/ex**	**Standard Error**	**P>|z|**
Age of household head	-.7971271	.51027	0.118
Sex of household	-.2931556	.2703	0.278
Married	.2652781	.34125	0.437
Divorced	-.0226005	.04621	0.625
Years of schooling	.1885473*	.10523	0.073
Special skill	.31936 ***	.08954	0.000
Family size	.8270716***	.32162	0.010
Land ownership	.8214956	.61926	0.185
Land size	-.4568484*	.27368	0.095
Perception of tenure security	.0847304	.08501	0.319
Cows	-.0936238	.14123	0.507
Oxen	.0117223	.18616	0.950
Credit	.1660406**	.07877	0.035
Electricity	.1885154 *	.09954	0.058
Irrigation	-.1591472***	.06477	0.014
Distance to the nearest market	.2891207***	.11366	0.011
Distance to the main road	.0904447	.13575	0.505

[a] *, **, *** represent significance at 10, 5 and 1 % levels, respectively

In terms of marginal effects, the regression results showed that the probability of non-farm employment participation positively increases with family size and is significant at 1 percent. As shown in table 11 the marginal effect of a unit change in family size, computed at mean of household size, enhances the probability of nonfarm participation by 0.103. This implies that the probability of nonfarm participation increases by 10.3 percent for one person increase in family size. This might suggest that households with more family size (perhaps greater availability of labor for farming) may have the labor power to participate in the nonfarm activities as agricultural income or activity is seasonal and not sufficient to meet their needs. This is from the fact that higher family size in a limited land (0.4ha) leads to greater surplus of the labor resource and, hence farmers try to seek additional income from non agricultural activities.

Age plays an important role as a determinant of nonfarm employment participation. The result indicates that, age of the heads of the household negatively influences the possibility of involvement in nonfarm employment and is significant at 10 percent. This could be due to various reasons; firstly, majority of the nonfarm works in the area are casual works and demand hard labor and hence it is obvious to observe that

younger households to participate more. Secondly, probably due to the increasing scarcity of farmland particularly to younger (landless) household and hence, they tend to seek other employment alternatives than farming.

Ownership of land is not significant in household decision making with regard to involvement in nonfarm employment but land size is found to be a strong influencing factor. Farm households with small plot sizes are more likely to participate in nonfarm employment than others.The marginal effect of a unit change in land size, computed at sample mean of holding size, on the probability of nonfarm participation is -0.171.This means that the probability of nonfarm employment participation decreases by about 17 percent for a one *Tsimad* decrease in land size (see Table 11.) This is plausible explanation. Because of the small size of farm land that farmers own, and decline in land productivity (92 percent own less quality land), majority of the households do not produce enough yields for the year to meet food security on this limited land. And thus, in order to supplement the household income, farmers are forced to engage themselves in other activities apart from farming.

A special skill positively and significantly influences the nonfarm employment participation, i.e. it increases the probability of involvement in nonfarm activities and suggests that skilled households are likely to engage themselves in more paying self-employment activities. More specifically possessing skills such as masonry, handcrafts and merchants increase the probability of involvement in nonfarm activities to the villages that are close the nearby towns while skills such as tannery, pot making, and goldsmith are associated to the villages that are far from towns.

Results of the regression model tell that distance to the nearest market has become one of the strong and major determinants of involvement in nonfarm employments. The significance and positive coefficient of the distance to the nearest market variable confirm that the concentration of the majority of the nonfarm activities to the town. The probability of nonfarm participation increases with proximity to towns. Put differently, households residing in the nearby the town are more likely to participate in nonfarm employments. This is due the fact that the opportunities for labor market and less commuting cost.

Access to a formal credit market is found to be one of the strong and major determinants of participation in nonfarm activities. Households with access to formal credit are more likely to participate in nonfarm activities than those without access. Access to the credit market gives opportunities to farm households to get the necessary capital to start up or to be participated in nonfarm employments.

A positive influence of village electrification on nonfarm employment participation was expected due to the fact that villages having electricity are close to the town/city and thus more nonfarm employment opportunities and labor market. The variable electricity is consistent with our prior expectation. Positive and significant influence of electricity on nonfarm employment participation is evident from the result.

Availability of irrigation seems to discourage participation in nonfarm employment. It is found to be negative and significant at 5 percent. Households with access to irrigation are less likely to participate in nonfarm employment. In other words household with a likelihood of a high income from agriculture do not participate in nonfarm activities. This makes sense because availability of irrigation requires more labor time to be spent in farming and also unlike crop production which is seasonal in nature, irrigation demands labor time throughout the year. On the top of this, farmers adopted irrigation in the area believed that irrigation income is better than such nonfarm activities income.

Finally, variables sex, education, marital status, perception of tenure security, livestock ownership and distance to the main road do not have a statistically significant relation with the probability of nonfarm employment participation

To estimate effect on food security given a household participated in nonfarm employments, the Heckman selection model is used. The results from the regression using the model are given in table below.

Table 13 Heckman estimations of nonfarm participation and household expenditure

Variables	Expenditure		Nonfarm participation	
	Coefficient	P>|z|	Coefficient	P>|z|
Household head sex	1382.751	0.376	-.7228009	0.274
Household head education	69.56429	0.551	.1486609	0.104
Married	1727.64	0.389	.6326218	0.435
Household head age	-63.99532	0.243	-.0344856	0.098*
Family size	483.8913	0.041**	.292024	0.005***
Special skill	1162.157	0.210	1.858289	0.001***
Land ownership	-4170.23	0.001***	1.707182	0.174
Land size	1168.752	0.058*	-.4820135	0.083*
Tenure security			.3006271	0.315
Cows	632.6635	0.018**	-.1179172	0.505
Oxen	-406.6525	0.488	.0176708	0.950

Irrigation	3656.588	0.000***	-1.028937	0.014**
Credit	-72.50531	0.924	.8328926	0.032**
Electricity	248.7872	0.782	.979403	0.048**
Distance to market	-3179.817	0.000***	.9558707	0.010**
Distance to main road	654.2338	0.423	.2990218	0.508
Constant	8369.945	0.010	-2.273986	0.010

Number of observations = 151

Censored observations = 72

Wald chi2(32)= 161.00

Prob > chi2=   0.0000

*, **, *** represent levels of significance at 10, 5 and 1 percent respectively

The statistically significant parameter, mills lambda, confirms the superiority of Heckman selection model (two stage) above the ordinary least square alternative. The role of nonfarm participation in improving food security is positive and significant. From the results, variables family size, land ownership, land size, cows, access to irrigation and distance to the market are found to be significant in explaining household yearly expenditure. Given that a household participated in nonfarm employments a one person increase in family size results in an increase in yearly expenditure by 483.89 birr. Landownership decrease yearly expenditure by 4170 birr. This is because land owners are less likely to spend for grains in comparing to those do not have land. In other words the landless households are basically buyers of agricultural outputs and one would expect for such households to spend more expenditures for food items. However, an increase in land size results in an increase in expenditure by birr 1168. One possible reason for this is a higher land size may result more production or agricultural income and which might result higher expenditure for household basic needs. Provided that a household participated in nonfarm work, an access to irrigation increase household yearly expenditure by 3656. Access to irrigation results more agricultural income which in turn results more expenditure. For a household participated in nonfarm employments an increase in cow results to an increase in yearly expenditure by birr 632. Distance to the nearest market affects yearly households' expenditure. For a household being seven km or one hour further from the town results in an increase in expenditure by birr 3179.This is basically due to high transportation cost.

6. Conclusions

The study attempts to investigate the link between food security and nonfarm employments whilst examining factors influence farmers to participate in nonfarm employments using the survey data collected from 151 randomly selected households from six villages of Woreda Gantafeshum, Eastern Tigrai, Ethiopia. Both descriptive analysis and econometric estimation results have been used to answer the stated key research questions. The following conclusions can be drawn.

Substantial numbers of farmers are involved in nonfarm activities to supplement farm income though the economy of the household is depending on farming.The result of the study shows that about 52 percent of the sampled households participated in nonfarm employments. The result also reveals that no significance difference in the level of participation in nonfarm employments between the male and female household groups.

Apart from food for work, masonry, daily labour and petty trade are the major nonfarm employments undertaken in the study area. The study points, among others, the three main reasons that explain the extent and involvement in nonfarm employments are insufficiency of income from agriculture, decline land size, soil fertility or productivity and shocks (rain failure, short rainy season, pests swarm, flood, etc) and thus farmers apparently participated in nonfarm employments due to push factors. But it should be noted that farmers undertake nonfarm activities during the dry or slack season.

The result of the study suggests that nonfarm employment improve farmers' livelihood. Farmers participated in nonfarm employments have shown improvements in daily food self sufficiency, housing, schooling of children and other. Further the statistical analysis confirms households that participate in nonfarm activities are more likely to spend for education, food, closing and health care than those who do not participate at all.

Nonetheless, farmers have been constrained by various factors while accessing the nonfarm employments. A frequently cited reason is absence of employment opportunities followed by lack of skill, and lack of nearby towns and transportation.

We found that land size, age, family size, special skill, electricity, credit, distance to the nearest market and access to irrigation are the most influencing variables in determining farmer's/household's participation in nonfarm activities.

Regarding the effect of nonfarm employment on households' food security, our study indicates that nonfarm employment provides additional income that enables farmers to spend more on their basic needs include: food, education, closing and health care. The result of the descriptive statistics also shown that there is a statistically significant difference in expenditures on basic needs between the participants and the non participants group. The result of the study implied that nonfarm employment has a role which is significant in maintaining household food security.

At household level, food security is maintained either by adequate production or earning sufficient income that enable household to purchase the required food. Here the policy option towards food security at household level is either to promote agricultural production or creating accesses to additional source of income such as nonfarm employments or a combination of both. In areas where agricultural production is not viable household should try to seek additional cash by involving in nonfarm employments. In line to this the study generally highlighted that nonfarm employments have positive contribution in meeting household food security. However, nonfarm employment opportunities are found to be limited. Therefore, rural development policy should promote nonfarm employments in attempt to address issues of food security.

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