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RESEARCH ARTICLE

EFFECTS OF AGRICULTURAL EXTENSION PACKAGES ON INCOME INEQUALITY: CASE FROM NORTHERN ETHIOPIA

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ABSTRACT

The study explores the impact of agricultural extension on households' income and income inequality at a micro level using data from 734 rural households (out of which 390 are extension participants and 344 are non-participants) in Tigray region, northern Ethiopia. It also deals with the determinants of income and income inequality. The data for the study is derived from eight tabias and three agro-ecological zones of the Geba catchment collected by MU-IUC project. Descriptive statistics with respective t-values, Gini Decomposition Analysis and OLS Model together with Regression based Inequality Decomposition Analyses are employed to the respective objectives of the study. In the decomposition analysis, off-farm income and livestock income show an inequality decreasing sources while agricultural (mainly crop) income reveals an inequality increasing source. However, some off-farm income sources such as wage income which includes food for work program run by the government working in rural projects has an inequality reducing effect. Generally, the Agricultural extension program has substantial positive impact on households' income.

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1. INTRODUCTION

Poor performance of agriculture has resulted in widespread poverty, chronic food insecurity and a growing reliance on international donors for food consumption (Mulat, 1997). This initiates government and concerned organizations to transform the old and traditional agriculture in to market oriented. One of the methods to transform agriculture is through the use of extension services. In the real world, people diversify their income from farm and non-farm activities in order to secure and improve their life. Agricultural extension practices improve the total agrarian economy and it also increases income sources and employment opportunities in farming activities. According to Belay (2003), PADETES uses Extension Management Plots (EMTPs) and a technology transfer model which, in principle, nurtures linkages between research, extension, input, and credit distribution. The major elements of the extension packages are fertilizer, improved seeds, pesticides and better agricultural practices mainly for cereal crops (teff[1], wheat, maize, barley, sorghum and millet).

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[1] Teff – the most common Ethiopian cereal crop and widely used for food consumption. There are three types of teff: red, white and mixture of two.

Extension services are widely exercised over all the country. Tigray, from northern Ethiopia is one of the regions in the country in which extension service is provided in an extended manner. Government of the regional state, Tigray, has launched an integrated household focused extension package program since 2003/04 to address the problem of poverty (BoARD, 2006). Historically extension service in Ethiopia has been focused on improving productivity and production in line with the focus of government agricultural development programs on improving food security (Berhanu *et al*., 2006). Such programs intervention and other market oriented development strategies can improve the livelihoods of farm households. The problem of income inequality is ever real phenomena in sub-Saharan Africa and third world countries. Ethiopian government tries to minimize the incident problem of food security using different strategies like Agricultural Development Led Industrialization (ADLI) and improving the agriculture through different extension programs. Tassew (2002) stated that current agricultural extension programs include farm and non-farm activities, encourage growth of small-scale business and create non-farm employment opportunities in rural areas. Many researchers have responded to the impact of extension on farm productivity, food security, poverty reduction and asset holdings, impact of off-farm activities on farm income and on the linkages of farm/non-farm

income and currently on income diversification. Habtemariam (2007) pointed out that the goals of many extension systems include improving agricultural productivity, attaining food self-sufficiency, producing industrial and export crops etc. Therefore, it can be understood that researchers give less emphasis on the effects of extension services on income inequality. Currently, impact of household packages on income and welfare are getting familiar (Habtu, *et al*, 2014, Kidanemariam *et al*, 2011 and Habtu, 2015). Still those literatures did not touch the income inequality side. Therefore, the overall impact of the agricultural extension services on farm households' income inequality is a crucial issue and not well researched yet in Ethiopia as well as in Tigray, northern Ethiopia. Thus, the study is used to examine impact of agricultural extension on income inequality of rural households. Specifically, it addresses how extension program is conditioning households' income inequality and what are the major determinants of income and inequality.

2. Methods and Data

2.1 Site Selection and Description of the Study Area

The research site is located in the Geba catchments of Tigray region[2], as part of northern Ethiopia. The study area (the Geba[3] catchment) covers 4600 km^2 area, 10 Woredas[4] and 168 Tabias[5]. It is characterized primarily by mixed farming (crop and livestock farming), which as part of the region, depends on rain-fed agricultural activities.

2.2 Sampling Method

Cluster and Stratified sampling methods together with simple random sampling tool is employed. A three stage sampling technique was used to collect the data. First, ten Woredas in this catchment were identified and grouped into clusters on the basis of their differences in agro-ecological features. Then, two lowland, six midland and two highland woredas are identified. Accordingly, four woredas Atsebi - wemberta (highland - Dega), Wukro (midland - Weina Dega), Saharti - Samre (midland - Weina Dega) and Tanqua-Abergle (lowland - Kola) were selected based on proportion. Second, sample of eight tabias (two tabias from each woreda) were randomly selected. The tabias selected are representative of the three agro-ecological zones. Finally, total sample of 734 households were randomly drawn from the selected tabias from a list of eligible households.

2.3 Methods of Data Analysis

2.3.1 Gini Decomposition Method

The effect of agricultural extension participation on income inequality can be analyzed using comparative analysis of both groups of households by using Gini decomposition[6] analysis. The Gini coefficient is defined as the ratio of the area between the Lorenz curve and the diagonal of equality to the total area between the diagonal of equality and the horizontal axis which is A/(A+B). A Lorenz curve plots the cumulative percentages of total income received against the cumulative percentages of recipients. It is the area between the Lorenz curve and the diagonal of perfect equality and varies from 0 (perfect equality) to 1 (perfect inequality). The more unequal the income distributions, the greater the distance of the Lorenz curve from the diagonal and the greater the Gini coefficient. Gini decomposition allows the decomposition of the overall Gini coefficient into different income components such as crop, livestock and off-farm incomes. Off-farm income includes wages income (payments for contract work, daily labor and may be salaries for full time work, food for work (Safety Net Program)[7]), household income from small scale own business, transfer payments and remittance, and migration income.

In decomposing the Gini coefficient, it provides two ways of measuring the contribution of any income source to overall income inequality.

1. Identifying how much of the overall income inequality is due to any particular source of income.
2. Whether each income source serves to increase or decrease overall inequality.

The source of decomposition of Gini coefficient can be developed by using Shorrocks (1982; 1983) decomposition by income sources notation and assuming that total income (Y) consists of income from *k* sources, namely y_1, y_2, ……., y_k. Therefore, total income, *Y,* is thus given as:

$$\boldsymbol{Y} = \sum_{\boldsymbol{k=1}}^{\boldsymbol{k}} \mathbf{y_k} \qquad \text{... ... ...} \quad 3.1$$

The Gini coefficient of total income (*G*) can be expressed as:

$$\boldsymbol{G} = \sum_{\mathbf{k=1}}^{\mathbf{k}} \boldsymbol{S_k} \mathbf{G_k R_k} \qquad \text{... ... ...} \quad 3.2$$

Where S_k stands for the share of income source *k* in total income, G_k is the Gini coefficient of income measuring the inequality in the distribution of income component *k* within the group, and R_k is the correlation coefficient between income from source *k* and can be defined as

$$\mathbf{R_k} = \frac{\mathbf{Cov}[\boldsymbol{Y_k},\ \mathbf{F(Y)}]}{\mathbf{Cov}[\boldsymbol{Y_k},\ \mathbf{F}(\boldsymbol{Y_k})]} \qquad \text{... ... ...} \quad 3.3$$

G_kR_k is known as the pseudo-Gini coefficient of income source *k*. The contribution of income source *k* to total income

[2] Region is an autonomous administration territory equivalent to one Administrative State in Federal Government.
[3] Geba is name of the river in which the study is going on its catchment, in Tigray region
[4]Woreda is the second administrative unit from lower administration units or local government, of Ethiopia equivalent to a district.
[5]Tabia is the smallest unit of local government in rural communities, just lower than Woreda and equivalent to street and each tabia consists of four villages.

[6]Decomposition in this case implies that income and inequality measures have additive characteristics across different income sources and over time.
[7] Rural households work for food which can be paid in kind run by the government. Mostly, people who are poor are engaged in such programs. This program highly contributes in environmental rehabilitation like soil and water conservation, trenches and check Dum etc

inequality is given as $S_k G_k R_k / G$, while the relative concentration coefficient of income source k in total income inequality is expressed as:

$$\mathbf{g_k} = \frac{\mathbf{G_k R_k}}{\mathbf{G}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 3.4$$

Where g_k, the relative concentration coefficient, is change in income source k that leads to change in the overall income inequality and income sources. When the relative concentration $g_k>1$ provides the aggravation of income inequality effect and with $g_k<1$ provides an equalizing effect or narrowing the income gap.

2.3.2 OLS Model

OLS regression is employed to know the extent of household socio-economic characteristics and other related variables influences income which in turn determines income inequality. This is because without identifying the determinants of income, it is not possible to identify factors affecting income inequality. The use of OLS model is best because there are no as such many zero values for income sources in the survey data.

The determinants of income can be examined by the OLS model as formulated by Gujarati D. (2004):

$$Y_i = \beta_0 + \beta_i X_i + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.5$$

Where Y_i is the total income and income components, β_0 is the constant and $\beta_{i,}$ = Regression parameters or coefficient that is i=1, 2,….n whereas X_i - the explanatory variables that can influence the dependent variable and ε_i regression residuals and error terms.

2.3.3 Regression based Inequality Decomposition Analysis

The statistically significant variables of the OLS model are decomposed in to regression based inequality analysis to show the extent they are contributing to income inequality. According to Fields (2002) where income is as a function of a certain number of "variables" or "factors" and the decomposition is based on the income-generating function written as:

$$Y_i = a_i' Z_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \quad 3.6$$

Where

$$a_i = [\alpha \ \beta_1 \ \beta_2 \ldots \beta_J \ 1] \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 3.7$$

And $Z_i = [1 \ X_{i1} \ X_{i2} \ldots X_{iJ} \ \varepsilon_i]$ $\ldots\ldots\ldots\ldots\ldots$ 3.8

The a_i coefficients can be estimated using appropriate econometric techniques in which it needs specification corrections. It is needed to decompose inequality by factor income, showing the regression based decomposition analysis to figure out how much percentage each income source is contributing to inequality and how much the significant variables have that factor inequality weight. This is the decomposition of inequality by additive factor components as of Shorrocks (1982).

$$Y_i = \sum_k Y_{ik} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 3.9$$

Where $Y_i = (Y_1 \ldots Y_N)$, and $Y_{iK} = (Y_{1k} \ldots Y_{Nk})$ and N is the total number of income recipients.

Shorrocks (1982) defined the relative factor inequality weight S_k as the percentage of income inequality that is accounted for by the k^{th} factor in his theorem of decomposition by additive factor components.

The relative factor inequality weights, S_k given by

$$S_k = \frac{\mathrm{cov}(Y_k, Y)}{\sigma^2(Y)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.10$$

Such that

$$\sum_k S_k = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 3.11$$

For any inequality index I(Y) which is continuous & symmetric, and for which I (μ, μ, ...,μ) = 0. Virtually all inequality indices satisfy these conditions, including the Gini coefficient (Fields, 2002). According to Shorrocks (1982), income generating function by factor components decomposition of income inequality, assume an inequality index I(Y) be defined on the vector of incomes Y= (Y_1, …, Y_N). The decomposition of income inequality is given as:

$$S_k Y = \frac{\mathrm{cov}(a_i Z_i, \ Y)}{\sigma^2(Y)} = \frac{a_i \ \ \sigma(Z_i) \ \ \mathrm{cor}(Z_i, \ Y)}{\sigma(Y)} \ldots\ldots\ldots\ldots 3.12$$

Where

$$\sum_{k=1}^{k+2} s_k(Y) = 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 3.13$$

$$\sum_{k=1}^{k+2} s_k(Y) = R^2(Y), \text{and} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.14$$

$$P_k(Y) = \frac{S_k(Y)}{R^2(Y)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.15$$

This holds for any inequality index I (Y_1, . . ., Y_N) which is continuous and symmetric and for which I(μ, μ, . . . , μ) = 0. This approach is used to examine determinants of income inequality by factor components and reveals which variables are contributing much to income inequality.

3. RESULTS AND DISCUSSION

3.1 The Nature and Description of the Data

The data were collected by MU-IUC (Mekelle University-Inter-University Council-VLIR) project in 2009. It included information on access to extension services. It includes demographic characteristics, farm characteristics, sources of

income such as agricultural (mainly crop), livestock ownership and livestock expenditure and off-farm incomes (wage, own business, transfer and remittance and migration incomes). There is detailed information on access to the following: asset ownership, credit facility, inputs and adoption of modern input, crop outputs and sales of previous year harvests, technology adoption status and so on. Out of the total sample size 734, 194 (26.43 percent) are female headed households and 540 (73.57 percent) are male headed ones. And 390 (53.13 percent) and 344 (46.87 percent) of households are participants and non-participants in the extension program, respectively. From extension participants 79 households (20.26 percent) are female headed and 311 households (79.74 percent) are male headed ones. This might indicate that female household heads are marginalized in extension package participation. Similarly, from extension non-participants 115 households (33.43 percent) are female headed and 229 households (66.57 percent) are male headed ones.

3.2 Comparative Analysis of Rural Income Inequality Decomposition

3.2.1 Overall Rural Income Inequality

The Gini coefficient of the per capita income as shown in table 3.1, for all population (for both extension participants and non-participants) is 0.5066 in the study area. This is an overall Gini coefficient of the income sources such as agricultural (mainly crop), off-farm and livestock incomes**.** Accordingly, the result signifies that agricultural (crop income) takes the lion share of the contribution to the income source which is 48 percent of the total income followed by income from livestock contributing 38 percent of the total income and off-farm income contributes the remaining 14 percent. The absolute contribution of agriculture (mainly crop), livestock and off-farm incomes to the overall income inequality is 0.3110, 0.1481 and 0.0475, respectively. On the other hand, considering the relative contribution of each income source to the overall income inequality, agricultural (mainly crop) income constitutes the largest inequality contribution which is 61.38 percent followed by livestock accounting for 29.23 percent and off-farm income the remaining 9.38 percent.

The result for crop income is consistent with the results of Adams, (2002) and Adder, (1997) that it is the main inequality contributor. Inequality increasing and decreasing sources of income are figured out by the relative concentration coefficient (g*k*). Accordingly, livestock and off-farm income are inequality decreasing sources. On the other hand, crop income is inequality increasing source in addition to its total contribution to the overall inequality. By how much the source of income aggravates inequality and/or narrows it can be distinguished by the percentage change impact of income source on inequality computed from relative concentration, g*k* and share of the income source, S*k*. Therefore, a 1 percent rise in the income sources of off-farm and livestock, results in decreasing (narrowing) income inequality by 0.051 and 0.084 percent, respectively. However, an equal 1 percent rise in agricultural (mainly crop) income results an increasing (aggravating) income inequality by 0.134 percent.

Whether income sources are inequality increasing or decreasing; it is a controversial issue that researchers argue differently. Here it can be argued that agricultural income (mainly crop) is the major inequality increasing whereas livestock and off-farm income are inequality decreasing source of income in northern Ethiopia. This may be due limited size of land, bad geographical topography, land degradation, and so on. This result is consistent with the (Adams 1994; 2002; De Janvry and Sadoulet, 2001; Zhu and Luo, 2006) that households have a higher participation rate (in particular in casual wage activity) than rich households, and then non-farm income can reduce rural inequality.

3.2.2 Overall Rural Off-farm Income Inequality

In the decomposition by off-farm income sources, the major ones are wage, own business, transfer and remittance and migration incomes. According to table 3.1 second part, wage income is the major source of off-farm income with 54.42 percent share and major absolute contributor to the overall off-farm income inequality accounting for 0.2814. It also accounts for 45.4 percent of the overall off-farm income inequality, the largest relative contribution to inequality. Similarly, the shares of transfer and remittance, own business and migration incomes are 23.66, 15.6 and 6.32 percent of the total off-farm income, respectively.

Table 3.1: ***Decomposition of Income Inequality by Incomes Sources in Northern Ethiopia***

Household size: fmsize

Sources	Income Share (S*k*)	Gini Correlation (R*k*)	Gini Index (G*k*)	Absolute Contribution (S*k**R*k**G*k*)	Relative (%) Contribution (S*k**R*k**G*k*/G)	Relative Concentration (gk= R*k**G*k*/G)	Impact of a 1% change in income source on inequality
Crop income	0.4796	0.9161	0.7078	0.3110	0.6138	1.2799	0.134
Off-farm income	0.1444	0.5312	0.6198	0.0475	0.0938	0.6499	-0.051
Livestock income	0.3760	0.8481	0.4644	0.1481	0.2923	0.7775	-0.084
Total	1.0000	-------	-----	**0.5066**	1.0000		

Decomposition of Off-farm Income Inequality by Incomes Sources in Northern Ethiopia

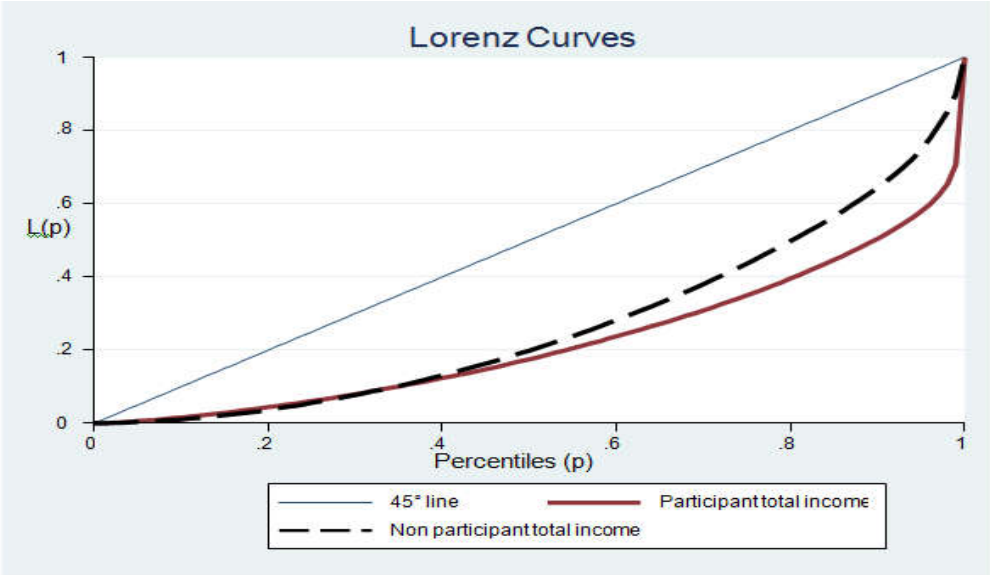
Wage income	0.5442	0.8427	0.6136	0.2814	0.4540	0.8343	-0.090
Business income	0.1560	0.8094	0.9303	0.1175	0.1895	1.2149	0.034
Transfer income	0.2366	0.8042	0.9407	0.1790	0.2887	1.2206	0.052
Migration income	0.0632	0.7015	0.9474	0.0420	0.0677	1.0723	0.005
Total	1.0000	-------	------	**0.6198**	1.0000		

Source: Own estimation from MU-IUC data

Table 3.2: Average difference of income sources by extension participation status

Source of income	Extension non-participants		Extension participants		Mean difference estimate = Mean(0)-mean(1)	t-value
	Mean	Percent	Mean	Percent		
Crop income	5105.918	38	12638.14	49	-7532.221	-1.4245
Livestock income	5687.492	42	7567.456	36	-1879.964	-3.0895***
Off-farm income	2633.128	20	2718.582	15	-85.454	-0.1347
Total	*13426.54*	*100*	*22924.18*	*100*	*-9497.639*	*-1.77**
Wage income	1102.265	42	1783.89	55	-681.6252	-2.7885***
Own business income	357.689	13.6	485.8077	16	-128.118	-0.8394
Transfer and remittance	978.218	37	259.7949	22	718.423	1.3108
Migration income	194.9564	7.4	189.0897	7	5.867	0.0961

Source: Own estimation from MU-IUC data
Notes: *** Significance at the 1% level and * Significance at the 10% level

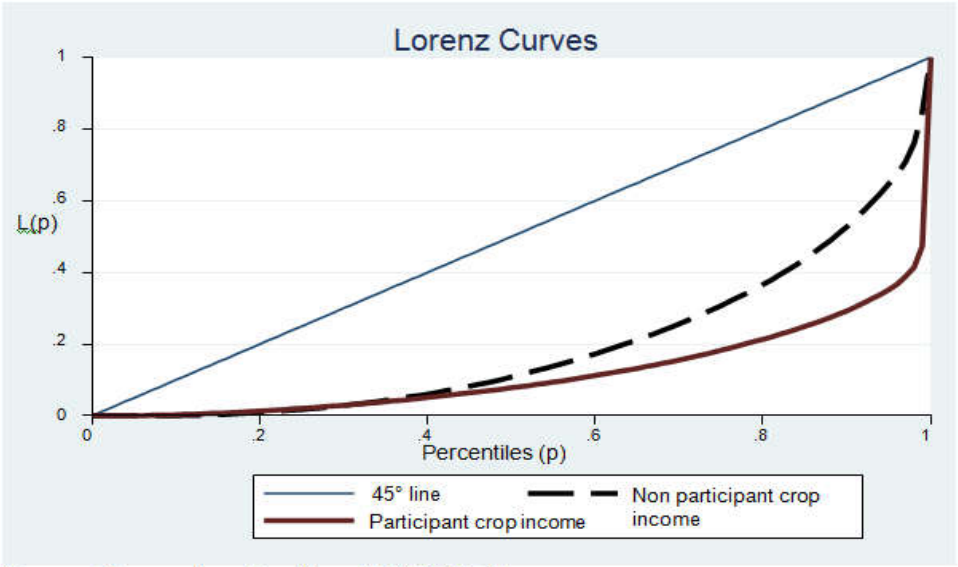


Source: Own estimation from MU-IUC data

Figure 3.1. Lorenz curve of per capita total income for extension participants and non-participants

Following this, the relative contribution to inequality from these sources are 28.87, 18.95 and 6.77 percent of the overall off-farm income inequality, respectively.

Gini index of per capita crop income for participants and non-participants is 0.75 and 0.58, respectively. In accordance with the index, extension participants show inequality divergence among themselves than the non-participants. This may be due to their initial assets and livestock holdings, farm size and extension participation levels. Gini indices of total off-farm - for participants and non-participants are 0.59 and 0.66, respectively as indicated in table 3.3 and 3.4 second part. This may be due to the wage income, which creates significant difference between the two groups. Participants, on average, exceed non-participants by around 682 ETB. It seems that the Gini index of participants is a little bit lower and shows stable income variability among themselves than their counterparts which means that the diversification of wage income is mainly from the poor i.e. push factors among participants. The Lorenz curve in figure 3.2 below depicts that per capita crop income of extension participants is far from the equality line indicating inequality divergence among participants than their counterparts; which is consistent with the Gini index of each group. The Lorenz curve in figure 3.3 shows that extension participants seems to have the closer distance to the diagonal equality line though a little bit crossing to each other in which it is difficult to decide implying that off-farm income inequality gap for extension participants' shows convergence among themselves than their counterparts. Beyond this, wage income, in both groups of households, has inequality decreasing effect. A 1 percent rise in wage income, leads to a decline of inequality among each of participants and non-participants by 0.05 and 0.13 percent, respectively but the absolute contribution of it to the total off-farm income inequality is 0.35 and 0.17, for the respective groups of households. The significant difference effect on participant households due to the wage income may be the government intervention in food security programs because wage income includes salary per month in rural works and food for work (Safety Net Program) by working in different rural projects. Taking this in to consideration, it can be concluded that wage income serves as a consumption smoothing source of income. Gini index of livestock reveals a difference among them in both groups of households, that is, 0.45 and 0.49 for participants and non participants, respectively.



Source: Own estimation from MU-IUC data

Figure 3.2: Lorenz curve of per capita crop income for extension participants and non-participants

Table 3.3: Decomposition of Income Inequality by Incomes Sources of *Extension Participant households* in Northern Ethiopia

Household size: fmsize

Sources	Income Share (S*k*)	Gini Correlation (R*k*)	Gini Index (G*k*)	Absolute Contribution (S*k**R*k**G*k*)	Relative (%) Contribution (S*k**R*k**G*k*/G)	Relative Concentration (g*k* =R*k**G*k*/G)	Impact of a 1% change in income source on inequality
Crop income	0.5254	0.9298	0.7447	0.3638	0.6796	1.2935	0.154
Off-farm income	0.1229	0.5319	0.5875	0.0384	0.0718	0.5838	-0.051
Livestock income	0.3516	0.8469	0.4469	0.1331	0.2486	0 .7070	-0.103
Total	1.0000	-------	-------	**0.5353**	1.0000		

Decomposition of Off-farm Income Inequality by Incomes Sources in Northern Ethiopia

Wage income	0.6494	0.8811	0.6139	0.3512	0.5979	0.9207	-0.052
Business income	0.1959	0.8424	0.9358	0.1544	0.2629	1.3418	0.067
Transfer income	0.0868	0.4813	0.8726	0.0365	0.0621	0.7149	-0.025
Migration income	0.0679	0.7039	0.9488	0.0453	0.0772	1.1368	0.009
Total	1.0000	------	------	**0.5875**	1.0000		

Source: Own estimation from MU-IUC data

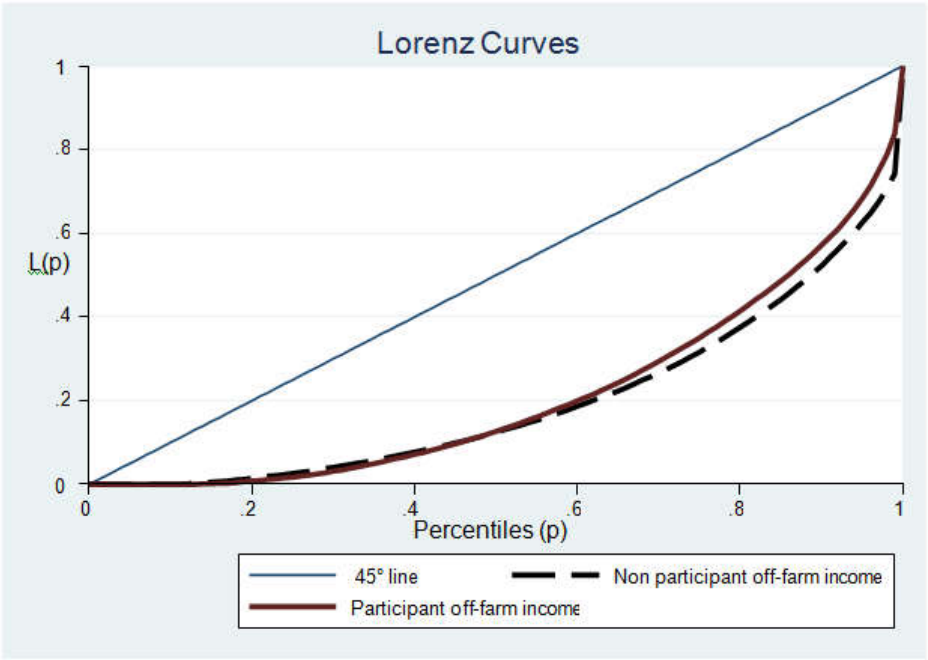
Table 3.4. Decomposition of Income Inequality by Incomes Sources of *Extension Non-Participant households* in Northern Ethiopia by Household size: fmsize

Sources	Income Share (Sk)	Gini Correlation (Rk)	Gini Index (Gk)	Absolute Contribution (Sk*Rk*Gk)	Relative (%) Contribution (Sk*Rk*Gk/G)	Relative Concentration (g*k*=R*k**G*k*/G)	Impact of a 1% change in income source on inequality
Crop income	0.3756	0.8594	0.5822	0.1879	0.4352	1.1587	0.060
Off-farm income	0.1931	0.5230	0.6603	0.0667	0.1544	0.7998	-0.039
Livestock income	0.4313	0.8451	0.4862	0.1772	0.4104	0.9516	-0.021
Total	1.0000	-------	-------	**0.4318**	1.0000		

Decomposition of Off-farm Income Inequality by Incomes Sources in Northern Ethiopia

Wage income	0.3924	0.7505	0.5889	0.1735	0.2627	0.6693	-0.130
Business income	0.0984	0.7164	0.9088	0.0640	0.0970	0.9860	-0.001
Transfer income	0.4528	0.8907	0.9556	0.3854	0.5837	1.2890	0.131
Migration income	0.0564	0.7030	0.9434	0.0374	0.0566	1.0044	0.0002
Total	1.0000	-------	-------	**0.6603**	1.0000		

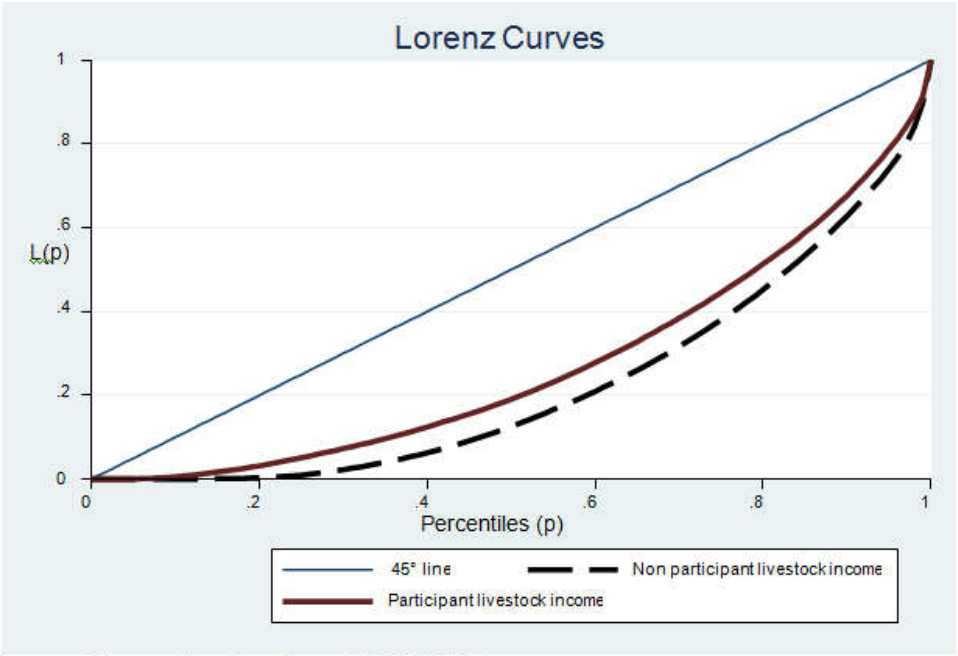
Source: Own estimation from MU-IUC data



Source: Own estimation from MU-IUC data

Figure 3.3: Lorenz curve of per capita off-farm income for extension participants and non-participants

Crossing Lorenz curve in Fig.3.3. is difficult to decide whether participants' off-farm income inequality gap or non-participants' inequality gap is convergence but it can only show a clue.



Source: Own estimation from MU-IUC data

Figure 3.4: Lorenz curve of per capita livestock income for extension participants and non-participants

As indicated in the Gini index, the Lorenz curve in Figure 3.4 is consistent with it. The income of livestock for participants is inequality stabilizing than their counterparts. This may be due to income diversification in livestock on the sides of the poor or due to push factors that livestock income is inequality decreasing source.

3.3 Regression based Decomposition Analysis of Income Inequality

The Gini decomposition analysis is limited in identifying the determinants of income and income inequality. It does not show how the household level characteristics such as education, age, gender, family size … and farm characteristics like farm size, farm ownership status … and others determine income and income inequality. The determinants of income and income inequality having those specific characteristics addresses whether income of the household increases or not which in turn determines the income inequality. Therefore, determinants of income are also determinants of income inequality when decomposed in to regression based analysis. Using Ordinary Least Squares (OLS) to estimate the determinants of income of the households is best method. Since the households do not generate total income of zero and not as such zero values from other income sources as well. The regression is on total income and on its major sources such as crop, off-farm and livestock incomes with respect to their explanatory variables. The model specification and goodness of fit of the OLS regressions are checked and fitted the overall model viability since R^2 for cross sectional data ranges from 0.2 to 0.4. No multicollinearity problems in all OLS regressions since the average VIF is 1.78. The goodness of fit (R^2) of the off-farm income regression is too low which is 6 percent. This is because the off-farm income activities in northern Ethiopia is highly dominated by food for work (Safety Net programs) which is run by the government and is open for all for food security. So, the off-farm market is not governed by the normal market condition.

Total Income

The results of OLS model estimation presented in table 3.5, for the determinants of total income shows that all variables, except age of the household head, dependency ratio and number of dependents are positively correlated with total income. Of its determinants, age, sex (gender) of the household head, adult equivalent family size, total farm size (in tsimad), land ownership status, total asset value and access to information are significantly different from zero at 1 percent level of significance. Whereas household head educational status is significant at 5 percent level. When adding one year more to the age of the household head, the total income of the family decreases by 0.66 percent. Being male and literate household head increases the chance of having more income by 22.98 and 11.6 percent, respectively. As the household family size in adult equivalent increases by 1 percent, total income increases by 45.55 percent which implies that larger family size tends to have higher income because he can contribute to the total income.

Similarly, when the total farm size (in tsimad) increases by 1 percent, it reveals that an increment on the total income by 36.4 percent. Since farm is the main source of crop income which also strongly influences the total income. Having own land and access to information influences total income positively by 33.4 and 14.43 percent, respectively. Finally, an increment in total asset value by 1 percent, leads to increase the total income of the household by 12.37 percent.

Table 3.5: OLS Analysis of Determinants of Rural Income in Northern Ethiopia (N=734)

Variables	Annual per capita household level income in log form			
	Total income βt	Crop income βc	Livestock income βl	Off-farm income βo
Age of head	-0.0066***	-0.0008	-0.0168***	-0.0204***
	(-3.31)	(-0.16)	(-3.43)	(-2.87)
Sex of head	0.2298***	0.3201*	1.0434***	-0.3851
	(3.26)	(1.70)	(5.98)	(-1.51)
Educational status	0.1160**	0.0426	0.2134	0.3961*
	(2.00)	(0.28)	(1.49)	(1.89)
ln(adult family size)	0.4555***	0.9403***	1.4295***	0.4903
	(4.91)	(3.81)	(6.24)	(1.47)
Dependency ratio	-0.0219	0.0930	0.1160	0.0941
	(-0.65)	(1.03)	(1.38)	(0.77)
No. dependents	-0.0228	-0.1626*	-0.1497*	-0.0682
	(-0.72)	(-1.92)	(-1.90)	(-0.59)
ln(total farm size)	0.3641***	0.8398***	0.8295***	-0.3583**
	(9.36)	(8.11)	(8.63)	(-2.55)
Total own land	0.3340***	1.5013***	0.540**	-0.4514
	(3.42)	(5.77)	(2.24)	(-1.28)
Total animals (tlu)	0.0002	-0.0002	0.0007	0.0009
	(0.55)	(-0.22)	(0.92)	(0.73)
ln(asset value)	0.1237***	0.1914***	0.3112***	-0.0303
	(4.97)	(2.89)	(5.06)	(-0.34)
Information access	0.1443***	-0.1997	0.4047***	0.3083
	(2.67)	(-1.39)	(3.03)	(1.58)
Constant	6.948***	2.4679***	1.5968***	8.002***
	(31)	(4.13)	(2.88)	(9.90)
F(11, 722)	48.10	28.71	52.89	4.11
Prob > F	0.0000	0.0000	0.0000	0.0000
R-squared	0.4229	0.3043	0.4462	0.0590
Adj R-squared	0.4141	0.2937	0.4378	0.0446
Root MSE	0.6811	1.8139	1.6839	2.4565

Source: Own estimation from MU-IUC data

Note: *** significance at 1 % level, ** significance at 5% level, * significance at 10% level

Values in parentheses are z-values, and Average VIF of all the regression above is 1.78

Total Agricultural (crop) Income

In the crop income the variables such household head sex (gender), adult equivalent family size, number of dependents, total farm size (in tsimad), land ownership status and total asset value are significant. All significant variables except number of dependents are positively correlated to agricultural (crop) income. Being male as a household head and having own land tends to raise its crop income by 32 and 150 percent, respectively. When adult equivalent family size, total farm size (in tsimad) and total asset value increase by 1 percent, total crop income increases by 94, 84 and 19 percent, respectively. However, when one dependent person comes to household, total crop income decreases by 16.3 percent.

Total Livestock Income

Livestock income is computed as the sale of animals and animal products. Age, sex (gender) of household head, adult equivalent family size, number of dependents, total farm size (in tsimad), land ownership status, total asset value and access to information are significant. Age of household head and number of dependents are negatively correlated with livestock income. A one year increment in age of household head and an addition of one dependent person to a family leads to decline the livestock income by 1.7 and 15 percent, respectively. Livestock income shows an increment by 143, 83 and 31 percent when there is a respective increment by 1 percent in adult equivalent family size, total farm size (in tsimad) and total asset value. Finally, being male as a household head, having land ownership status and access to information raises the livestock income by 104, 54 and 40.5 percent, respectively.

Total Off-farm Income

The off-farm income is the sum of wage, own business, transfer and remittance and migration incomes. It is influenced by age, literacy status and total farm size (in tsimad) of household head. The older the age of household head and the larger the size of the farm (in tsimad), the smaller becomes the off-farm income. Accordingly, when a household head becomes older and older, the off-farm income declines by 2 percent. Similarly, as total farm size (in tsimad) increases by 1 percent, the off-farm income declines by 36 percent. This is due to engagement in his/her farm takes more time (more working hours) when the size of farm becomes larger and larger. Being literate a household head has a positive influence on off-farm income by 39.6 percent since he/she is able to view different dimensions because of awareness for diversification to improve his/her living standards.

3.3.1 Determinants and Factor Weights of Income Inequality

To factor out the determinants of income inequality, a regression based decomposition analysis has been done to know the relative contribution (inequality weight) of each significant variables of the OLS model to the overall income inequality and income source inequalities. All statistically significant variables from the OLS model in table 3.5 are decomposed in to regression based inequality analysis to show which income determinant and how much it is accounting for the levels of inequality. Looking in to the inequality weight of the factors (agricultural mainly crop, livestock and off-farm incomes) for the different income sources reveals that the different factors have different contribution to inequality weight (See table 3.6).

Total Income

The most important variable is total asset value which accounts for 93.72 percent of the factor inequality weight. In similar manner, total farm size accounts for 15.66 percent of the factor inequality weight. The variables such as land ownership status, age of the household head, adult equivalent family size, gender (male headed) and literacy status of the household head account, in the factor inequality weight, for 15.63, 7.34, 6.61, 3.7 and 2.05 percents, respectively. Accordingly, those factors have inequality increasing effect in the factor inequality weight. Whereas access to information contributes to the factor inequality weight by 0.35 percent in opposite direction means that it has inequality decreasing effect.

Total Agricultural (Crop) Income

In the agricultural (mainly crop) income decomposition, total farm size contributes the lion share to factor inequality weight of 25.95 percent next to the regression residual. The next higher contribution comes from total asset value of the household in which it accounts for 23.60 percent of the factor inequality weight. Contributions to the factor inequality weight from own land is 11.8 percent. Other statistically significant variables such as family size in adult equivalent and being male as head contribute their own share to the factor inequality weight by 8.97 and 2.83 percent, respectively. However, the number of dependents in the family contributed to the factor inequality weight by 2.49 percent in opposite direction implying that it is inequality stabilizer factor while the other significant variables are inequality aggravating factors.

Total Livestock Income

Livestock income is decomposed on its statistically significant variables. The most important variable here is total asset value which contributes the largest share to the factor inequality weight by 26.4 percent. Total farm size is the second largest contributor to factor inequality weight by 21.30 percent. The contribution of other statistically significant variables such as family size in adult equivalent, gender of the household (male head), land ownership status, the number of dependents are 16.61, 15.38, 5.58 and 0.06 percent, respectively. However, age of the household head in the family contributed to the factor inequality weight by 1 percent in opposite direction implying that it is inequality stabilizing factor.

Total Off-farm Income

The statistically significant variable next to the regression residual in the off-farm income is gender of the household (male head) with an inequality weight of 5.19 percent followed by total farm size which contributes 2.35 percent to factor inequality weight. The age of the household contributes nothing to the factor inequality weight which stands in the neutral side.

Table 3.6: Regression based Decomposition of Inequality Indices for Total, Crop, Livestock and Off-farm Income in Northern Ethiopia (N=734)

Factors	Sj(per capita log Total income)	Sj (per capita log Crop income)	Sj (per capita log Livestock income)	Sj (per capita log Off-farm income)
Age of head	0.0734***	0.0195	-0.0100***	-0.0000***
Sex of head	0.0370***	0.0283*	0.1538***	0.0049
Educational status	0.0205**	0.0014	0.0144	0.0519*
ln(adult family size)	0.0661***	0.0897***	0.1661***	0.0010
No. dependent	-0.0035	-0.0249*	0.0006*	0.0064
ln(total farm size)	0.1566***	0.2595***	0.2130***	0.0235**
Total own land	0.1563***	0.1180***	0.0558**	0.0198
ln(asset value)	0.9372***	0.2360***	0.2640***	0.2907
Information access	-0.0035***	-0.0039	0.0435	0.0113
reg. residual	-0.4400	0.2766	0.0989	0.5907
Gini coefficient	0.0452	0.1048	0.0946	0.1888

Source: Own estimation from MU-IUC data
Note: *** significance at 1% level, ** significance at 5% level, * significance at 10% level

4. Conclusion

Gini decomposition analysis is used to examine the effects of different sources of income such as agricultural (mainly crop), off-farm and livestock incomes on rural income inequality due to extension participation. As the sample survey is from rural households that predominantly an agricultural based society, agricultural (mainly Crop) income plays a dominant role as an income source followed by livestock and off-farm income. In the comparative analysis, off-farm income and livestock income show an inequality decreasing sources while agricultural (mainly crop) income reveals an inequality increasing source for both groups of households. Within the off-farm income, the wage income which includes food for work and other rural projects open for all has an equalizing effect in both groups of households whereas the other sources varies accordingly. The significant variables from the OLS model which shows their effect on income, total farm size (in tsimad), land owned, family size in adult equivalent and total asset value are the most important factors of total income, agricultural income and livestock income while total farm size is the case in the off-farm activities. In the regression based decomposition analysis, some of the significant factors for the overall income inequality such as total asset value, total farm size (in tsimad), land owned, age of the household and family size have higher contribution to the factor inequality weight of income sources, respectively.

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Annexes

Annex 1: Estimation of the Propensity Score using Probit Model

The p-score has been used by extension participation status including the necessary variables. The balancing condition is satisfied that 734 households are matched in 6 final blocks (344 extension non-participants to 390 participant households) which implies 100 percent of the population have similar characteristics. Therefore, comparison is possible.

Algorithm to estimate the propensity score

The treatment is extension participation

Extension participation status of a household	Freq.	Percent	Cumulative
0	344	46.87	46.87
1	390	53.13	100.00
Total	734	100.00	

Estimation of the propensity score
Iteration 0: log likelihood = -507.32767
Iteration 1: log likelihood = -437.98739
Iteration 2: log likelihood = -436.13624
Iteration 3: log likelihood = -435.9448
Iteration 4: log likelihood = -435.89507
Iteration 5: log likelihood = -435.88602
Iteration 6: log likelihood = -435.88541
Iteration 7: log likelihood = -435.88541

Probit regression — Number of obs = 734; LR chi2 (15) = 142.88; Prob > chi2 = 0.0000; Log likelihood = -435.88541; Pseudo R2 = 0.1408

Extension participation	Coefficient	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Age of head	0.0392***	0.0088	4.47	0.000	0.0220	0.0563
Sex of head	0.0521	0.1337	0.39	0.697	-0.2099	0.3141
Educational status	0.2393**	0.1143	2.09	0.036	0.0153	0.4633
Adult labor force	0.1675***	0.0410	4.09	0.000	0.0872	0.2478
ln(total farm size)	0.0421	0.0896	0.47	0.638	-0.1335	0.2177
Access to irrigation	0.0906	0.1275	0.71	0.477	-0.1591	0.3404
Distance Mekelle	0.0137***	0.0027	5.04	0.000	0.0084	0.0190
Distance Woreda	0.0289***	0.0080	3.61	0.000	0.0132	0.0446
Total animals (tlu)	0.0044	0.0048	0.92	0.359	-0.0050	0.0137
Total animals in1996 (tlu)	5.34e-06	5.27e-06	1.01	0.311	-4.99e-06	0.00002
Total own land	0.1604	0.1995	0.80	0.421	-0.2306	0.5514
Information access	0.2591**	0.1045	2.48	0.013	0.0542	0.4639
Member to community org.	0.4279***	0.1222	3.50	0.000	0.1884	0.6674
Extension years	0.0594***	0.0127	4.67	0.000	0.0345	0.0844
Distance to ext. center in (hr)	-0.0494	0.1208	-0.41	0.682	-0.2861	0.1873
Constant	-4.5661***	0.5450	-8.38	0.000	-5.6344	-3.4978

Note: 0 failures and 1 success completely determined.
Note: the common support option has been selected. The region of common support is [0.0474, 1]
Source: Own estimation from MU-IUC data

Description of the estimated propensity score in region of common support
Estimated propensity score

Percentiles		Smallest		
1%	0.0889	0.0474		
5%	0.1584	0.0549		
10%	0.2330	0.0652	Obs	734
25%	0.3680	0.0690	Sum of Wgt.	734
50%	0.5466		Mean	0.5301
		Largest	Std. Dev.	0.2104
75%	0.6935	0.9810		
90%	0.7954	0.9849	Variance	0.0443
95%	0.8467	0.9999	Skewness	-0.1998
99%	0.9271	1	Kurtosis	2.2545

Step 1: Identification of the optimal number of blocks: Use option detail if you want more detailed output

The final number of blocks is 6
This number of blocks ensures that the mean propensity score is not different for treated and controls in each blocks.

Step 2: Test of balancing property of the propensity score
Use option detail if you want more detailed output

The balancing property is satisfied
This table shows the inferior bound, the number of treated and the number of controls for each block

The balancing property is satisfied
This table shows the inferior bound, the number of treated and the number of controls for each block

Inferior of block of pscore	Extension Participation Status of a household 0	1	Total
0.0474	75	11	86
0.25	80	25	105
0.375	51	68	119
0.5	68	87	155
0.625	45	105	150
0.75	25	94	119
Total	344	390	734

Note: the common support option has been selected

End of the algorithm to estimate the pscore

Source: Own estimation from MU-IUC data

Annex 2: Probit Model Specification for Extension Participation status

-------- True --------

Classified	D	~D	Total
+	286	138	424
-	104	206	310
Total	390	344	734

Classified + if predicted Pr(D) >= 0.5
True D defined as extenpart!= 0

Sensitivity	Pr(+| D)	73.33%
Specificity	Pr(-|~D)	59.88%
Positive predictive value	Pr(D| +)	67.45%
Negative predictive value	Pr(~D| -)	66.45%
False + rate for true ~D	Pr(+|~D)	40.12%
False - rate for true D	Pr(-| D)	26.67%
False + rate for classified +	Pr(~D| +)	32.55%
False - rate for classified -	Pr(D| -)	33.55%
Correctly classified		67.03%

Source: Own estimation from MU-IUC data

Annex 3: Conversion Factor for Tropical Livestock Unit (TLU)

Animal type	Tropical Livestock Unit (TLU)
Calf	0.25
Heifer	0.75
Cow and Ox	1.00
Horse and Mule	1.10
Donkey	0.70
Camel	1.25
Sheep and Goat	0.13
Chicken (Poultry)	0.013

Source: Storck, *et al.* (1991)

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