INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, ECONOMICS & MANAGEMENT

IJRCM

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REVIEW OF LITERATURE

NEED/IMPORTANCE OF THE STUDY

STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESES

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

SCOPE FOR FURTHER RESEARCH

ACKNOWLEDGMENTS

REFERENCES

APPENDIX/ANNEXURE

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ROLE OF IRRIGATION FROM DIVERSION ON RURAL PRO-POOR IN CENTRAL TIGRA

GEBREGZIABHER GEBREYOHANNES DESTA
LECTURER
DEPARTMENT OF ECONOMICS
COLLEGE OF BUSINESS & ECONOMICS
MEKELLE UNIVERSITY
MEKELLE

ABSTRACT

Main intent of this paper is to evaluate the livelihood impact of irrigation water from diversion on local inhabitants; in fact, there are many debates on the effect of irrigation on the welfare of local communities; some of the works report pro of positive effect, whereas others for negative. In this paper, to investigate the impact, ordinary least square regression analysis is employed. Market demand availability to agricultural produce from irrigation is to refer the intensity of adequacy to demand to the commodity under consideration, and here as the demand availability to commodities produced from irrigation increases by a unit, then the per capita annual consumption expenditure of the rural poor involved in the irrigation increases by 19.95%, statistically significant at 5%. Respondents were inquired to explain on whether they had adequate water source mainly in small scale diversion for irrigation. This variable was regressed against household welfare, and the STATA result exhibited that, compared to controlled households, as the treated household's access to water resource for irrigation increases by a unit, then the per capita annual consumption expenditure increases by 63.61%, statistically significant at 5%. The regression output attempts to explain that, the consumption expenditure explained by household welfare increases by 31.36%, compared to the controlled households. This regression is significant at 5%. This implies that, as the household's participation in diversion small scale irrigation increases, their welfare and income increases.

KEYWORDS
Irrigation from diversion, per capita consumption expenditure.

1. INTRODUCTION

In recognition on the water potential of the country and reverse the effect of rainfall variability on agricultural production, the government of Ethiopia has given due focus on expanding small scale and large scale irrigation schemes, among others. The focus is clearly put on the long term development strategy of the country in the Agricultural Development Led Industrialization (ADLI) strategy. The current five year plan (Growth Transformation Plan) also gives emphasis on further expansion of the irrigation development. This is based on the assumption that irrigation development has positive effect on crop production by making possible growing seasons more than once and/or supplementing the rain-fed production during rainfall shortage.

Conceptually, there are two opposing views about the impact of irrigation development on the national economy. On the one side, there are some works that report the positive effects of irrigation on agricultural productivity and household welfare. Based on their views, the importance of irrigation to rural livelihoods is highlighted by the fact that irrigated farmland provides 43% of global cereals production and 60% of the grain production in developing countries (IWMI 2000). In contrary to the positive contribution of irrigation water generated from small scale diversion sources, proponents of the other side have also reported some negative effects of irrigation development on agricultural productivity. Their concern is that though irrigation can play a central and dynamic role in the improvement of rural livelihoods, it is usually criticized in terms of its inefficiency in water use, high capital and recurrent costs, lack of sustainability, and association with inequity in the distribution of both land and water (N Hasnip, etal. 2001).

2. PROBLEM STATEMENT

Given the two opposing views and empirical evidences of the impact of irrigation on agricultural productivity and household welfare, one need to undertake a location specific study about the impact of irrigation, which is an aim of this study. Besides though there are few studies on impact of irrigation on agricultural productivity and household welfare in Tigray (Tesfay 2007).

However, the studies seem not representative of the region and the evidences provided for the studies are also mixed. Furthermore, the study about the status of irrigation development from diversion in Tigray also seems scanty. Thus, in this study, it is aimed to document the current status of irrigation development and investigate the impact of irrigation on household welfare in rural. The direct benefits of irrigation development are increased crop yield and the like. The indirect benefits are related to enhanced crop productivity that relaxes labour for off farm employment, enhance possibility of live stock development, etc .The other view argues that irrigation infrastructures could have negative effects on local economy since the irrigation development could result in water-borne diseases. Besides, they may carry pollutants that harm both human and ecosystem.

Alike to the conceptual view, the empirical evidence about impact of irrigation is also mixed. There are some works that report positive effect of irrigation on agricultural productivity and household welfare. World Bank declared that, in the near doubling of world grain production that took place between 1966 and 1990, irrigated land with deployment of basic inputs was responsible for 92% of the total production. Irrigation is also the key to developing high-value cash crops, and, by helping guarantee consistent production, it stimulates agro-industry and creates significant rural employment (World Bank 1997).

Given the mixed conceptual and empirical evidence of the impact of irrigation on agricultural productivity and house hold welfare, one need to undertake a location specific study about the impact of irrigation, which is an aim of this study. Thus, in this study, the researcher aims to document the current status of irrigation development from small scale diversion sources and investigate the impact on household welfare in rural Tigray.

3. OBJECTIVE

The general objective of this study aims to assess and investigate the impact of irrigation development from diversion on the welfare of local household in *Laelay Maichew Wereda*, rural Tigray.

Specific objectives of this study intends:

- To assess effects of micro diversion irrigation on rural inhabitants
- To identify major constraints in the irrigation development

4. MATERIALS AND METHODS

4.1. DATA SOURCES AND METHOD OF DATA COLLECTION

PRIMARY DATA

The combination of qualitative and quantitative data was needed for this research in order to enable a rigorous investigation without omission and exclusion of important details and insights Access to basic irrigation water resources; proximity; adequacy, market access, factors of product and the like were basic variables. In addressing these variables qualitative data are the field study included focus group discussions (FGDs), key informant interviews, household surveys, and direct observations. Semi-structured checklists were also designed to administer the data required. Likewise, a semi-structured and open-ended

questionnaire was developed to administer the household survey. A field survey was conducted in all *kebelles*. The enumerators visited all *kebelles* and collected 200 households following the sample selection design.

SECONDARY DATA

Secondary data was collected from regional and district Agriculture and Rural Development offices. The secondary data type includes: Sources of irrigation by space, production, input utilization, socio-economic and demographic nature by space and the like.

4.2. SAMPLING DESIGN AND SAMPLE SIZE DETERMINATION

Tigray region had 34 rural districts, among which*Laelay Maichew* district was selected on the basis of simple random sampling method. Furthermore, 200 households were drawn from the sample frame on the basis of systematic random sampling method from each *kebelle*. Respondents were also classified in to two categories (treated and controlled).While reated households were the respondents exercising crop production by employing irrigation water using diversion, controlled households produced only through rain fed. Treated group comprised 88 (44%) sample households. In contrast, the controlled groups comprised 112 (56%) sample households, that do not have access to the irrigation water in any way and this was the reason why they were classified as controlled households. Here it ought to be clear that, the term diversion includes irrigation water sources like: River, spring-water, check-dam, traditional and modern diversion methods.

SAMPLE SIZE IS DRAWN FROM *KEBELLE* (AN AREA REPRESENTING ADMINISTRATIVE BOUNDARY)

No	*Kebelle*	Population	HHH	Beneficiary	Sample	Treated	Control
1	Dura	5,075	1,153	414	21	9	12
2	Aditsehafi	4,758	1,081	351	18	8	10
3	Medoge	6,185	1,406	199	10	4	6
4	Dereka	8,167	1,856	567	29	13	16
5	Debrebrhan	2,537	577	112	6	3	3
6	Seglamen	3,092	703	113	6	3	3
7	Hatsebo	8,643	1,964	284	14	6	8
8	Natkablae	2,617	595	30	2	1	1
9	Lesalso	5,630	1,280	147	7	3	4
10	Welel	5,075	1,153	351	18	8	10
11	Miha	2,776	631	107	5	2	3
12	Mayweini	6,740	1,532	557	28	12	16
13	Edagarbi	5,472	1,244	146	7	3	4
14	Awleo	4,283	973	86	4	2	2
15	Mahbereselam	4,209	956	463	24	10	13
Total		**32,592**	**7,407**	**6,894**	**200**	**88**	**112**

4.3. DATA ANALYSIS

Evidence and findings are analysed using percentages, graphs, mean, and the like. Furthermore, different econometric models were specified in the estimate of the impact of irrigation on household welfare/poverty reduction. However the effort to employ Heckman and PSM models failed, because the assumed and expected selection bias problem of the intervention was not found, this implies that, the intended models to be employed didn't suffer from selection bias, and here only OLS regression method is employed. Using the household survey collected and specified, household welfare model in (1) the control for other regressors or factors that affect household welfare. Impact assessment is tricky and specifications in (1) could reveal baised estimates about the effect or irrigation from diversion on household poverty.

$$\ln C_i = \alpha + \beta H_i + \delta E_i + \psi X + \gamma Irrigation + \varepsilon_i \quad \ldots\ldots(1)$$

Where in C_1 is the natural log of per capital household's expenditure, H1 is vector of regressors accounting for household's demographic characteristics, E_1 is vector of variables representing for market opportunities to products, x is vector of regressors controlling for other factors that affect household welfare, irrigation is indictors of variables measuring access to irrigation from diversion variables. α is the intercept; and β, δ, ψ are vector of parameters to be estimated measuring the effect of households demographic characteristics, market opportunities to products and other control variables respectively γ is parameter of our main interest that measures the effect of irrigation from diversion on household welfare. ε_1 is a white noise disturbance term.

Household welfare model is specified that takes in to account the effect of irrigation from diversion as in (1) above. In fact, the effect of other factors is controlled that affect household welfare by including them as regressors. That is, household's welfare measure in terms of per capita and access to irrigation and other village characteristics. During estimations, we use an indicator to capture household poverty by employing per capita consumption expenditure.

The specification in Table (1) only avoids for omitted variable biases. Indeed in impact evaluation the problem is not only of omitted variable bias but also of endogeneity bias the estimates. The endogeneity problem arises due to measurement error or due to the effect of un-observables that simultaneously affect household's decision to access or use irrigation from diversion and household welfare. That is households decide to access or use irrigation is based on non-random decision factors. These factors may also be factors that also affect household welfare but not observables to the researcher.

5. RESULT AND DISCUSSION

5.1. SEX AND EDUCATIONAL LEVEL DISTRIBUTION

Educational Level of Household Head	Sex of Household Head		Total
	Male	Female	
Never any Schooling	31	5	36
Religious or Traditio	34	5	39
Primary School Incomp	67	10	77
Primary School Comple	15	1	16
Grade 7 Completed	5	3	8
Grade 8 Completed	9	0	9
Grade 9 Completed	1	0	1
Grade 10 Completed	3	1	4
Grade 11 Completed	1	1	2
Technical and Vocatio	1	0	1
Diploma	5	0	5
Degree	2	0	2
Total	174	26	200

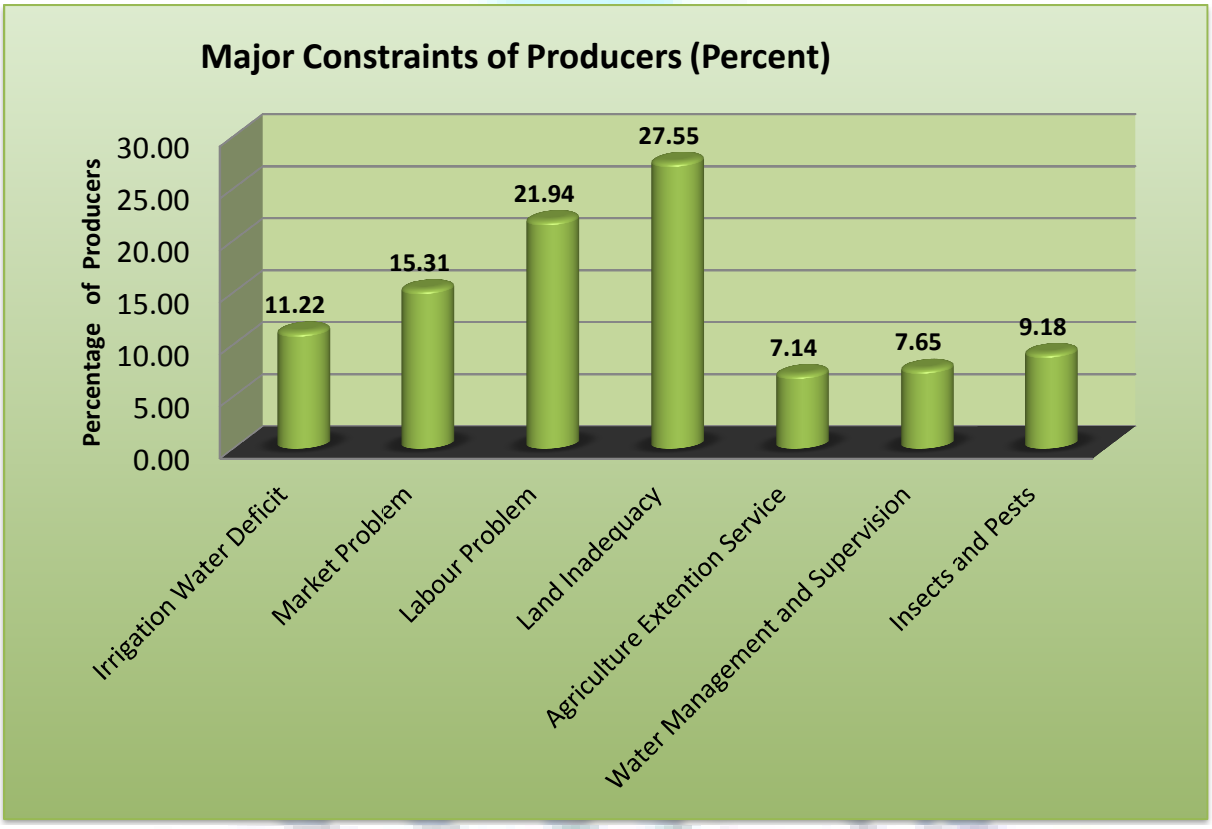
The above table shows that 87% of the respondents are males with females accounting for only 13%. This implies that, the area of farming is an occupation for the male as compared to females, from this context it might be possible deduce that majority of the female are assigned to prepare food for the males while working on their farms, rear and bear children, exercise other home activities and the like. Furthermore, the educational background of the female headed households is lower, majority are illiterate and or never completed elementary school, and this accounts 76.92%. Similarly the educational level of the male headed households is also 75.86%. This implies that, the respondents are less educated.

5.2. SOCIO – ECONOMIC PROFILE OF RESPONDENTS

Variables	Observation	Mean	Std. Dev.	Min	Max
Age in year	200	43.40	11.14496	24.00	80.00
Family size	200	5.57	1.794772	2.00	11.00
Irrigable plot size (hectare)	200	0.16	0.0120588	0.13	0.20
Total plot size (hectare)	200	0.84	0.6936557	0.00	3.50
Per-capita expenditure (birr)	200	5,894.42	5630.322	337.5	54,887.00
Livestock holding (birr)	200	4,576.26	7151.163	83.00	43,570.00
Distance to market (km)	200	7.055	0.7842514	6.00	8.00

Using the STATA software, mean results of different socio-economic profiles are figured out. Age is particularly important factor in farming particularly in irrigation activities, according the above data, the mean age of respondents is estimated at 43.4 years old. Average family size is in fact 5.57 persons per household. Mean of the total plot size and irrigable plot size are 0.84 and 0.16 hectares respectively, and the irrigable plot size seems by far lower. The mean per capita household expenditure and livestock holding are 5,894.42 and 4,576.26 birr respectively. Lastly, the average distance of farm gate to market is estimated at 7 + 055 km.

5.3. MAJOR CONSTRAINTS FACED BY PRODUCERS



Respondents where inquired to explain the major problem they are facing in the crop production via irrigation from diversion sources. 54 (27.55%) of the treated households replied that land for irrigation activity is too small to be engaged in the production at full capacity. The percentage for labour deficit, market and water adequacy problems is 21.94%, 15.31% and 11.22% respectively.

Linear regression

					Number of obs =	167
					F(15, 151) =	14.76
					Prob > F =	0.0000
					R-squared =	0.4946
					Root MSE =	.514

lnper_capi~n	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
asset_hold~g	9.01e-06	4.13e-06	2.18	0.031	8.51e-07	.0000172
lnlivestoc~d	-.0690089	.0349166	-1.98	0.050	-.1379971	-.0000206
lndistance~t	.2446529	.330007	0.74	0.460	-.4073746	.8966805
dummymkt_d~1	.1995005	.0835888	2.39	0.018	.0343459	.3646551
dummywater~2	.6361997	.1203208	5.29	0.000	.3984699	.8739295
dummycashc~2	-.115675	.0844836	-1.37	0.173	-.2825975	.0512476
dummyexten~2	-.1105981	.0845808	-1.31	0.193	-.2777128	.0565165
pesticide_~e	-.0847689	.0845961	-1.00	0.318	-.2519137	.0823759
fertilizer~e	-.0734848	.0844821	-0.87	0.386	-.2404045	.0934349
dummysampl~2	.313691	.1232655	2.54	0.012	.0701432	.5572388
dummyeduc_~4	-.0811157	.1531248	-0.53	0.597	-.3836595	.2214281
lnfamily_tot	-.2554594	.1123633	-2.27	0.024	-.4774667	-.0334522
lnage	.0380915	.1519441	0.25	0.802	-.2621195	.3383026
lnplot_irrig	-.1345674	.4512231	-0.30	0.766	-1.026094	.7569588
dummyhh_re~1	.2900643	.1283021	2.26	0.025	.0365651	.5435635
_cons	7.796663	1.221632	6.38	0.000	5.382965	10.21036

5.4. IMPACT OF IRRIGATION FROM DIVERSION ON HOUSEHOLD LIVELIHOOD

Based on the above multiple linear regression result, we found that asset holding, livestock holding market demand availability, water adequacy for irrigation, sample nature of the respondent, family size, household member relation to the family significantly affecting the per capita annual consumption expenditure. However, variables like distance to market, cash crop production, agricultural extension service, pesticide, fertilizer, household head's education level, age and irrigable plot land found not to have significant effect on per capita annual consumption expenditure.

Natural log of Per Capita Annual Household Consumption Expenditure (lnper_capi~n)

5.4.1. ASSET HOLDING AT HOUSEHOLD LEVEL (asset_hold~g)

Asset holding in this study includes many components like monetary value for agricultural implements, house furniture, precious metals, deposits and the like. Taking household total asset holding as one explanatory variable, the regression output states that, as the household total asset holding increases by one birr, then their effect to the per capita annual consumption expenditure increases by 901%, statistically significant at 10%. This result exhibits an adverse relationship between the explanatory and the dependent variable, implying that, as the number of household members increase the average per capita consumption expenditure declines.

5.4.2. NATURAL LOG OF HOUSEHOLD LIVESTOCK HOLDING (lnlivestoc~d)

Keeping other factors constant, taking household total livestock holding as one explanatory variable, the regression output states that, as the household livestock holding increases by 1%, then the effect to the per-capita annual consumption expenditure decreases by 6.9%, which is statistically significant at 10%. This result exhibits an adverse relationship between the explanatory and the dependent variable, implying that, household's labour and other resources need to concentrate in the irrigation activities. The culture exercised by local farmers for mixed agricultural production seems ambiguous, because the enterprise from livestock raring is adversely affecting household welfare (engaged in irrigation activities). In this context, it is simple now to deduce that the co existence of labour and capital competition by both enterprises (livestock raising and crop production from irrigation). Immense empirical evidence argue that in rural communities households engage in more than one livelihood activity at a time (Ellis 1999; Bryceson 2000; Ellis et al. 2003). This is to mean that, taking our result case; livestock raring is not the primary livelihood activity of the household as the activity that generates the highest proportion of the household's overall income is from participation in crop production from irrigation water.

5.4.3. MARKET DEMAND AVAILABILITY TO COMMODITY, DUMMY VARIABLE (dummymkt_d~1)

Market demand availability to agricultural produce from irrigation is to refer the intensity of adequacy to demand to the commodity under consideration, and here as the demand availability to commodities produced from irrigation increases by a unit, then the per capita annual consumption expenditure of the rural poor involved in the irrigation increases by 19.95%, this is statistically significant at 5%. This result exhibits positive relationship between demand adequacy to products from irrigation water and farmers income explained in consumption expenditure. This implies that, as the degree and intensity of transactions to products from irrigation increases in magnitude then welfare of the treated household's increase.

5.4.4. WATER ADEQUACY FOR IRRIGATION, DUMMY VARIABLE (dummywater~2)

Respondents were inquired to explain on whether they had adequate water source mainly small scale diversion for irrigation. This variable was regressed against household welfare, and the STATA result exhibited that, as the treated household's access to water resource for irrigation increases by a unit, then the per capita annual consumption expenditure increases by 63.61%, statistically significant at 5%. This result exhibits a positive relationship between the explanatory and the dependent variable, implying that, water source endowment to a location really matters. Please refer the aside STATA window, and is depicting that, the income explained in per capita household consumption expenditure of the treated households (with access to irrigation) is greater by 2,332.17 birr as compared to the controlled households, the ttest is statistically significant at 1%. Physical availability and adequate allocation of irrigation water are two of the most pressing resource management issues globally (Tinoush J. J. etal. 2009).

5.4.5. SAMPLE NATURE OF THE RESPONDENT, DUMMY VARIABLE (dummysampl~2)

Here sample nature of the respondents is to demarcate between control and treated households. In this regard, the regression output attempts to explain that, the consumption expenditure explained by household welfare increases by 31.36%, compared to the controlled households. This regression is significant at 5%. This implying that, as the households participation in diversion small scale irrigation increases, their welfare and income increases. World Bank clearly underlined that, access to irrigation water largely contributes to food security of the rural population. In particular, irrigated agriculture contributes 30-40 per cent to the Gross Domestic Products (GDPs) of Central Asian countries, mainly Kyrgyzstan, Tajikistan and Uzbekistan (World Bank, 2003).

5.4.6. EFFECT OF HOUSEHOLD TOTAL FAMILY SIZE ON PER CAPITA ANNUAL CONSUMPTION EXPENDITURE: NATURAL LOG OF HOUSEHOLD TOTAL FAMILY SIZE (lnfamily_tot)

Keeping other factors constant, taking household total family size as one explanatory variable, the regression output states that, as the household total family size increases by 1%, then their effect to the per capita annual consumption expenditure decreases by 25.54%, statistically significant at 5%. This result exhibits an adverse relationship between the explanatory and the dependent variable, implying that, as the number of household members increase the average per capita consumption expenditure declines compared to small sized households.

5.4.7. HOUSEHOLD MEMBER RELATION TO FAMILY, DUMMY VARIABLE (dummyhh_re~1)

Citrus paribus, the regression output states that, as the household membership to the family is head, then the effect to the per capita annual consumption expenditure increases by 0.29%, statistically significant at 5%. This result exhibits a positive relationship between both variables.

5.5. TESTS AND REGRESSION DIAGNOSTICS

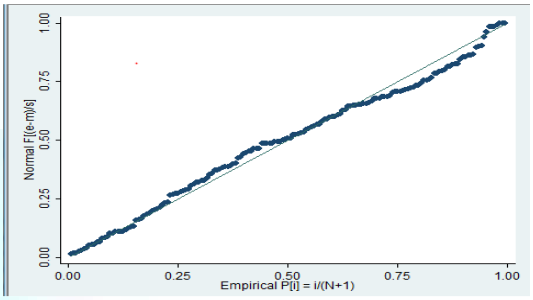
The ordinary linear regression (OLS) is employed in investigating the impact of irrigation from diversion. To reassure the robustness of our empirical evidences extracted from the data, it urges to examine the distribution of the variables, without verifying the data on whether the assumptions underlying OLS regression are rectified or not. This is therefore to check the assumptions of OLS regression are attained. It should be noted that, for the regression case, problems like: model specification, normality, heteroskedasticity, and multicolinearity assumption are tested. Furthermore, the sum mismatched variables are rectified by transformation and robust regression methods. Please refer the tests in the following test diagrams.

MODEL SPECIFICATION TEST

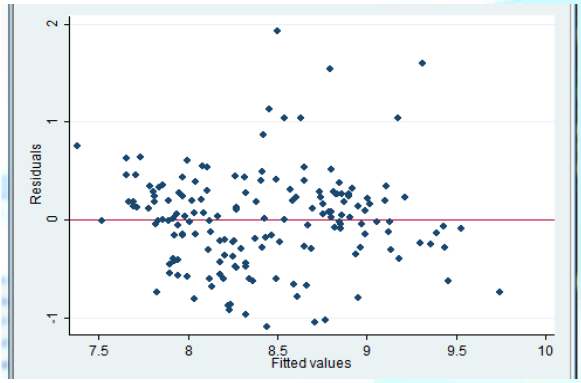
Source	SS	df	MS		
Model	39.1891925	2	19.5945963	Number of obs =	167
Residual	39.7423046	164	.242331126	F(2, 164) =	80.86
				Prob > F =	0.0000
Total	78.9314971	166	.475490947	R-squared =	0.4965
				Adj R-squared =	0.4904
				Root MSE =	.49227

lnper_capi~n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	-.9588334	2.477937	-0.39	0.699	-5.851606	3.933939
_hatsq	.1152524	.1457213	0.79	0.430	-.1724794	.4029842
_cons	8.295582	10.50972	0.79	0.431	-12.45623	29.04739

CHECKING NORMALITY OF RESIDUAL



HOMOSCEDASTICITY OF RESIDUALS



MULTICOLLINEARITY TEST

Variable	VIF	1/VIF
dummysampl~2	1.97	0.508564
dummywater~2	1.74	0.573277
dummymkt_d~1	1.50	0.667131
asset_hold~g	1.37	0.728715
pesticide_~e	1.33	0.754320
lndistance~t	1.26	0.796257
dummycashc~2	1.23	0.813537
dummyexten~2	1.14	0.874497
lnage	1.13	0.886605
dummyeduc_~4	1.13	0.886908
lnplot_irrig	1.11	0.903937
fertilizer~e	1.10	0.907002
lnlivestoc~d	1.05	0.948298
lnfamily_tot	1.04	0.961359
dummyhh_re~1	1.04	0.963882
Mean VIF	1.28	

6. CONCLUSION AND SUGGESTIONS

Based from the data analysis the following concluding remarks are noted.

- Using the STATA software, mean results of different socio-economic profiles are figured out. Mean of the total plot size and irrigable plot size are 0.84 and 0.16 hectares respectively, and the irrigable plot size seems by far lower. The mean per capita household expenditure and livestock holding are 5,894.42 and 4,576.26 birr respectively.
- Respondents where inquired to explain the major problem they are facing in the crop production via irrigation from diversion sources. 54 (27.55%) of the treated households replied that land for irrigation activity is too small to be engaged in the production at full capacity. The percentage for labour deficit, market and water adequacy problems is 21.94%, 15.31% and 11.22% respectively.
- Based on the multiple linear regression result, we found that asset holding, livestock holding market demand availability, water adequacy for irrigation, sample nature of the respondent, family size, household member relation to the family significantly affecting the per capita annual household consumption expenditure. However, variables like distance to market, cash crop production, agricultural extension service, pesticide, fertilizer, household head's education level, age and irrigable plot land found not to have significant effect on per capita annual consumption expenditure.
- The regression output states that, as the household livestock holding increases by 1%, then the effect to the per-capita annual consumption expenditure decreases by 6.9%, which is statistically significant at 10%. This result exhibits an adverse relationship between the explanatory and the dependent variable, implying that, household's labour and other resources need to concentrate in the irrigation activities.
- Market demand availability to agricultural produce from irrigation is to refer the intensity of adequacy to demand to the commodity under consideration, and here as the demand availability to commodities produced from irrigation increases by a unit, then the per capita annual consumption expenditure of the rural poor involved in the irrigation increases by 19.95%, this is statistically significant at 5%. This result exhibits positive relationship between demand adequacy to products from irrigation water and farmers income explained in consumption expenditure.
- Respondents were inquired to explain on whether they had adequate water source mainly small scale diversion for irrigation. This variable was regressed against household welfare, and the STATA result exhibited that, as the treated household's access to water resource for irrigation increases by a unit, then the per capita annual consumption expenditure increases by 63.61%, statistically significant at 5%. This result exhibits a positive relationship between the explanatory and the dependent variable, implying that, water source endowment to a location really matters.
- The regression output attempts to explain that, the consumption expenditure explained by household welfare increases by 31.36%, compared to the controlled households. This regression is significant at 5%. This implies that, as the household's participation in diversion small scale irrigation increases, their welfare and income increases.
- Coming again to household total family size as one explanatory variable, the regression output states that, as the household total family size increases by 1%, then their effect to the per capita annual consumption expenditure decreases by 25.54%, statistically significant at 5%. This result exhibits an adverse relationship between the explanatory and the dependent variable.

7. ACKNOWLEDGMENT

The first appreciation goes to all the respondents who shared their information and invaluable ideas. Furthermore, I am very grateful for the enumerators who have worked hard to get the required information through administered questionnaire and who carefully posted the data in to the data spreadsheet. Last but not least.

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