Irrigation, Food Production and Consumption Pattern in Smallholder Rural Households

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by

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ABSTRACT

Conceptually, the benefits of irrigation are realized through improvements in agricultural productivity. At household level, the agricultural production increases could be followed by improvements in food consumption patterns. The goal of this thesis is to examine the relationship between irrigation, food production and household consumption patterns for the rural smallholders. A survey was undertaken and information was collected on demographics, landholdings and agriculture, irrigation, returns of crop cultivation, consumption behaviors, farmer perceptions and experiences, and other related variables. The results show that the addition of irrigation to the overall production system increases the agricultural income of households but the amounts spend on food for each household did not increase as consequence. However better dietary diversity was found on the consumption pattern of the irrigated households with higher income. Integrated approaches are needed to secure a healthy diet when the food supply of the family is increasing.

Key words: Irrigation, agriculture production, household, food consumption

BIOGRAPHICAL SKETCH

Yidnekachew Ewnetu was born in 1985 EC and grew up in Debretabor, Ethiopia where he completed his elementary through high school studies. Then he joined Mekelle University and received a BSc. Degree in Natural Resources Economics and Management. He worked in the Amhara Region of Ethiopia as a food security programs coordinator after the completion of his undergraduate program. After one year time he had the chance to attend a Master of Professionals Degree Program by Cornell University which was hosted by Bahir Dar University in Bahir Dar, Ethiopia.

"This work is dedicated to my family and friends who love me"

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LIST OF ABBREVIATIONS

ETB	Ethiopian Birr
FAO	Food for Agriculture Organization
HH	Household
PA	Peasant Association
ROA	Rain-fed only agriculture
RIA	Rain-fed + Irrigated agriculture
UN	United Nations

CHAPTER ONE

1. INTRODUCTION

Although food is one of the basic human needs, it has been a great challenge for many nations to satisfy the demand for food. The number of people consuming less than the nutritional requirement of 2,100 calories per day in Sub-Saharan Africa was estimated at 337 million in 2001. This is equal to 57 percent of the population of the region (Rosen and Shala, 2002). Studies show that the world population could reach eight billion by 2025. Nearly all of the increase of two billion people in the next 25 years will be in the developing countries (McCalla, 2001).

Several reasons have been given for the shortage of food in the agricultural systems of Africa: Small-scale farming, land degradation, weak linkages to markets and little or no access to external inputs (Clover, 2003). In addition, the ever-increasing size of population has put great pressure land and water resources, which are the major agricultural production factors. In fact, future agricultural output will have to be produced with less land and less water and in a resource friendly way (McCalla, 2001). Therefore, a key strategy to alleviate poverty and improve food insecurity of Sub Sahara Africa is to assist poor farmers in increasing productivity (Tafesse**,** 2003). One of the ways to increase productivity is with irrigation. Meanwhile, irrigation needs to be combined with other or additional inputs such as higher-yield crop varieties, pest control chemicals or strategies, and nutrient applications (e.g., fertilizer). Experience has shown that irrigated agriculture in addition to other development interventions makes more food available but may not necessarily improve the food security of individual households of the users (Tafesse**,** 2003). It is important to differentiate between “enough to eat” and “food security”. Food security exists when "all people at all times have access to safe nutritious food to maintain a

healthy and active life" (FAO, 1996). The main goal of food security is for individuals to be able to obtain adequate food needed at all times, and to be able to utilize the food to meet the body's needs. Food security is multifaceted. The World Bank (2001) identified three pillars underpinning food security; these are food availability, food accessibility, and food utilization

Food availability for the farm household means ensuring that the produce sufficient food for their own consumption. However, due to lack of adequate storage facilities and pressing needs for cash to spend on other household items, the households end up in many cases selling excess produce during the harvesting period, and sometimes rely on market purchases during the "hungry" season in the months before harvest. *Food access* means reducing poverty. Simply making food available is not enough; one must also be able to purchase it, especially the low-income households (Sen, 1981). Farm families with limited access to productive resources such as land, inputs and capital, required for attaining physical efficiency in food production could be food insecure, i.e., resource poverty could lead to low productivity, food insufficiency, and lack of income to purchase the needed calories.

Food utilization means ensuring a good nutritional outcome, which is nutrition security. Having sufficient food will not ensure a good nutritional outcome if poor health due to unrelated (or related) causes results in frequent sickness. Building this pillar means investing in complementary resources such as nutrition education, health care, provision of safe water and better sanitation, instituting gender symmetry, and removal of child abuse practices (Doppler, 2002).

Because increasing yield alone cannot be an indicator for household food security, this study attempts to examine the relationship between households' food production, irrigation use and household food consumption in the rural livelihood systems of Ethiopia. Specifically, we will:

- Assess the agricultural income disparity between households that use irrigation water and those that do not
- Analyze the households' food consumption patterns with varying levels of agricultural income
- Analyze households' food utilization and consumption patterns, and its implications on household food security

The study was conducted in Gumara watershed in Fogera woreda, which is one of the eight Woredas bordering Lake Tana. This woreda has an estimated 23,354 ha of water bodies. The Woreda is classified as one of the surplus agricultural production Woredas in the Region. The Gumara watershed is endowed with beautiful diverse natural resource, with capacity to grow diverse annual and perennial crops. The altitude ranges from 1774 to 2410 masl. The mean annual rainfall is 1215 mm and ranges from 1100 to 1340 mm (MoA, 2005).

CHAPTER TWO

2. BACKGROUND INFORMATION

2.1 Impact of increased supply

Increasing production and productivity of agricultural systems is the main focus of many development interventions which in turn are expected increase for food security. Below selections on the expected impacts of increased food supply are quoted from: DFID (2002):

1. Agriculture contributes directly and indirectly to poverty reduction and food insecurity. Most importantly it supports *access* by providing poor people with income and employment opportunities. But it also contributes to *supply* through production of food, raw materials and other environmental, social and cultural goods and services. It promotes and supports economic growth, creates jobs and ensures that there is enough food at a global level. Where there is a geographical mismatch between demand and supply, agriculture productivity can play critical role in reducing the vulnerability of the poor, through its impact on food availability and prices. A better understanding is needed of the specific role of sustainable agricultural development in poverty reduction and pro-poor growth in different circumstances.
2. But increasing food production on its own will not reduce hunger and poverty. It is important not to equate food security with food production or to conclude that hunger will be solved simply through increased investments in agriculture. In some areas and for some vulnerable groups, for example subsistence farmers in areas with few other opportunities, farming is a direct contributor to food security. But for many poor consumers such, as the urban poor, the rural landless and the destitute, agriculture contributes only indirectly. There may be significant linkages with the agricultural sector, and agricultural productivity does play role in keeping

food prices down is important. But it is important to know who produces the food, who has the technology and knowledge to produce it, and who has the power to purchase it.

2.2 Increased number of different foods or food groups consumed

The number of different foods or food groups consumed in a household provides a measure of the quality of the diet by reflecting dietary diversity, thus serving as an important complement to the eating occasion's indicators. To accurately capture dietary diversity, this indicator should be evaluated in terms of the variety of food groups (meats, milk, fruits, and vegetables) consumed, rather than by simply totaling all types of foods consumed (Swendale and Ohri-Vachaspati, 1999).

As a food-security indicator, dietary diversity is usually highly correlated with such factors as caloric and protein adequacy, percentage of protein from animal sources (high quality protein), and household income. Even in very poor households, increased food expenditure resulting from additional income can serve to increase the quantity and quality of the diet. Calculating dietary diversity requires only marginally more detailed information than is required to assess the number of daily eating occasions. Therefore, the data are still relatively easy and inexpensive to collect and analyze (Swendale and Ohri-Vachaspati, 1999).

For ease of analysis, the number of different food groups consumed should be calculated, rather than the number of different foods. Knowing that households consume, for example, an average of four different food groups implies that their diets offer some diversity in both macro and micro-nutrients. This is a more meaningful indicator than knowing that households consume four different foods, which might all

be cereals. The U.N. Food and Agriculture Organization (FAO) (1984) use the following set of food groups in its food balance sheets:

1. Cereals
2. Root and tubers
3. Pulses/legumes
4. Milk and milk products
5. Eggs
6. Meat
7. Fish and seafood
8. Oil/fats
9. Sugar/honey
10. Fruits
11. Vegetables
12. Miscellaneous

These groups can be adapted to the local context to reflect both cultural and economic patterns in food selection (e.g., "high" and "low" status foods). The list can also be expanded to specify foods of particular nutritional value, such as those high in Vitamin A or iron. The groups used for a particular survey should be meaningful with respect to the program objectives and project-level interventions. For example, while including the addition of sugar or soft drinks to the list may not indicate improved nutritional status, it may be associated with increased income. This would be important to measure if the project goal is "improved food security through increased income." Nonetheless, the total number of groups included in this indicator should not be too large, as interpretation of results becomes difficult. (Swendale and Ohri-Vachaspati, 1999)

2.3 Fine tuning indicators

In Ethiopia, cereals, mainly teff, are the basic constituents of the daily diet and legumes and livestock products are added to the diet with increases in income. Ethiopian cuisine characteristically consists of spicy vegetable and meat dishes, usually in the form of *wat* (or wot), a thick stew, served on top *injera*, a large sourdough flatbread, which is about 50 centimeters (20 inches) in diameter and made out of fermented teff flour (Henze, 2000). In programs where increased consumption of Vitamin A rich fruits and vegetables is encouraged, an appropriate diversity indicator could separate fruits and vegetables high in Vitamin A to form another group Once the set of food groups has been defined, data for the "number of food groups" indicator can be collected by asking each respondent a series of yes - or - no questions. This allows the interviewer to list the predominant products from each food group consumed by the respondent's household, and thus provide relevant examples for each of the food groups (Swendale and Ohri-Vachaspati, 1999).

The respondent should include the food groups consumed by household members in the home, or prepared in the home for consumption by household members outside the home (e.g., at lunchtime in the fields). As a general rule, foods consumed outside the home that were not prepared in the home should not be included. While this may result in an underestimation of the dietary diversity of individual family members (who may, for example, purchase food in the street), the indicator is designed to measure household diversity, on average, across all members. Including food purchased and consumed outside the household by individual members increases the risk of overestimating the dietary diversity of household members overall. However, in situations where consumption outside the home of foods not prepared in the household is very common, survey implementers may decide to include those foods

when measuring this indicator. Such decisions should be clearly documented, so subsequent surveys can use the same method. The following data in Table 1 is an example of data collection for a number of food groups:

Table 1: An example of data collection for a number of food groups

Interviewer: Yesterday, did you or anyone in your household consume…		
Food Group	Yes	No
Cereals and Grains	1	0
Grain Legumes	1	0
Roots	1	0
Meat, Milk, Poultry and eggs	1	0
Vegetables	1	0
Fruits	1	0

The sum of the "yes" responses quantifies the indicator for each household, which can then be averaged over the target population. For a sample among three households (A, B, and C), the responses might look something like those in Table 2 below. An answer of "yes" takes the value of 1; a "no" answer takes the value of 0.

Table 2: An example of filled format for a number of food groups data collection

	A		**B**		**C**	
Food Group	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Cereals and grains	1		1		1	
Grain legumes	1		1		1	
Roots	1			0		0
Meat, milk, poultry and eggs	1			0	1	
Vegetables		0	1			
Fruits	1			0	1	
Total	5		3		4	

In this example, household A has the greatest dietary diversity, with a score of 5; household B has the least diversity, with a score of 3. The average diversity of the sample is (5+3+4) divided by 3 or 4.

CHAPTER THREE

3. STUDY SETTING AND METHODS

3.1 Sampling and Data Collection

During August, September and October 2008, a survey was conducted on 160 smallholders in four kebelles of Gumara watershed from the Northern highlands of Ethiopia. The kebelles are under the administration woreda of Fogera in the Amhara Regional State. Irrigated agriculture is found in some parts of all the kebelles, while rain-fed agriculture is common to all.

It is important to note that surveyed kebelles were selected considering their similarity in agro ecology and cultural behaviors of households. The only intention was to observe production difference among households due to their access to irrigation water for agriculture. Thus, it was possible to look for the households' food consumption response for agricultural income shift.

Households with rain-fed only and irrigated + rain-fed agriculture were the targets for the survey. The intention was to select twenty households from each system. Thus, twenty households were randomly selected from each of the four kebelles. The selection procedure was such that each household was selected at random from a list of the kebelle people. Each of these selected households was given the chance to select one household in their kebelle who was in the opposite system and who is not in the list of the first sample. For example, a household from the list of kebelle households was selected and found to practice rain-fed only agriculture. This household then selected another household in the same kebelle but practicing rain-fed and irrigated agriculture and not yet selected for the survey. In the end it was possible to get twenty samples in each of the two systems in the four kebelles.

The sampled households were interviewed with pre-tested structured questionnaire for gathering data and information on various aspects of household economies including demographics, landholdings and agriculture, irrigation, returns of crop production, food consumption behaviors, farmers' perceptions and experiences, and other related variables (see Appendix for the survey questionnaire). The survey covered all cropping seasons during the 2007/08 agricultural year. The methods and measurements for the two basic variables, agricultural yield and food consumption pattern needs detailed explanation.

3.2 Agricultural Production

There are two major rivers that are of great economic importance to the woreda. These rivers are mainly used for irrigation during the dry season for the production of horticultural crops, mainly vegetables. Some farmers also use ground water to produce vegetables, cereals and pulses.

Gumara River is one of the rivers which cross the four target kebelles of this study area. Household surveys were used to gather recent agricultural yield data from the sample households which were selected in equal proportion from households with rain-fed only and rain-fed + irrigated agriculture systems. Households were asked to recall the yields from all crops grown during the production year of 2007/08. The amount of yields was initially recorded using the number of sacks, for cereals and grains, and wood boxes, for vegetables. The appropriate weights of such local packages were taken from measurement. The weight in kilograms of each crop yield was then recorded in a format which contains all types of crops which is grown in the area. In addition the cultivated land size and price of the harvested crops during harvesting period was obtained from the survey. The crop yields were converted to

monetary value using the average annual market prices of each crop. The aggregated yield value of each household was taken as an indicator for the agricultural income level of the households.

3.3 Household Food Consumption Pattern

Households' food consumption was estimated using the total value of food consumed by the household, including own production, and the number of different foods and food groups consumed in a week period of time. If the intention is to correlate household consumption with other household variables, as well as to analyze consumption patterns and their determinants, FAO recommended using at least four days of recall per household. Thus total food expenditure for the last 7 days before the interview date was taken as food budget.

A food balance sheet was used to record the consumed food items. It contains food items which are the common food sources of the society (see the appendix page 32 for the table containing the food groups). The quantities of each food items were converted to monetary value using the average annual market prices. The household member who is responsible for food preparation and food stock transaction was interviewed to complete the food balance sheet.

Chi square statistic test was made to determine whether or not agricultural income have a statistically significant relationship with households' food budget and dietary diversity. In addition, the significance of agricultural income differences between household groups under the system of rain-fed only and rain-fed + irrigated agriculture was tested using independent samples testing method. The tests were done using Statistical Package for Social Science (SPSS) for Windows Release (SPSS, Inc.,

Chicago, Illinois). The data was also analyzed using statistical methods through Microsoft Excel and the outputs of the analysis are here presented using graphs, tables and figures.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Irrigation and Food Production

Gumara River has created opportunities for irrigation development, which is believed to be a means for livelihood improvement in the watershed. Besides the river, ground water is the alternative source of irrigation water. Eighty-five percent of the respondents from rain-fed + irrigated agriculture are irrigating from the river and its feeders, 6% are from the ground water and the remaining 9% use springs, ponds and other sources. Pumping motor and pedal pumper are the two basic technological tools of the irrigation system. Due to its lower price, pedal pumpers are owned by more RIA households (47% of the respondents). Only 31% of the households have their own motor pump, while the remaining do not own but rent pumps.

Principal irrigated crops are shaded in the Table 3. Onion, rice, and chickpea are the major crops grown using irrigation water (Table 3). Similarly rice, chickpea and maize are the major crops in the rain-fed agriculture. Currently the major marketable crop commodities in each farming systems as agreed by the watershed community are rice, horticulture (onion, pepper and tomatoes), oil crop (*noug*) and Pulses (chickpea). Table 3 also shows the dominancy of such marketable crops.

Table 3: Mean annual crop production in rain-fed + irrigation (RIA) and rain-fed only (ROA) agriculture systems based on collected survey data

Crop types	Average annual Price (ETB per 100kg)	**Mean annual production values per households/ETB/**			
		rain-fed + irrigation		rain-fed only	
		Thousands ETB	Percentage	Thousands ETB	Percentage
Rice	753.0	20.8	38	16.4	51. 9
Maize	420	3.0	5	2.7	8.4
Teff	887	2.0	4	3.0	9.4
Onion	510	18.9	34	0.0	0.0
Chickpea	850	4.0	7	4.6	14.6
pepper	3375	0.1	0.2	0.0	0
Tomato	167	1.0	2	0.0	0
Sorghum	583	1.3	2	1.2	3.9
Millet	706	2.7	5	3.7	11.6
Noug	400	0.2	0.5	0.1	0.5
Total		*54.8*	*100*	*31.8*	*100*

Irrigated rice and onion production systems account for 72% of the total crop income in the RIA system. Rice production has been introduced some five years ago in the Fogera plains with 30 farmers in two peasant associations on 6 ha of land. It is grown during the main rainy season and is planted in June. The only rice variety used is locally known as X-Jigna. The mean yield is about 3.5 ton/ha and ranges from 2 to 8 ton/ha depending on the land type and management practices. Horticultural crops production, particularly onion, is the other major agricultural activity during the dry season using irrigation.

Rice, teff, maize, sorghum, chickpea, millet and *noug* are cultivated through rain-fed agriculture; whereas rice, onion, pepper and tomato are cultivated through irrigated agriculture. A significant annual farm income difference exists between household groups with rain-fed only agriculture (ROA) and with those who rely on rain-fed +

irrigated agriculture (RIA). Figure 1 clearly indicates that the marginal income for every additional hectare of land is increasing at a higher rate in RIA than the ROA system.

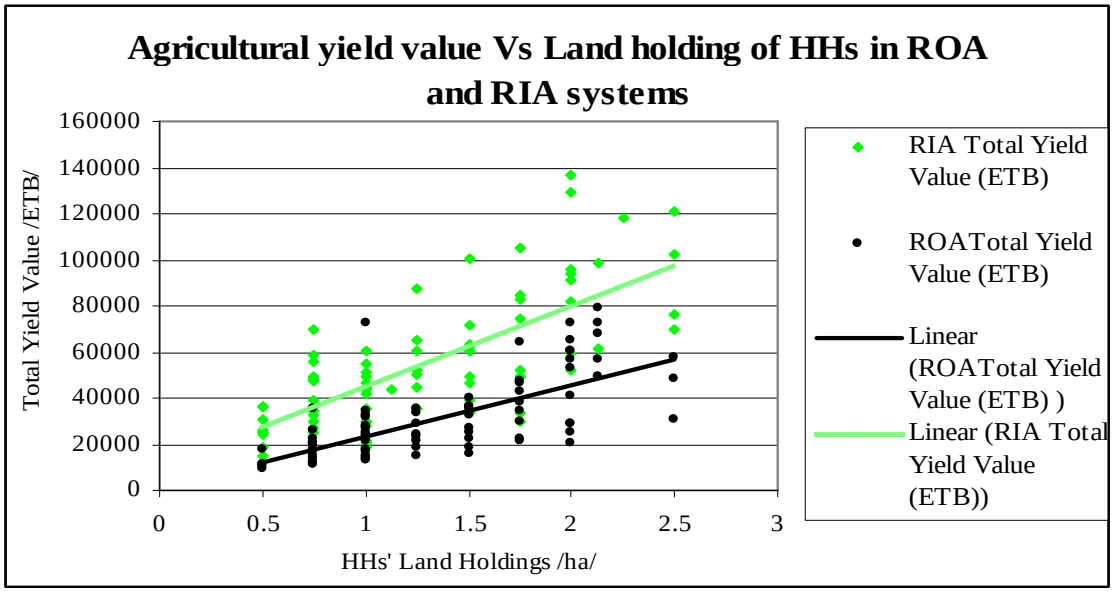

Figure 1: Land holding and agricultural yield in both rain-fed only agriculture (ROA) and Rain-fed and irrigated agriculture (RIA) systems

The irrigation agriculture is mainly market-oriented, whereas rain-fed agriculture is dominated by crops intended for household consumption. The RIA HHs earn an average income of 23,900 ETB from irrigated crops, which is 43% of their total (Table 3). RIA households also earn 43% more farm income per hectare of land than the ROA households. Rice, onion and maize account for 38, 34 and 7% of the total crop yield income, respectively, in RIA (Table 3).

As shown in Table 4, the significance value of the Levene's test for equality of variances is less than 0.05; hence it is possible to conclude that the average of 5,706

ETB more income by RIA households is not due to chance alone. In summary, irrigation allows a hectare of land to produce more than rain-fed agriculture. The value of per hectare crop production under irrigated settings is about twice that under rain-fed settings. So the introduction of irrigation if water is available could be taken as a key strategy for increasing production and farm income of smallholder households.

Table 4: Independent samples test for per capita yield income of households (HHs) in the RIA and ROA system

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
									Lower	Upper
per capita yield income of HHs	Equal variances assumed	5.2	.024	-8.4	158	.0	-5706	6799	-70479	-43655
	Equal variances not assumed			-8.4	141	.0	-5706	6799	-7048	-43644

4.2 Food Production and Consumption

Conventionally it is believed that as income raises, households both the amount of food and the composition of the diet change. In particular, there is a substitution of higher-value for lower-value foods (Arjunan, 2001). Thus our hypothesis was that increments in households' agricultural income would bring improvements in households' food consumption pattern both in quantity and nutritional quality. However, the food consumption data of the sampled households reveals that there is no significant difference among households with varying agricultural income (Table 5).

Table 5: Chi-Square tests for the relationship between agricultural income and households' food budget

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19680 (a)	19557	.27
Likelihood Ratio	1518	19557	1
Linear-by-Linear Association	28	1	.0
N of Valid Cases	160		

a 19840 cells (100.0%) have expected count less than 5. The minimum expected count is .01.

To determine whether or not this value indicates a significant relationship, it is important to examine the probability that this distribution of frequencies occurred by chance alone. The conventional probability level used to answer this question is **.**05**.** And if the probability is greater than .05, then the variables are not significantly related. Since the probability is greater than .05, which is 0.266 in Table 5, it is possible to conclude that there is no a statistically significant relationship between agricultural income and households' food budget. It becomes the same for the relationship between agricultural income and dietary diversity with a probability of 0.444 which is far greater than the conventional probability level of 0.05 (Table 6).

Table 6: Chi-Square Tests for the relationship between agricultural income and dietary diversity

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	800 (a)	795	.44
Likelihood Ratio	470	795	1
Linear-by-Linear Association	49	1	.0
N of Valid Cases	160		

a 960 cells (100.0%) have expected count less than 5. The minimum expected count is .01.

Even though RIA households have earned higher income than ROA households from crop production, their consumption of cereal foods is not different. The RIA households have incorporated some additional food items in their diet. Since nutrient availability is varied among various food items, it is plausible that the RIA households on average have a more balanced diet.

Either the non-food expenditures or the savings of the RIA households should have to reflect the excess agricultural income over the ROA households. As evidence 75% of households who have the tin roofed house are from RIA households. Only 17% of the ROA households have the tin roofed house, the rest lives on a grass roofed houses. Thus, RIA households may be using their additional income from agricultural production to purchase items other than food.

Figure 2 illustrates the linear relationship between HHs' agricultural income and their food consumption expenses. The positive slope of the line graph indicates that there the food consumption expenses only increase marginally when the farm income increase, while the farm income elasticity of food consumption expenses is nearly zero.

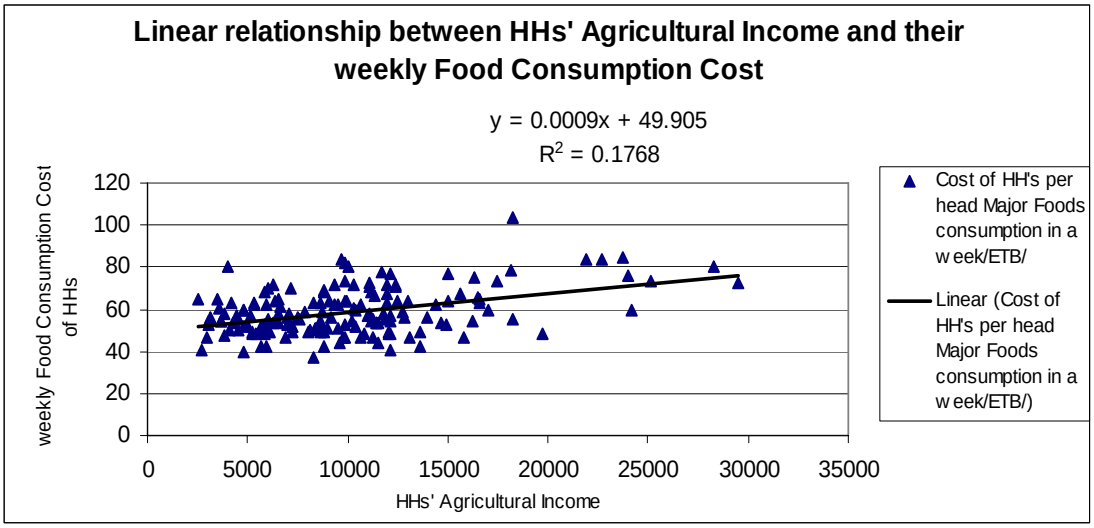

Figure 2: Relationships between households' agricultural income and their food budget

For the other indicator of food consumption used in this study, dietary diversity, six major food groups were identified (Table 7). The number of different foods or food groups consumed in a household provides a measure of the quality of the diet by reflecting dietary diversity, thus serving as an important complement to the eating occasion indicators. The high income RIA HHs consume more of four food groups than ROA HHs which have the lower income. These are grain legumes, roots, meat-milk-poultry and eggs, and vegetables. All households in the two systems have consumed cereals and grains. Fruits were taken by few households in both settings with a week period of time. The food groups which constitute the livestock products are preferred foods and their consumption is taken as a reflection of social status.

Table 7: Dietary diversity of the consumed food in RIA and ROA households

HH Groups	Percentage of HHs Having the food groups					
	Cereals and Grains	Grain Legumes	Roots	Meat, milk, poultry and eggs	Vegetables	Fruits
RIA HHs	100	89	72	39	81	10
ROA HHs	100	79	46	25	66	10
Average	100	84	59	32	74	10

Food consumption items are directly linked with the varieties which are produced in the farmyard. Rice, chickpea, teff and maize are frequently used for the daily diet. The households may have concerns depending on purchased food, instead they prefer to produce crops for own consumption and send the surplus to the market. Due to urbanization and settlement of basic infrastructures, of the availability of grazing land is diminishing over time. In response, the price of forage has increased, resulting in higher profits for forage producers. But the community is still resisting devoting a piece of land for forage cultivation. Price variability and lack of predictability are stated as reasons for their unwillingness to specialize in recently-introduced cash crops like onion, and forage production. Even though the agricultural income has risen through introduction of irrigation, households still apparently fear finding themselves with insufficient cash income to maintain desired (or necessary) consumption levels.

4.3 Food Utilization

Food utilization means ensuring a good nutritional outcome, which is nutrition security. This study did not assess all the dimensions of food utilization, but we analyzed the gain from agricultural income increases. As income increases, an increase is expected in the consumption of quality foods such as pulses, fruits, milk

and diary products, which, while adding to calories, contribute significantly to the increase in other nutrients particularly lacking in the diets of the poor.

In Gumara watershed, changes occurred in the diet in response to a change in economic circumstances. The number of food groups consumed by high-income groups, RIA HHs, is 20% greater than the ROA HHs (Table 8). The difference has come due to the shifts in consumption by high income groups from the usual cereals and grain legumes to the highly preferred livestock products. Cereals remains and important food group because it is the basic components for almost all of the traditional menus.

Table 8: Dietary diversity of households in both ROA and RIA system

HH Groups	RIA	ROA	Average
HH size	4.2	4.5	4.4
HH Land Holding (ha)	1.3	1.4	1.3
Average of HHs' Annual Total yield income/thousands ETB/	54.8	31.8	43.3
Average of HHs' Annual per capita yield income/thousands ETB/	12.9	7.2	10.1
Cost of HHs' Major Foods consumption in a week/ETB/	252	253	252.5
Cost of HH's per head Major Foods consumption in a week/ETB/	61	57	59
Dietary Diversity of HHs in a week	3.9	3.3	3.6

4.4 Production and Food Security

According to FAO's definition food security exists when "all people at all times have access to safe nutritious food to maintain a healthy and active life" (FAO, 1996). This encompasses the three pillars of food security: access, availability and utilization of food. Improvements in food production could raise the availability of food. It could

also raise the agricultural income of the producer and improve purchasing power, under certain circumstances. However, in the case of large productivity increases, prices for food crops could fall more than production increases (because the demand for food tends to be price and income inelastic), resulting in lower incomes for net sellers of food crops (but benefits for net buyers). This would result in households relying more on their own production, which typically will include a small number of food groups. The probability of getting wider range of the basic food nutrients gets smaller. This logic reveals that production increments could not necessarily result household food security.

In Gumara watershed, production increases raised only agricultural income. The marginal increase in food budget did not respond significantly. Meanwhile, dietary diversity of households' consumption has shown a positive change in response for rise in agricultural income (Figure 3).

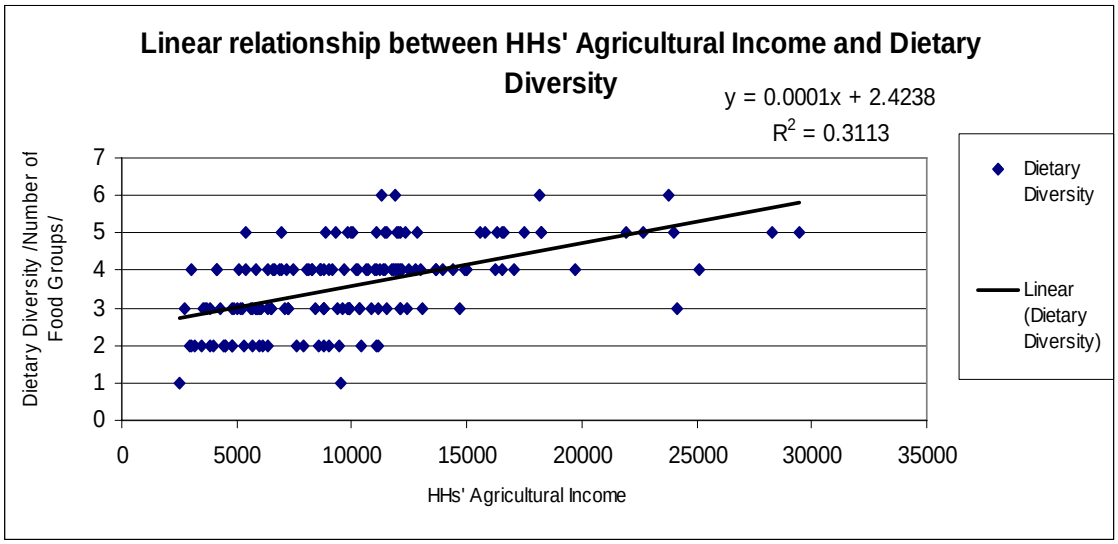

Figure 3: Households' agricultural income and dietary diversity

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Conceptually, the benefits of irrigation are realized through improvements in: agricultural productivity, employment and wages, incomes, consumption, food security and overall socioeconomic welfare. These benefits tend to be interrelated. Through these benefits, irrigation water is linked to food security both directly and indirectly. Irrigation can benefit the poor through increased yields, lowering the risk of crop failure, and generating higher and year-round farm employment. It can enable smallholders to adopt more diversified cropping patterns, and to switch from low-value subsistence production to high-value market-oriented production.

The survey carried out as part of this study revealed a significant yield income difference between rain-fed only and rain-fed + irrigated systems of agriculture. The Levene's test for equality of variances has shown that the average of 5706 ETB more income by RIA households is not due to chance alone. The households' income with rain-fed + irrigated agriculture is 43% greater than the rain-fed only households. Other determinants for yield and income differences were minimized by selecting respondents in a limited geographical area, but it is not possible given the current study design to attribute all of these observed differences to the availability of irrigation. However, a large component of the difference is probably due to irrigation, given that agro-ecology, input and output markets, agricultural extension services and land tenure systems were nearly similar for both farming systems. Households with higher incomes could build assets and savings which will give them a better opportunity to access farm inputs and take risks to try new ideas. This casual linkage

could increase the living standards disparity among households with in a small community.

Chi square tests have shown that there is no a statistically significant relationship between agricultural income and households' food budget. This implies that households' food budget didn't respond significantly to increased income from agricultural products generated through irrigated systems. In addition the relationship between agricultural income and dietary diversity has become statistically insignificant with a probability of 0.44 which is far greater than the conventional probability level of 0.05.

Households with irrigated and rain-fed agriculture consumed a wider variety of crops but the number of food groups only marginally increased. This can be the reflection of the households' lower understanding about the direct and indirect consequences of undernourishment. Tradition also limits food choice options to the usual Injera with Wot, which is usually made of two items. A small positive shift towards likely better nutritional status is indicated by high income households consuming livestock products more frequently. This may have occurred because these food items reflected of a better status, but increased consumption of livestock products is commonly observed throughout the developing world with increases in income.

Irrigation investments shift the supply of agricultural products, and can have a strong positive effect on growth, benefiting populations in the long run. In the short term as shown by this study, increased yield did not necessarily results in greater food security. Integrated approaches in which education plays an important role could shorten the period in which food security is reached. Thus overall additional

conclusion of this study is that irrigation investments should not always serve as a proxy for a decreased food insecurity of the rural households

5.2 Recommendations

Any programs that work for agricultural production and productivity growth will have a direct or indirect impact on food security. But positive impacts are more likely to result if the approach is integrated with complementary projects. All three major pillars should be considered in efforts to enhance food security. The first is food availability; which could be positively influenced by growth in production. The second, concerning the accessibility of the available food, which commonly depends on the existence of purchasing power and the accessibility of credit and market access. Lastly, the accessed food should be properly utilized by individuals, and it should contain important food nutrients for an active and healthy life.

Irrigated agriculture will continue to produce the bulk of food in areas where it is accessible and may lead to production specialization in cash crops (possibly for export) These products can enhance the development of new agro-industries, which in turn will probably lead to employment generation, increased wage rates and business opportunities that could positively influence the livelihood of the community.
The food budgets of households in RIA and ROA are similar. The additional income from irrigation does not create greater food budget. The food preferences of improved nutritional outcomes would result if households could concentrate on a diversified diet, but this may not be affordable for some households. Increasing nutritional knowledge to improve household food choices should get attention in the policies and programs concerning food security. Extension services are also important to teach households selecting and preparing nutrient rich food items.

The income from rain-fed agriculture is lower. Increasing the crop water productivity in rain-fed agriculture will be one of the effective pathways towards attaining food security in the entire population, if combined with complementary production technologies, information and functional markets. A significant effort has therefore to be invested in producing more food with less freshwater. In addition, irrigation agriculture should be accessed through integrated water investments to raise the current production level. Introduction of new technologies for using pond water, ground water and other sources for irrigating additional plots is also vital.

Finally the following points are recommended for better linkage between production and consumption, although many have been tried for more than 50 years, with mixed success.

- Encouraging irrigation agriculture and creating additional access through integrated water investments is important to increase crop productivity and hence raise agricultural yield.
- The establishment of agro-based industries is suggested to create market for farm produces and to prevent low prices due to excess production. In addition employment and new business opportunities could benefit the landless and/or low income households.
- Due to the growth in yield income, the marginal income will raise purchasing power of households; thus recommended food items should be introduced and supplied to the nearby markets.
- Improved nutrition programs should be integrated with production growth concerned projects. And it should arrange and facilitate awareness creation programs about health risks of nutrient deficiency and shifting the individuals' interest towards the nutritious food items.

- Improving food utilization behavior of households should get attention by any of food security related programs and the encompassing policies should have to strengthen monitoring and evaluation mechanisms.

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APPENDIX

1. Household Questionnaire: 1

(HH demography and socio-economic Characteristics)

Date _____

1. Woreda_____ Kebelle _____

Village/Gotte_____

2. Name of the Household Head _____

3. Name of the Household members

No	Name	Sex		age	Education	
		M	F			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

4. What is your marital Status?
   1=single
   2=married
   3=separated
   4=widowed
   5=divorced

5. How many hectares of land do you own?_____ Ha

6. How far is the nearest market for your household?
   _____km

7. Is your house tin roofed or Grass roofed?
   Yes= 1 No= 0

2. Household Questionnaire: 2

(HH Water Use)

1. What are the main sources of water for any purposes of your household?
   1=River 5=Dams
   2=Springs 6=Tap water
   3=Ponds 7=other/specify
   4=Ground water
2. What are the main purposes of water for your household?
   1=Drinking and food preparation
   2=Livestock use
   3=Irrigation
   4=Fishery
   5=other/specify
3. If irrigation is one of the purposes, which of the above water sources is used for irrigation?
   1=River 5=Dams
   2=Springs 6=Tap water
   3=Ponds 7=other/specify
   4=Ground water
4. How many hectares of your land do you irrigate?
   _____ Ha
5. What kind of irrigation system you apply for your farm?
6. Do you use any irrigation technologies for irrigating your land?
   1=Yes 2=No
7. If yes, what are the technologies?

3. Household Questionnaire: 3
(HH Crop Production)

1. Which of the fallowing crops did you cultivate and how much yield did you harvest in the previous production season from rain fed agriculture only?

Type of crops	Yes	No	Yield (kg)	For Own consumption (Thick only)	For sale (Thick only)
Barley					
Wheat					
Teff					
Rice					
Sorghum					
Maize					
Pea					
Horse bean					
Linseed					

Lentil					
Sunflower					
Chickpea					
Noug					
Tomato					
Potato					
Beat-root					
Carrot					
Onion					
Garlic					
Cabbage					
Pepper					
Swiss chard					
Other (specify					

2. How many hectares of land were used to produce the above crops?
   _____ha

3. Which of the fallowing crops did you cultivate and how much yield did you harvest in the previous production season from irrigation agriculture only?

Type of crops	Yes	No	Yield	For Own consumption	For sale
Barley					
Wheat					
Teff					
Rice					
Sorghum					
Maize					
Pea					
Horse bean					
Linseed					
Lentil					
Sunflower					
Chickpea					
Noug					

Tomato					
Potato					
Beat-root					
Carrot					
Onion					
Garlic					
Cabbage					
Pepper					
Swiss chard					
Other (specify					

4. How many hectares of land were used to produce the above crops? _____ha

4. Household Questionnaire: 3

(HH food Consumption Pattern)

S/N	Food Group	Frequency						
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
1	Cerial grains							
1.1								
1.2								
1.3								
1.4								
1.5								
2	Grain Legumes							
2.1								
2.2								
2.3								
2.4								
2.5								
3	Roots							
3.1								
3.2								
3.3								
3.4								
3.5								
4	Meat, Milk, Poultry and eggs							
4.1								
4.2								

4.3								
4.4								
4.5								
5	Vegetables							
5.1								
5.2								
5.3								
5.4								
5.5								
6	Fruits							
6.1								
6.2								
6.3								
6.4								
6.5								
Sum								

5. How much was the market price of the above crops at the time of harvesting and a month before harvesting?

Type of crops	Price during harvesting (ETB)	Price a month before harvesting (ETB)	Type of crops	Price during harvesting (ETB)	Price a month before harvesting (ETB)
Barley			Noug		
Wheat			Tomato		
Teff			Potato		
Rice			Beat-root		
Sorghum			Carrot		
Maize			Onion		
Pea			Garlic		
Horse bean			Cabbage		
Linseed			Pepper		
Lentil			Swiss chard		
Sunflower			Other (specify)		
Chickpea					

6. How is the overall price trend of the farm products from year to year?
   1=Increasing
   2=Decreasing
   3=No change

5. Household Questionnaire: 4
(Attitudes, perceptions and behaviors of HHs)

1. What motivating factors encourage you to use the available water sources for irrigation purpose?
   ☐ Distance to the water source
   ☐ Wealth of the household
   ☐ Availability of the household
   ☐ Distance to the nearby market
   ☐ Others/state_____

2. What constraints hold you from using the available water sources for irrigation purpose?
   ☐ Distance to the water source
   ☐ Wealth of the household
   ☐ Availability of the household
   ☐ Distance to the nearby market
   ☐ Others/state_____

3. Have you got extension services about irrigation systems and its applications?
   ☐ Yes ☐ No

4. What problems you are facing in using the water for irrigation purpose?
   1._____
   2._____
   3._____

5. Have you ever got training about improving your family's feeding habits?
   ☐ Yes ☐ No

6. Did you get any food aid from any source in the last three years?
   ☐ Yes ☐ No

7. Did you face food shortages due to any reason in the last three years?
   ☐ Yes ☐ No

8. What criteria do you consider to decide on the menu of crops to be cultivated in your farm land?
   ☐ Market value
   ☐ Productivity
   ☐ Social value
   ☐ Desirability for home consumption
   ☐ Others/state_____

9. What criteria do you consider to decide on the menu of crops to be included in your daily food varieties?
   ☐ Social acceptance/value
   ☐ Its importance for your health
   ☐ Its taste
   ☐ Market value
   ☐ Others/state_____

Focus Group Discussions

Issue I- **Water Use**

Objectives: - To identify the motivating factors for households to use the water sources for irrigation purpose.
- To identify the constraints that limits the use of such water sources for irrigation activities
- To identify the existing problems in using the sources for irrigation, if any and for its future expansion.

Issue II- **Crop production**

Objectives: - To identify the major crop types which is produced in the study area.
- To assess the selection parameters of crop types to be cultivated in each farm.

Issue III- **HH Food Consumption**

Objectives: - To identify the major crop types that are used for home consumption in the area.
- To assess the selection parameters of crop types to be included in the daily feed menu.

Data and Analysis formats of the study are attached with this document. The file containing this information is created by Ms Excel program and it will be sent through CD as requested.