ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
INSTITUTE OF DEVELOPMENT RESEARCH (IDR)

RICE CULTIVATION AND RURAL HOUSEHOLD FOOD SECURITY IN FOGERA WOREDA PLAIN, SOUTH GONDER ZONE, AMHARA NATIONAL REGIONAL STATE OF ETHIOPIA

BY

LEGESSE GELAW ZELEKE

JULY, 2007
ADDIS ABABA

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
INSTITUTE OF DEVELOPMENT RESEARCH (IDR)

RICE CULTIVATION AND RURAL HOUSEHOLD FOOD SECURITY IN *FOGERA WOREDA* PLAIN, SOUTH GONDER ZONE, AMHARA NATIONAL REGIONAL STATE OF ETHIOPIA

By

LEGESSE GELAW ZELEKE

A RESEARCH THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF ARTS IN DEVELOPMENT STUDIES, RURAL LIVELIHOOD AND DEVELOPMENT.

JULY, 2007
ADDIS ABABA

TABLE OF CONTENTS

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

Lists of Tables

Lists of Figures

List of Maps

List of Appendices

Dedication

This Thesis manuscript is dedicated to my beloved and smart child Bethelhem Legesse, whom I always consider her as a substitute of the lonely and dearly loved my sister the late Fentanesh Gelaw.

Acknowledgment

Above all, my praises goes to ''the Lord God'' who have given me the tolerance and patience to reach at this stage.

I would like to express my gratitude to my academic advisor Dr. Workneh Negatu (Associate Professor) for his assistance in providing me valuable comments, suggestions and technical supports on the essence and contents of this study from the beginning up to its completion.

I promote my thanks to Amhara National Regional State Bureau of Agriculture that gave me sponsorship. I am also grateful for the support and accommodation (computers, photocopy, etc.) given by South Gondar Zone Agricultural and Rural Development Department during my stay in the field. Additionally, I would like to thank SAA-Regional Rice Program (especially for Dr. Tareke Berhe), Amhara Agricultural Research Institute and Addis Ababa University for financial grant and technical support to complete my thesis on time.

My thanks also go to Ato Alemayehu Walle, *Fogera Woreda* Agronomist Head, for his assistance during the selection of data collectors and served as a supervisor through out the data collection process.

I am thankful to my wife Shashitica for bearing in my absence handling our smart child Bethelhem Legesse. I also gave great appreciation for her patience and commitment during the process of the study. Moreover, I express my thanks to my daughter, Bety who lacked my care and support for her academic achievement when I was working my post graduate study. In fact, I never forget the late W/o Sintayehu Biyadigie, my mother, and Ato Gelaw Zeleke, my father, for their all over contribution to my academic success.

Finally, I would like to thank my friends and relatives who directly or indirectly gave me support in the course of the study. In this regard Tesfaye Asefa,Goshu Worku, Gizachew Sisay, Tafere berhe, Melesse liyhe, Abebaw Nega, Akililu Fikadie, Emebet Mengisitu, Melkie Tadesse, Akilog Yimer, Shumiye Alemu, Nina Negash, Ager Endale,Melese yigrem are to be mentioned for their friendly advice and their technical support.

Acronyms

AICAF	Association for International Corporation of Agriculture and Forestry
ANRS	Amhara National Regional State
BBM	Broad Bed Maker
BoARD	Bureau of Agricultural and Rural Development
BoFED	Bureau of Finance and Economy Development
CRDA	Christian Relief Development Association
CSA	Central Statistics Authority
DAP	Di-amonium Phosphate
DA's	Development Agents
DPPC	Disaster Prevention and Preparedness Commission
ENCU	Emergency Nutrition Coordination Unit
EPRDF	Ethiopian People Revolutionary and Democratic Front
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
FSP	Food Security Program
FWARDO	*Fogera Woreda* Agricultural and Rural Development Office
GNP	Gross National Product
GOs	Governmental Organization
HA (Ha)	Hectare
HH	Household
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
IPMS	Integrated Production and Market Success
IRRI	International Rice Research Institute.
Kcal	Kilo Calorie
Kg	Kilogram

Acronyms

LAC	Latin America and Caribbean
MoA	Ministry of Agriculture
MHa	Million Hectare
MoI	Ministry of Information
MT	Million Tone
No.	Number
N/Ha	Nitrogen per Hectare
NGO's	Non Governmental Organization
NWZMS	North West Zone of Metrological Site
O.Sativa	Oryza Sativa
OSSREA	Organization for Social Science Research for East Africa
PA	Peasant Association
PRSP	Poverty Reduction Strategy Paper
P_2O_5	Di-phosphrous penta oxide
Qt/qt	Quintal
SGZ	South Gondor Zone
SG2000	Sasakawa Global 2000
SPSS	Statistical Package for Social Scientists
SPR	Subsistence Potential Ratio
T/Ha (t/Ha)	Tone per Hectare
TVET	Technical, Vocational and Educational Training Center
UN	United Nation
UNDP	United Nation Development Program
UNICEF	United Nation International Children Education Fund
US	United State
USAID	United State Agency for International Development
WB	World Bank
WHO	World Health Organization

Glossary of local terms

Abrik (Kewus Nefas)	Wind that blows from North to south in October unpredictably and cause to dry plant of crops including paddy rice in *Fogera* plain
Dabo Kolo	Roasted small round dough ball
Filfil	Semi-polished rice
Genfo	Porridge
Gota	Local container made from mud to store grain or flour
Jelefet	Unpolished rice
Jibajibo	Medium size bird with black body color, but part of the body between its legs is white coated and its bill and legs are red in color
Kebele	Local administration under district
Kiremit	Wet season
Kinche/Nifro	Boiled rice
Nech ruz	White rice
Nur	Communal pasture
Siljo	Food made from a mixture of been flour, oil, mustard and spices
Shorba	Soup
Tella	Local beer
Timad	A unit locally used to measure land size (four timad is equal to one hectare)
Woreda	District
Weina- Dega	Middle high land area
Wetet Yemesele	Milk like
Yetemeshene ruz	Polished rice
Yewuha Esat	Swampy water that heated by sun light which causes to dry paddy rice
Zurha	Rice like grass or weed plant

ABSTRACT

In Ethiopia poverty is widespread and over half of the population live under poverty line. Food poverty is more prevalent in rural areas, where the majority of the population lives. Amhara region is suffering from both chronic and transitory food insecurity problems. In Amhara region the agricultural sector is characterized by inadequate resource endowments, traditional methods of cultivation and husbandry practices, limited access to land saving agricultural innovation such as high yielding varieties. Hence, there is a gap between food supply of the sector and demand. Hence this study attempts to examine & assess the contribution of rice production to the food security of rural households in Fogera Woreda plain, South Gondar Zone, Amhara National Regional State. Income changes of households due to rice, amount of production and productivity, food security situation of the household, extent and constraints of rice production were addressed in this study.

Qualitative and quantitative methods of data collection and analysis were employed in this study. In the process of the study both primary and secondary data were used. In this study purposive sampling procedures was used to select the three potential rice producing areas from 25 PAs in the Woreda. In each selected kebele 30 households; a total of 90 rice and non-rice producer households were selected by proportionate stratified random sampling techniques for the study. Direct observations, Key informants & focus group discussions were under take by the researcher for the study. The required data were collected using interview schedule through structured open and closed ended questionnaires. Data and information made available through the various instruments were analyzed separately through qualitative analysis on the basis of descriptive approach/Narrating the situation and quantitatively by cross tabulation / tables using SPSS soft ware for simple frequency distribution, percentage computations and partial budget analysis.

The survey result revealed that, farmers in Forgea plain are benefiting from rice production. The annual production and income of most farmers is rising. The increment of the income has changed the life of the households in many ways. Rice is serving farmers as a cash crop and an important source of employment and income. The farmers have produced an average of 45 quintals of rice over a single harvesting year per hectare. Rice has good market demand in Fogera plain and its price is much higher than the major local crops. It is the source of income to pay tax, credit, buy clothes and purchases some inputs and for other routine expenses. Rice `` the white gold`` for Fogera farmers, rescues thousands of people from hunger and helped lessen poverty, and to sustain livelihoods. The survey result also shows that households who are benefiting from rice have shown better income and food security situation (Kcal availability, meals per day, coverage of food per year, clothing, health situation and housing) than non-rice producer households. However, there are problems of processing and threshing machines, weed, improved seed, water & crop management techniques in the plain.

The rice production that began recently changed the food security of Fogera rural households and their family life for the better. Hence, there should be a need for large-scale production of this potential food crops (rice) because farmers and their families in the flood areas/ swampy environment are not capable to produce other crops and also they are idle in rainy season due to flooding. Thus rice with excellent performance in this environment should be an alternative food crop and needs further research.

CHAPTER ONE: INTRODUCTION

1.1 Background

Ethiopia is one of the developing countries characterized by low GNP/ Gross National Product/ & the least per capita income level. According to World Bank report (WB, 2002) poverty is widespread and over half of the population live under poverty line. The food poverty line that provides the minimum food requirement per adult per annum is very low in the country in general and Amhara region in particular. Food poverty is more prevalent in rural areas, where the majority of the population lives (MoARD, 2003; MoI, 2003).

The economy of Amhara region is highly dependant on agriculture and an estimated 85% of the population gains its livelihoods directly or indirectly from agricultural production. Through the implementation of agricultural extension program, outstanding results have been registered in terms of productivity increment, especially in most of the potential *Woredas* of the region. However, the situation at household level is quite different and most rural households are facing sever food shortage problems through out the year. The region is suffering from both chronic and transitory food insecurity problems mainly caused by insufficient and scarce agricultural productivity, sever land degradation and poor soil fertility, erratic rainfall, lack of alternative off farm and non farm income, lack of appropriate technology, insufficient use of water resources for agriculture, increase population pressure, lack of adequate social services and absence of marketing and credit facilities (Mesfin, 2003; BoFED, 2004).

According to the regional survey conducted in 2003, 76.5% of the sample households responded that they don't have enough stock until the next harvest. The number of population that was chronically affected by food insecurity in 2003 was estimated about 2,455,242 which accounts for about 17% of the total population of the region and 36% of the total population living in the food insecure *Woredas* (BoARD, 2003).

Currently, there are favorable conditions in terms of policy issues for food security related interventions. The regional government in corporation with local communities

and donor agencies is exerting a concerted effort to break the cycle of poverty and to promote a more sustainable rural household production and provide more purchasing power to rural food insecure households. Rice is one of the technologies used in Amhara region to promote household production (BoARD, 2003).

Rice is staple food for over one -half of the world population; most of them are living in densely populated tropics and sub tropical areas. About 90% of the world rice is grown in China, India, Japan, Korea, Southeastern Asia, and the adjacent islands of the pacific. Rice production is one of the means of livelihoods in the world, including Ethiopia and the study area. Rice, a leading cereal crop in many countries, is grown on all the continents except Antarctica. All rice-growing countries have shown a definite up ward trend in rice production during the past 25 years. The world rice acreage and average yield have increased by 133 million hectare in 1971 to 144 million hectare in 1983 and 310 million tones in 1971 to 406 million tones in 1983 (Konokhova, 1985). But now a day's rice planted area in the world is 150 million hectares and its production is 500 million tones (IPMS, 2005).

Until the late 1980's, the major means of livelihoods of the people of *Fogera* plain was cattle herding. Besides to this they used to cultivate some crops such as teff (*Eragrotis tef*), grass pea (*Lathyrus sativus*), wheat (*Triticum spp*), millet (*Eleusine coracana*), chickpea (*Cicer artietinum*), lentils (*Lens culinaris*), Maize (*Zea mays*) and hot pepper (*Capiscum spp*). However, the availability of much water lay in the plain make *Fogera* plain conducive for rice cultivation. This also affects the local crops that don't need too much water in the plain. The first attempt to introduce rice cultivation in the plain parts of the *Woreda* was made in 1973. However, the adoption was late and become successful after a continuous intervention of government and agricultural research institutions since 1974 (Tefera, 2006; 58). It is believed that the wide availability of wild rice (Oryzea longistaminata) in the swampy and water logged areas of *Fogera* plain has initiated research institutions to carry out experiments in different parts of the country that were assessed to have similar ecology (Sewunet, 2005).

According to Sewunet, 2005 experiments conducted on rice production indicated that 13 to 55 quintals of rice per hectare had been produced in *Fogera* plain since 1993. The high

yielding quality of rice in the area encouraged policy makers to introduce it. In order to initiate large-scale rice production, North Korean experts provided technical assistance to *Shaga* and *Jigna* peasant producer cooperatives in *Fogera* during the *Derg* period. The *Pawe* agricultural research center also carried out experiments on rice since 1987 (Ibid).

The Ethio-Korean project was launched in 1984/85, and this was a major turning point to the widely introduction of rice in *Fogera* plain. However, in 1990, due to the dissolving of producer cooperatives because of the internal conflicts in Ethiopia, the Korean assistances were interrupted and the efforts of the rice production and pump irrigation were discontinued (Tefera, 2006). Owing to the current government policy direction and emphasis to achieve food self sufficiency, *South Gondar Zone* and *Fogera Woreda* agricultural office restarted the discontinued rice production in 1993/94. An expert in the *Woreda* collected seed from different peasants and disseminate it to voluntary peasants. The pioneers of cultivation of rice at individual level were peasants from Nabega and *Shaga PAs* of the *Woreda*. The success of 30 farmers then increasingly encouraged the adoption of rice production in the area and the neighboring *Woredas/kebeles* become producer of rice after it had been widely spread and internalized .The type of rice that has been widely spread is locally known as *Nech Ruz/white rice)* due to its color. The agricultural experts call it X-Jigina (Abrham, 2006).

The significant changes in rice production and mode of adoption as a livelihood system of the *Fogera* plain people are the little studied issues in different disciplines. Thus, this in turn initiates and motivates the current researcher to identify and analyze the contribution of rice production to food security of rural farm households. This study, therefore, is designed to examine the contribution of rice cultivation on the food security of rural households in ANRS, South Gondar Zone, *Fogera Woreda* plain.

1.2 Statement of the Problem

As in the past decades the trend of ever growing demand for food remains to be the major challenges to world agriculture. Government intervention in rural and agricultural development has been the growing concern of many studies in African countries including Ethiopia starting from mid 1960's to address poverty and economic stagnation. However, the peasants to give up their traditional practices and local crops as well as

limited adoption of new technologies had hampered the agricultural transformation in Ethiopia and in Amhara region (including *Fogera Woreda*). As a result of slow adoption of new technologies and inputs of production, productivity of crops has been low for many decades (Mesfin, 2003).

Even though, some farmers are producing rice in small scale, there are multitude production constraints like; Lack of well recognition of rice as a potential crop, lack of sustained and intensified research, lack of trained manpower, lack of improved package and extension methods as well as lack of processing machines are the major constraints that impede rice production, utilization and its dissemination across wider areas in the *Woreda* (Tesfaye 2001). In *Fogera* plain, the focus of the extension was introducing rice through supplying of local rice seed. But there is lack of availability of high yielding variety of rice seed. Moreover the extension method does not strengthen the existing techniques of crop production. Farmers do not know much how to grow rice on the flooded area, frequency and time of weeding, how to maintain and control the water level, how to use fertilizers, how to control pests & how to harvest and thresh rice crop far better than before (Sewunet, 2005). But introduction of exotic variety of crop requires not only adopting it in to the existing production system in order to gain acceptance of recipients but also needs to adopt it in to the local food consumption habits. Hence efforts including research to promote the consumption of the new crops are essential to continue its production better.

The *Rib* and *Gumara Rivers* in *Fogera Woreda* crosses 8 PAs that causes great flooding in those PA plains. In addition Lake*Tana* also overflow during heavy rainy summer. So in these 8 PAs the labor and resources remain unutilized during the main crop production season (*Meher*). The local farmers produce crops with residual soil moisture since rain fall is unreliable when the flooded area is drained. The overall result of the above problems is low crop production that leads to food deficit to the plain farm households, which in turn made citizens dependent on aid for many years (Tefera, 2006).

Even though some researchers studied rice in *Fogera* plain they asses and examine only the agronomic practices of rice like spacing, fertilizer application, seed rate, weeding,

land use change, etc. This indicates that there is a great gap of research study in the *Fogera* plain regarding to role of rice to food security, income, employment, etc.

Therefore, promotion of rice in the *Woreda* and assessment and expansion of improved package with appropriate extension method is required to alleviate food shortage problem of the area and to exploit the currently uncultivated flooded and swampy plain. However, the significant changes in rice production and mode of adoption as a livelihood system of the *Fogera* plain people are hardly studied issues in different disciplines. Thus, it is found to be important to identify and analyze the contribution of rice cultivation to food security of rural farm households to promote the crop, rice, into the study area and others.

1.3 Objectives

1.3.1 General Objective

The over all objective of the research is to assess the extent (magnitude), constraints of rice cultivation and its contribution to rural households food security in *Fogera Woreda* plain.

1.3.2 Specific Objectives

The specific objectives of this research are;

1. To examine the extent of rice cultivation in *Fogera* plain.
2. To examine the contribution of rice cultivation to households food security in *Fogera Woreda* plain.
3. To identify the major constraints of rice cultivation in *Fogera Woreda* plain.
4. To suggest policy implications (interventions).

1.4 Research Questions

1. What are the extents of rice cultivation in *Fogera* plain?
2. What are the contributions of rice cultivation to household's food security in *Fogera wereda* plain?
3. What are the major constraints of rice cultivation in *Fogera wereda* plain?
4. What are the policy implications to be suggested?

1.5 Significance of the Study

The transformation of agricultural sector will result in the production of sufficient food to feed both the agricultural and non-agricultural population. The agriculture sector release labor, capital, food, raw materials, market, etc to the non farming sectors. The increased agricultural production and employment opportunities would generate increased income to farming and non farming families. Hence this study enhances agricultural transformation by promoting crop production.

It is also important for policy makers to know the contribution of new technology (rice) for the efficient allocation of the country major resources for research, extension and development programs. The finding (production objective) of the study can also provide inputs to rural development endeavors in the country for further promotion of the crop and research.

Therefore, this study tried to assess the contribution of rice production to food security of rural households in order to utilize such flood prone potential areas of the country and the study area to increase their productivity and alleviate food insecurity.

1.6 Scope and Limitation of the Study

The research tried to examine the contribution of rice production to food security particularly in Amhara region with particular emphasis on *Fogera Woreda* plain in *South Gondor Zone*. Despite the selected topic is linked with many other issues, the study concentrates to the contribution of rice cultivation to food security, extent and constraints of rice cultivation on rural households in *Fogera Woreda* plain.

In *Fogera* plain there are 14 rice growing and 8 potential rice growing *kebeles*. However due to limited resources (budget, time and facilities) the study was limited to only 3 potential *kebeles*. Hence, the researcher was limited to a number of farmers who are sample from the three *kebeles* for the household survey.

Primarily, the study was confronted with time and budget constraint. Thus, it was restricted to limited area coverage and sample size (one *Woreda* with 90 households). Secondly, the analysis was made based on the households own estimation of crop production and income. Thirdly, the study was based on a one time survey and could not capture the variability in harvest due to variability of climate at different times. Fourthly, there was shortage of empirical studies related to the thesis topic.

1.7 Organization of the Thesis

The thesis was organized in five chapters. The next chapter deals with literature review including agronomy of rice, extent and constraints of rice cultivation, conceptualizing food security, determinants and indicators of food security, policy and situation of food security in Ethiopia and contribution of rice to household food security. The third chapter presents the research methodology, methods of data collection, data sources, sampling methods and methods of data analysis. Chapter four presents the descriptive analysis of demographic characteristics of households and description of the study area. It also includes situation analysis of extent and constraints of rice, input supply, extension and credit services, farming system of rice, preparation, consumption and marketing of rice. More importantly this part of the paper explains the contribution of rice to household food security and income. Lastly, part five concludes the findings and forward some recommendations based on the study result.

1.9 Definition of Some Terms

Adoption – Single technology or package accepted and applied by farmers after going through various stages or phases.

Extent- It is the size and magnitude of rice producers and their rice land holdings

Family size-The total number of members of a household

Farming system- It is defined as the cropping pattern, the crops grown, the livestock production system and the use of natural resources and the way these are integrated to each other

Household- A person or group of persons living together in the same housing unit sharing common meals arrangement regardless of kin relation

Household member-The human individual constituting a household

Household head- A person who has the final decision making power on major issues of the household and represent the household in formal and informal institutions

Land reform- Is the redistribution of land to the rural poor for equity and agricultural efficiency purposes

Livelihood- It comprises the capabilities, assets and activities for a means of living

Non farm income- It is defined as the level of income earned by a farmer from any kind of activities other than agricultural farm lands

Off farm income- It is defined as the level of income earned by a farmer from any kind of labor other than agricultural labor on his own farm lands

Paddy field-is a flooded parcel of arable land used for growing rice and other semi aquatic crops

Paddy rice- A rice which grow in a flooded /marshy arable lands

CHAPTER TWO: LITERATURE REVIEW

2.1 Historical and Agronomic characteristics of Rice Cultivation

2.1.1 Origin and distribution

The genus *Oryza* belongs to the tribe *Oryzeae* in the subfamily *Paoideae* of the great family *Gramineae*. There are 25 Species of *Oryza*. Of these only two species are cultivated, namely *Oryza sativa L.* and *O. gleberrimasteud. O. Sative* is the common rice grown through out the warmest regions of the world where as *O. globerrima* is grown to a limited extent in the flood plains of West Africa (Konokhova, 1985).

O. glaberrima originated around the swampy head waters of the Niger-river in West of Africa. Its characteristics are smooth, hairless glumes, red grains, and short legules with roundish tips, high seed dormancy and stiff upright panicles with few or no secondary branches. Its importance in Africa is decreasing as it is replaced by modern cultivars of *O. sativa* (Ibid).

Oryza sativa has been cultivated in South & East Asia since ancient times. It was domesticated well over 5,000 years ago. The general consensus of opinion is that rice was domesticated in India, probably the Coastal area of Eastern India where there are marshy areas. The presence of wild rice species, the cultivars diversity, including primitive coarse grain forms, and the presence of many dominant genes lend support to this view (Onwueme and Sinha, 1991). During very early periods, rice spread from India, to Southern China and to all the countries of South and East Asia. Rice spread from India to Iran, Egypt, Italy, and Spain. The Portuguese introduced rice in to Brazil and the Spaniards introduced it to Central-America. *O. sativa* was also taken to West Africa in the early 19thc. Rice has been grown in Africa since ancient times (Ibid).

2.1.2 Area & production

Rice is grown in the tropical and subtropical regions of all continents. It grows even in the temperate regions of North China during the 1960's and 1970's there were a constant increase in global rice production. During 1961-5 rice was grown on 124 million hectares in the world with an annual production of 253 million tones where as in 1979 the figures

rose to 145 million hectares and 380 million tones, an increase of 16% in area and 50% in production. This increase in production was mainly due to the adaptation of modern cultivars and improved cultural and management practices. In 1989, rice was grown on 150 million hectares and the total production was 506 million tones, a further increase in production of 33% (AICAF, 1992).

Over 90% of the total rice crop is grown in South and East Asia. In hectares, India, and in production, China is the leading country in the world. Africa allows for 2% of total world rice production. In Africa there has been a rapid increase in rice consumption and also in production. There was 47% increase in area and a 30% increase in production from the average of the period 1961-5 to 1979, and a further 15% increase in area and 20% in production from 1974 to 1989 (Onwueme and Sinha, 1991).

2.1.3 Utilization and growth requirement of the rice crop

Rice is used mainly for human food and is consumed mostly in the form of whole grains. The processing of paddy or rough rice is designed so that a high yield of unbroken grain may be obtained. Paddy on milling gives approximately 20% husks, 50% whole (unbroken) rice, 16% broken rice and 14% bran & meal (Tesfaye, 2001).

Rice is the staple food of more than 60% of the world's population. It is the staple food for most people of Eastern Asia. About 50% of rice in the world is produced and consumed in the Asian region. Rice is a high calorie food with protein content less than wheat (ENCU, 2004).

The protein content of milled rice is usually 6 to 7%. Rice, however, has higher amino acid content when compared with other cereals as sorghum, maize and barely. The biological value of its protein is high. The fat content of rice is low (2.5%) and much of the fat is lost during milling. Rice contains low percentage of calcium. Rice grain contains as much B group vitamin as wheat. Milled rice loose viable protein, vitamins and minerals in the milling process, during which the embryo and the aleurone layers are removed. However, much of the loss of nutrients can be avoided through parboiling process (Tesfaye, 2001).

Table 1- The nutrient content of different crops.

No	Nutrients	Teff	Wheat	Rice	Maize	Sorghum	Barley
1	Protein %	11	11.0	9.4	9.4	8.6	8.5
2	Fat %	2.6	1.9	1.8	4.4	3.6	1.5
3	Fiber %	3.5	1.9	8.8	2.2	1.9	4.5
4	Carbohydrate %	30	69.3	64.7	69.2	71.3	67.4
5	Mineral ash %	3.0	1.7	5.00	1.3	2.4	2.6

Source: Addis Zemen News Paper, Tuesday march 2, 1989 56th year, No. 153 Amharic edition cited in Tesfaye, 2001.

It is also used in the form of parched rice, rice flakes, puffed rice and rice pudding. Starch made from broken rice is used as a laundry starch and in the manufacture of cosmetics and textiles. Beer, wine and spirits are also made from rice. Rice wine, which may contain 10-15% alcohols, is usually made from glutinous rice. Rice bran has high oil content (14-17%). The oil is clear, light colored and odour less and can be used as a salad and cooking oil, for soap manufacture, as a carrier for insecticides and as anti corrosive and rest- resistant oil. Wax can also be obtained from the bran (Onwueme and Sinha, 1991).

Rice hulls are used in many ways; a roughage for cattle fed, chicken litter, ammunition for fertilizers, filter aid, burnt for floor sweepings and as filter for building materials. Rice hull ash can be used as a source of high grade silica, in the manufacture of building blocks, as an absorbent, a soil conditioner, a carrier for pesticides and as filler for insulating materials. Rice straw is feed to livestock. It is also used for the manufacturing of straw board, hats and mats, and for thatching (Ibid).

2.1.4 Adaptation

Rice is grown under such widely differing conditions that it is difficult to define the climate that is most suitable for its development. One of the main reasons for this wide range of climate conditions is with great diversity of rice cultivars. Except Antarctica, every continent on the planet produces rice. It is grown from the equator to latitude 53° N

(in China) and 40° S and from sea level to 3, 000 m in the Himalayas. The choice of limiting factor to its growth is not climate but the water supply (Konokhova, 1985).

On account of its heat-loving characteristics, rice is a crop most suitable for the tropics and sub tropics, although it is also grown during the summer in warm temperate regions. Great intensity of light and solar energy found in sub tropical and warm temperate areas probably constitute an essential favorable factor in rice growing and are perhaps responsible for high average yields. The mean optimal temperatures for rice cultivation ranges between 20°c and 35°c. Long periods of sunshine are essential for high yields (Mukiibi, 2001).

Rice transpires 600-1200 mm of water for each crop, and 1,000-1800 mm is needed to produce rice crop. Although lack of water is the primary constraint to high and stable rice yields, too much water is also a problem (AICAF, 1992). Sandy soils are usually unsuitable for growing rice. Their low capacity for holding water and nutrients and their high permeability make it difficult to maintain the necessary flooded conditions without using excessive quantities of water.

Rice grows under a wide range of soil acidity and alkalinity (PH.3.5 -8.5). To a large extent its tolerance to variation in soil PH. stems from the ability of rice to grow in submerged soil and the fact that under water the PH. of acid soil increase and that of alkaline soils decrease by up to 2 units (Mukiibi, 2001)

2.1.5 Botanical description

Rice is an annual grass with erect culms 60-180 cm tall. It has a shallow root system which is mainly concentrated in the upper soil layer, to a depth of 20-25 cm. Rice is uniquely adopted for growth in submerged soils because it posses aerenchmatic cellular structures in its leaves, stems, and roots which permit diffusion of air from the leaves to submerged root for normal respiration and nutrient absorption. This semi- aquatic nature of plants allows it to be grown in the many great river basins and deltas of tropical and sub tropical Asia, where it provides the principal food for the multitude of people living there. Other wise, these areas would undoubtedly be unable to support even one quarter of their populations (Sewunet, 2005).

Rice is hygrophyte and often cultivated in the lowlands as a semi- aquatic crop with variable depths of water for a period, which may extend to cover the whole of its life cycle. The inflorescence is a loose and many-branched panicle. Each branch of the panicle bears one or more spike lets (Onwene and sinha, 1991).

3.1.6 Cultivation

Cropping systems

There are many cropping systems for rice cultivation.

- Monoculture-only rice is grown year after year.
- A short-duration water - loving crop is grown before rice.
- Double cropping of rice in the uplands-- rice is grown either as a sole crop or an inter crop, or on rotation with other crops which are either grown before or after the rice crop.

Upland rice cultivation

This is also known as dry land rice cultivation or hill rice cultivation. Upland rice is grown as a rain fed where there is adequate rain fail (at least 750 mm) for 3-4 months. Upland rice is much less important in Asia as it covers only 10% of the total rice area, but it is very important in Africa, where upland rice accounts for 75% of the total rice area. As irrigation facilities are becoming increasingly available, there is good scope for low land rice cultivation in tropical Africa. For upland rice flooding is not needed. The water requirement of upland rice is almost half or even less than that of lowland rice (AICAF, 1992).

Lowland rice cultivation

This is also known as swamp rice, wet rice, or flooded rice cultivation. The rice is grown on flooded or irrigated land. It is the most important cultivation system of rice in Asia, and is now becoming popular in Africa. In this system the crop is grown in water from the time of planting until the approach of harvest. The depth of floodwater does not exceed 50 cm. There are two methods of lowland rice cultivation, the direct sowing method and the transplanted method.

2.1.7 Land preparation

Land preparation for lowland rice cultivation starts with the bunding and leveling of the field to impound water and to permit even flooding. The land for rice production has to be ploughed repeatedly in summer to obtain the necessary depth. About 4-5 ploughing with interval of 6-7 days is fair (Tesfaye, 2001). At sowing time, the soil need to be well pulverized but fairly compact and completely free of weeds and stubbles, the field for direct sowing should be thoroughly leveled. For successful deep-water rice culture on extra leveling of land, in addition to deep ploughing, is the first aim of land preparation. If the level of water in the field during seeding stage is not equally high in all division, severe damages to the plants may be caused (Ibid).

2.1.8 Planting method and time of sowing

The seed rate for direct sowing by broad casting is 80-100kg/ha and by dibbling 60-70 kg/ha. Only well filled viable seeds should be used for sowing. Seeds may be sown directly by broad casting or transplanting the seeding. Time of sowing seems to be the most important factor that determine the yield of the crop, sowing time of deep water rice should be at least 4-5 weeks before the time of water stagnation so that the crop may have established quite well and would be in opposition to grow with the rise of water. Any delay in sowing beyond the second and third week may attack the grain yield adversely. If water level in deep water areas usually reach its peak, the life cycle of the crop will extend over a period of months or more (Onwoene and Sinha, 1991)

2.1.9 Fertilizer

The yield of the crop depends basically more on a constant supply of essential nutrients from the soil. Although high levels of production are seldom possible without the applications of commercial fertilizers. Practically, all rice areas require addition of mineral fertilizers for economical yields. Various chemical soil and plant tissue analysis methods are used to determine the fertilizer requirement of rice and rice soil. 120-140 kg N/ha, 40-50 kg p_2o_5 per hectare are required and flooding the field increases the availability (Konokhova, 1985).

Rice growing in *Fogera* and its surrounding requires 125kg DAP and 75 kg Urea, all the recommended DAP and one fourth of the Urea is mixed and applied at the time of sowing. The remaining urea is divided in to two and applied 20-30 days and 50-60 days after emergency of seedling (BoARD, 1992).

2.1.10 Time & frequency of weeding (weed control)

Yields of rice are seriously reduced by competition from weeds during the early growth stages. Weeds are a considerable problem in direct seeded rice fields because the weeds and rice germinate at the same time, and there is no standing water to inhibit weed growth. In transplanted rice, weeds are less of a problem as they are controlled during puddling. The standing water in the field during the growing season helps to eliminate many weed Species.

To obtain good yields of rice, weeds must be controlled in time. They can be controlled physical and chemical methods (risone, stom F-34, Tamariz). In India and in US the yield losses due to weed varieties are 10% and 15% respectively (Schmutterer, 1990). In Asia lowland rice culture involves two basic steps namely, puddling and flooding rice fields and subsequent control of weed by hand labor, machine devices or herbicides. The more plough the land preparation the fewer the weeds. The degree of subsequent weeding depends heavily on water control. Alternate flooding and drying encourages weed growth. If fields kept flooded, weed population can be to minimum (Ibid). Rice crop is easily damaged by weed and there fore require high attention for weed control. Early weeding should be carried out 20 to 25 days after seedling emerges. Frequency of weeding is 3 up to 4 times accordingly (Sinha, 1991& Getachew, 2000)

2.1.11 Harvesting, threshing & processing

The right stage to harvest rice is when the ear is nearly ripe and the straw is still slightly green. At this stage the moisture content of the grain is about 18-25%. The commonest method of harvesting is by hand, using a serrated sickle. In mechanized cultivation, harvesting is usually done by combine harvester.

Threshing is done either manually by beating the plants against a hard surface or on wooden plants, or by hawing animals tread on the sheaves. A foot-operated pedal thresher also does threshing, or portable drum type thresher operated by an engine. These threshing machines are economical and time saving. With combines, harvesting, threshing, winnowing and bagging are done in one operation, after which the grains are dried in a dryer (Sinha, 1991).

Rice may be par boiled before milling. This consists of steeping it in hot water, steaming it, and then drying it down to suitable moisture content for milling. The commercial milling of rice comprises cleaning, hulling (removal of the hulls) and milling, a process in which the bran and the germ are partially or wholly removed. The whole kernels from which the hulls have been removed are known as brown rice. The bran of the brown rice grain is then removed by a machine. The product from this machine is unpolished milled rice from which the outer bran layers have been removed. The unpolished milled rice is then polished in a machine that removes the aleurone layer and any adhering particles, and yields polished rice (AICAF, 1992).

2.1.12 Yield/ Storage

Few crops show such high variation in yield as rice. The highest average yields are obtained in subtropical and temperate regions. The highest yields are obtained in Australia, more than 7 tones per hectare. In tropical Africa, the average yields vary between 1 & 3 tones per hectare (Sinha, 1991).

Large looses occurs during storage, chiefly the result of insects, rodents, fungi & bacteria damage. Diseases and insect pests of rice are blast, stem rot, bacterial leaf blight virus diseases, stem borers (rice stem borer, rice stalk borers), plant bugs, worms (armyworm), and grasshoppers. These all disease and insect pests' cause's extensive damage to the crop from the seedling stage to the ripening stage, and also to grains during storage (konokhova, 1985).

2.2 Extent of Rice Cultivation

2.2.1 Rice production in the world

During 1960s and 1970s there was a constant increase in global rice production. The world's leading rice-producing countries are China, India, Indonesia, Bangladesh and Thailand. During 1961-5 rice was grown on 124 million hectares in the world with an annual production of 253 million tones where as in 1989 rice was grown on 146 million hectars and the total production was 506 million tones, further increase in production of 50% (Sinha, 1991).

Table 2- Average annual rates of rice growth (%) by major rice growing continent 1967-1997

Continent	Production	Area	Yield
Asia	2.5	0.4	2.1
Africa	2.8	2.2	0.6
Latin America & Caribbean	2.5	0.4	2.1
World	2.5	0.4	2.1

Source : FAO, 2002

Rice is the second most important crop in the world after wheat (which has an annual cultivation area of 213 million hectares (MHa)) and is grown annually on 150 MHa, with an annual production of 593 million tones (MT) and an average productivity of 3.91 tone/Ha. The major rice growing continents in the world are Asia, Africa and Latin America. Asia and Latin America have similar rates of growth in area (0.4), production (2.5) and productivity/yield (2.1) respectively. Growth in these regions was equal to the rate of growth globally. However, in Africa, production, area and productivity increased at a rate of 2.8%, 2.2% and 0.6% per year respectively (Table 2) (FAO, 2002).

Table 3- Average area and production of rice during the last four decades

Period	World	Africa	Asia	South America
	Average area in million hectare			
1961-1970	125.30	3.48	118.83	5.04
1971-1980	139.85	4.5	128.24	6.52
1981-1990	144.6	5.39	132.58	6.87
1991-2000	150.09	7.11	122.65	5.70
% Increase	19.78	104.10	3.22	13.13
	Production million tones			
1961-1970	265	6.11	286.10	8.62
1971-1980	379.56	7.90	360.00	11.66
1981-1990	499.81	10.02	474.75	15.04
1991-2000	560	15.49	471.20	18.04
% Increase	111	153.46	64.70	109.19

Source : FAO, 2002

From 1961 to 2000, world rice area, production and productivity increased from 125 to 150 MHa, 265 to 560 MT and 2.11 to 3.75 tones per hectare respectively. In Africa area, production and productivity increased from 3.5 to 7 MHa, 6 to 15 MT and 1.75 to 2.18 tones per hectare respectively (FAO, 2002).

Important rice producing countries in tropical Africa are Madagascar (16.9%) and Nigeria (24.8%). In addition to these, Sierra Leone, Cote-divaire, Guinea, Guinea Bissau, Liberia, Zaire, Tanzania, Mali and Senegal are the other main rice producing countries of tropical Africa, producing more than 0.1 million tones annually (FAO, 2000). Africa produces on average of 16.67 MT (million Tones) of paddy rice per year (1987-1997) on 7.62 million Hectare (MHa), the equivalent of 2.9 and 4.9% of the world's total rice production and rice area respectively

Table 4 - Rice harvested area (Million Hectare) and Paddy rice production (Million Tones) in different regions of Africa.

	Rice area (MHa)			Production (MT)		
Country	1987	1997	Change	1987	1997	Change
North Africa (8.1%0	0.40	0.63	+0.23	2.38	5.38	+3.02
West Africa (56.5%)	2.79	4.38	+1.59	4.23	7.05	+2.83
East Africa (24.6%)	1.65	1.94	+. 029	3.00	3.66	+0.62
Central (8.5%) & Southern Africa (2.3%)	0.42	0.67	+0.25	0.45	0.58	+0.13
Total	5.26	7.62	+2.36	10.08	16.67	+6.69

Source : FAO, 2000

2.2.2 Rice cultivation in Ethiopia

ENA, 2003 indicates that in Ethiopia there are above 2.2 millions of hectares of land that are suitable for rice production. In spite of the huge potential of the country to produce different rice types, the crop is not under cultivation in many parts of the country. Now a day, rice cultivation is concentrated only in some areas such as *Pawe, Gambella, Fogera, Libo Kemkem, Dera, Denbia and Alfetakusa Woreda, MizanTefri, Jimma (Gojeb area), Melkaworrer, Arbaminch, North Shewa, South Wollo (Chefa), Dangila-Jewi, Bichena, Metema Quora, and Metema Armachiho* (Welelaw, 2005).

In 1957 a plantation started rice growing at *Metahara*, along with the Awash River. Later rice adaptation and screening experiments had been initiated and conducted at *Fogera, Gambella, Melkaworer, Debrezeit and Arbaminch* from 1968 to 1988 by different individuals as well as organizations (Sewunet, 2005). According to Welelaw, 2005 166,500 Ha of Lake Tana belt, 29050 Ha of *Metema Quora*, 65476 Ha of *Metema – Armachiho*, 18694 Ha of *Dangila –Jawi*, 10500 Ha of ha of *Bichena*, 137326 Ha of *South Wollo*, 201955 Ha of *North Shewa* and 1580499 Ha of other areas are suitable for rice cultivation since 1994.

During 1994, 256 HHs cultivated rice in area of 65 Ha and produced 1265 quintals. After five years, in 1999 16383 HHs cultivated rice in an area of 6775.5 Ha and 313921 quintals was produced in Amhara region. This indicates a tremendous increase in the response from the part of farmers to produce rice in Ethiopia. This supports the food security problem in the country. These rice development activities again achieved promising results with in short periods (BFED, 2002).

Rice cultivation is increasing from year to year. With in 12 years (1993-2005), all *kebeles* of the *Fogera* plain become producer's of rice. In the study area, rice also increased from 2 PAs to 14 PAs and this supports about 30 households, 1993 to 13000 households, 1997 and to 15, 945 households in 2004/2005 (Tefera, 2006). Out of 28,000 hectares of potential area for rice production more than 22 %(6,378 hectares) of the land have been used for paddy rice production in 2005 (FWARDO, 2005; Tefera, 2006; IPMS, 2005). Latter rice cultivation expands to *Dera Woreda* in 5 PA's, *Fogera* in 14 PA's, and *Libokemkem* in 8 PA's.

2.3 Constraints of Rice Cultivation in *Fogera* Plain

According to Welelaw (2005) there are a number of problems faced by the producers, traders and consumers of rice. The major problems faced by producers are:

- Shortage or absence of processing machine (lack of polishing technology)
- Over flooding
- Lack of family labor to weed rice together with other crops
- Unavailability of transport means
- Low quality of rice product to get higher price.
- Lack of flooding (water) especially at early stage (seedling) and in time of maturity.
- Supply of all rice products to the market just after harvesting.

There is only one unknown variety (*X.jigna*) that has been introduced. The seed system is farmer to farmer. Broadcasting is the method of sowing used in the area, even though it is suggested that better yield could be obtained through transplanting (IPMS, 2005). Weed is a major problem that needs three to four times hand weeding during its vegetative growing stage. Weeding is the most important and labor intensive activity in rice

production. Rice needs high person per day (labor) for weeding. Diseases and pests especially rice blast (fungal) is the major problems of the *Fogera* plain area (Welelaw, 2005; Sewunet, 2005; IPMS, 2005).

2.4 Conceptualizing Food Security

2.4.1 Definitions & concepts of food security / insecurity

The concept of food security of households (HHs) is a recent development of 1980s. The concept of food security of individuals or HH members is an even more recent debate. The shift in the concept of food security focused on access to food (the ability to acquire food) as well as on supply (availability) in the HH (Maxwell, 1992; Devereux, 2001).

Food security is a multi- faceted concept, variously defined and interpreted. On one hand, it implies the availability of adequate supply at the global and national level, on the other the concern is with adequate nutrition and well-being. Food security is a concept originated in the 1970s, in the discussion of international food problems at a time of global food crisis. At that time, food security was understood as adequacy of food supply at global or national level. This view, food availability decline (FAD), of food security assumed that good-sized food balance sheet at macro level ensures HH (and individual) level food security (Maxwell, 1996). Hence, in 1974, food security was defined by the world food conference as;

> Availability at all times of adequate world food supplies of basic food stuff to sustain a steady expansion of food consumption and to offset fluctuation in production and prices (UN, 1973 cited in Tilaye, 2004).

As a result, national and international food policies focused on ways of increasing food production rather than on policies that focus on ensuring access to food at the HH and individual levels.

In fact, there was an increasing trend in per capita food production at the global and national level, yet HH level food insecurity that attains famine proportions paralleled with comfortable aggregate food availability. Despite increases in global food production, significant portion of population of the third world have been suffering from hunger and malnutrition. This is because of the fact that availability of food at the global level does

not guarantee acquisition of food at national or HH levels. Many countries that are food self-sufficient were found to be food insecure at lower unit of analyses due to lack of efficient food system or due to lack of the capacity to raise food entitlement, Food Entitlement Decline (FED), (Getahun, 2003).

Hence, in 1983, FAO expanded the concept of food security to include securing access by vulnerable people to available supplies. FAO's 1983 definition of food security is:

> Ensuring that all people at all times have both physical and economic access to the basic food that they need (FAO, 1983 cited in Tilaye, 2004).

As a result, academic and policy focus started to shift towards micro-level issues affecting food security of individuals, HHs and communities. Theoretical basis for this paradigm shift was set by Amaritya Sen's, 'entitlement approach'. The entitlement approach, and later works that build on it focus on the access of HHs to food through own production, income, gathering of wild foods, community support (claims), assets and migration (Young, 1997).

Hence, during the 1980s due to the growing incidence of hunger, famine and malnutrition in many parts of the third world, the concept of food security was redefined in such away that the unit of analysis shifted from national and global levels to HH and individual levels. It was also made to focus on food availability as well as on access to food. The argument on `` access `` in the early 1980s was a turning point to the progress of the concept and assessment of various food security related problems (Maxwell, 1992). World Bank (1986), defined food security as;

> Access by all people at all times to enough food for active and healthy life (Maxwell & Frankenberger, 1992: 68).

In 2001 food security was redefined as;

> Food Security is a situation that exists when all people at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and nutritious food and food preferences for an active and healthy life (FAO, 2002).

Maxwell and Frankenberger (1992) cited nearly above 200 definitions and developments in the concept of HH food security. For instance, the following are some of the definitions that are most frequently cited by writers and researchers.

a) HH food security by the UN (1990) cited in Tilaye, 2004, is defined as `` the ability of HH members to assure them selves sustained access to a sufficient quantity and quality of food to live active and healthy life``
b) FAO, 1983 in Maxwell and Frankenberger, 1992:68 defines food security as "ensuring that all people at all times have both physical and economic access to the basic food they need."
c) Every one has access to sufficient quantities of good quality food at all times (Oxfam, 1997).
d) Access by all people at all times to the food needed for a healthy life (WHO, FAO, 1992).
e) Access to food, adequate in quantity and quality to fulfill all nutritional requirements for all HH members through out the year (UNICEF, 1986) in Young, 1997

Conversely, food insecurity is a state of being unable to acquire food and lack of access by all people at all times to enough food for an active and healthy life (Devereux, 2003) There are two kinds food insecurity; chronic and transitory. Chronic food insecurity is a continuous food inadequacy caused by the inability to acquire food (constant failure in access to food). It affects HHs that lacks the ability either to buy or produce enough food. Transitory food insecurity is a temporary decline in HHs access to enough food. It is a temporary phenomenon related to the cropping cycle or to a sudden short fall in food access or availability, it is not a one- time event, it is cyclical. This could be caused by instability in food production, a fall in income, increase in food prices as a result of disasters (Maxwell, 1992; Filmon, 2001; Getahun, 2003, Devereux, etal., 2003),

According to FAO, 2002 Food insecurity is defined as a situation in which the individuals of a society have neither the physical nor the economic access to the nourishment they need.

As Maxwell (1996) has pointed out in reality it is very difficult to distinguish between chronic and transitory food insecurity. HH may face conditions of transitory food insecurity with remarkable frequency; very possibly in the lean period before harvest, which turns out to be chronic when the frequency and severity of scarcity extends. If the HH suffers two seasons in arrow, and is forced to sell some or all of its assets to survive, it turns to be chronic food insecurity.

2.4.2 Core concepts of food security

Literature on HH food security contains many concepts. However, most of them adapted four core concepts; sufficiency, access, security and time (Maxwell, 1996; Devereux, etal, 2003).

Sufficiency

The concept of 'enough food' or sufficiency is presented in different ways in the literature; as a minimal level of food consumption; as basic food needed, or as the food adequate to meet nutritional needs and as minimum calorie requirement. It concentrates more on calorie required not to survival but for all family members to live healthy, active and productive lives. This means, having enough to eat is not enough by it self rather it requires adequate calories for an active and healthy person on a sustainable basis (Maxwell and Frankberger, 1992; Elias, 2001; Tilaye, 2004; Tsegu, 2006).

Sufficiency represents the calorie required for healthy and active life. Taking the above considerations together, it is clear that the concept of enough food is problematic. Nevertheless, it appears to make sense a) to concentrate initially on kilocalories, b) to define needs not just for survival, but also for `` an active and Healthy life," c) to begin with individual need and build up to the household (Maxwell , 1992;Tilaye, 2004).

Access & entitlement

Access Marks the ability to produce, purchase, exchange or get food through gifts (transfers). It is often argued that the focus on access is a phenomenon of the 1980s, largely resulting from the pioneering work of Amartya Sen (1989) on food "entitlements`` (Devereux, etal, 2003)

Sen (1981) cited in Tsegu, 2006, demonstrated that a decline in food availability was neither necessary nor sufficient to create hunger. He showed that famine could occur in the absence of any change in production, if the value of people production and work activities declined relative to the cost of staple food. Access to food can be achieved through purchase even if HHs are not self sufficient from own food production.

Security

Security refers to the balance between vulnerability, risk and insurance. It is secure access to enough food. This builds on the ideas of vulnerability to entitlement failure focusing more clearly on risk. According to Maxwell (1992), the risks to food entitlements can originate from many sources including variability in crop production and food supply, market price variability, risk in employment and wages, risks in health and morbidity and conflicts. The risk of profile of individuals, HH and communities will be determined by the channels through which their access to food is normally mediated and by the assets, which are available to them as buffers. The most food insecure HHs will be those facing the greatest probability of entitlement failure with the least assets (Tilaye, 2004; Tsegu, 2006).

A risk to food insecurity has three dimensions; (1) the risk of exposure to crisis (shock); (2) the magnitude or consequences of the crisis, and (3) HH vulnerability to these crises (Bohle, 1993; Alexander, 1992 cited in Tsequ, 2006). The later dimensions categorized as an important aspect that is determine by the adequacy of HHs capacity to cope up with crisis. From this perspective Ashaug (1995) cited in Tilaye, 2004; Dejene, 2004; Maxwell & Smith: 1992:33 identified three kinds of HHs;

- Enduring HHs -which maintains HHs food security on a continuous basis
- Resilient HHs -which suffers from shocks but recover quickly.
- Fragile HHs-Which becomes increasingly insecure in response to shocks.

Time

It indicates whether food insecurity could be chronic, transitory or cyclical. Secure access to enough food at all times is the fourth concept in understanding food security. When a

HH can cope with, recover from shocks, and maintain its capacities at all times, sustainable food security is attained. The time dimension refers to the intensity and characteristics of food insecurity in terms of its duration and frequency. That is transitory (short term fluctuation in food production resulted from climatic changes and/or/ fluctuation in food prices or incomes or chronic (a long term decline of HHs access to enough food (Maxwell, 1992).

However, according to some literatures the definition of food security has three dimensions; a) availability (refers to the necessary quantity, safety and cultural acceptability of food for human consumption, b) Access to available food (physical and economic access or entitlement to food). It is due to lack of market and road infrastructure and limited purchasing power. C) Use and utilization of food by HHs and individuals / only when available food at HH level is consumed according to the needs of individual HH members, and can be utilized by the body for physical, mental development and productive activities, an active and healthy life is possible (Dejene, 2004).

2.4.3 Determinants of households' food security

In much literature of food security three core determinants of HH food securities are known (Omosa, 1998; Alamigir and Arora, 1991; Hubbed, 1995; and Gittinger, etal, 1987 cited in Nurabdi; 2006).These three core pillars of food security are food availability, food access, and food utilization; all pillars are required to achieve success. The first two (availability and access) are the major determinants (WB, 2000; Young, 1997). Availability factor refers to the preference of sufficient food for all people through production and purchase. Availability of sufficient food is determined by domestic food stock, commercial food imports, food aid and domestic food production. There are four forms of HH entitlements, which can be converted in to purchasing power such as production based, own-labor, trade based and exchange. The appropriate use of the available food is determined the utilization dimension (Nurabdi, 2006; FAO, 1997).

According to FAO, 1997 the components of HH food security comprise supply, access, and stability. The supply side of HH food security depends on adequate food supply at

national, HH and individual level and access of each family member to sufficient food to meet nutrient requirements. Access includes physical, economic and social access to foods that are culturally acceptable. Stability according to FAO implies the ability of the HH to have all year round to produce or buy food. Eshetu, 2000; Degefa, 2005 undertake a study on determinants of HH food security in Amhara region and concluded that sex of the HH head, family size, the size of crop harvest, proximity to town, livestock holding and number of oxen owned by the HH are positively and significantly affect per capita food kilo calorie availability.

According to FAO (1998) and CRDA, 2000 cited in Filmon, 2001; Getahun, 2003 and Workneh, 2005 the specific sources of HH food security in Ethiopia are summarized in to five sets of dimensions. The first set is related to food production mainly based on crop and livestock. The second set is related to cash income from different sources mainly based on marketing and other trade based incomes. The third set is related to reserves of food stock or other assets that would possible be liquidated. The fourth one is related to institutional assistance from formal and mutual basis. The fifth one is related to different forms of remittances.

The composition and level of individual or households income at a given point in time is the most direct and measurable outcome of the livelihood process. Income comprises both cash and in-kind contribution .To the material welfare of the individual or HH deriving from the set of livelihood activities in which HH members are engaged. The cash earnings component of income includes items like crop or livestock sales, wages, rents, and remittances. The in-kind component of income refers to consumption of own farm produce, Payments in kind (e.g. in food), and transfers or exchanges of consumption items that occur between HHs with in rural communities (Grace, 1997; Scoones, 1998; Ellis, 2000; Frenkenberger, 2002).

The construction of a livelihood therefore has to be seen as an ongoing process, in which it can't be assumed that the elements remain the same from one season, or from one year to the next. Assets can be built-up, eroded, or instantaneously destroyed. Available activities fluctuate seasonally, and across years, especially in relation to larger economic

trends in national economy and beyond. Access to resource and opportunities may change for individual HHs due to shifting norms and events in the social and institutional context surrounding their livelihoods (Chambers, 1983; Ellis, 2000; Frenkenberger, 2002) Generally, HH level food security is very important in so far as the HH is the basic unit of analysis that determines the production and consumption level of its members (Chambers, 1983).

2.4.4 Household food security indicators

As food security is a multidimensional issue, it is determined by interrelated socio-economic, political and natural factors. HH food security is mainly affected by the process of economic status of the HH and socio-economic situation of a given economy. Thus, it is a complicated task to measure HH food security in situation where there is no universally agreed yardstick (Chisholm etal, undated cited in Tsegu, 2006).

Yet, Frankenberger (1992) has summarized the security indicators in to process indicators and outcome indicators. The former indicator includes food supply and food access situation and the latter serves as proxies for food consumption. According to frankenberger, 1992, Tsegu, 2006 the most common indicators of food security revolve around measures of food consumption. In Practice the availability of food required in kilocalories (Kcal) equivalent is the benchmark measure for food security (Maxwell, 1996; Samson, 2002 cited in Nurabdi, 2006).

Generally, both quantitative and qualitative measurements are employed in most assessment, analysis and monitoring of HH food insecurity. Debebe, 1995 cited in Abera, 2002 has rendered three sets of indicators useable in early warning systems; (1) food supply indicators (rain fall, area planted, yield forecast and estimates of production; (2) social stress indicators (market prices, availability of food in the market, labor pattern, wage and migration; (3) individual stress (nutritional status, death and mortality).

A number of indicators (for monitoring food security) have been identified along with the development of the concept of food security. Different types of HH food security indicators are classified in to three main categories namely supply indicators, food access

indicators and out come indicators (Demeke, etal, 1995 and CRDA, 2000 cited in Nurabdi, 2006, Elias, 2001, Abera, 2002, Eshetu, 2000, Tilaye, 2004, Tsegu, 2006; FAO, 1997). Supply indicators provide a general picture of a given area and society. Such indicators are in most cases aggregated and hardly serve to monitor food stress at HH level unlike access indicators. Out come indicators serve as proxy estimates for measuring HH food situation. In addition the summary of HH food security indicators, draw from Frankenberger, 1992; Devereux, 2001 is indicated in the following text box.

Table 5 - Household food security indicators.

Supply indicators	Food access indicators	Out come indicators
• Meteorological data	• Dietary change	• HH food consumption frequency
• Situation of N/R	• Sales of production asset	• HH budget & expenditure change
• Agricultural Production data	• Livestock sale	• Subsistence potential ratio
• Market information	• Diversification of income	• Nutritional status
• Conflict	• Land use practice	• Storage estimates
	• Seasonal migration	• HH perceptions of food insecurity
	• Access to credit	

Source: Frankenberger, 1992; Devereux, 2001

There fore, HH food security assessments can assume variety of approaches ranging from relatively broader indicators to immediate proxies can be employed to measure food security depending on the situation at hand. There is no fixed rule as such. Some people use `` process`` indicators whereas others use `` out come`` indicators and still others use a combination of both. More rigorous approaches would prefer to assess calorie intakes in order to determine individual nutritional status. As stated by FAO (1997) the relevance of specific HH food security indicators vary with topographic diversity, agricultural condition and the people. Thus the application of a given set of indicators needs to be area or population group specific (Maxwell, 1996; Abera, 2002).

2.4.5 Food security challenges, causes and situations in Ethiopia

Food security challenges and causes in Ethiopia

Risks to an individual or HH of loosing access to food arise from different sources. These include; variability in crop production and food supply, market and price variability; loss of employment and wage earnings; health problems and morbidity; and a drop in the quantity or quality of assets. These factors affect the ability to either produce food for consumption, or to generate or maintain assets that can be used to purchase adequate food (Dejene, 2004).

A study on food security constraints in Ethiopia by Wolday Amha cited in Tilaye (2004), in Northern Ethiopia indicate, land holding size is the main constraint (84%) for achieving food security. There are also other important constraints such as high prices of inputs (67.4% of the respondents), in sufficient rainfall (64.2% of the respondents), high population growth (62.8% of the respondents), Pest and disease (35.8% of the respondents), land degradation (35.4% of the respondents), Malaria (33.3% of the respondents), limited access to credit (28.8% of the respondents) which affect the level of food security.

webb etal (1994) in Getahun, 2003, identified a number of interrelated factors that contribute to famine such as prone-ness to climatic-driven production fluctuations, lack of employment opportunities, limited asset bases, isolation from major market, low level of technology, constraints to improvement in human capital and poor health and sanitation environment. Getachew (1995) also indicates that HHs risk of food insecurity and famine were greatly increased by long term secular decline in resource endowment, combined with unfavorable food policy intervention. He underlines that the prevailing inability of Ethiopia's small-scale agriculture to feed its population is mainly generated by the neglect of rural development policy especially the neglect of the poor and the decline in access to productive resources up on which most of the livelihood are built.

Agriculture is the bedrock of the Ethiopian economy. It is the mainstay in realizing the food security in the country. It is the source of livelihoods especially for rural people who

constitute for more than 85% of the total population of the country (Eshetu, 2000). But in Ethiopia agriculture has registered poor production records for the past three decades and the production was not compatible with required amount of consumption. This poor performance of the sector has resulted in wide spread food insecurity in the country. The reasons, the number, and the magnitude vary from place to place with in the country. Research findings from a community assessment of 21 *kebeles* of South *Wello* and Oromia Zones of the Amhara region has come out with several factors resulting in sever food shortage and HH food insecurity or poor performance of the agricultural sector including: poor management (lack of manpower), lack of improved technologies (improved seed), in appropriate policies, unstable organizational structure, Population pressure, inadequate and (or diminishing farm size and land degradation, lack of oxen, inadequate and variable rainfall; land tenure insecurity; lack of credit and inputs, backward farming practices and lack of adequate extension, poor infrastructure (road and marketing); and others (like crop pests and diseases)(both livestock & crop) and war (Yared, 2001; Elias,2001; Devereux, et al ,2003; Nurabdi,2006).

- **Food security situation in Ethiopia**

Ethiopia suffers from an extremely low level of human development. It was ranked 92nd out of 94 developing countries on the United Nations Development Programmes Human Poverty Index. Its GDP per capital is US $ 810 (adjusted for purchasing power parity), and 98.4% of Ethiopians live on US $ 2 per day or less UNDP, 2003 cited in Dejene, 2004). The economy is based on Agriculture. The problems of extreme poverty are exacerbated by persistent drought and serious environmental degradation.

As one of the largest recipients of food aid in sub Saharan Africa, food security is a major concern in Ethiopia. The proportion of food aid in the total production amounted to about 10% between 1985 and 2000. The intensity and severity of food insecurity has been rising over the years. On average, some 6.6 million people were affected each year between 1991/92 and 2002/03, compared to 4.5 million between 1980/81 and 1990/91. Some 14.5 million, over two times the number in 1984/85, have succumbed to the current drought (1999). Food production is estimated to have declined by 20%. Recurrent droughts, rapid population growth, cultivation of marginal land, war and low levels of

agricultural productivity have contributed to food insecurity in Ethiopia Debebe (1999) cited in Eshetu, 2000.

Ethiopia has been self-sufficient in staple food and was classified as a net exporter of food grains till the late 1950. It was documented that the annual export of grain to the world market rose to the extent of 150,000 tons in 1947/48 Debebe, 1999 cited in Eshetu, 2000. However, starting the early 1960's, the country's domestic food supply situation has been declining and failed to meet the food requirements of the people. Except in 1996, Ethiopia has long been a food deficit country. Even under normal climatic conditions, the country experiences a shortfall in food production to the tune of 25% of what the country's people actually need and are therefore living below the absolute poverty line. The emergency food aid import requirement for these food insecure populations may reach as much as 8000000 metric tones per year (Temesgen, 2001).

Table 6 - Food production and availability in Ethiopia (000 Metric Tone).

Detail	1980-82	1983-85	1986-88	1989-91	1991-94
Domestic production	6597.8	6168.3	6022.5	6484.8	5885.4
Import	558.1	923.4	1453.1	1539.1	1388.6
Export	54.1	45.4	33.2	25.1	18.3
Food availability	7101.8	7046.3	7443.3	8192.9	7225.7
Per capita production (kg)	176.0	149.5	149.5	132.2	114.2
Per capita food availability (Kg)	189.3	170.9	170.9	163.1	140.8
Surplus (Deficit)	(1358.2)	(2283.7)	(2846.9)	(4347.0)	(3698.3)

Source: Debebe, 1999 cited in Eshetu, 2000

This inter annual fluctuation on the food availability has been balanced both by commercial and food aid. Commercial imports have increased from 0.5 million tons to a level of 1.5 million tons, which has shown a 300% increment. Between the period of 1980 and 1994, the proportion of import volume to domestic production has ranged

between 6% and 24% that is per capita food import raised from 10 kg relatively good years to a level 30 kg in bad years (Debebe, 1999 cited in Eshetu, 2000).

Amhara region is one of the surplus crop producing areas of the country. However, the situation of farmers at HH level is quite different and most farmers, mainly, living in the eastern part are facing food shortage through out the year. According to the regional survey conducted in 2003, 76.5% of the sample HHs responded that they don't have enough stock until the next harvest. The number of population that was chronically affected by food insecurity was estimated about 2,455,242 which accounts for about 17% of the total population of the region and 36% of the total population living in the food insecure *Woreda's* (BoARD, 2003).

Generally, at national level, the country has been threatened many times by strong food insecurity problems. The cause can be poor performance of the agricultural sector. To change this trend of food insecurity and unstable agricultural sector, the governments have tried to create a situation that increases productivity through agricultural extension packages (Temesgen, 2001)

2.4.6 Policies & strategic efforts towards enhancing food security in Ethiopia

Micro scale intervention have much to do in addressing HH food insecurity with improving income and reducing poverty; increasing agricultural production by food insecure rural HHs; ensuring fair prices to producers and consumers and making basic services available to the food insecure HHs. In this direction government has to under take some actions or measures (Abera, 2002).

Currently, there are favorable, conditions in Ethiopia in terms of policy issues for food security related interventions. The National Policy for Disaster Prevention and Preparedness, the National Food Security Strategy (FSS) and the National Poverty Reduction Strategy Paper (PRSP) are among few to mention (DPPC, 2005; FSP, 2003).

The promotion of rural development that focuses on sustained poverty reduction among the rural obviously improves food security. Appropriate technologies and producers'

incentives to enhance both production and employment are also the strategic remedies of food insecurity and poverty. Provision of rural credit and agricultural extension designed at food insecure HHs are also important instruments of addressing HH food insecurity. Equally attitudinal changes to strengthen local leadership and empowerment of women and community participation are vital instruments to make external resources more productive in alleviating HH food insecurity (Abera, 2002; BoARD, 2003).

The Amhara National Food Security Strategy has been revised based on the new rural and agricultural development policy and strategy. The National Food Security Strategy focuses on increasing the availability of food through domestic (own) production, ensuring access to food for food deficit HHs and strengthening emergency response capability. Addressing both the supply and demand sides of the food equation, the revised strategy in Amhara region is targeted mainly to the chronically food insecure moisture deficit areas. It focuses on environmental rehabilitation as a measure to reverse the current trend in land degradation, and as a source of income generation for food insecure HHs. Water harvesting and the introduction of high value crops, livestock and agro forestry development have been new elements in the revised strategy to solve food insecurity and to attain HH food security (BoARD, 2003).

2.4.7 Contribution/role of rice cultivation to household food security

Rice is grown in 26 countries in Latin America and the Caribbean region (LAC), which produce over 22 million tones (MT) of paddy per year. Even at today's historically low grain prices, rice production provides approximately US $ 4.5 billion of income to the thousands of rice growers in the region. An approximately equal amount of revenue is generated in rice processing, distribution and retail sales. While significant improvements have been witnessed in rice production in the LAC, regional demand still surpasses production. The region has a net deficit of nearly 1 million tones of milled rice annually, resulting in a net out flow of revenue from the region of over US $ 300 million a year (FAO, 2000).

In Asia the rice systems helped lessen hunger and poverty, and to sustain livelihoods. Thus, in East-plus- South Asia, adequately nourished persons increased in number from

1.12 billion in 1970 to 2.56 billion in 1996. Incomes doubled during 1970-2000: the number of non-poor persons increased from 1.80 billion in 1970 to 2.34 billion 1998 (FAO, 2002). The Asian rice lands support almost 3 billion rice consumers: one-half of the world's population, and more than one-half of its hungry. The intensity of that nutritional support is often very considerable (FAO, 2002).

IFAD (2001) reports that as food- staples' yields increased during the 1970s and 1980s there was a substantial decrease in poverty incidence. IFAD was thus able to affirm that the wheat-and rice led green revolution during 1960-1990 did indeed manifest an excellent anti-poverty record. In the current (1998-2000) global production of the three dominant food security cereals; rice, wheat and maize each 580-610 million tones/ annual. It is note worthy also that among those three crops; the proportion that is used for poor persons, food is much the highest for rice. Thus in dietary terms, as also in social, economic, and ecological terms, the contributions of non-rice crops and of livestock are in the major rice growing countries dwarfed by those of rice (FAO,2002).

The commercial cultivation of hybrid rice in China has allowed about two million hectares of rice lands to be diversified to other uses, which helps increase farmer's incomes. Rice production, post harvest activities and the processing of rice into other products provide the main source of employment and income for at least 50 million families. This grain fed thousands of people for longer periods than any other grain did (FAO, 2002). Rice provides about 22% of the world's supply of calories and 17% of the proteins (Welelaw, 2005).

It has proved practically for many years that hybrid rice has more than 20% yield advantage over improved inbred varieties. In recent years, the nation wide average yield of hybrid rice is 7 tone/Ha, about 1.4t/ha higher than that of inbred varieties (5.6 t/ha). Yearly increased paddy in China due to growing hybrid rice can feed 60 million people each year. There fore, hybrid rice has been playing a critical role in solving the food problem of China thus making China the largest food self-sufficient country (FAO, 2000). In the mountains of Northern Vietnam, paddy rice plays a major role in most HHs

food security. A survey of 300 HHs in Balkan province revealed the importance of paddy rice in recent agrarian changes (FAO, 2002).

Rice is the staple food in many countries of Africa and constitutes a major part of the diet in many others. During the past three decades the crop has seen a steady increase in demand and its growing importance is evident given its important place in the strategic food security planning policies of many countries (FAO, 2002).

Rice is a potential crop having greater adaptation to the poorly drained and swampy areas of *Fogera* plain. It yields more than any other field crop growing in the plain. With the currently available data of productivity level at the farmers field (average 26 and 18 quintal per hectare at *Fogera and Metema* plains respectively), paddy produced from a hectare of land could possibly sustain 4 more people if supplied with the minimum requirement of 200 kg food/ person / year than teff (the regions major food crop (Sewunet, 2005). Rice has a variety of uses in the preparation of local food and beverages (*injera*, bread, porridge, syrup, local beer and local liquor) either done or mixed with other crops such as teff, millet, wheat, and maize (Sewunet, 2005; Tefera, 2006).

Farmers in *Fogera Woreda* are benefiting from rice production. It is serving farmers as a cash crop. The annual production and income of most farmers is rising. The farmers have produced about 40 quintals of rice over a single harvesting year per household. Rice production that began recently changed the lives of rural farmers in the plain (EPRDF, 2003). Rice `` the white gold`` for *Fogera* farmers, rescues thousands of people from hunger (IPMS, 2005). Rice has good market demand in *Fogera* plain its price is much higher than the major local crops. It is the source of income to pay tax, credit, buy clothes and purchases some inputs and for other routine expenses (Tefera, 2006).

According to Tesfaye, etal, 2005 rice is the leading crop followed by teff and wheat both in area and production in *Fogera Woreda*. However, it is the dominant crop in *Fogera* plain both in area and production. It is among the major cash and food crops in the area. Water flooding is the most intermittent problem of *Fogera* plain farmers during the main cropping season and they were forced to migrate to other areas in search for food and

other job opportunities because farmers and their families in the flood areas/ swampy environment are not capable to produce other crops and also they are idle in rainy season due to flooding. However, due to the introduction of rice has made some these areas productive and created a very significant change in the livelihood of farmers. As the result, they have become food self-sufficient (Welelaw, 2005).

Technology development and transfer is crucial to achieve food security, economic stability and poverty reduction. Successful agricultural technology development and transfer contribute to economic development by increasing production and productivity through providing new knowledge and skills. New agricultural technologies play a catalytically role in agricultural development through bringing a positive changes in the entire economy. Some technologies have been imported and adapted to local conditions to bring food security like rice technologies (Tesfaye, etal, 2005: unpublished).

2.5 Analytical Framework

Household food security is determined by variety of interrelated factors. In much literature of food security three core determinants of HH food security are drown (Omosa, 1998; Hubbed, 1995; Gittinger, et, al., 1987 cited in Nurabdi, 2006). Based on these literatures, the following working framework has been developed to guide this study to examine the food security level at household level.

In the framework (fig. 1) below food security is the function of three sets of factors; food availability, access to food and food consumption and utilization. The framework illustrates the relationship between these variables indicators of each that can be used for food security assessments and monitoring.

As the model indicates the major causal factors that affect rice cultivation at household level are weed, lack of processing machine, lack of improved variety, pest, wind, lack of extension system, shortage of water, lack of adequate agronomic practice and over flooding. The extent of rice cultivars also determines rice cultivation at household level in the plain. These factors in turn affect household food security at household level.

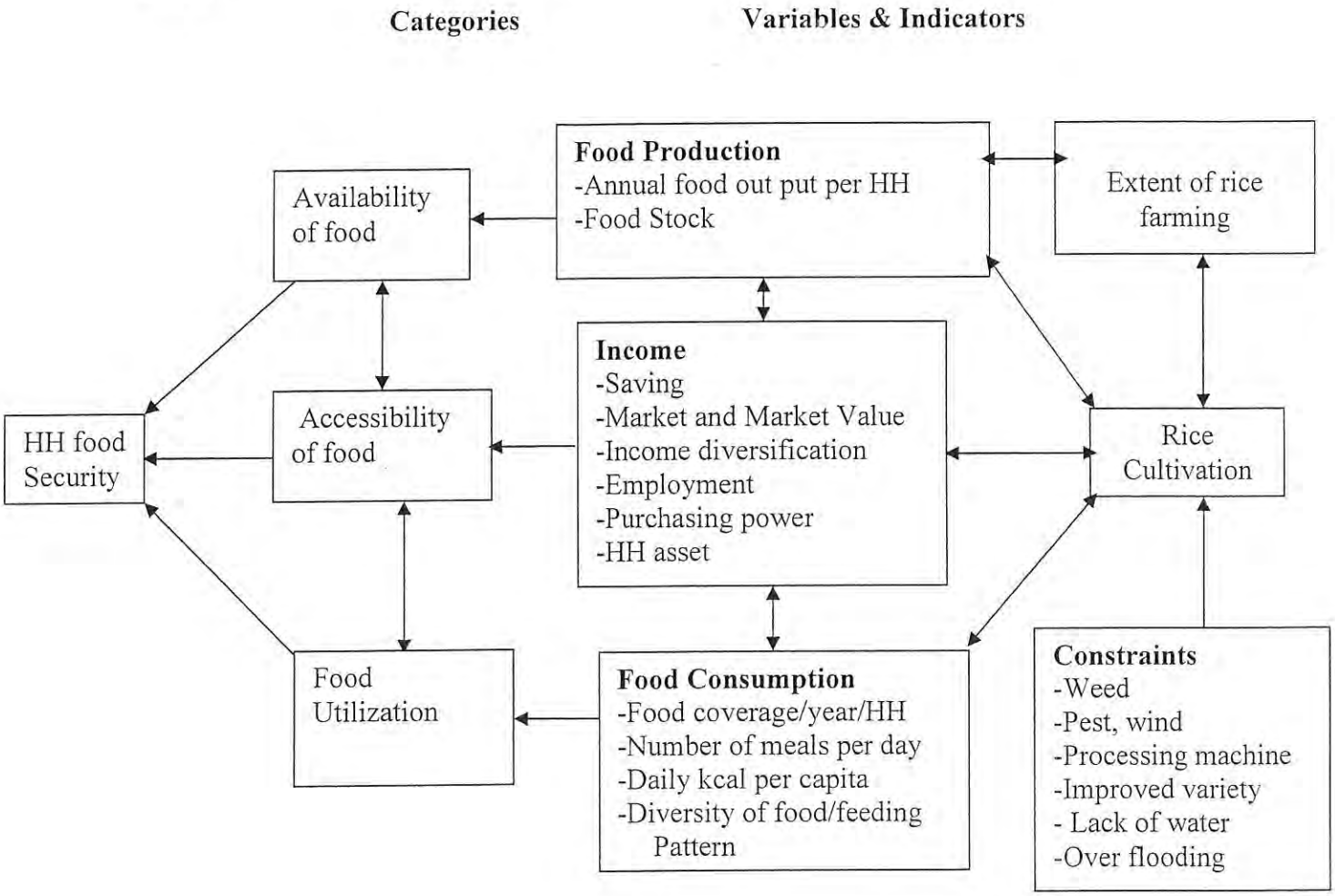
As the framework indicated, rice cultivation determines food production, income and food consumption at HH level and in turn this variable also determines rice cultivation.

The availability of food is determined by food production. Food production includes different indicators like the annual food out put per HH per hectare and food stock. Access to food is determined by income of the household .The HH income includes saving of HH, market value of a crop, income diversification (from non farm, off farm, and on farm income), wage labor (employment), HH fixed and variable assets, and purchasing power of households. The food utilization is the appropriate use of the available food .The food intake, feeding pattern, number of meals per day, daily Kcal per capita available and diversity of food consumption determines the utilization and use dimension of food security at HH level. Food consumption is determined by converting per capita food supply in to calorie using the nationally recommended level, 2200Kcal per adult equivalent per day and grain calorie equivalent conversion factors. In the case of Ethiopia, the recommended total calorie intake per individual per day is 2211 Kcal (CSA, 2001 cited in Nurabdi, 2006; Edilegnaw, etal, 2006). The researcher used SPR (Subsistence Potential Ratio) to calculate the food security situation of the area by taking the ratio of Kcal availability and requirement of the HHs in adult equivalents and grain Kcal equivalents. That means; SPR= Available Kcal / Required Kcal per HH

In Fig.1 food production variable and accessibility of food determines availability of food at HH level. Similarly, income variables and availability of food determines the access of HH food. The accessibility of food and food consumption variable also determines food utilization at HH level. Generally the framework might suggest that a direct link exists from food availability to food access and food utilization. There is also a direct link between food production, income and food consumption variables at HH level. That means the absence or/and presence of one variable affects or determines the other variable at HH level.

As indicated in Fig. 1, Food security is the function of availability, access and utilization, which are the major components (measurements) of HH food security in this context. Thus the contributions of rice cultivation to food security at HH level were examined by using the framework (fig.1).

Fig.1- Conceptual Framework for contribution of rice cultivation to household food security



Source: Adapted from USAID (1999) in Nurabdi, 2006, UNICEF (1990) cited in Tilaye (2004), Young (1992) cited in Elias 2001, and Devereux, 1993b.

CHAPTER THREE; METHODOLOGY

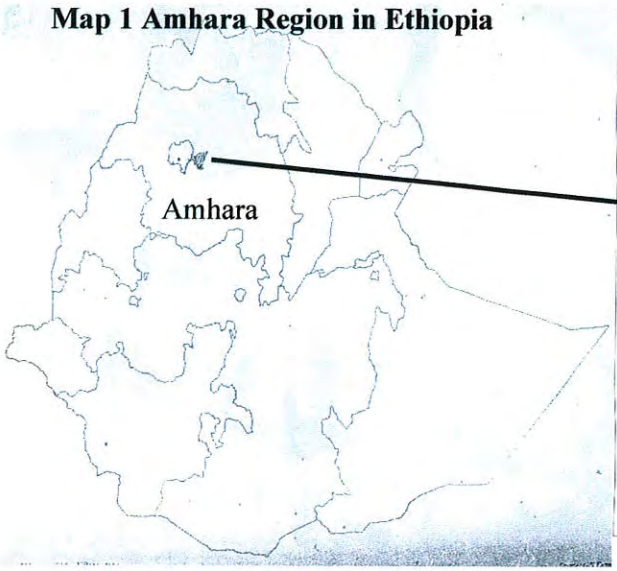
3.1 Description of the Study Area

Location and topography

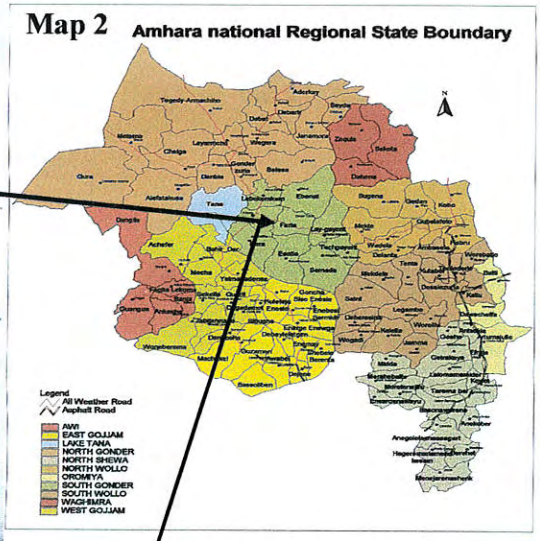
This study was under taken in *Fogera Woreda* plain located in *South Gondar Zone*, Amhara National Regional State of Ethiopia. It is one of the106 *Woreda's* of the ANRS and one of the 9 districts of South *Gondar Zone*. It is located at $11^0$58'44'' N latitude and $37^0$41'48''E longitude. *Wereta* is the capital of the *Woreda* and is found at 625km from Addis Ababa and 55km from the regional capital, *BahirDar*. The study area is part of *Fogera* plain that lies to the east of Lake Tana, near the town of *Wereta*. The plain is currently located in districts of *Dera* in 5 PAs, *Fogera* in 14 PAs, and *Libokemikem* in 8 PAs. *Libo* in the North, *Dera* in the South, *Estie* in the Southeast, *Farta* in the East and Lake Tana in the West are boundaries of the *Woreda*. It has 28 local administrative *kebeles*, of these, 25 and 3 are rural and urban *kebeles* respectively. *Shina*, Shaga, Kidist-Hanna, *Nabega* , *Wagetera*, *Quire Michial* , *Wereta-Zuria* and *Kokit & Abuha* are the 8 potential rice producing PA's of the study that are situated in the extreme flood plains of *Fogera* (Abraham, 2006).

The total land area of the *Woreda* is 117,405 hectare. Flat land accounts for 76%; mountain and hills 11% and Valley bottom (gentle slops) 13% respectively. Average land holding is about 1.4 hectare with minimum and maximum hectare of 0.5 and 3 hectare respectively.

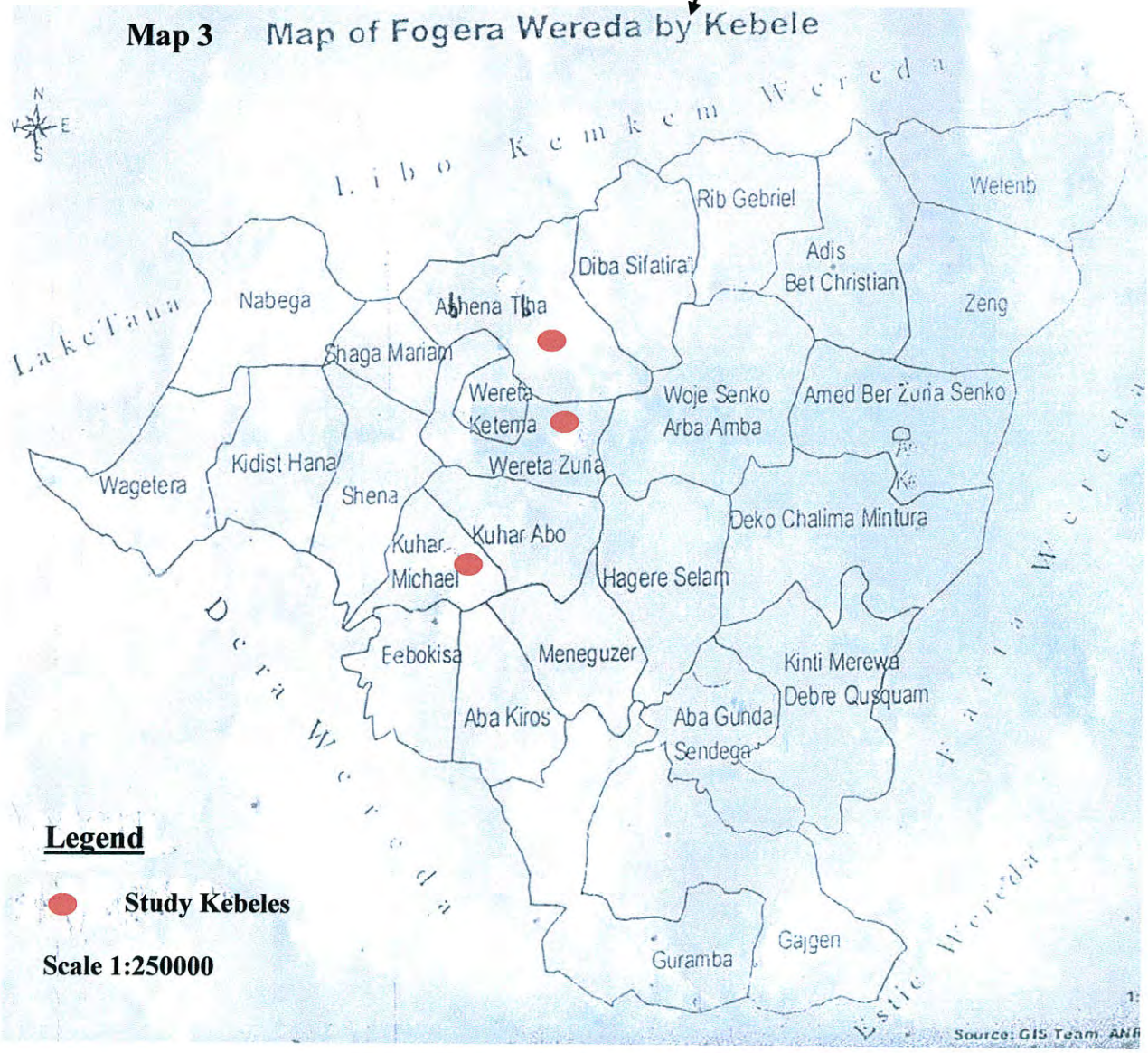
Map 1 Amhara Region in Ethiopia



Map 2 Amhara national Regional State Boundary



Map 3 Map of Fogera Wereda by Kebele



Legend

Study Kebeles

Scale 1:250000

Population

The total human population of the *Woreda* is 233529; the rural population is estimated at 206717. The number of agricultural households is 42746 (IPMS, 2005).

Table 7- Total population by holders and sex.

Holders	Total population			Agricultural households		
	Male	Female	Total	Male	Female	Total
Rural	105726	100991	206717	38471	4275	42746
Urban	13674	13138	26812	-	-	-
Total	119400	114129	233529	38471	4275	42746

Source: *Fogera Woreda* Agricultural Office, 2006

Out of the total inhabitants 227726 are followers of Ethiopian Orthodox Church, which is 97.5%. The rest 1.5% and 1% are Muslims and followers of other sects of Christianity respectively (BoFED, 2004).

Cropping system

Fogera Woreda is endowed with beautiful diverse natural resource, with capacity to grow diverse annual and perennial crops. *Fogera* is classified as one of the surplus productive *Woreda* in the region. The dominant crops grown on the district are teff, finger millet, maize, rice, noug (*Guizatia abyssinica*) predominantly during the wet season, whereas leguminous crops including grass pea, chickpea and lentils are produced on residual soil moisture as sequential crops during the dry season beginning from September.

Altitude, rainfall and temperature

The elevation/altitude of the *Woreda* ranges from 1774 to 2516 m above sea level. It is predominantly classified as *Weina-Dega* ecology. The average elevation of the plain is 1820 m above sea level. The mean annual rainfall ranges from 1216 mm to 1336 mm. Farmers depend on Meher season rain for crop production. The average yearly minimum and maximum temperature are 12°c and 28°c (NWZMS, 2004 cited in FWARO, 2006).

Soil

The soil of the study area is vertisol. As a result, it is very hard and cracks when dry and swells and becomes very plastic and sticky when wet. On the flood plains, soil management poses special problems due to high clay content and related physical properties of vertisol. According to *Fogera Woreda* agricultural office, the dominant soil type in the *Fogera* plain is black clay soil (Ferric vertisol), while the mid and high altitude areas are arthic (Luvisols). The soil of the *Woreda* constitutes of 65% black, 20% brown, 12% red and 3% grayish.

Water body

Fogera is one of the 8 *Woreda's* bordering Lake *Tana* and has an estimated water body of 16144 hectares. The two rivers, *Rib* and *Gumara*, flow in to the Lake *Tana* originating from *Mount Guna*, 13881 feet above sea level in the east direction of the Lake. As these rivers approach the level of Lake Tana, the water over flows their banks and flooding forms perennial swamp in almost all parts of the study *kebeles* during the rainy seasons. Lake Tana that receives floodwater in all direction also contributes for the flooding. These two major rivers have 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 water pump to produce vegetables, cereals and pulses. These rivers are the main causes of flooding in the study Area, and this in turn creates good environment for rice production (Tefera, 2006).

Infrastructure and utility service

Concerning infrastructures there is one High School (grade 9-10), 4 junior secondary school (grade 5-8), and 28 elementary schools in the *Woreda.* There are 1 health center, 7 clinics and 2 health posts in the *Woreda.* The commercial bank of Ethiopia operates in the *Woreda* capital, *Wereta. Wereta* Agricultural and Vocational Training Center (TVET) is found on the out skirts of the town. It is situated on top of a hill over looking the beautiful *Fogera* plains on the way to *Bahir-Dar*. The *Woreda* has supplies of potable water, electric power, and telephone services and has 1.7 km asphalt road that crosses the town. There are also 38 km of all weather roads and 67 km of dry weather road (IPMS, 2005).

Land use pattern

According to the *Fogera Woreda* Agricultural office, the land use pattern of the *Woreda* is as shown below (Table-8).

Table 8 - Land use pattern of *Fogera Woreda.*

NO.	Land use	Area (Ha)	%(Share)
1	Cultivated land	51472	43.8
2	Grazing land	26999	23
3	Forest and Bush land	2190	2
4	Land covered by water	16144	13.75
5	Un cultivable land	20600	17.55
	Total land	117405	100

Source: FWARD, 2006

Among the cultivated land, the area that is suitable for rice production in 14 producing *kebeles* is estimated to be above 28,000 hectares.

Characteristics of sample *kebeles*

Quire micheal

It has a total population of 3674. Among this 1884 is male and 1789 is female. The *kebele* has 1173 households. Of this, 1061 are males and 113 are females. From the total households 743 are producers of rice where as the rest 430 are non-producers of rice. 32% and 68% of the land is flat and up and down respectively. It has 100 % *Weina-Dega* ecology. Its cropping pattern is dominated by *meher* production. In addition to this, they plant vegetables by irrigation and grow pulse crops by residual moisture on dry season. The major crops grown are rice, millet, teff, and maize. In the *kebele* the average land holding is 1.2 hectare and has a total cultivated land of 1814 hectares. The rainfall is 1400 mm and above. Its altitude is 1810-1950 m above sea level. Red and black soil dominates the area. The income source of the *kebele* is mainly crop production followed by small livestock production and very small labor wage, petty trade, weaver and local drink selling.

Wereta zuria

It has a total population of 5019. Among this 2434 is male and 2758 is female. The *kebele* has 1151 households. Of this, 994 are males and 158 are females. From the total households 498 are rice producer of households where as the rest 653 are non-producers of rice. 20 % and 80 % of the land is flat and up and down respectively. It has 100 % *Weina-Dega* ecology. Its cropping pattern is dominated by *meher* production. In addition to this, they plant vegetables by irrigation and grow pulse crops by residual moisture on dry season. The major crops grown are rice, millet, teff, and maize. In the *kebele* the average land holding is 1.35 hectare and has a total cultivated land of 1553 hectares. The rainfall is 1400 mm and above. Its altitude is 1800-1830 m above sea level. Red and black soil dominates the area. The income source of the *kebele* is mainly crop production followed by small livestock production and very small labor wage, petty trade, weaver, and local drink.

Abuha & kokit

It has a total population of 4828. Among this 2558 is male and 2270 is female. The *kebele* has 1054 households. Of this, 901 are males and 153 are females. From the total households 534 are producers of rice where as the rest 520 are non-producers of rice. 35% and 65% of the land is flat and up and down respectively. It has 100 % *Weina-Dega* ecology. Its cropping pattern is dominated by meher production. In addition to this, they plant vegetables by irrigation and grow pulse crops by residual moisture on dry season. The major crops grown are rice, millet, teff, and maize. In the *kebele* the average land holding is 1.32 hectare and has a total cultivated land of 1407 hectares. The rainfall is 1400 mm and above. Its altitude is 1810-1950 m above sea level. Red and black soil dominates the area. The income source of the *kebele* is mainly crop production followed by small livestock production and very small labor wage, petty trade, weaver, and local drink selling.

3.2 Selection of the Study Area

Fogera Woreda plain was selected as a research site using purposive sampling techniques. Because in *Fogera* plain there is high coverage of rice land and large number

of rice producers compared to other plains in the region. There are also practical rationales for selecting *Fogera Woreda* as the area of case study. The major reasons are;

- Researcher's familiarity with the *Woreda* or setting and knowledge of the local language and culture.
- The researcher's profession (agriculture) and working experience in the area as agronomist and protectionist will enable the researcher to have relevant preliminary information for the study.
- The area has a great potential to produce rice due to its swampy and flooding environment that is not suitable for other crops.
- As per the researcher information, no study has been conducted in the *Woreda* especially regarding the contribution of rice production on food security of *Fogera* plain households.
- Better accessibility of the area so as to complete the thesis on time.

3.3 Data Sources and Collection Methods

The choice of the methods of a particular study depends on the purpose of the research at hand. In a given research, the choice of methods influences the way in which the researcher collects and analysis data. However, there are no strict rules as such for the choice of the method but a researcher needs to strike a balance between the cost and time available for the research, and depth and breadth of information needed to be analyzed by either qualitative and quantitative or both methods (Robsen, 1993 and Kumar,1996).

Both qualitative and quantitative method of data collection and analysis were employed in the current research. Survey research strategies and descriptive research purpose as a basic tool of research to assess the contribution of rice production to food security of rural households in *Fogera Woreda* plains were used. Qualitative research is proved to give a chance to acquire experiences on, extents and constraints of rice cultivation and its contribution to food security. This study thus made use of data from primary and secondary sources

3.3.1 Data collected

The study requires a wide variety of information that would help to answer the major objectives. Such as the amount of production and productivity of rice at household level, change in production and area of rice, the income change of households due to rice production, the status of food security and well being of households (frequency of taking meals per day, length of food secure months of the year, food habit of HHs by type of food item, Kcal availability and requirements of HHs and responses of HHs perception to food security status), employment situation, health education situation, attitudes of people, contribution of rice production on asset creation at household level, role of institutions and organizations for rice production, challenges and constraints of rice production.

3.3.2 Data sources

This study makes use of data from primary and secondary sources. The primary sources of data were the selected survey plain households, agricultural extension agents, rice traders, rice processing machine owners, *Adet* rice research staffs, Sasakawa Global rice officers, ILRI improved productivity and marketing success officers, *Fogera Woreda* crop production experts and others. The secondary sources of data comprise; South *Gondar Zone* Rural and Agricultural Office reports, *Fogera Woreda* Rural and Agricultural Office reports, ILRI reports and socio-economic survey, Sasakawa Global 2000 reports, books, journals, internet, and other published and unpublished sources.

3.3.3 Primary data collection

First hand information is the major component of the study. Collection of such data was accomplished through instruments or techniques of household survey (intensive interview of households at PA level), focus group discussions, key informant interviews and direct observation. Further elaboration regarding the generation of primary data is set in the following sections.

Interview of household heads

Interview is often understood as an exchange of views between persons who have a conversation about a topic of common interest (Robson, 1993). The conversation is intended to be free flowing, with the interviewer able to follow up on questions or to pursue new information that may come up during the interview. Hence, to assess the contribution of rice cultivation on food security at household level and related issues, data that could answer the research questions or objectives were collected using carefully prepared and tested structured open-ended and closed ended formal (respondents) interview schedule questionnaires. Six trained enumerators from the locality were employed to enumerate the questionnaires from 90 selected households from the selected 3 *Kebeles*.

Key informant interview

Key informant interview was employed particularly using semi-structured interview schedule, for topics prepared to guide the specific questions during the interview. To collect necessary data concerning contribution of rice production to food security of rural households like; income change, amount of production, social & economical contribution of rice production to food security, challenges and problems encountered for rice production. Key informants who have rich knowledge and expertise in the field, as well as experts and institutions involved directly or indirectly in rice production activities were taken as respondents.

In this case, 3 DA's From the study *Kebeles*, 2 agricultural office staffs in *Wereta* (head and agronomist), 3 rice traders from *Wereta* town, 2 researcher from *Adet* research institution (rice program coordinator), 1 rice officer from Sasakawa Global 2000, 1 rice researcher from ILRI (IPMS), 1 health extension posts and 1 from education (*kebele* teachers) were interviewed to get the above information. Informal discussion was conducted to obtain first hand information on contribution of rice to the food security of households from the key informants and households.

Focus group discussion (FGD)

Focus group discussion implies a conversation mediating by a researcher in an informal setting and approach with the purpose of gathering data on designed topics. It allows group interaction such that participants are able to build on each other in ideas and comments to provide in depth views not attainable from individual settings, unexpected comments and new perspectives could be explored easily while discussing the issue (Robson, 1993).

FGDs were conducted by the lead researcher with the help of an assistant who take notes of the discussion. Six FGD were conducted with rice producers and non-producers in all the 3-sample *kebeles*. This made to get data about the contribution of rice production on food security of households. The data was used to cross check with the information that was gained through the survey interview with peasant households. Each FGD have 8 HH members with different ages and sexes who are selected purposively from church, *Kebele Office*, mourning site, etc. from both rice producers and non-producers.

This method was employed to obtain opinions, attitudes and views from the groups and helps to elaborate, clarify and counter check ideas, experiences and arguments that were obtained through other methods. It is also used to include the consensus or disagreements of group on the evidences of socio-economic changes in the rural communities of the *Fogera* plain. Hence, it was carried out after completion of Household survey.

Direct observation

The researcher observed the situation at field level and conducted transect walk to observe rice production activities in the field, feeding habit of people and its contribution to food security of peasant households (housing, fixed assets, etc.).

3.3.4 Secondary data collection

The works of various authors (individuals and organizations) were great inputs for this study. These secondary sources had contributed much for the preliminary knowledge

essential to supporting the finding's reported in the study. The data sources are mentioned earlier in the data source section.

3.4 Sampling design

The degree of precision desired, methods of analysis, objectives of the research, cost, time, etc determine the type of sampling design to be adopted (OSSREA, 2001). Multi stage purposive sampling selections with *Woreda and kebeles* at first stage and second stage and farmers (households) at the third stage with stratified random sampling were followed for the study. Out of the total *kebeles* (25) of the *Woreda*, 14 *Kebeles* are known for their rice production potential. But only 8 *Kebeles* are growing rice prominently because of its swampy environment. Among the 8 potential rice producing *kebeles* of *Fogera Woreda*, 3 *kebeles (Wereta Zuria,Quare Michal and Kokit & Abuha)* that have both plain and non plain land were selected purposively to compare the food security situation of the household. Because the plain peasant *Kebele produces* rice due to its swampy nature of the area and the non-plain are not producers of rice.

After deciding the sample area and sampling design it was important to fix the sample size, considering the cost and reliability of the study. From the list of households, by proportionate stratified simple random sampling using replacing lottery method, 30 households (3%) in each *kebele* and a total of 90 rural households were selected from the three selected *kebele*. Here the original list of rice producers and non-producer households prepared for the year 2006 and maintained in the *Kebele* Agricultural Office was referred as a sampling frame. Thus, sample size were 90 rice producing and non-producer farmers considering the time, finance and homogeneity of the household (like the same farming system) in the plain and other resource constraints of the researcher.

Table 9 - Number of sample households in the selected *kebeles in Fogera Woreda.*

Type of HH	*Kebeles*							
	Quaire Micheal		Wereta zuria		Abuha &Kokit		Total	
	Total HH	Sample HH Size & share (%)	Total HH	Sample HH Size & share (%)	Total HH	Sample HH Size & share (%)	Total HH	Sample HH Size & share (%)
Rice producers	743	19 (3)	498	13 (3)	534	15 (3)	1775	47 (3)
Non rice producers	430	11 (3)	653	17 (3)	520	15 (3)	1603	43 (3)
Total	1173	30 (3)	1151	30 (3)	1054	30 (3)	3378	90 (3)

Source: Survey data, 2007

As seen in Table 9, in the study 80 male heads and 10 female heads were selected in the three selected *kebeles*. The proportion of male to the total sample households was 88.9% and the proportion of female was 11.1%.

3.5 Methods of data analysis

Data analysis is the process of linking data that are gathered from the field (Kumar 1996) Data and information made available through the various instruments concerning rice cultivation and food security in the plain were analyzed both qualitatively (by describing and narrating) and quantitatively using descriptive statistics. In addition to this, the various responses obtained from interview questioners were categorized & coded, then these were fed in to a computer and analyzed using SPSS/statistical package for social scientists/ software for a simple frequency distribution (means and standard deviation), percentage computations, cross tabulation and partial budget analysis (partial cost – benefit analysis).

CHAPTER FOUR; FINDINGS AND DISCUSSION

4.1 Demographic Characteristics of Sample Households

4.1.1 Sex, age and family size of sample households

Sex is one of the most important non-economic factors of the household heads. As the findings indicated out of the 90 respondents 80 households were headed by male where as 10 were headed by female. In the sample households, therefore, it might be logical to infer that 88.9% of the household heads are male where as 11.1% are female (Table-10).

Table 10 - Distribution of sample households by sex and age.

Variable	Rice producer		Non rice Producer		Total	
	Freq.	%	Freq.	%	Freq.	%
-Sex						
Female	7	15	3	7	10	11.1
Male	40	85	40	93	80	88.9
Total	47	100	43	100	90	100

Source: Survey data, 2007

Age composition is another important factor to distinguish households. The result shows that (Table 10) all household heads were between 15-64 years of age. However, the difference comes when considers the age composition of household members. In *Fogera* plain, the survey result showed that the average age of the sample household heads was 41.2 years. The family size of the household was also found to be 5.9.

Table 11 – Average age composition of sample household members in the study.

Category	Rice producers (N=47)	Non rice producers (N=43)	Total household (N=90)
	Frequency	Frequency	Frequency
Below 14 age			
Female	1.5	1.5	1.5
Male	1.3	1.7	1.5
Total	2.8	3.2	3
15-64 age			
Female	1.4	1.1	1.2
Male	1.8	1.4	1.6
Total	3.1	2.5	2.8
Above 64 age			
Female	0	0.02	0.02
Male	0.02	0.16	0.18
Total	0.02	0.18	0.2
Total			
Female	2.9	2.6	2.7
Male	3.1	3.2	3.2
Total	6	5.8	5.9
Av.Family size	6	5.8	5.9

Source: Survey data, 2007

In Table 11, the 90 sample households accommodate about 532 family members. Out of this 268 (50.3 %) are children below the age of 14; 254 (47.7%) are between the age range of 15 and 64; and the remaining 10 (2%) constitute elders whose age is above 64.

4.1.2 Marital status of sample households

Marital status of household head is one aspect of determining demographic characteristics of sample households. The marital condition of households influences the income and the consequent food security situation of the family. In the current research, marital status of sample households was assessed and result is portrayed in Table 12.

Table 12 - Distribution of Marital status of sample household heads.

Variable	Rice producer		Non rice Producer		Total	
	Freq.	%	Freq.	%	Freq.	%
Marital Status						
Married	41	87.2	40	93.1	81	90
Single	1	2.1	0	0	1	1.2
Divorce	2	4.3	2	4.6	4	4.4
Windowed	3	6.4	1	2.3	4	4.4
Total	47	100	43	100	90	100

Source: Survey data, 2007

In the study area in Table 12, both in rice and non-rice producers, married household heads constitute the dominant proportion. Out of the 90 respondents, only 1.2% are not yet married, 81 (90%) are married. The remaining 9 households (8.8%) are either divorced or windowed. The marital status of the rice producer households and non-rice producer households are almost similar.

4.1.3 Educational status of sample households

In Ethiopia, illiteracy is common among the rural societies. The study area household also showed difference in their educational levels. This educational level is expected to have an implication on household food security, crop management and input application.

Table 13 - Distribution of sample household heads by level of education.

Variable	Rice producer		Non rice Producer		Total	
	Freq.	%	Freq.	%	Freq.	%
Level of Education						
Illiterate	12	25.5	12	27.9	24	26.7
Read and write	26	55.3	12	27.9	38	42.2
Elementary	8	17	18	41.8	26	28.9
High school	1	2.2	1	2.4	2	2.2
Total	47	100	43	100	90	100

Source: Survey data, 2007

As Table 13 indicated about 25.5% and 27.9% of rice and non-rice producers are illiterate respectively. The proportion of households who can read and write is higher in the case of rice producers, which is 55.3% compared to that of non- rice producers (27.9%).

Generally, as the result indicated in Table 13 read and write household heads are dominant in both sample households. The remaining 26.7% of the households are illiterate, some 2.2% have attended high school education and 28.9% of the household heads have attended elementary education.

4.1.4 Occupational status of sample household heads

In the study, attempts have been made to compare the occupation of rice producers and non-rice producers. The table presented below summarizes the distribution of household heads in each occupation.

Table 14 - Major occupation of sample household heads.

Variable	Rice producer		Non rice Producer		Total	
	Freq.	%	Freq.	%	Freq.	%
Occupation						
Farming	46	98	42	97.6	88	97.8
Local drink	1	2	1	2.4	2	2.2
Total	47	100	43	100	90	100

Source: Survey data, 2007

As can be seen from the Table 14, 97.8% of the sample households are farmers, and very little less than 2.2% are local drink sellers. In each sample households, farming is the major occupation and is very significant as compared to other occupations.

4.1.5 Religion and ethnicity of sample households

According to the survey result, all respondents (100%) belong to the Amhara ethnic group and Ethiopian Orthodox Christianity.

4.2 Farming System and Agricultural Production in *Fogera* Plain

4.2.1 Crop production in Fogera plain

The crops grown in the surveyed *kebeles* are almost similar in types and different in productivity levels mainly depending on the management and the potentials of the area as a whole. The main crop types grown in the study areas are rice, teff, millet, maize, pepper, onion (*Allium cepa*), chick pea, grass pea, lentils, etc. According to the development agents and focus group discussants, out of the total mentioned cultivated crops in the surveyed *kebeles* rice takes first rank in rice producer households where as in non-rice producer households' millet takes first rank in area coverage and production/yield.

Farming system in the study area is mainly dominated by mixed agriculture. This includes crop production and livestock production. Crop production dominates the

farming system where as livestock productions play a minor role with the exception of its role in the provision of draft power. As per the data obtained from household survey result in rice producer households, among the major crops grown in the study area rice is more productive.

According to the interviewed households in Table 15, rice had better yield, hail, disease and flood resistance than teff. However, it has inferior characteristics regarding to early maturity, drought, labor demand per hectare and weed resistance.

Table 15- Respondent's perception on rice compared to teff and millet with regard to different crop characteristics.

Crop characteristics	Household perceived status (N=47)						
	Rice to millet				Rice to teff		
	Better	No difference	Inferior	Total	Better	Inferior	Total
Yield	47			47	47		47
Drought resistance			47	47		47	47
Disease resistance		47		47	47		47
Early maturity		47		47	47		47
Labor demand			47	47		47	47
Weed resistance			47	47		47	47
Hail resistance		47		47	47		47
Flooding resistance	47			47	47		47

Source: Survey data, 2007

As the above Table 15 indicates, rice had also better yield and flood resistance compared to millet. However, it has inferior demand for labor requirement per hectare and weed resistance. According to the respondents, the two crops millet and rice have the same quality regarding to disease resistance, hail resistance and early maturity.

The net value obtained from the production of three major crops (teff, millet and rice) in the study area households is different (Table 16).

Table 16 - Partial budgets of rice, teff and millet per hectare of land in rice producers

Activity/operation	Rice	Teff	Millet
Plowing (Birr/Ha)	480	480	480
Weeding (Birr/Ha)	1920	800	1440
Harvesting (Birr/Ha)	400	320	400
Threshing (Birr/Ha)	240	240	240
Seed/Birr (Birr/Ha)	275	120	225
Fertilizer (Birr/Ha)	0	0	0
Chemicals (Birr/Ha)	0	0	0
Total cost (Birr/Ha)	3315	1960	2785
Total production value/Ha	13500	2400	3300
Difference (value minus Cost)	10185	440	515

Source: Survey data, 2007

Table 17 - Value share of rice production from major crops which is produced in the HH/Ha.

Crop	Area (Ha)	Average Production (Q)	Market price Birr/Q	Total value	Share in % from the three total
Rice	1	45	300	13500	70.3
Tef	1	6	400	2400	12.5
Millet	1	15	220	3300	17.2
Total				19200	100

Source: Survey data, 2007

As indicated in Table 16, rice costs 3315 birr per hectare of land for farm operation. However, the total production value of rice was 13500 Birr per hectare of land. It has a difference of surplus value of 10185 Birr per hectare. In the case of teff, its cost and value is 1960 and 2400 Birr respectively. In the case of millet, its cost and value is 2785 and

3300 Birr per hectare respectively. From these we understand that in both crops there was a surplus value. However, the net benefit of rice was almost 20 times and 25 times greater than millet and teff respectively. As shown above in Table 16, in one hectare of rice land the household almost gets 10200 Birr net surplus value as compared with cultivation of millet and teff. Similar to this finding Tesfaye, et al (2005) reported that the net return of rice when compared with the net return of teff and maize is greater by 522 and 298% respectively. This indicates that rice technologies have a great contribution to income and food security in *Fogera* plain.

4.2.2 Rice cultivation and livestock production in the plain

The livestock production of the study area includes cattle, small ruminants and pack animals. In the study area, all households possess livestock. However, focus group discussants generalize that the situation of livestock production in the study area has deteriorated.

Table 18 – Rice producers' reasons for the decline of livestock number in the plain.

Reasons	No. of respondents	%
Rice introduction	9	19.2
Land reform	5	10.6
Over flooding	4	8.5
Weed (*Amicala*)	1	2.1
Shortage of grazing land	27	57.5
All	1	2.1
Total	47	100

Source: Survey data, 2007

As per the household survey result in Table 18, shortage of grazing land is the major constraint for 57.5% of the total sample households. In addition to the shortage of grazing land, rice introduction (19.2 %), 1975 land reform and 1997 land redistribution (10.6 %),

over flooding (8.5 %) and weed infestation *Hygrophila auriculata* (Amicala) 2.1% are some of the constraints for the decline of livestock number in the plain.

According to focus group discussants, because of the external and internal pressure, the communal grazing land (nur) is on the decline from time to time. The reasons are associated with, conversion in to farm land, house construction on the grazing land, plantation of eucalyptus tree on grazing land, land reform (government distributes *nur*/grazing land to cultivated land to attain food self sufficiency), introduction of wet land rice and irrigation cultivation and introduction of *Amicala* weed (thorny plant that covers most of the *nur* (grazing land) and in turn damages the grass.

The current policy of the Amhara region restricts movements of cattle for grazing purpose to hilly side in Kermit (rainy season) and to plain in dry season *(bega)* this result in decline of the number of cattle per household. The government also encourages crop production to alleviate the food shortage problems they faced. As farmers involve increasingly in sedentary agriculture their demand for farm also increases. Farmers who have farm land near the *nur (*common grazing land) move in to the communal grazing land by crossing the border and through land theft encroaching in to grazing land. *Fogera* farmers argue that land theft has been aggravated since the introduction of wet land rice in *Fogera.* In early times, most of marshy areas were not cultivated because most local crops were not suitable to grow in swampy areas during the rainy season. However, because of the adoption of paddy rice in *Fogera the* demand for marshy areas for rice production has increased that also resulted in redistribution of some of these lands in 1997. Both the above-mentioned factors are contributory for the shift from cattle herding to paddy rice cultivation and irrigation in *Fogera* plain.

4.2.3 Rice Faming practices in *Fogera* plain

Land preparation and sowing

Preparation of rice field usually starts in March. It needs plowing three to four times with the help of local plow (*Maresha*), before sowing of the rice seed. Oxen are the important source of draft power in the area for plowing.

Table 19 - Cultivation calendar of major crops in *Fogera* plain.

Crops	Land preparation	Sowing date	Weeding	Harvesting	Threshing	Remark
Rice	Mar.24-May 8	June 5-July 7	July 27-Sep.18	Nov.24-Dec.8	Dec..28-Feb.7	Rain fed
Teff	June12-Aug.6	Aug.16--Sep.15	Sep.25--Oct.10	Nov.9-Dec9	Nov.10-Feb1	Rain fed
Millet	Mar.29-May5	May10-June10	Aug.1-Sep.25	Jan.1-10	Jan11-Apr.8	Rain fed
Maize	Oct.1—May10	May20-June20	July15-July30	Aug30-Sep30	Oct.1-Oct30	Rain fed
Chickpea, Grass pea, Lentil	Sep.21-Nov.10	Sep.25-Oct.25		Feb.22-May7	Feb.-Apr.	Residual moisture

Source: Survey data, 2007

In *Fogera* plain, there are two major seasons in the area, the long dry and rainy short seasons. There are three production seasons (cropping system) of crops and vegetables in the area. The rainfall season, from May to October is the time for cultivation of teff, millet, rice, noug and pepper. From October to march farmers produce grass pea, durum wheat, lentil and chickpea using residual moisture. October to June is the period of cultivation for variety of vegetables and crops such as maize and teff through irrigation.

All respondents in Fogera perform broadcast sowing of rice seed after the last plowing. In the plain, farmers carry out direct sowing of rice from June 5 to July 7 using hand-sowing method. According to farmers, this is the optimum time for sowing. As Fogera *Woreda* agricultural office, rice experts, the recommended rice seed rate ranges from 80 Kg to 100 kg/hectare. Nevertheless, most farmers are sowing up to 140 kg/hectare to reduce weed infestation and to minimize tillering capacity of the rice plants. This amount of seed rate is contradicted to scientific seed rate of rice 80Kg/hectare. It germinates with in three weeks and grows as the flooding water increases during the rainy season.

Weeding and protection

Farmers start to weed when the growth reaches the level of identifying the rice plant from weed plants. The focus group held in *Quaire Micheal*, *Wereta Zuria* and *Abuha & Kokit* indicated that rice needs hand weeding at least three to four times during its vegetative growing stage. It consumes high labor than other major crops (teff and millet).

As the study indicates, rice needs intensive labor for weeding. According to the rice producer households in the study area 66% of the household stated that weeding operation faces labor shortage whereas 31.9% of the households said weeding and harvesting faces labor shortage. The remaining 2.1% said, labor shortage occurs in the harvesting operation. Rice usually reaches flowering stage in October. At this stage weeding is not carried out. This is because weeding at this stage exposes the flowers to drop and affects its yield.

Harvesting and threshing

Farmers harvest rice at full ripening growth stage and when most of the leaves become yellowish. It is harvested in November. According to focus group discussants, *X-Jigina* variety has shattering problem. Although farmers harvest their rice at early period before full grain maturity and drying to prevent from shattering and to keep the moisture of the field to plant the next crops. This early harvesting results low grain quality and low market price.

Cultivators mostly thresh the rice crop in November and December. *Fogera* use two methods. The first is hand threshing. They employ it when the farmers need the rice straw for the roof thatching which replaces *Zurha* and other indigenous grasses. The second is oxen threshing. It is practiced when the farmers have time constraint or when they need the rice straw for animal feed. According to the household respondents 68.1% (32 households) thresh their paddy rice by oxen where as 31.9% (15 households) thresh by hand.

Processing and storage

Based on observation, discussion with farm households, rice grain traders and processing machine owners at *Wereta* the rice crop has three levels of processing. The first level is the type of rice immediately after threshing locally knows as ***Jelefet***. It is a crop with its hull and bran layers. It is rice in the husk and farmers reserve it for seed. Farmers also sell and store it at this level.

The storage facilities and storing methods in the study area are traditional. Most of the rice growers are using traditional storage facilities called "***Gota***". The *Gota* is unlimited in size and is adjustable. The second level is locally called ***Filfil***. At this level, the outer hard cover of the rice is removed with grinding mill at cost of six Birr per quintal. Only thin bran layers remain at this condition. Farmers separate the grained husk and the grain rice with wind. Then they convert the grain into flour with further milling by grinding mill. Hence, households consume rice at the level of ***filfil*** in many ways.

The third level is called ***Yetemeshene ruz*** (polished rice). At this level, the outer covers of the rice are removed with rice machine at *Wereta* at cost of 10 Birr per quintal. According to rice grain traders and machine owners, there are more than 10 rice polishing machines and above 20 grinding mills in *Wereta* town. However, in rural areas there is no even one rice machine for the process of white rice. Nevertheless, there are nine grinding mills in rural. According to SG2000 agricultural expert, to solve this problem SG2000 rice program have planned to purchase one thresher, two rice machines and one flourmill for cooperatives in the service of farmers for rice processing / polishing.

Rice food preparation and consumption

Like the cultivation practices, *Fogera* households adopted the consumption of rice in to their own custom and norms of food preparation and consumption. Agriculturalists, Home agents and SG2000-Rice Program play a significant role to change the *Fogera* plain people in to consumers of rice.

According to the respondents, rice turns out to be their favorite food for both in the household consumption and ceremonies presently. In the plain, all the respondents

(100%) consume and accepted rice as a food. They also said rice became the most, first priority, important staple food items in the plain. The survey result indicates that, 48.9% of the household consumed rice in the form of injera only. 46.8% of the households consumed rice in the form of injera, bread, porridge and local beer/tela. The remaining 4.3% consumed rice in the form of injera and bread only. In general, people in *Fogera* plain mainly consumed rice in the form of injera.

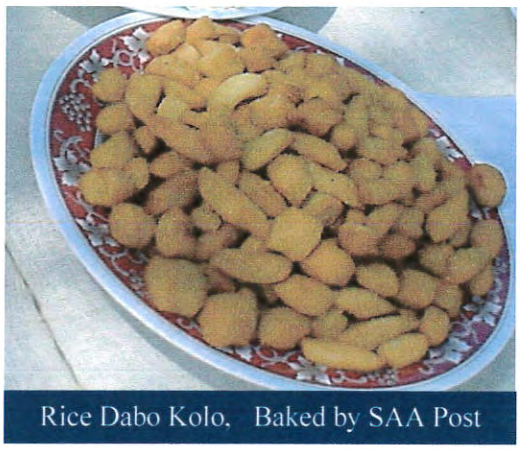
The farmers said that rice has good taste, color, palatability when mixed with other crops and it is easy to prepare, and save rice powder (because it needs more water during dough preparation). All the respondents (100%) use rice mixed with teff and millet. The color of injera prepared from white rice has high value. Because of this, they call it locally as ''***Wetet yemesele***'' means milk like. It is cool, soft, elastic and palatable. Development of moulds on the surface of rice injera is not common problem as compared to other types of Injera made from teff and millet.

Fig 2- Different types of local dishes prepared from rice

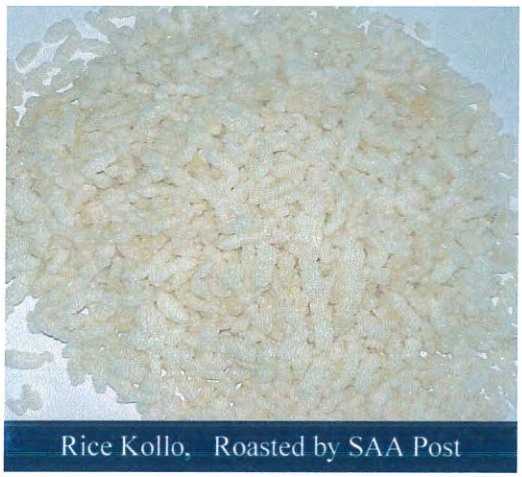
Rice Injera. Baked by SAA Post Harvest

Rice bread. Baked by SAA Post Harvest

Rice Porridge. Cooked by SAA Post



Rice Dabo Kolo. Baked by SAA Post



Rice Kollo. Roasted by SAA Post

Rice Cookies. Baked by SAA Post

Source: SG2000-Rice program, 2005

Further more *Fogera* women appreciate the quality of rice to mix with other crops and its suitability to prepare different types of local dishes and drinks. Due to the above excellent value they call it locally ***''Hulun Esh''*** means rice is versatile because it can be used to prepare all types of local foods. Moreover, they have a high regard for its excellence to present to respected guests. To express this feature, they commonly say in Amharic '' ***Engida fit bikerb yemayasafir ena Yemiyakora''*** literally this denotes that '' it does not dishonor you if it is presented to guests and it gives you pride and dignity.''

Fogera women prepare local alcoholic beverage like local beer ***and*** *Arekie*/local liquor 'simply by fermenting the paddy rice in to malt. The local alcoholic drinks prepared from rice are sweet which leads them to drink more, intoxicated, and consequently creates difficulty in their health.

As shown in figure (2), rice can be also used to prepare a variety of traditional dishes like *Genfo (Porridge), Kinche, Nifro (Boiled rice), Kolo (Roasted grain), Dabokolo (small round dough ball roasted), Atmit (Gruel), and Shorba (Soup)*. Occasional dishes like *Siligo* (made from a mixture of bean flour, oil, Mustard, and Spices) are also prepared from rice especially during the fasting season of the Orthodox Christians. Similar to this finding Tesfaye, 2001; Sewunet, 2005 and Tefera, 2006 stated that rice used mainly for human food and is consumed mostly in the form whole grains. They also said that rice has a variety of uses in the preparation of local food and beverage (injera, bread, local beer, etc) either alone or mixed with other crops such as teff and millet.

Marketing process of rice

The success of agricultural development depends, among other institutions, on the existence of efficient marketing system. According to the respondent farmers of the three *kebeles* rice, teff, millet, maize and other crops (chickpea, grass pea, pepper, onion, tomato (Lycopersicum esculentum), lentil, etc.) are the major products delivered to the market.

Table 20 –Major products delivered to the market by sample households, 2006.

Type of crop	Rice producers (N=47)		Non Rice producers (N=43)		Share of rice in Birr (%) from rice producers
	Average mount delivered Qt/HH	Birr	Average mount delivered Qt/HH	Birr	
Rice	6.7	1864	0	0	55.2
Tef	0.3	120	0.2	84	
Millet	0.5	121	2.6	646	
Maize	0.9	143	2.7	419	
Others	3.6	1326	6.1	1151	
Total	12	3574	11.6	2300	

Source: Survey data, 2007

As indicated in the Table 20, out of the major products delivered to the market, rice was their number one product followed by maize, millet and teff orderly in rice producer households. In non-rice producer households millet and maize was their first supply product followed by teff and other crops. The share of rice, 1864 Birr, from rice producers was found to be 52.2% compared to the total type of crop delivered to the market.

Rice is increasingly becoming cash crop in *Fogera*. It has good market demand. The price of market at the beginning (1993/94) was between 40 and 60 Birr per quintal. Now a day the price is much higher than the major local crops in relation to production per hectare. It is the source of income to pay tax, credit, to pay for clothes, and purchase some inputs and for other routine expenses. Tefera, 2006 also confirmed this result by his study about change of land use from livestock to irrigation and rice cultivation in *Fogera Woreda*.

In 2006 at harvest, after harvest and in rainy season farmers sell one quintal of unpolished rice grain for Birr 156, 162, and 177 respectively. Averagely farmers sell one quintal of unpolished rice for Birr 165. However, the price of a quintal of polished rice at harvest.

after harvest and in rainy season was Birr 264, 277, and 293 respectively. The average price of this polished product was 278 Birr. Many of the farmers sell their rice grain to rice traders (whole sellers and intermediaries) and rice machine owners at some reduction cost (least cost). That is why the average price of polished rice grain was 278 Birr. Nevertheless, the price of polished rice at rice traders was 300-320 Birr per quintal at *Wereta* town. Some farmers do not sell the rice immediately after threshing because of their marketing prediction that its price will increase during the rainy season.

As per data obtained from household survey result, more than 90% of the rice producer households supply rice at *Wereta* town, which is found at far distance to many of the *kebeles*. The distance affects the price and household access to market. According to the rice traders, the population of the surrounding urban centers; *Bahirdar, Gondar, Wereta* and others prefer *Fogera* rice than rice imported from aboard. This is because the imported rice is relatively expensive and its price was more than 500 Birr at minimum, 550 Birr at average and 600 Birr at maximum per quintal in *Wereta* market in 2006. However, the price of local rice was 270 Birr at minimum, 285 Birr at average and 300 Birr at maximum per quintal. It has almost a surplus difference of 300 Birr compared to imported rice per quintal at maximum value of both rice types. Similar to this finding (ENA,2003) said, Ethiopia which has above two million hectares of land suitable for the cultivation of rice, spends over 250 million Birr in hard currency on rice import per annum. This shows local rice production greatly reduces foreign currency expenses to import the rice grain.

Traders also transport the rice grain to very distant urban centers in Ethiopia such as Dessie, Addis Ababa, etc where they can fetch higher prices. Moreover, the roads from Addis Ababa to *Gondar* and from *Wereta to Weldiya* link *Fogera* plain to Central and North Ethiopia. There fore, the availability of infrastructure to transport production to different parts of the country also contributes to the increasing adoption of rice. Price fluctuation did not affect much the production of rice because it became staple food of the peasants in the area. This shows that rice contribution as a source of cash income and food in the plain is immensely growing.

According to the household respondents, the majority of farmers (76%) transport their goods using pack animal (donkeys) and the rest (24%) used head load. However, rice grain traders used cart for transportation from rural to town.

Farmers where asked to identify the major market related problems they faced. Accordingly, they list some problems such as cheep / low price, lack of price information, lack of processing machine, and lack of storage facilities. According to the respondents the most important problems to rice market were lack of processing machine. It accounts 57.5 % of the responses. Like wise rice producer households identify low price, lack of price information and lack of storage facility as market related problems in descending order with percent responses of 8.5, 2.1, and 2.1 respectively. The remaining 29.8% of the households stated that all the above mentioned problems (lack of processing machine, low price, lack of price information and lack of storage facilities) had been created in the plain.

4.3 Extent of Rice Cultivation and Associated Factors in Fogera Plain

Along with the continuous intervention to introduce rice in *Fogera* peasants, *kebele* development agents and rice expert of the *Woreda* agricultural office stated additional contributory factors for the increasing adoption of rice. These are its better productivity, use as a cattle feeding, adoptability to the swampy ecology, good home consumption, for house roofing and its good market price. After it had been adopted in *Nabega* and *Shaga* PAs rice crop has widely spread to other plain *Kebeles* of *Fogera Woreda* and neighboring *Woreda* of *Libo kemkem and Dera* by farmer-to-farmer seed exchange and buying from the markets.

The research result showed that the average productivity of rice per hectare (45qt) is 8 times greater than teff (6qt) and 3 times greater than millet (15qt). It is suitable for double cropping system because of its early maturity characteristics. All of the respondents point out that rice gave more yield per unit area than other field crops and they also cultivates pulses (lentil, chick pea, rough pea) at the end of the rainy season, following the harvest of rice. This idea / or finding was also supported by (IPMS, 2003; Tesfaye, 2005; Tefera, 2006).

According to *Fogera Woreda* agricultural office, rice production and coverage is increasing from year to year. With in 12 years all *kebeles* of the *Fogera* plain have become producer of rice.

Table 21 - Extent (trend) of rice production in *Fogera Wereda.*

Year	No. of PA's	No. of peasants	Area in Ha	Production in Q.	Yield per hectare
1993	2	30	6	162	27
1994	5	256	65	1625	25
1995	5	494	130	1690	13
1996	5	1374	487	14610	30
1997	11	2957	1113	16138	14.5
1998	13	4450	1670.5	41762	25
1999	13	6158	1968	61008	31
2000	14	9413	2907	101745	35
2001	14	9796	3037	106295	35
2002	14	11032	3346	117110	35
2003	14	15000	3980	139300	35
2004	14	15945	6378	287010	45
2005	14	21683	14918.5	671332.5	45

Source: FWARO, 2006

As shown in Table 21, the involvement of peasants in rice production increased from 30 in 1993/94 to 21683 in 2006/2007. Out of 28000 hectares of potential area for rice production, more than 53 % (14918.5 hectares) of land have been used for paddy rice production. Similar to this finding AICAF (1992) and Onuweme and Sinha (1991) stated that rice grown in the tropical, subtropical and temperate regions during the 1960's and 1970's there was a constant increase in global rice production. BFED (2002) also said that during 1994, 256 households cultivated rice in area of 65 hectares and produced

1625 quintals. After five years in 1999, 16383 households cultivated rice in an area of 6775.5 hectare and 313921 quintals produced in Amhara region.

The production of rice per hectare varies between 13 and 45 quintals. The *Woreda* agriculture had no specific justification about the irregularity and the same yield per hectare in four consecutive years (2000, 2001, 2002 and 2003). However, as respondents said production of rice could decrease due to poor weeding, bird attack, disease, over and lack of flooding, and lack of careful recording.

As the study indicated the average rice land holding in the study area was 0.688 hectare. The land holding per households ranges from 0.375 to 1.5 hectare. The average proportion of cultivated land allocated to rice compared to the total land holding cultivated land per household was 33% (a minimum of 22% and a maximum of 46%). In the plain the yield of rice per hectare per household ranges from 30qt to 64 qt (an average of 45 qt).

Table 22 - Distribution of HHs by land holding with respect to major crops.

Landholding in Ha	Rice producers (N=47)					
	Rice		Millet		Tef	
	Frequency	%	Frequency	%	Frequency	%
0	1	2.1	20	42.6	22	46.8
0.1-0.49	7	14.9	17	36.2	23	49
0.49-1.00	36	76.6	10	21.2	1	2.1
1.1-1.5	3	6.4			1	2.1
Total	47	100	47	100	47	100

Source: Survey data, 2007

The above Table 22 shows 17% of the rice producer households had less than 0.5 hectare where as 83 % of the households had greater than 0.5 hectare. Further more 6.4% of the households had greater than a hectare. The majority of the sample rice households

(76.6%) had 0.5 to 1 (one) hectare of rice land. In the study *kebele* the majority of the sample households have less than 0.5 hectare of millet and teff. This indicated that the landing holding size of rice is much greater than millet and teff in the plain. This could be because farmers have given great attention to rice due to its high productivity, high resistance to flooding and high market value.

4.3.1 The role of extension service in the adoption of rice cultivation

Agricultural extension system manages the knowledge and information flow from the source to the receiver. Farmers and their formal and informal institutions as part of the main actors in development activity had been addressed in the extension service. But the degree of addressing was not as intended. Hence, there is a gap between the extension service given to farmers and the actual situation in rural areas including the study *kebeles*.

As stated by agricultural experts of *Fogera Woreda*, the extension approach and structure since 1974 has been changing from time to time based on the political agenda of the different governments. The *Derg* period was based on socialist model of rural transformation. Hence, peasant producers' cooperatives were the focus and the means of the extension programme. In this period, the extension to introduce rice through producers' cooperatives by the technical support of South Korean experts had created some influence on enlightened cooperative members to preserve the rice seed during the transition from the *Derg* to EPRDF-led government.

As the study indicated among the rice producer households 91.5 % of the first rice seed sources were the producers' cooperative member farmers. The remaining 8.5 % were agricultural offices through extension agents. According to the explanation of the *Fogera Woreda* agricultural experts, since 1993/94 the Amhara National Regional State Agricultural Bureau, the *South Gondar Zone* Agricultural Office, *Fogera Woreda* Office of Agriculture, *Adet* Research Institutes, and NGO's (Sasakawa Global 2000-Rice program and IPMS / ILRI had been promoting the production of rice in *Fogera* plain.
In *Fogera* plain meeting of farmers to got extension services by development agents were normally takes place immediately after the completion of church attendance. In this

society where all of the farmers are followers of the Orthodox Christianity, churches are good forums to get most of the farmers and household members.

Table 23 - Frequency of visits by extension agent per month.

Number of contacts/month	Rice producers		Non rice producers		Total	
	No. of HH	%	No. of HH	%	No. of HH	%
Once	4	8.5	11	25.6	15	16.7
Two times	15	31.9	9	20.9	24	26.7
Three times	11	23.4	12	27.9	23	25.6
Four times	17	36.2	11	25.6	28	31
Total	47	100	43	100	90	100

Source: Survey data, 2007

In this survey as showen in Table 23, all the respondent households were visited by the development agents in both rice and non-rice producer households. Among these households, in both producers, 31% of them confirmed that they had contacts with DAs four times in a month, 26.7% two times in a month, 25.6% three times a month and 16.7% only once in a month. However, 91.5% of the sample rice producer households confirmed that they had contacts with DAs two and greater than two times in a month unlike non-rice producers (74.4%). This indicates that rice producers got much visits than non-rice producers. This is due to the focus of rice crop. Responses of group discussants at *Kebele* level showed that the most frequent meeting place of farmers and DA's were farmer fields, churches and public meeting places.

After the introduction of rice by Korean rice experts in *Fogera,* the agricultural experts collected seeds from the *Jigina Kebele* peasants and distributed to selected peasants of *Nabega and Shaga* PA's in 1993/94. The successful adoption of rice in these PAs has been used as good ground to encourage other PAs and *Woredas* in *Fogera* plain. Furthermore, agricultural experts have targeted to create awareness on how to cultivate and consume rice and to have feed back from the producers and consumers. The *Fogera*

Woreda agricultural office, Sasakawa Global 2000 Rice programmes, IPMS and *Adet* research institute were organizing field days to demonstrate new techniques of production to peasants. The field days were used as means of sharing experience among peasants. Therefore, they exchange knowledge on how to grow rice on the flooded areas, to determine the amount of seed needed per unit area of land, how to weed , maintain and control the water level for paddy rice, as well as ways to prepare local food from rice crop.

According to key informants of agricultural experts, Sasakawa Global 2000 Rice Program performed many activities to promote the rice crop in the plain like; Post harvest management of rice, spacing, fertilizer application, row planting, seed multiplication and supporting of cooperatives (rice thresher, rice mill, etc). As the respondents said, *Adet* Research Institute also contributes for the further expansion of rice by accomplishing rice-breeding activities, rice culture, fertilizer application and variety improvements.

According to key informants, during the past few years, the continuous effort to promote the production and consumption of rice faced negative reaction and resistance from peasants. The first type of resistance revolved around the grass like nature of rice (*Zurha/Phalaries miner*). At early time farmers in the plain said that, rice is an improved grass ''*Zurha*'' which is brought by government. They believed that it makes them slim, gray and dry. It is not good for health. Consuming rice makes a person thin and week. People with hemorrhoids do not eat rice, because they believe that eating rice may aggravate the problem. Some also believed that it exposes people to constipation, some with in fertility. Nevertheless, now a day both interviewed respondents, focus group discussants and key informants stated that there is no local crop, which gives high productivity, good and suitable for consumption and good market value like rice in swampy areas of *Fogera*.

4.3.2 Input supply and credit services in *Fogera* plain

Input supply in *Fogera* plain

As the population growth out paced the growth of food production, agricultural inputs like fertilizer ,improved seeds and pesticides are important sources to bring change in production and productivity of crops for sustaining life.

Table 24 - Users of modern agricultural inputs by sample households, 2006.

Type of input	Rice producers (N=47)	%	Non rice producers (N=43)	%	Total No. (N=90)	Total Input users %
Fertilizer	0	72.3	38	88.4	38	42.2
Improved Seed	2	4.3	3	7	5	5.6
Other inputs (pump, Beehives, etc	11	23.4	2	4.6	13	14.5
Total	13	27.6	43	100	56	62.2

Source: Survey data, 2007

In this survey, as indicated in the Table 24 households were asked whether they have utilized modern agricultural inputs such as inorganic fertilizers, improved seeds and pesticides. The result of the survey indicated that 100% of the rice producers did not use fertilizers in 2006 where as 4.3% of the households used improved seed for maize and pepper. 23.4 % of the rice producer households used farm inputs such as irrigation pump, beehives, etc. It was observed that 88.4% of the non-rice producer households used fertilizer and 7% of the households used improved seed other than rice seed. The remaining 4.6% used other farm inputs.

As indicated in Table 24, all the peasant informants and agricultural experts of *Fogera Woreda* stated that all rice producers were not used chemical fertilizers due to the availability of sediments and the absence of erosion and fear of leaching. If fertilizer is applied, it will be automatically flooded and washed away. The fertility status of the land is high unlike the neighboring hilly areas. However, contradictory to this result ANRS BoARD (1992) stated that rice growing in *Fogera* and its surrounding requires 125 Kg DAP and 75 Kg Urea per hectare.

The plain households use different types of mechanisms to protect the fertility of their land. First, the geographical location of *Fogera* plain is suitable to receive eroded and delta soil from upland in the East, North- East and South- East directions during the rainy season. The plain households divert small rivers from their banks to the plain to retain the silt. This is mostly done towards the end of the rainy season. *Fogera* plain has no problem of soil erosion. Secondly, the plain households maintain the fertility of their plots of land by collecting and depositing of weed plants during weeding and preparation of the field for sowing. The decayed weed usually stays at the farm field and used as a fertilizer. Thirdly, although it is declining due to the decrease in the numbers of cattle per peasant household dung of cattle have been used to maintain and recover the soil fertility. In this case, farmers keep their cattle at night in their farmlands during the dry seasons. The fourth method of protecting soil fertility is crop rotation. After harvesting the field of rice, teff, and millet, they cultivate pulses using the residual moisture irrigation. They believe that grass pea, chickpea and lentils are good pulse crops to recover the soil fertility.

Credit services in *Fogera* plain

In general, credit service enables smallholder farmers to purchase modern inputs and there by, increase farm production. In the study area, credit (for farm tools, beehives, livestock husbandry, fertilizers, improved seeds, etc) was given mainly by farmers' service cooperatives and to some extent Ambasel, AISCO (Agricultural Input and Supply Corporation) and ACSI (Amhara Credit and Saving Institution). Some households in the plain purchased inputs on cash.

According to the survey result 25.5% of rice producers and 46.5% of non-rice producers took a loan (credit). The remaining 74.5% of the rice producers and 53.5 % of the non-rice producers did not take a loan (credit). Generally, the majority (64.4%) of the households did not take a credit. The non-rice producers used greater credit especially fertilizer. This is mainly because the fertility of the soil in non-rice producer areas is very low compared to the rice producers.

4.5 Major Constraints of Rice Production in *Fogera* plain

One objective of the research was to assess the major rice production constraints that cause poor harvest in the *Fogera* plain. All the three *Kebeles* were found to have similar constraints. Focus group discussion with farmers, development agents and key informants indicated that weeding, lack and over flooding, lack of improved seed, lack of processing machine, wind, birds, pests and diseases, lack of adequate extension service and lack of modern agronomic practices are the major constraints that affect the productivity of rice. The constraints are also explained by Getachew, 2000; Welelaw, 2005; IPMS, 2005.

. Weeding

Weeding is the most important and labor intensive activity in rice production. According to the producers, if the rice crop was not weeded on time and frequently at least three times the yield of rice extremely decreases. Sinha (1991) and IRRI (1981) cited in FAO ,2002 indicated that in order to obtain good yields of rice weeds must be controlled on time and needs three to four times weeding.

Shortage of rainfall / Lack of flooding

Productivity of rice can be affected by the amount and duration of rainfall. Late beginning and early stopping of rainfall commonly affects rice production. Especially, lack of enough rainfall and floodwater at flowering and ripening stages usually results in low productivity. It is a problem in less flooded places. Konokhovo (1985) and Mukiibi (2001) have found similar results that the choice of limiting factor to rice growth is not climate but the water supply. Lack of water is the primary constraint to high and stable rice yields; too much water is also a problem. In order to prevent this problem farmers mostly harvest and collect flood water by making terracing of mud around the field of each plots of rice. It prevents the flow of water out of the field.

Excess rainfall / over flooding

According to the respondents, the other problem is related to over flooding and concentration of water in paddies. In this case, it is a huge over flooding which drains and

covers the entire rice field under water. It causes the rice to fall on the ground and mixes with the mud (***delta***) of the flood. It is the result of fast moving floodwater which over flows on the entire field of the plain for more than two days and thus damages any thing underneath. The extreme sinking of rice plants affects the biological processes of growing and getting sun light. It results in irreversible damage of the whole field of the rice. Sinha (1991) stated that if water level in deep water areas usually reach its peak, the life cycle of the crop will extend over a period of months.

Similarly, when there is continuous strong sunlight in rice paddies with too much stagnant floodwater the water became hot to the extent of creating reddish coats and results in drying of the rice plant. The solution according to farmers is to drain the water. The problem associated with flooding and concentration of stagnant water is locally called as *''Yewuha sat''* (fire of water), literally means water that burn the rice plant.

Wind

Further more, farmers state the problem related with strong wind that results in the failure of rice crop. It blows from North to South in October unpredictably. Before the starting of the wind early in the morning, the weather condition became too cold. Then the wind blows starting from 8.00 am up to 12.00 am, in most cases it stays one to two days. The rice plant then turns white and the rice dries at flowering and ripening stage. This is locally known as ***''Abrik or Kewus nefas*** (disturbing wind). According to the agricultural experts, scientifically it is called rice head blast. As the respondents said, the solution to this problem is early planting.

Birds

The attack of birds is the other problem. The bird locally known as ***Jibajibo*** attacks every type of crop through out the year. It gets its name due to its voracious habit like hyena. It is medium sized bird with black body cover. It is the damaging bird. The second, third and fourth damaging bird is Stork (***Shimela)*** and Duck respectively.

Insect pests and diseases

According to peasant respondents and agricultural experts the most common insect pests and diseases in the plain that reduces rice yield are stalk borer, beetles, termites, head blast, etc. These pests attack the roots, stalk, leaves, seedlings, and stem of the crop and causes enormous damage from time of planting until harvesting and during storage.

Lack of improved seed

To exploit the potential of land and to produce more quantity and quality of crops different methods can be applied along with good management of land. One aspect in this regard is the use of improved seed. Adet Agricultural Research Institute releases four varieties which were demonstrated in the farmer's field. In the study area, there are only one unknown varieties of rice, *X-jigina*. In the plain, there was no any improved wet land and upland rice varieties which is practiced in the farmers field. Even the non-rice producer household's need upland rice due to its high yielding and high marketing characteristics, none of the institution still brings modern varieties.

An *X-jigna* variety has splintering (shattering) problem. Due to the fear of this shattering problem, farmers in the plain harvest the crop early before full maturity and drying. This results low grain quality and low market price of the crop. This result also supported by Welelaw, 2005.

Lack of processing machine

According to interview households, focus group discussants and key informants in the rural plain there is no any processing machines to polish the brown rice in to white marketable rice. Even if there are ten processing machines in *Wereta* town, it costs 10 Birr per quintal to polish rice grain. It is very expensive, far from residence of farmers, time consuming and increases transportation cost.

Poor agronomic practices and feeding patterns

In the plain, many of the respondents and focus group discussants do not apply modern agronomic practices of rice production such as flooding (water) management, fertilizer

application, planting method, spacing of sowing, time of harvesting, pest controls, etc. Even though the respondents' use rice as many traditional dishes, the majority of the farmers do not knew how to prepare modern food items from rice grain except making injera and bread.

Lack of adequate extension service

All the above problems are associated with extension services by the responsible government institutions. According to key informants the reason for the above some problem could be lack of sufficient awareness about the importance of such technologies. In the study *Kebeles*, there was still a gap between extension agents and farmers in regarding to the awareness of new technologies. The service being provided by the extension agents to farmers are usually focused on seasonal government activities (seasonal mass mobilization work).

4.6 Contribution of Rice Cultivation to Households Income and Food Security in *Fogera* plain

4.6.1 Contribution of rice to income in the plain

The household income is determined by the source of income. In this regard, attempts have been made to identify the major sources of incomes of the sample households comparing rice producers and non-rice producers. The income from crop output was computed by valuing the total output using average market price. It is difficult to get genuine data of income particularly in communities whose income source is highly diverse and inconsistent. This was also true in *Fogera* plain. Even the household heads themselves may not exactly know what they actually earn in a month. Nevertheless, an attempt was made to capture the approximate level of income earned by households.

According to the respondents, about three types of household income sources were specified in the study area. These are; crop production, livestock production and non-farm and off farm activities.

Table 25 – Income (Birr) of sample households by income sources (2006).

Description and income source	Rice producers (N=47)		Non rice producers (N=43)	
	Average income in Birr/HH/year	% of income	Average income in Birr/HH	% of income
Crop production	11385	96.8	6268	92.2
Livestock	271	2.31	424	6.2
Non farm and off farm	98	0.89	108	1.6
HH average income	11754		6800	
Total		100		100

Source: Survey data, 2007

As clearly revealed in Table 25 crop production is the main source of income that accounts for 96.8% of those households who were producing rice followed by livestock (2.3%) and non-farm and off farm (0.89%) in *Fogera* plain. Similarly, in non-rice producer households crop production also ranked first by accounting 92.2% where as livestock and non-farm (petty trade, pottery, handcrafts, mills, wage labor, etc) accounts for 6.2% and 1.6% respectively.

The average annual income of rice producers and non-rice producer households was found to be 11754 and 6800 Birr respectively. In rice producer households among the crop average annual income rice took a great share of income that is 61.7% and from the total average annual income of the household the share of rice was 59.8%. This indicates that rice is the main and most important source of livelihood and income for rice producers in *Fogera* plain. Now a days the contribution of crop as a means of household income is maximum and livestock is minimal in the plain. This clearly shows that, the contribution of rice for family income is increasing.

Table 26 - Crop income share in relation to total HH crop income for 2006 cropping season.

Income source	Rice producers (N=47)			Non rice producers (N=43)			Test for difference in income
	Average HH income Birr	% share	SD	Average HH income Birr	% share	SD	Rice with teff and millet
Tef	294	2.6	410	612	9.77	626	10.41***
Rice	7027	61.7	4411	0	0		
Millet	754	6.63	936	2361	37.6	1558	9.51***
Maize	637	5.61		1291	20.68		
Chickpea	844	7.41		235	3.73		
Rough pea	910	8		318	5.07		
Others	919	8.05		1451	23.15		
Average income	11385			6268			
Total		100			100		

*** - It is highly significant at 1% error level

Source: Survey data, 2007

As indicated in Table 26, the average annual crop income of rice producer households was 11385 where as in non-rice producer households it was found to be Birr 6268. It was almost twice greater than those of non-rice producers. From the rice producer households' income, the lion share goes to rice (61.7%). This result implies that households who are benefiting from rice have shown better income than non-rice producer households. In non-rice producers millet took the great income share (37.6%) compared to other crops. As shown in Table 26 except rough pea and chickpea the income from the listed crops (millet, teff, maize and others) were greater in non-rice producers than rice producers. Nevertheless, the total income of the rice producers was higher than non-rice producers. The income difference between the rice and non-rice producer households is attributed to the cultivation of rice.

In Table 26, in rice producer households the mean annual income of rice was 7027 and its standard deviation was 4411 Birr. It is very significant at 0.01 error level compared to teff 294.8 Birr and millet 754 Birr. The mean and the standard deviation of non-rice producer household's income were greater than rice producers in teff and millet crops. Nevertheless, due to rice crop the total mean of rice producers was high. The mean income of rice exceeds by Birr 6733.1 and 6273.9 from that of teff and millet mean income respectively. This all shows the great contribution of rice to income in the plain households.

Table 27 - Household Income generated from sale of Livestock.

Livestock product	Rice producers (N=47)	Non Rice producers (N=43)
	Average income Birr	Average income Birr
Hides/Skin	9.6	12.2
Honey	66	56
Egg	33.2	68.7
Milk	26.9	70.9
Butter	40.8	216
Live animal sale	94.6	-
Total	271	424

Source: Survey data, 2007

As Table 27 indicates, the income from livestock products came from hide/skin, butter, live animal, eggs, honey, and milk. Non-rice producers were greatly involved in producing livestock products and this group was generating larger average annual income of 424 Birr than rice producers 271 Birr. This all indicates that non-rice producers have got much livestock income than rice producers. However, when taking the total income source of the household, crop mainly rice took the lion share of the annual income.

4.6.2 Contribution of rice to households' food security

The level of Calorie available to a household is a crucial indicator of status of food security. In addition to this, the average number of meals that household members consume a day was another out come indicators considered in this study. The perception

of food about their food security status is another important aspect of household food security. Consumption pattern, the nature of food aid, length of secure months of the household, etc also indicates the food security situation of a household.

Kilo calorie availability of the households in the plain

In this study, Kcal availability and Kcal requirement of the household were computed by the following procedures. First, the total household crop production was converted in to calorie equivalent. That is converting all grain types in to quintal and then converting the quantity in to calorie equivalent based on the standard stated by Ethiopian Health and Nutrition Research Institute food composition table (Appendix 2 and 3). Finally, subsistence potential ratio (SPR) was computed to estimate the level of household food security by taking the ratio of household Kcal availability and Kcal requirement per year per adult equivalent. Households who have SPR of greater than one and equal to one were food secure and less than one were food insecure (Edilegnaw, et al, 2006).

Table 28 - Distribution of available Kcal per HH per year from crop production, 2006

Kcal availability/Requirement per household	Rice producers (N=47)	Non rice producers (N=43)	Share of rice in Kcal availability	Share of rice in Kcal availability (%)	t calculated
Average (mean) Kcal Availability	8250927	4452489	5356885	64.9	5.01***
Average (mean) Kcal Requirement	4151424	3802485			
Surplus (Difference)	4099503	650004			
Std. in Kcal availability	4439862.9	2581248.9			
Minimum	2578500	1368500			
Maximum	21530500	13685000			
Range	18952000	12316500			

***- It is significant at 1% error level

Source: Survey data, 2007

Based on Table 28, in rice producer households the lowest and the highest kilocalorie per household per year were found to be 2578500 and 21530500 respectively. However, in non-rice producer households the minimum and maximum kilocalorie per household per year was 1368500 and 13685000 respectively. The majority of rice producer households produce excess Kcal compared to non-rice producers. As shown in Appendix 8, 42.6% of rice producer households produce greater than 8000000 Kcal where as in non rice producer households only 4.7% produces greater than 8000000 Kcal. Households who produce greater than 4737700 Kcal were fulfilling the minimum requirement of Kcal (2200 Kcal * average family size 5.9). In this regard 82.9% of the rice producer households and 44.2% of non-rice producer households met the minimal Kcal requirement (Appendix 8).

In Table 28, the mean Kcal availability (8250927) of rice producing households was almost twice of non-rice producers (4452489). In rice producer households, the average surplus of Kcal per year per household was 4099503 where as in non-rice producer households were 650004. It was almost six times greater than non-rice producer households. The mean Kcal availability in rice producers was highly significant by higher than that of the non-rice producer households at 0.01 error level. Among the rice producer households, the mean availability of Kcal share of rice was 64.9% (5356885). It was very high compared to millet (752921) and teff (199072). The mean availability of millet and teff in rice producer households was less than Kcal availability in non-rice producers. However, the over all mean of Kcal availability of rice producer was much greater than non-rice producers. This shows the contribution of rice to food security in rice producer households was very high and smart.

Table 29 - Subsistence Potential Ratio (SPR) of sample households in the plain, 2006.

SPR	Rice producers (N=47)		Non rice producers (N=43)	
	No.of HHs	%	No.of HHs	%
Food secure (SPR >1)	40	85.1	25	58.1
Food insecure (SPR <1)	7	14.9	18	41.9
Total	47	100	43	100

Source: Survey data, 2007

As indicated in Table 29, by using SPR measurement/indicator seven households (14.9%) and eighteen households (41.9%) in rice and non-rice producer households were food insecure respectively. The remaining 85.1% of rice producers and 58.1% of rice producers were food secure respectively. An about 51.3% of the rice producer households have a subsistence potential ratio of greater than two where as only 20.8% of the non-rice producer households have greater than two. From this, we can generalize that the majority of rice producer households were food secure. This is highly due to rice. The family size determines the food security situation of the household by increasing the Kcal requirement of the household (Appendix, 10). Similar to this result Eshetu (2000) and Degefa (2005) undertake a study on determinants of household food security in Amhara region and conclude that sex of the household head, family size, the size of crop harvest, etc are positively and significantly affect per capita food kilo calorie availability.

Coverage capacity of household food security from own production

Based on the analysis made on the capacity of coverage of annual household food requirement from own production, the result indicated that 91.5% (43 households) of rice producer households and 58.2% (25 households) of non-rice producers were able to meet their food requirements through out the year. The remaining 8.5% (4 households) and 41.8% (18 households) in rice and non-rice producer households respectively could cover their food requirement only for about nine months from own production. Based on the analysis made, 75.6% (68 households) of the sample households in both producers cover

their food requirement through out the year. The rest 24.4% (22 households) covered their food requirement for nine months. As the result indicates the number of rice producer households' who covered their food requirement for twelve months is much greater than non-rice producer households.

As the respondents stated, after the introduction of rice the majority of rice households in the plain fulfilled family consumptions and became self-sufficient. From this it can be said that, rice has contributed more on the capacity of coverage of annual household food requirement and to extend the length of food secure months of the households. In rice and non-rice producer households the major staple foods of the household were rice and millet respectively. Thus, these crops were the most important in relation to food security. In general, rice producer households have much better capacity of coverage than non-rice producers. There were empirical evidences that confirmed this result (for instance, in China rice grain fed thousand's of people for longer periods than any other grain did (FAO,2000).

Frequency of food intake in the plain

In relation to number of meals consumed, specific questions were presented to all respondents to indicate the frequency of meals per day. Except holidays, animal products and vegetables are consumed rarely in the study area.

Table 30 - Number of daily meals of HH members by different harvests.

No. of daily meals	Rice producers		Non rice producers		Total	
	No. of HH	%	No. of HH	%	No. of HH	%
Once	1	2.1	1	2.4	2	2.2
Twice	15	31.9	21	48.8	36	40.1
Three times	28	59.6	21	48.8	49	54.4
Four times	3	6.4	0	0	3	3.3
Total	47	100	43	100	90	100

Source: Survey data, 2007

As presented on Table 30, rice producer households who ate three and more than three meals per day were 66% (31 households) where as in non-rice producers who ate three and more than three meals per day were 48.8% (21 households). Almost every household in the sample had two meals a day. Nevertheless, the proportion of meals per day in rice producers was greater than non-rice producers. According to focus group-discussants and key informants, in rice producer areas rice make up greater parts of the diets of the population.

Food aid situation in the *Fogera* plain

In addition to level of food production (availability) and access to productive resources, the frequency of food aid distribution and need in the area is also a reasonably good indicator of food security.

Table 31 - Need and reception of food aid by sample households.

HH responses	Need of food aid for rice producers before rice introduction		Need of food aid for rice producers after rice introduction		Recipients of food aid from rice producers before rice introduction		Recipients of food aid from rice producers after rice introduction		Need of food aid for non rice producers	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Yes	28	59.6	0	0	27	57.5	0	0	17	39.5
No	19	40.4	47	100	20	42.5	47	100	26	60.5
Total	47	100	47	100	47	100	47	100	43	100

Source: Survey data, 2007

As Table 31 shows the great majority of the rice producer sample households 57.5% (27 households) have been receiving food aid before the intervention of rice (until 2001,when the extent/coverage of rice is low) (see appendix-4). The rest 42.5% (20 households) were not involved in food aid. However, after the introduction of rice all producer households have been neither received nor wanted for food aid. In non-rice producer households 39.5% (17 households) needed food aid and the rest 60.5% (26 households)

did not need at all. All non rice producer households have not been involved in food aid in the study area.

All respondents of rice producer households said, ''thanks to rice, we all not need aid, we all not need blanket, and we all not need maize flour.'' This response indicates that after the introduction of rice the people of *Fogera* plain do not need food aid. This implies that rice solved the critical and bottleneck problem of the area. Similar to the above data FAO (2000) said that, the rice system helped lessen hunger and poverty, and to sustain livelihoods and rice is an important crop for food security, poverty alleviation and improved livelihoods in China. Rice production that began recently changed the lives of rural farmers in the plain (EPRDF, 2003). IPMS (2005) also confirmed that rice ''the White Gold'' for Fogera farmers, rescues thousands of people from hunger.

Perception of households on their food security status

The quantitative data was supported by qualitative information by assessing the perception of households on their food security status. The respondents confirmed that the rice producer households were on a better position regarding to food security than before the intervention. They have also become better food secured than the non-rice producers. According to the households' perception, the number of households who could feed themselves through out the year has increased following rice introduction.

Table 32 - Perception of rice cultivators on their livelihood situation after the intervention of rice.

Description	Deteriorated		Same		Improved		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Food consumption					47	100	47	100
Livestock possession	22	46.8	4	8.6	21	44.6	47	100
Income increment			1	2.1	46	97.9	47	100
Schooling			2	4.3	45	95.7	47	100
Clothing			1	2.1	46	97.9	47	100
Saving			36	76.6	11	23.4	47	100
Housing	1	2.1	14	29.8	32	68.1	47	100
Other investment			34	72.3	13	27.7	47	100
Health care			1	2.1	46	97.9	47	100
Labor wage					47	100	47	100

Source: Survey data, 2007

As Table 32 shows, the majority of the households reported that there is an improvement on food consumption (100%), over all income increment (97.9%), schooling (95.7%), clothing (97.9%), saving (23.4%), employment/ labor wage (100%), housing (68.1%), health (97.9%), and other investment (27.7%) after the introduction of rice in the plain. On the contrary, there were major responding households who reported that there is deterioration in livestock possession (46.8). Some numbers of households also reported that there was no improvement or deterioration of livestock due to the introduction of rice.

Table 33 –House types of sample households.

Type of housing	No. of HHs in rice producers		No. of HHs in non rice producers	
	Freq.	%	Freq.	%
Grass thatched	11	23.4	14	32.6
Iron Sheet	22	46.8	17	39.5
Iron Sheet and Grass thatched	14	29.8	12	27.9
Total	47	100	43	100

Source: Survey data, 2007

As Table 33 indicates, 23.4% (11 households), 46.8% (22 households), and 29.8% (14 households) of rice producers have grass thatched, iron sheet and both grass thatched and iron sheet types of house respectively. In non-rice producers 32.6% (14 households), 39.5% (17 households), and 27.9% (12 households) have grass thatched, iron sheet and both grass thatched and iron sheet types of house respectively. According to the majority of households, the money (resource) that helped to construct the house came from crop sale that was mainly from rice.

According to the perception of the households and key informants in the *Fogera* plain, there was an increasing trend of labor employment after the introduction of rice. The daily labor cost was significantly increased from six Birr per day (1998) to 13 (thirteen) Birr per day and nine Birr per day (2006) in rice producers and non-rice producers respectively. This is because rice needs very much intensive labor and it needs high frequency of weeding.

In *Fogera* plain, the households used both family labor and hired labor for rice weeding and harvesting. In the area, June for plowing and sowing, July to September for weeding, October to January for harvesting and threshing are the busiest periods. When the need arises, laborers are hired from *Wereta* town. Most of the laborers are migrants from high

lands of *Farta* and other *Woredas of* South *Gondar Zone*. As mentioned above for harvesting and weeding one daily labor was hired for 10 to 15 Birr per day (average 13.6 Birr) plus the accommodation of lunch and local beer (produced from rice).

In general this result indicated that rice created employment not only for the surrounding areas of wage laborers but also for neighboring *Woredas* of land less and poor daily laborers. There was empirical evidence that support this finding. For instance FAO stated that rice is an important source of employment and income in rural areas. Rice production employs 1 billion people and is essential to the economic development of rural areas in India, Bangladesh and South East Asia (http:www.fao.org).

According to the focus group discussants, in Fogera plain, the households' health situation was improved and farmers can pay for the service of health. In the plain the saving conditions of the household was also improved in the form of grain and money. Rice producer households were also better in educating their children. In the plain the marital conditions of the households were also improved. This is because before the introduction of rice in the plain the hilly side households were not volunteer to marry the plain household girls and boys. This is also due to the poorness of the plain households before the introduction of rice. But now a days due to the introduction of rice in the plain this cultural problem of marital conditions were improved.

5. CHAPTER FIVE; Summary, Conclusion and Recommendations

5.1 Summary of Findings

All rice-growing countries have shown a definite up ward trend in rice production during the past 25 years. In the study area, rice production has increased from 2 PAs to 14 PAs and this supports about 30 households in 1993 to 21683 households in 2007.

As the study indicated among the rice producer households 91.5% of the first rice seed sources were the producers' cooperative member farmers. The remaining 8.5% were agricultural offices through extension agents. In this survey all the respondent households were visited by the development agents in both rice and non-rice producer households. Among these households ,in both producers, 31% of them confirmed that they had contacts with DAs four times in a month , 26.7% two times in a month ,25.6 % three times a month and 16.7% only once in a month. Responses of group discussants at *Kebele* level showed that the most frequent meeting place of farmers and DA's were farmer fields, churches, and public meeting places.

The average productivity of rice per hectare (45 qt) is 8 times greater than teff (6qt) and 3 times greater than millet (15qt). In one hectare of rice land the household almost gets 9000 Birr net surplus value as compared with cultivation of millet and teff. The net benefit of rice was almost 20 times and 25 times greater than millet and teff respectively. Rice is suitable for double cropping system because of its early maturity characteristics. The average rice land holding in the study area was 0.688 hectare. The land holding per households ranges from 0.375 to 1.5 hectare. In the study *kebele* the majority of the sample households have less than 0.5 hectare of millet and teff. This indicated that the landing holding size of rice is much greater than millet and teff in the plain.

Rice had better yield, drought, hail, disease, and flood resistance than teff. However, it has inferior characteristics regarding to early maturity, labor requirement and weed resistance. Rice had also better yield and flood resistance compared to millet. However, it has inferior quality in labor requirement, weed resistance and hail resistance. According

to the respondents, the two crops millet and rice have the same quality regarding to disease resistance and early maturity.

Rice turns out to be their favorite food for both in the household consumption and ceremonies presently. In the plain, all the respondents (100%) consume and accepted rice as a food. Rice became the most, first priority, important staple food items in the plain. Farmers in *Fogera* plain mainly consumed rice in the form of injera. Out of the major products delivered to the market, rice was their number one product followed by maize, millet and teff orderly in rice producer households. In non-rice producer households millet and maize was their first supply product followed by teff and other crops. In 2006 averagely farmers sell one quintal of unpolished rice for Birr 165. However, the average price of polished product was 278 Birr. Nevertheless, the price of polished rice at rice traders was 300 Birr per quintal at *Wereta* town.

Rice weeding needs intensive labor. According to the rice producer households in the study area 66% of the household stated that weeding operation faces labor shortage whereas 32% of the households said weeding and harvesting faces labor shortage. The remaining 2% said labor shortage occurs in the harvesting operation. According to the household respondents 68.1% (32 households) thresh their paddy rice by oxen where as 31.9% (15 households) thresh by hand. Weeding, lack and over flooding, lack of processing machine, lack of improved seed, wind, birds, pests, lack of adequate extension service, and lack of modern agronomic practices are the major constraints that affect the productivity of rice in the plain. The most important problems to rice market were lack of processing machine, low price, lack of price information and lack of storage facility in descending order with percent responses of 57.5%, 29.8%, 8.5%, 2.1%, and 2.1% respectively.

As clearly revealed in the result crop production is the main source of income that accounts 96.8% of those households who were producing rice followed by livestock (2.3 %) and non-farm (0.89%) in *Fogera* plain. Similarly, in non-rice producer households crop production also ranked first by accounting 92.2% where as livestock and non-farm (petty trade, pottery, handcrafts, mills, etc) accounts 6.2% and 1.6% respectively. The average annual income of rice and non-rice producer households was found to be 11754

and 6800 Birr respectively. In rice producer households, among the crop annual income rice took a great share of income that is 61.7% and from the total annual income of the household the share of rice was 59.8%. Among the rice producer households, the mean availability of Kcal share of rice was 64.9% (5356885). It was very high compared to other crops. The majority of rice producer households produce excess Kcal compared to non-rice producers. Based on SPR of the household 85.1% (40 households) of the rice producer and 58.1% (25 households) of non-rice producer households were food secure..

As the result indicates the rice producer households' who covered their food requirement for twelve (12) months were much greater than non-rice producer households were. Rice producer households who ate three and more than three meals per day were 66% (31 households) where as in non-rice producers who ate more than three meals per day was 48.8% (21 households). Almost all every households in the sample had two meals a day. The majority of the sample households 57.5% (27 households) have been receiving food aid before the intervention of rice. The rest 42.5% (20 households) was not involved in food aid. However, after the introduction of rice all producer households neither involved nor wanted of food aid. In non-rice producer households, 39.5% (17 households) needed food aid and the rest 60.5% (26 households) do not needed at all.

In *Fogera* plain, there is an improvement on food consumption, over all income increment, clothing, employment, housing and other investment after the introduction of rice in the plain. The households' health situation was improved and farmers can pay for the service of health. In the plain the saving conditions of the household was also improved in the form of grain and monetary. Rice producer households were also better in educating their children.

5.2 Conclusion

Rice is a potential crop having greater adaptation to the poorly drained and swampy areas of *Fogera* plain. It yields more than any other field crop growing in the plain and contributes a lot in relaxing the food insecure situation of the farming community. In the *Fogera* plain rice was the main and most important sources of livelihood and income for rice producers due to its high productivity, high resistance to flooding and high market

value. The survey result also shows that households who are benefiting from rice have shown better income and food security situation (Kcal availability, number of meals per day, coverage of food per year, clothing, health situation, housing and education) than non-rice producer households. Hence, in *Fogera* plain the contribution of rice to household food security and poverty reduction in rice producer households was highly improved and smart. But, there are problems of processing and threshing machines, weed, improved seed, lack of water & crop management techniques in the plain.

5.3 Recommendation and Policy Implications

Based on the study findings, some recommendations that require due attention in the efforts to ensure food security at household level in the country in general and in Fogera plain in particular are forwarded below.

- There should be a need for large-scale production of this potential and alternative food crops (rice) because farmers and their families in the flood areas/ swampy environment are not capable to produce other crops and also they are idle in rainy season due to flooding. Thus rice with excellent performance in this environment should be an alternative food crop. Policy makers must be convinced that rice is a strategic crop to attain food security in the study area and in all parts of Ethiopia which is suitable for rice.
- Agricultural yield limiting factors such as pests and diseases, wind, weed, over and lack of flooding, lack of agronomic practices (water management, weeding, sowing method, seed rate, fertilizer application and post harvest techniques) and lack of processing machine should be removed through problem solving agricultural research and extension.
- Results of the study showed that rice production had a significant influence on income, food security and employment. Hence, efforts must be taken to increase the production level by delivering improved variety of rice to producers and variety adaptation trials by researchers have to be conducted on the actual production site. Because there is no any improved variety in the plain.
- Because of its good characteristics of yield, market value, flooding resistance, early maturity, pest and disease resistance the current coverage of the rice land should be

increased to use the potential area of the *Fogera* plain (Above 28000 hectares) and the country (Above 2.2 million hectares). EIAR, National and International Research Institutions, GOs and NGOs should give big emphasis for the rice crop and the research works on rice have to be comprehensive and follow team approach. The concerned institution should have to get real information on the amount of rice imported; its cost incurred and compares the cost benefit of imported rice and local rice to promote the local crops in the country.

- Rice farmers associations have to be established to facilitate rice technologies transfer, production and Marketing system.
- Training should be given for farmers on production aspects and women should also be trained on the processing and consumption of rice. Modern preparation of food from rice should be given more emphasis. So the Government should have to build human capacity at all level (*Kebele, Woreda, Zone* and Region) through training to promote the crop, rice.
- Rice should not be husked and polished by ordinary flour mills. But farmers use these mills to polish the rice grain. Hence, this results in poor quality of rice grain and in turn results low market price. The farmers were also charged high cost per quintal to polish rice grain. So any concerned institutions should supply and provide processing machines to the farmers to solve these critical problems.
- Finally, to overcome the problems of rice production and to promote the crop much more community participatory research is needed.

REFERENCES

Abera Aderie (2002).The impact of the 1996 Amhara region land redistribution on Productivity and household food security, a comparison between the losers and the beneficiary households, the cause of *Enebisie Sarmidir*. RLDS MSC Thesis (un Published) presented to the School of Graduate Studies of Addis Ababa University, Ethiopia.

Abraham Andualem (2006). Assess *Fogera*, Annual report, *Fogera Woreda* Information office, *Wereta*.

ANRS Bureau of Agriculture and Rural Development (1992). Annual report, Bahirdar.

ANRS Bureau of Agriculture and Rural Development (2003). Rural households socio-economic baseline survey of 56 Woreda's in the Amhara region, Volume 7, Bahirdar

Association for International Cooperation of Agriculture and Forestry (1992). Handbook of tropical rice cultivation, Japan.

Bureau of Finance and Economic Development (2002). Annual statistical Bulletin, ANRS, Bahirdar.

_____ (2004). Development indicators of Amhara region, 2nd edition, Bahirdar.

Chambers, R. (1983). Rural Development, Putting the last first, London, Longman,

CSA (1999). The 1994 population and housing census of Ethiopia, Analytical report, Addis Ababa, Ethiopia.

Degefa Tolossa (2005). Rural livelihoods, poverty and food security in Ethiopia; A case study at *Erensa* and *Garbi* communities in *Oromia Zone*, Amhara National Regional State, Norwegian University of Science and Technology, Doctoral Thesis, Trondheim,

Dejene Aredo (2004).Contribution of NGOs to household food security, the case of

world vision Ethiopia; ANRS, Addis Ababa, Ethiopia

Devereux, S. and Maxwell, S. (2001). Food security in sub Saharan Africa, London, Intermediate technology development Group.

Devereux, etal, (2003). Destitution in Ethiopia's Northern Eastern highlands, Amhara National Regional State, IDS Brighton, UK, University of Sussex.

Scoones, I. (1998). Sustainable rural livelihoods, Framework for Analysis, IDS working paper 72, Brighton, UK

Edilegnaw, et al (2006). Reversing rural poverty in Ethiopia, dilemmas and critical issues, proceeding of the 9th annual conference, the Agricultural Economics Society of Ethiopia, Addis Ababa.

Elias Berhanu (2001). Constraints and coping strategies for attaining HH food security, RLDS MSC Thesis (unpublished) presented to the School of Graduate Studies of Addis Ababa University, Arbaminch.

Ellis,F. (2000). Rural livelihoods and diversity in developing countries, New York, Oxford University,

Emergency nutrition coordination unit (2004). Emergency Nutrition Intervention Guideline, DPPC, Addis Ababa.

Eshetu Bekele (2000). The underlying causes of household food insecurity and coping strategies, the case of *Legambo Woreda*, MSC Thesis(unpublished) presented to the School of Graduate Studies of Addis Ababa University, Ethiopia.

FAO (1997). Human nutrition in the developing world, Rome.

_____ (1998). The right to food in practice, Rome, Italy.

_____ (2000). Global rice production Scenario, http:// www.fao.org

_____ (2002). The state of food security in the world (2001). http:// www.fao.org, http://www.usp.ac.fi, Rome.

Filmon Hadaro (2001). Female HH heads, food security and coping strategies in *Konso Woreda* of south Ethiopia, RLDS MSC Thesis (unpublished) presented to the School of Graduate Studies of Addis Ababa University, Ethiopia.

Farmers witnessing success in Agricultural development (2003). http:// eprdforgans.org /EPDRF-Doc/Articles/News/from-dec/farmerswitnessing.htm.

Food security and Disaster Prevention and Coordination Office (2005). Annual report, Bahirdar

Fogera Woreda Agricultural and Rural Development office (2005).Annual report on agricultural activities, planning and training service, *Wereta.*

_____ (2006). Annual report, *Wereta.*

Frankenberger, T.R. (1992). Indicators and data collection methods for assessing household food security, Rome.

Frankenberger, T.R., etal (2002). Household livelihood security assessments, a tool kit for Practitioners, TANGO International Inc. Tucson, Arizone, Atlanta.

FSP (2003). The New coalition for food security in Ethiopia, Volume 1, Addis Ababa.

Getachew Afework (2000). Rice in *fogera plain, Adet.*

Getachew Diriba (1995). Economy at the cross roads; famine and food security in rural Ethiopia, CARE International Ethiopia, Addis Ababa, Ethiopia

Getahun Bikora (2003). Challenges and prospects of food security in Ethiopia, Proceedings of the food security conference, Addis Ababa

Grace, C. (1997). Agricultural Intensification and rural sustainable livelihoods, A think piece, IDS working paper, 64, UK.

Improved productivity and Market success / International Livestock research institute (2005). *Fogera Woreda* pilot learning site diagnosis and program design, Addis Ababa. http:// www.birdlife.org/datazone/sites/index.Html

Konokhova, V. (1985). Rice growing, Moscow.

Kumar, R. (1996). Research methodology, a step by step guide for beginners, India, New Delhi

Maxwell, S. and Smith, M. (1992). Household food security; a conceptual review, UNICEF and IFAD, New York and Rome.

Maxwell, D.G. (1996). Measuring food insecurity and severity of coping strategies, international food policy research institute, Vol.21, No.3, USA, Washington.

MEDaC (1999). Survey of the Ethiopian economy; Review of post reform developments, Addis Ababa, Ethiopia.

Mesfin Astatikie (2005). Analysis of factors influencing adaptation of Triticale and its impact; the case of *Farta Woreda*, an MSC. Thesis presented to the School of Graduate Studies of Alemaya University, Ethiopia.

Ministry of Information (2003). Ethiopia Federal Democratic Republic State, Rural development polices, strategies and systems, Addis Ababa

Ministry of Agricultural and rural development (2003). Annual report, Addis Ababa.

Mukiibi, J. (2001). Agriculture in Uganda, Volume 2, Crops, Kampala.

Nur Abidi Mohammed (2006). The role of micro finance in strengthening pastoral household food security in Somali region, MSC. Thesis presented to the School of Graduate Studies of Addis Ababa University, Ethiopia.

Onwueme I.C. and Sinha T.D. (1991). Field crop production in Tropical Africa, Netherlands, CTA.

OSSREA (2001). Issues in social science research, Module 1, Addis Ababa, Ethiopia.

Robsen, C., (1993). Real world research, a resource for social scientists and practitioner researchers, London; Blackwell.

Regional strategies on rice production (2003).http://www.telecom.net.et/-ena/archivenglish/october2003/124923.2910.htm

Schmutterer, H. (1990). Crop pests in the Caribbean, Eschborn.

Sewunet Ashebir (2005). Effect of Nitrogen and seed rates on grain yield, yield components and Nitrogen uptake of rain fed rice in *Fogera*, MSC. Thesis presented to the School of Graduate Studies of Alemaya University, Ethiopia.

Tefera Tegegne (2006). Change in land use; Transformation from cattle herding to rice production and irrigation among *Fogera plain* peasants, MSC. Thesis presented to the School of Graduate Studies of Addis Ababa University, Ethiopia.

Temesgen Aklilu (2001). The role of rural community training in Agricultural production and household food security, the experience of Agri-service Ethiopia, MSC. Thesis presented to the School of Graduate Studies of Addis Ababa University, Bale, Ethiopia.

Tesfaye Alemu (2001). Lowland rain fed rice promotion on libokemkem plain, BSC. partial fulfillment of the course, Alemaya University, Ethiopia.

Tesfaye, et al. (2005). Socio economics of rice technologies in the North West Ethiopia, Adet, unpublished.

Tilaye Teklewold (2004). Food security, determinants and HH coping mechanisms in *GeraKeya Woreda*, Amhara region, RLDS MSC.Thesis presented to the School of Graduate Studies of Addis Ababa University, Ethiopia.

Tsegu Gebretsadik (2006). Impact of household extension package on food security and income of rural households in Tigray, the case of *kilte Awlaelo Woreda*, RLDS MSC Thesis presented to the School of Graduate Studies of Addis Ababa University, Ethiopia.

WB (2000). Rice around the world, World Bank food security.htm

Welelaw Sendeku (2005). Factors determining supply of rice; MSC Thesis presented to the School of Graduate Studies of Alemaya University, Ethiopia.

Workeneh Negatu (2005).Technological progress and farm income, an empirical observation from rural Ethiopia, Proceedings of the conference on poverty and development in Ethiopia; challenges and options, IDR, Addis Ababa.

Yared Amare (2001).Food security and sustainable livelihood in Ethiopia, forum for social studies, Addis Ababa.

Young, H. (1997). Food security-theory and practice of assessment and analysis in emergencies, an Oxfam perspective, Oxford.

APPENDICES

Appendix-1 Research questionnaires for HH survey, key informants and FGD

1. **Instructions for interviewers**
   - ✦ Give greeting and thanks to their coming
   - ✦ Make brief introduction about your self to each farmer before starting the interviews. Tell them the purpose and objectives of your study clearly.
   - ✦ Try to avoid any expectations
   - ✦ Please ask each question so clearly and patiently until the farmer under stands.
   - ✦ Please fill up the interviews schedule according to the farmers reply (don't put own opinion).
   - ✦ Please, don't try to use technical terms while discussing with farmers and don't forget the local units.
   - ✦ Please pass your appreciations and thanks at the end of the interviews for the relevant information they delivered and for the time they spent with you.
2. **General points about the interviewee, the study area & Personal background**

   Name of the interviewer_____

   Name of supervisor_____

   Date of interview; Date /month /year ____ _____ _____

   Full name of interviewee_____

   Household code number_____

   Name of PA's_____

   Signature of interviewee_____

Personal data of the sample HH heads

Variable	Frequency	%
-Sex		
❖ Female		
❖ Male		
-Age		
❖ <14		
• Female		
• Male		
❖ 15—64		
• Female		
• Male		
❖ >64		
• Female		
• Male		
Marital status		
❖ Married		
❖ Single		
❖ Divorce		
❖ Windowed		
Literacy		
❖ Illiterate		
❖ Read only		
❖ Write only		
❖ Read and write		
❖ Elementary		
❖ High school		
❖ Other		
Occupation		
• Farming		
• Wage labour		

Variable	Frequency	%
• Petty trader		
• Daily		
• Local drink trading		
• No job		
• Other		
Religion		
• Orthodox		
• Islam		
• Protestant		
• Mission		
Ethnicity		
• Amhara		
• Others		

3. Household interview questionnaires

3.1. Farming system & production

1. What are the major levels of subsistence (stable food) of the HH in order of importance? 1. Rice 2. Tef 3.Millet 4. Maize 5.Cattle 6.Others
2. Have you ever planted rice? 1. Yes 2. No
3. If No, why? _____
4. If yes, when did you start using (planting) it ---------- year, if not, why?
5. Why do you choose the crop rice? 1. High yielding 2. Flood resistance 3. Drought resistance 4. Pest resistance 5. High yielding & Flood resistance 6. All 7. Others specify
6. What are the major crops you grow in the plain? _____ _____ _____
7. Where did you get the rice seed you first saw? 1. Extension agent 2. Woreda Agricultural office 3. From farmers 4. Adet research institute 5. Others specify
8. From where did you first hear about rice? 1. TV 2. Radio 3. DA

4. Producer Cooperatives 5. 1 & 2 6. All 7. Others specify

9. How long is the time since you have first heard about rice_____years?

10. If you know rice how do you compare the characteristics of this crop with substitute crops teff?

Perceived status	Yield %	Drought resistance	Disease%	Early maturity	Labor requirement	Weed resistance	Hail resistance	Flooding resistance
Better								
Inferior								
No.D/c								

11. If you know rice how do you compare the characteristics of this crop with substitute crops millet?

Perceived status	Yield %	Drought resistance	Disease%	Early maturity	Labor requirement	Weed resistance	Hail resistance	Flooding resistance
Better								
Inferior								
No.D/c								
No.clue								

12. What do you think of the yield of rice? 1. High 2. Low 3. Medium 4. Others specify

13. How much yield do you get per hectare?

Rice	Unit	Total
Area		
Yield/ha		

14. Land use patterns of the individual HH in local measurement (2006)

Crops	Area in Timad
Rice	
Teff	
Millet	
Chickpea	
Rough pea	
Maize	
Others	
Total	

15. How did you weed your rice land? 1. Family labor 2. Hiral labor 3. Herbicides 4. 1 & 2 6. All 7. Others specify
16. If you weed the rice land manually and hiral labor, how much is the price of labor per day?

    Before rice _____ after rice_____ in non rice producer Area's_____
17. Did you grow crops next to rice? 1. Yes 2. No
18. If yes, what did you grow next to rice? Why? _____
19. What benefit did you get from the rice production? _____
20. On which type of field you normally plant rice? 1. On hillside 2. On swampy plain area 3. On Swampy hill area 4. Others specify
21. Why do you grow rice on this type of field? 1. Flood resistance 2. Water lover 3.Both 4. Others
22. Which soil type is the most preferred for rice production? _____
23. What are the planting methods of rice in the plain? 1. Row planting 2. Transplanting 3. Broadcasting 4. Other specify
24. What are the problems & constraints you encountered during the process of rice cultivation? _____ _____ _____ _____ _____ _____ _____
25. Are grazing lands enough for your livestock? 1. Yes 2. No
26. What are the reasons for the decline of livestock number in the plain? 1. Over flooding 2. Government Policy 3. Rice introduction 4. Land reform 5. Shortage of grazing land 6. 5. 2& 3 6. All 7. Others specify

3.2 Credit availability and input used

1. Types & use of improved farm inputs by the HH?

Types of crops	Fertilizer use in Q	Improved seed use in Q	Pesticides use in Kg	Herbicides use in litter	Others inputs used	Total birr incurred
Rice						
Tef						
Millet						
Maize						
Others						

2. Cost of inputs per Ha of land for different crops

Activity	Rice	Teff	Millet
Seed Q/Ha			
Cost of seed/Birr			
Fertilizer Q			
Cost of fertilizer			
Chemicals/Lit			
Cost of chemicals			
Others			
Total cost			

3. Have you ever used fertilizer with rice? 1. Yes 2. No

4. Have you used manure for rice? 1. Yes 2. No

5. If yes, what are the types of manure used? _____

6. Have you ever received any credit service during the last production season? 1. Yes 2. No

7. If yes, for what purpose did you use the loan? _____

8. From which agency did you borrow? _____

9. Have you paid back your loan 1. Yes 2. No

10. Have you faced cash shortage for down payment to obtain input credit? 1. Yes 2. No.
11. Where you get the cash to buying inputs? 1. Crop sale 2. Livestock sale 3. Off farm Income 4. Non-farm income 5. 1 & 2 6. All 7. Others specify
12. If your answer is from crop sale, which crop? _____
13. What are the major problems you faced to get in put credit?

3.3 Extension Service

1. Are you benefiting /using from extension services? 1. Yes 2. No
2. Which institution was your primary source of information (first heard) about rice?
   1. Agricultural office 2. Producer cooperatives 3. Adet research center 4. Korean project 5. Others
3. Did you have any contact with extension agents during the last crop season? 1. Yes 2. No
4. If yes, on average how many days did the Development agents contacted you per month 1. Once 2. Two times 3. Three times 4. Four times 5. Non 6. others
5. Have you been attending any agricultural training program? 1. Yes 2. No
6. Have you ever attend any field demonstration day arranged? 1. Yes 2. No,
7. If yes, which types of crops were demonstrated? _____
8. From whom do you get advice on the use of rice/new technology/ other than extension agents? __

3.4 Labor availability

1. Did you face any labor shortage during the last cropping season? 1. Yes 2. No.
2. If yes, for which farm operations did you face the shortage of labor? 1. Ploughing 2. Weeding 3. Harvesting 4. Threshing 5. 1 & 2 6. All 7. Others specify
3. How did you solve the shortage? 1. Family labor 2. Hiral labor 3. All 4. Other specify
4. For which farm operations did you hire labor for rice? 1. Ploughing 2. Planting 3. Weeding 4. Harvesting 5. 1 & 2 6. All 7. 3 &4 8. Others specify
5. Can you get labor to hire when you are in need? 1. Yes 2. No

6. How were the labor requirements (need) after rice? 1. Increased 2. Decreased 3. No difference 4. Others
7. How was the labor price per day after rice for rice weeding? 1. Increased 2. Decreased 3. No difference 4. Others
8. Are there family members who are engaged in off farm activity? 1. Yes 2. No
9. Average labor requirements and cost of different crops per Ha of land

Activity p/day & Birr/Ha	Rice	Teff	Millet
Labor for plowing			
Cost of plowing			
Labor for weeding			
Cost of weeding			
Labor for harvesting			
Cost of harvesting			
Labor for Threshing			
Cost of Threshing			

3.5 Income and Expenses

1. What are your main sources of income In order of importance? 1. Crop sale 2. Livestock sale 3. Off farm in come 4. Non farm income 5. Other specify
2. What is the income earned from livestock and livestock products during last season?

Livestock product	Hides/Skin	Honey	Egg	Milk	Live animal sale	Butter	Total
Average income							

3. What is the income earned from crop products during last season?

Crop	Area	Production	Market price	Total value	Share in %
Rice					
Tef					
Millet					
Maize					
Rough pea					
Chickpea					
Total					

4. Have you earn non-farm in come during last crop season? 1. Yes 2. No
5. If yes, the amount of in comes earned; handcraft---------- Petty trade ----------
   Sale of Firewood ---------Others------
6. Have you earned an off farm in come during the last crop seasons? 1. Yes 2. No.
7. If yes, in what activities and the amount of in come? Selling of labor___ Renting of oxen____ Renting of land _____others specific ----------
8. Are you saved money? 1. Yes 2. No
9. If yes, where it comes? 1. From crop sale 2. From livestock sale 3. From non-farm income 4. Off farm income 5. 1 & 2 6. Others
10. If your answer is from crop sale, which crop contributes more? 1. Onion 2. Rice 3. Maize 4. Noug 5. Peppers 6.Others

3.6 Health and Education issues

1. What is the contribution of rice production on health? _____
2. What is the contribution of rice on Education? _____
3. How many children you have and number of children reach schooling?
4. How many children you send to school last year?

School age boys/HH	Boys attending school	School age girls/HH	Girls attending school

3.7 Food security issues

1. Duration of HH consumption coverage (self sufficient) per year? 1. 12 months 2. 9 months 3. 6 months 4. 3 months 5. Others specify
2. Number of daily meals of HH members by type of harvest? 1. Once 2. Two times 3. Three times 4. > Four times 5. Others
3. What is your main staple food by type of food item? 1. Rice 2. Teff 3. Millet 4. Maize 5. Rice with Teff 6. Others
4. What is your perception on food security situation of the area after coming rice? 1. Improved 2. The same 3. Decreased 4. Others
5. How was the availability and requirement of **Kcal** to your families?

Source of Kcal	Unit	Production	For sale	Crop purchase	Loan/credit	Crop loose	for Seed	Net consumption availability per HH	Kcal availability	Kcal required
Crop										
Rice										
Tef										
Millet										
Maize										
Rough pea										
Chickpea										
Others										
Total										

6. Of the crops produced to which one do you give due attention regarding food security?

   1. Rice 2. Teff 3. Millet 4. Maize 5. Others

7. Why do you pay more attention to that crop? _____

8. Perception of rice cultivars on their Livelihood situation after the intervention

Description	Deteriorated	Same	Improved	Don't know
Food consumption				
Livestock possession				
Income increment				
Schooling				
Clothing				
Saving				
Housing				
Other investment				
Health care				

9. For have many months/year have you received food aid? _____

HH responses	Need of food aid Before rice	Need of food aid After rice	Involved in food aid Before rice	Involved in food aid After rice	Need of food aid /non rice producers
Yes					
No					
Total					

10. Is the food you produced this year enough to feed the whole family all year and cover other expenses? 1. Yes 2. No

11. Have you ever fulfill family consumption since you have started to grow rice? 1 Yes 2. No.

12. If yes, what is the reason? _____

13. What is the type of house you build? 1. Grass 2. Tin 3. Both grass & Tin 4. Others

14. If your answer is tin, what is the source of income to build the house? 1. From crop sale 2. From livestock sale 3. From non-farm income 4. Off farm income 5. Others

15. If your answer is from crop sale, which crop contributes more? 1. Rice 2.Teff 3. Maize 4. Peppers 5. Onion 6. Millet 7. Others

3.9 Consumption habits

1. Did you consume rice? 1. Yes 2. No
2. What are your staple foods for your family? 1. Rice 2. Tef 3. Millet 4. Maize 5. Rough pea 6. Others specify
3. Which type of diet do you prefer more? Why? _____
4. In what form do you consume rice? 1. Injera 2. Bread 3. Local drink 4. Porridge 5. 1 & 2 6. All 7. Others specify
5. Do you use rice alone or mixed with other crops? _____, Why?
6. Have you accepted rice as a food now? 1. Yes 2. No

3.10 Marketing process of rice

1. Have you sold crops recently? 1. Yes 2. No.
2. If yes, what is the total amount produced, consumed, you have sold and price you have received during last production_year?

Types of crops	Total produced		Amount consumed		Amount sold	
	Q	Birr	Q	Birr	Q	Birr
Rice						
teff						
Millet						
Maize						
Noug						
Others specify						
Total						

3. Do you know price of rice in the market? 1. Yes 2. No
4. If yes, do you think the price is fair? 1. Yes 2. No

5. What is the price of rice in quintal? At harvest, husked rice_____ White rice_____; after harvest, husked rice_____ white rice_____; in summer, husked _____ white_____
6. Where do you sell your agricultural product? 1. At farm gate 2. Market 3. All 4. Others
7. At what season do you usually sell your farm product? 1. At harvest 2. After harvest 3. In summer 4. Others
8. What do you feel, about the price of the crops at harvest? 1. Normal 2. Costly 3. Cheap 4.Others
9. What are the major products you delivered to the market?_____
10. Do you store rice, why? For how long? _____
11. Is your rice quality accepted by the customers/traders? 1. Yes 2. No
12. If No, what is the reason? _____
13. Do you produce other farm products for market instead of rice?
14. Which product is the most important in terms of price and production? 1. Rice 2. Tef 3. Millet 4. Maize 5. Rough pea 6. Others

Crop	Area in Ha	Yield/Ha	Total production	Unit price	Total value in Birr
Rice					
Tef					
Millet					
Maize					
Noug					
Pepper					
Others					
Total					

15. To whom did you sell your rice product this year? 1. Rice machine owners 2. Rice whole sellers 3. Middlemen 4. Consumers 5. 1 & 2 6. All 7. Others specify

16. What are the transports means to transport your rice product? 1. Cart 2. Head load 3. Pack animal 4. Cars 5. 1 & 2 6. All 7. Others specify
17. How much you pay to transport your paddy product to reach to the market? _____
18. What are the processing activities in preparing the paddy product for sale and consumption? Sale ____ _____ _____ _____consumption _____ _____ _____ _____
19. How do you thresh your paddy rice? 1. By hand 2. Husker (Mill) 3. Polisher (Machine) 4.Oxen 5. 1 & 2 6. All 7. Others specify
20. What are the costs incurred in polishing and husking (Milling) per Quintal? ___ & ___
23. What are the major problems in marketing process of rice as a whole? 1. Lack of processing machine 2. Lack of market information 3. Low price 4. Lack of storage facilities 5. Low quality 6. 1 & 2 7. All 8. Others specify

3.11 Production technology & Weather

1. Did you use production increment methods /technological package /? What are they? Which one is frequently used?
2. What are the convenient and inconvenient weather conditions for rice production? _____ __
3. Which weather condition affects rice production more? _____
4. Can you tell the most suitable rainfall condition for rice production from your experience in terms of: -
    - Distribution ----------
    - Duration ----------
    - Intensity ----------
5. Did you practice water-harvesting techniques for rice production? 1. Yes 2. No
6. If yes at what stage of the crop and what kind of water harvesting system you used? _____
7. Would flooding affects other crops other than rice? 1. Yes 2. NO
8. If Yes, why? _____

9. Would flooding affect rice? 1. Yes 2. No
10. If yes, why? _____
11. Are flooding affects your livelihood? 1. Yes 2. NO
12. If yes, do you need settlement for the future? 1. Yes 2. No
13. If yes, Why? If no, why?

4. **Check lists for Focus group discussion,**

4.1. Social Contribution

1. Impacts of rice on Employment, Job creation
2. Daily wage of labor in *Fogera plain* before and after rice, in summer and winter
3. The health condition of the household in the plain and health service
4. The sources of money for health service
5. Education /schools in the plain
6. Number of children and enroll school in the households
7. Source of income for school expenses
8. The roles of teachers in rice production
9. Number of students before and after the rice
10. The impact of rice production on Education
11. farmers education and health service fee in the plain

4.2 Economic Contribution

1. The impact of rice production on creating fixed and variable assets
2. Farmers investment other than own farming
3. The income change of the household before and after the rice production
4. The size of land you sown and amount of production you have got starting from rice coming.
5. Years you involved in food aid
6. Need of food and material aid
7. The food security situations of the area
8. People benefited from rice production
9. The households well being and capabilities in the plain

4.3 Cultural Contribution

1. The attitudes of people in the plain on rice
2. Social relations before and after rice among people
3. The level of acceptance as food, purpose they used rice
4. The sayings of people about rice negatively and positively
5. Level of acceptance of rice immediately after coming
6. Time of acceptance rice as a livelihood system and as a food
7. Rice production and religion or cultural values
8. Rice production and livestock farming
9. Rice production and other crop cultivation

4.4 Role of institution and Extension service

1. The institutions and organizations involved on rice production
2. The role of different institutions and organizations for rice production
3. Rice marketing
4. The levels of their role on rice production
5. Extension contact
6. Frequency of extension contact
7. Communication with DA's
8. Access to credit, input supply, market & Cooperative.
9. Use of inputs for rice production
10. Need of credit from the government

4.5 Trend, adoption, Extent, and Intensity of rice

1. Time of Cultivation of rice at first time
2. Access of rice seed for the first time, where and who gave the seed
3. Acceptance of rice to the rural people of *Fogera* plain
4. Shift of farmers to rice instead of cattle herding
5. The history /trend of rice on the plain
6. The level of adoption of rice on the plain
7. The factors for adoption and not adoption of rice starting from rice coming
8. The Extent and Intensity of rice cultivation on the plain

4.6 problems and prospects of rice

1. The problems and constraints for rice production
2. Crop managements of rice
3. Problems you encountered during the process of rice production
4. Any complaint against rice
5. The prospects of rice production in the plain

5. Check list for Key informant's interview

***5.1*Check list for Key informants' interview for Adet and IMPS Staffs.**

1. How was the program of rice production started?
2. Who contributes the coming of rice in the plain?
3. Is the policy supports rice production? If not, why?
4. What was your role in rice production?
5. Have you noticed any effect of the rice production on the peasants social, cultural, economic, and political life?

***5.2* Check list for Key informant's interview for Rural Development staffs (Woreda experts & Developing Agents)**

1. When was the program started?
2. How was the program of rice production started?
3. Who contributes the coming of rice in the plain?
4. How your office participated in it?
5. Is the policy supports rice production? If not, why?
6. Is there any change in extension services in rice production?
7. What are the attitudes of people in the plain on rice?
8. What are the sayings of people about rice negatively and positively?
9. What are the institutions and organizations involved on rice production?
10. What are the role of different institutions and organizations for rice production?
11. What are the levels of their role on rice production? Who involved more?
12. What is the history /trend of rice on the plain?
13. What is the level of adoption of rice on the plain?
14. What are the factors for adoption and not adoption of rice starting from rice coming?

15. Of the crops produced to which one do you give due attention.
16. Why do you pay more attention to that crop?
17. What are the food security situations of the area?
18. How was the households well being and capabilities in the plain? Why these happen?
19. Why farmers shift to rice instead of cattle herding?
20. What types of effects are observed in the plain after the coming of rice on livelihoods of farmers?
21. It is only due to rice or others? Justify?
22. What are the prospects of rice production in the plain?
23. What are the problems and constraints that limit rice production?
24. How do you over come the above-mentioned problems locally?

5.3 Check lists for key informants of Health staffs.

1. How many health services are there?
2. Can farmers paid health service fee on time, if yes, why, if not, why?
3. What do you think the impacts of rice on health services?

5.4 Check lists for key informants of Education staffs

1. Number of students before and after the rice? It is increasing, if yes, why, if not, why?
2. What is the impact of rice production on Education? Do you think they have direct relation ship?
3. Can farmers paid education fee on time, if yes, why, if not, why?

5.5 Check lists for key informants of Administration staffs.

1. What was the role of your institution in rice production?
2. Has the rice production minimized the expense of government?
3. What problems rice production solved in the plain?
4. What are the political impacts of rice production on the plain?

4.6 Check lists for key informants of Processors &Traders

1. Can you state about the quality of paddy rice product supplied by farmers to you for further processing or sale.
2. Is the quality of rice supplied by farmers comparable to that of rice imported and supplied to the market?
3. It not comparable, why? _____
4. How much is the processing cost per Q of rice, which is produced and offered by farmers,
5. Can you estimate the price of one Q of processed rice?
6. Can you tell main problems in purchasing, processing and marketing of rice?

6. Conclusion of Interview Questionnaires

- What are the Extents and Intensity of rice cultivation in *Fogera Woreda* plain?
- What are the contributions of rice cultivation on the Food Security of rural households in *Fogera plain*?
- What are the major problems of the plain for rice cultivation in your perception? What will be your measure?

Appendix 2: Conversion factor used to estimate the adult equivalent units

Age Group	Male	Female
0-24 Months	0.4	0.4
25-48 Months	0.48	0.48
49-59 Months	0.56	0.56
5-6 years	0.56	0.56
7-8 years	0.64	0.64
9-10 years	0.76	0.76
11-12 years	0.80	0.88
13-14 years	1.00	1.00
15-18 years	1.20	1.00
19-59 years	1.00	0.88
60-98 years	0.88	0.72
Not specified	1.00	1.00

Source; World Bank, 1993 cited in Tsegue, 2006; MEDaC, 1999

Based on the above scales and in accordance to the categorized date on age of family members the average values were used to generate the following table.

Adult equipment values used in the study for age groups

Age Group(years)	Male	Female
$\leq$ 14 years	0.65	0.66
15-64	1.1	0.94
>64	0.94	0.86

Appendix 3: Calorie composition of foods commonly used in Ethiopia (in terms of 100 gm)

Crop	Calorie/100 gm
Cereals	
Barely	334
Maize	356
Wheat	336
Rice	344
Millet	326
Sorghum	338
Teff	339
Pulses	
Horse bea	344
Chick pea	363
Field pea	354
Vetch	347
Vegetables	
Carrot	42
Tomato	28
Garlic	118
Potato	74
Shallot	57
Pepper	40
Oil Seeds	
Line seed	349
Nug	486

Source: Agren Gunnar and Rosalind Gbson, 1968 cited inTsegue, 2006

Appendix 4: Number of relief beneficiaries in South Gondar Zone

Year	No. of people assisted		Amount distribution quintal	
	Other 9 Woredas	Fogera	Other 9 Woredas	Fogera
1993	177639	9085	81954.4	3089.9
1994	514129	0	308623	0
1995	281036	0	193242.7	0
1996	133417	164	56420	63.96
1997	126621	5610	61612.9	1504.7
1998	225081	9775	94870.4	5228.9
1999	356040	9780	178113.6	8557.5
2000	592202	18304	348378.6	8128.97
2001	326731	21360	228960.2	267
2002	265728	0	235712.9	0
2003	666400	10000	367988.9	9000
2004	251600	0	274890	0
Total	3916624	64854	6398207	26840.93

Source; Regional DPPC, 2005

Appendix-5; Ethiopia vulnerable population to acute food insecurity, 1981-2003

Year	Total population	Vulnerable population (million)	% of total population
1981	36.67	2.82	7.7
1982	37.77	3.7	9.8
1983	38.9	3.3	8.5
1984	40.07	4.21	10.5
1985	41.21	6.99	17
1986	42.39	6.14	14.5
1987	43.4	2.53	5.8

Year	Total population	Vulnerable population (million)	% of total population
1988	44.84	4.16	9.3
1989	46.12	5.35	11.6
1990	47.44	3.21	6.8
1991	48.79	7.22	14.8
1992	50.18	7.85	15.6
1993	51.61	4.97	9.6
1994	53.09	6.70	12.6
1995	54.65	3.99	7.3
1996	56.37	2.78	4.9
1997	58.2	3.36	5.8
1998	59.88	4.10	6.8
1999	61.67	7.19	11.7
2000	63.5	10.56	16.6
2001	65.34	6.24	9.6
2002	67	10.72	16
2003	68.09	14.3	21

Source; Degefa, 2005 cited in DPPC for vulnerable population size; and CSA for population size

Appendix-6; List of key informants in the study area

No.	Full Name	Sex	Position	Site
1	Mitiku ASfaw	Male	Rice Researcher	Adet
2	Sewagegne Tariku	Male	International Rice Research Coordinator	Adet
3	Alemayehu Walle	Male	Agr. & RD office, Agronomist head	Fogera
4	Tewabe Getu	Male	Agr. & RD office, Head	Fogera
5	Ajebush Azene	Male	Agr. & RD office, Development Agent	Quire Michal

No.	Full Name	Sex	Position	Site
6	Tilahun Agmassie	Male	Agr. & RD office, Development Agent	Abuha & Kokit
7	Abebaw Reta	Male	Agr. & RD office, Development Agent	Wereta zuria
8	Melesse Liyhe	Male	Sasakawa Global 2000 Rice programe Expert	Wereta
9	Teshome Deriso	Male	ILRI,IPMS- Research & Dev. Assistant	Wereta
10	Belay Getenet	Male	Rice Trader & Rice machine owner	Wereta
11	Adamitie Mengesha	Male	Rice Trader	Wereta
12	Addis Humer	Male	Rice Trader & Rice machine owner	Wereta
13	Grimachew Melaku	Male	Teacher	Kokit
14	Haymanot melaku	Female	Health expert	Kokit

Appenidx-7;

Some formulas used in the study to compute the food security of the household in the plain.

- **Net Kilo calorie availability per household** = Production per household-crop sale-post harvest crop loose-seed reserve + crop purchase.
- **Kilo calorie requirement per household** = Number of Adult Equivalent per household *minimum standard requirement per household per day.
- **Subsistence potential ratio** = Kilo calorie availability per household /Kilo calorie requirement per household.
- **Calculated t** = Mean 1-Mean 2 /√ sd1/n 1+sd 2/n 2

(Source; Edilegnaw, etal, 2006)

Appendix 8 - Distribution of available Kcal per sample HH per year from crop production 2006 cropping season

Available Kcal	Rice producers		Non rice producers		Total Frequency	Total %
	Frequency	%	Frequency	%		
500000-1000000						
1000001-2000000			5	11.6	5	5.6
2000001-3000000	2	4.3	6	14	8	8.9
3000001-4000000	6	12.8	13	30.2	19	21.1
4000001-5000000	3	6.4	8	18.6	11	12.2
5000001-6000000	4	8.5	3	7	7	7.8
6000001-7000000	8	17	2	4.7	10	11.1
7000001-8000000	4	8.5	4	9.3	8	8.9
>8000001	20	42.6	2	4.7	22	24.4
Total	47	100	43	100	90	100

Source; Survey data, 2007

Appendix-9 ; Kcal avalibility by type of net crop production/HH

No.	Rice			tef			Millet			others			T kcal Av.			Fsindex (SPR)
	kcal/Q	N.quan.	T kcal av.	kcal/Q	Nquan.	T kcal av.	kcal/Q	quan.	T kcal av.	kcal/Q	quan.	T kcal av.	kcal/Q	quan.	T kcal av.	
1	344000	21	7224000	339000	0.75	254250	326000	3	978000	355000	5.7	2023500		30	10479750	3.8957
2	344000	53	18232000	339000	1	339000	326000	2	652000	355000	6.5	2307500		63	21530500	8.0038
3	344000	27	9288000	339000	0	0	326000	5	1630000	355000	9	3195000		41	14113000	2.562
4	344000	23	7912000	339000	0.7	237300	326000	7.6	2477600	355000	2.7	958500		34	11585400	2.581
5	344000	15	5160000	339000	2	678000	326000	0	0	355000	5	1775000		22	7613000	2.8301
6	344000	38	13072000	339000	1	339000	326000	2.6	847600	355000	10	3550000		52	17808600	4.7591
7	344000	22	7568000	339000	2.5	847500	326000	6.6	2151600	355000	17	5857500		48	16424600	5.1135
8	344000	37	12728000	339000	1.5	508500	326000	3.5	1141000	355000	7	2485000		49	16862500	4.1095
9	344000	15	5160000	339000	0	0	326000	2.5	815000	355000	4.5	1597500		22	7572500	1.3909
10	344000	20	6880000	339000	0.9	305100	326000	2.9	945400	355000	9	3195000		33	11325500	2.1019
11	344000	21.5	7396000	339000	0	0	326000	0	0	355000	6	2130000		28	9526000	2.5457
12	344000	7.6	2614400	339000	0.5	169500	326000	0	0	355000	2.3	816500		10	3600400	0.8774
13	344000	8	2752000	339000	0.7	237300	326000	0.7	228200	355000	5.6	1988000		15	5205500	1.2208
14	344000	6	2064000	339000	1	339000	326000	4	1304000	355000	6.5	2307500		18	6014500	2.7741
15	344000	6	2064000	339000	1.2	406800	326000	3.6	1173600	355000	9.2	3266000		20	6910400	2.5689
16	344000	6	2064000	339000	1	339000	326000	4	1304000	355000	6	2130000		17	5837000	1.8127
17	344000	4.5	1548000	339000	0	0	326000	3	978000	355000	6	2130000		14	4656000	1.7308
18	344000	25	8600000	339000	1	339000	326000	2.5	815000	355000	10	3550000		39	13304000	2.5807
19	344000	14	4816000	339000	0	0	326000	5.5	1793000	355000	3.5	1242500		23	7851500	1.4572
20	344000	18	6192000	339000	1	339000	326000	0	0	355000	0.9	310625		20	6841625	1.1576
21	344000	8	2752000	339000	0.9	305100	326000	0	0	355000	5.3	1863750		14	4920850	1.502
22	344000	14	4816000	339000	0.75	254250	326000	0	0	355000	4.5	1597500		19	6667750	1.4854
23	344000	30	10320000	339000	1	339000	326000	2.5	815000	355000	3.8	1331250		37	12805250	2.8733
24	344000	8	2752000	339000	0	0	326000	0	0	355000	2	710000		10	3462000	1.0751
25	344000	21	7224000	339000	0	0	326000	0	0	355000	2	710000		23	7934000	1.5936
26	344000	6	2064000	339000	1.5	508500	326000	0	0	355000	2.8	976250		10	3548750	0.8323
27	344000	16	5504000	339000	0.5	169500	326000	0	0	355000	4.3	1508750		21	7182250	1.0855

Appendix-9 ; Kcal avalibility by type of net crop production/HH

No.	Rice			tef			Millet			others			T kcal Av.			Fsindex (SPR)
	kcal/Q	N.quan.	T kcal av.	kcal/Q	Nquan.	T kcal av.	kcal/Q	quan.	T kcal av.	kcal/Q	quan.	T kcal av.	kcal/Q	quan.	T kcal av.	
28	344000	5	1720000	339000	1.5	508500	326000	6.5	2119000	355000	5.5	1952500		19	6300000	1.3621
29	344000	8.5	2924000	339000	1	339000	326000	4.6	1499600	355000	4.6	1633000		19	6395600	1.9521
30	344000	21.5	7396000	339000	2	678000	326000	0	0	355000	3	1065000		27	9139000	2.995
31	344000	5.5	1892000	339000	0	0	326000	7.7	2510200	355000	4.9	1721750		18	6123950	1.9018
32	344000	23	7912000	339000	1.7	576300	326000	0	0	355000	0	0		25	8488300	1.705
33	344000	14	4816000	339000	0	0	326000	4.5	1467000	355000	3.1	1100500		22	7383500	1.5963
34	344000	2	688000	339000	0	0	326000	5	1630000	355000	9.5	3372500		17	5690500	1.8649
35	344000	5	1720000	339000	0	0	326000	1	326000	355000	1.5	532500		7.5	2578500	0.7485
36	344000	5	1720000	339000	0	0	326000	0	0	355000	3.6	1278000		8.6	2998000	0.839
37	344000	9.5	3268000	339000	0	0	326000	3.4	1108400	355000	8	2840000		21	7216400	1.0098
38	344000	4	1376000	339000	0	0	326000	0	0	355000	4.8	1704000		8.8	3080000	0.4627
39	344000	26	8944000	339000	0	0	326000	2.5	815000	355000	4.5	1597500		33	11356500	3.0349
40	344000	36	12384000	339000	0	0	326000	4.9	1581100	355000	4	1420000		45	15385100	2.5478
41	344000	13.8	4747200	339000	0	0	326000	0	0	355000	9.3	3301500		23	8048700	2.0456
42	344000	2	688000	339000	0	0	326000	5	1630000	355000	2	710000		9	3028000	0.5402
43	344000	16	5504000	339000	0	0	326000	0	0	355000	2.5	887500		19	6391500	2.948
44	344000	21.5	7396000	339000	0	0	326000	0	0	355000	17	6035000		39	13431000	3.144
45	344000	8	2752000	339000	0	0	326000	0	0	355000	3.5	1242500		12	3994500	1.8492
46	344000	10	3440000	339000	0	0	326000	0	0	355000	4.5	1597500		15	5037500	1.9979
47	344000	5	1720000	339000	0	0	326000	2	652000	355000	5	1775000		12	4147000	0.6447
48	344000	0	0	339000	1.5	508500	326000	7	2282000	355000	9	3195000		18	5985500	1.0866
49	344000	0	0	339000	4.5	1525500	326000	10	3260000	355000	17	6035000		32	10820500	2.7278
50	344000	0	0	339000	2.5	847500	326000	9	2934000	355000	10	3550000		22	7331500	1.9593
51	344000	0	0	339000	5	1695000	326000	15	4890000	355000	20	7100000		40	13685000	3.8212
52	344000	0	0	339000	0.5	169500	326000	1.5	489000	355000	2	710000		4	1368500	0.8354
53	344000	0	0	339000	2.5	847500	326000	5.5	1793000	355000	5.5	1952500		14	4593000	2.8038
54	344000	0	0	339000	0.5	169500	326000	6.5	2119000	355000	4	1420000		11	3708500	1.1546

Appendix-9 ; Kcal avalibility by type of net crop production/HH

No.	Rice			tef			Millet			others			T kcal Av.			Fsindex (SPR)
	kcal/Q	N.quan.	T kcal av.	kcal/Q	Nquan.	T kcal av.	kcal/Q	quan.	T kcal av.	kcal/Q	quan.	T kcal av.	kcal/Q	quan.	T kcal av.	
55	344000	0	0	339000	0	0	326000	6.5	2119000	355000	2.5	887500		9	3006500	1.3867
56	344000	0	0	339000	0	0	326000	9	2934000	355000	2.5	887500		12	3821500	1.1868
57	344000	0	0	339000	0.85	288150	326000	4.5	1467000	355000	6.5	2307500		12	4062650	1.2648
58	344000	0	0	339000	0.7	237300	326000	3.5	1141000	355000	0.7	248500		4.9	1626800	0.5052
59	344000	0	0	339000	1.5	508500	326000	2	652000	355000	5.5	1952500		9	3113000	0.6825
60	344000	0	0	339000	0.8	271200	326000	7.7	2510200	355000	7.8	2769000		16	5550400	0.9391
61	344000	0	0	339000	0	0	326000	4	1304000	355000	2	710000		6	2014000	0.4723
62	344000	0	0	339000	1	339000	326000	1	326000	355000	3.5	1242500		5.5	1907500	0.3105
63	344000	0	0	339000	0.5	169500	326000	6	1956000	355000	6.3	2218750		13	4344250	0.844
64	344000	0	0	339000	3	1017000	326000	8	2608000	355000	12	4082500		23	7707500	1.4789
65	344000	0	0	339000	0	0	326000	3.7	1206200	355000	4.7	1668500		8.4	2874700	1.0655
66	344000	0	0	339000	4.7	1593300	326000	9.7	3162200	355000	5.7	2023500		20	6779000	1.0823
67	344000	0	0	339000	1.2	406800	326000	14	4401000	355000	9.5	3372500		24	8180300	1.5917
68	344000	0	0	339000	0	0	326000	7.7	2510200	355000	2.7	958500		10	3468700	0.927
69	344000	0	0	339000	0.4	135600	326000	6.7	2184200	355000	9.7	3443500		17	5763300	1.1883
70	344000	0	0	339000	1	339000	326000	6	1956000	355000	5	1775000		12	4070000	0.8799
71	344000	0	0	339000	1	339000	326000	3.7	1206200	355000	2.7	958500		7.4	2503700	0.8227
72	344000	0	0	339000	0.6	203400	326000	4.7	1532200	355000	7.7	2733500		13	4469100	1.6613
73	344000	0	0	339000	1.7	576300	326000	6.7	2184200	355000	5.8	2041250		14	4801750	1.2832
74	344000	0	0	339000	4.6	1559400	326000	12	3749000	355000	13	4473000		29	9781400	2.2854
75	344000	0	0	339000	0	0	326000	4.7	1532200	355000	4.8	1686250		9.5	3218450	0.7548
76	344000	0	0	339000	1.3	440700	326000	2.5	815000	355000	4	1420000		7.8	2675700	0.6534
77	344000	0	0	339000	0	0	326000	6.5	2119000	355000	3	1065000		9.5	3184000	0.5577
78	344000	0	0	339000	0	0	326000	7.7	2510200	355000	4.5	1597500		12	4107700	0.8881
79	344000	0	0	339000	1.5	508500	326000	0.6	195600	355000	6	2130000		8.1	2834100	1.0567
80	344000	0	0	339000	0	0	326000	9.6	3129600	355000	10	3656500		20	6786100	2.1075
81	344000	0	0	339000	0.35	118650	326000	6.7	2184200	355000	4	1420000		11	3722850	1.159

Appendix-9 ; Kcal avalibility by type of net crop production/HH

No.	Rice			tef			Millet			others			T kcal Av.			Fsindex (SPR)
	kcal/Q	N.quan.	T kcal av.	kcal/Q	Nquan.	T kcal av.	kcal/Q	quan.	T kcal av.	kcal/Q	quan.	T kcal av.	kcal/Q	quan.	T kcal av.	
82	344000	0	0	339000	0.8	271200	326000	3.8	1238800	355000	4.6	1633000		9.2	3143000	0.6059
83	344000	0	0	339000	0	0	326000	4	1304000	355000	7	2485000		11	3789000	1.1767
84	344000	0	0	339000	0	0	326000	2.3	749800	355000	2.5	887500		4.8	1637300	0.5097
85	344000	0	0	339000	2.6	881400	326000	5.2	1695200	355000	4.7	1668500		13	4245100	1.5781
86	344000	0	0	339000	0.4	135600	326000	9.8	3194800	355000	1	355000		11	3685400	1.7061
87	344000	0	0	339000	0	0	326000	4	1304000	355000	2.7	958500		6.7	2262500	0.4892
88	344000	0	0	339000	0	0	326000	3	978000	355000	2	710000		5	1688000	0.7224
89	344000	0	0	339000	0.7	237300	326000	4.8	1564800	355000	4.8	1704000		10	3506100	1.3034
90	344000	0	0	339000	0	0	326000	5.7	1858200	355000	5	1775000		11	3633200	1.682

Appendix-10 ; Kcal requirement & adult equivalent convertion factor by sex and age

NO.	<14 age		Ave.Convertion		Adult Eq.			15--64 age		Ave.Convertion		Adult Eq.			>64 age		Ave.Convertion		Adult Eq.			Total Adult Eqv.	Kcal req. Standared	kcal req./year
	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total			
1	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
2	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
3	2	2	0.7	0.7	1.3	1.3	2.6	1	3	0.9	1.1	0.9	3.3	4.2	0	0	0.9	0.9	0	0	0	6.86	803000	5508580
4	1	3	0.7	0.7	0.7	2	2.6	2	1	0.9	1.1	1.9	1.1	3	0	0	0.9	0.9	0	0	0	5.59	803000	4488770
5	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
6	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.66	803000	3741980
7	1	2	0.7	0.7	0.7	1.3	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4	803000	3212000
8	2	1	0.7	0.7	1.3	0.7	2	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.11	803000	4103330
9	1	0	0.7	0.7	0.7	0	0.7	3	3	0.9	1.1	2.8	3.3	6.1	0	0	0.9	0.9	0	0	0	6.78	803000	5444340
10	3	1	0.7	0.7	2	0.7	2.6	2	2	0.9	1.1	1.9	2.2	4.1	0	0	0.9	0.9	0	0	0	6.71	803000	5388130
11	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.66	803000	3741980
12	2	1	0.7	0.7	1.3	0.7	2	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.11	803000	4103330
13	2	3	0.7	0.7	1.3	2	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.31	803000	4263930
14	1	0	0.7	0.7	0.7	0	0.7	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.7	803000	2168100
15	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
16	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
17	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
18	3	2	0.7	0.7	2	1.3	3.3	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	6.42	803000	5155260
19	3	1	0.7	0.7	2	0.7	2.6	2	2	0.9	1.1	1.9	2.2	4.1	0	0	0.9	0.9	0	0	0	6.71	803000	5388130
20	3	2	0.7	0.7	2	1.3	3.3	2	2	0.9	1.1	1.9	2.2	4.1	0	0	0.9	0.9	0	0	0	7.36	803000	5910080
21	0	0	0.7	0.7	0	0	0	2	2	0.9	1.1	1.9	2.2	4.1	0	0	0.9	0.9	0	0	0	4.08	803000	3276240
22	1	3	0.7	0.7	0.7	2	2.6	2	1	0.9	1.1	1.9	1.1	3	0	0	0.9	0.9	0	0	0	5.59	803000	4488770
23	1	1	0.7	0.7	0.7	0.7	1.3	1	3	0.9	1.1	0.9	3.3	4.2	0	0	0.9	0.9	0	0	0	5.55	803000	4456650
24	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
25	1	2	0.7	0.7	0.7	1.3	2	1	3	0.9	1.1	0.9	3.3	4.2	0	0	0.9	0.9	0	0	0	6.2	803000	4978600
26	2	3	0.7	0.7	1.3	2	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.31	803000	4263930

Appendix-10 ; Kcal requirement & adult equivalent convertion factor by sex and age

NO.	<14 age		Ave.Convertion		Adult Eq.			15--64 age		Ave.Convertion		Adult Eq.			>64 age		Ave.Convertion		Adult Eq.			Total Adult Eqv.	Kcal req. Standared	kcal req./year
	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total			
27	1	2	0.7	0.7	0.7	1.3	2	2	4	0.9	1.1	1.9	4.4	6.3	0	0	0.9	0.9	0	0	0	8.24	803000	6616720
28	2	2	0.7	0.7	1.3	1.3	2.6	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.76	803000	4625280
29	0	0	0.7	0.7	0	0	0	2	2	0.9	1.1	1.9	2.2	4.1	0	0	0.9	0.9	0	0	0	4.08	803000	3276240
30	1	0	0.7	0.7	0.7	0	0.7	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	3.8	803000	3051400
31	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
32	1	2	0.7	0.7	0.7	1.3	2	1	3	0.9	1.1	0.9	3.3	4.2	0	0	0.9	0.9	0	0	0	6.2	803000	4978600
33	2	2	0.7	0.7	1.3	1.3	2.6	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.76	803000	4625280
34	1	0	0.7	0.7	0.7	0	0.7	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	3.8	803000	3051400
35	1	1	0.7	0.7	0.7	0.7	1.3	2	1	0.9	1.1	1.9	1.1	3	0	0	0.9	0.9	0	0	0	4.29	803000	3444870
36	1	1	0.7	0.7	0.7	0.7	1.3	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	4.45	803000	3573350
37	2	2	0.7	0.7	1.3	1.3	2.6	2	4	0.9	1.1	1.9	4.4	6.3	0	0	0.9	0.9	0	0	0	8.9	803000	7146700
38	2	3	0.7	0.7	1.3	2	3.3	3	2	0.9	1.1	2.8	2.2	5	0	0	0.9	0.9	0	0	0	8.29	803000	6656870
39	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.66	803000	3741980
40	3	2	0.7	0.7	2	1.3	3.3	1	3	0.9	1.1	0.9	3.3	4.2	0	0	0.9	0.9	0	0	0	7.52	803000	6038560
41	1	0	0.7	0.7	0.7	0	0.7	1	3	0.9	1.1	0.9	3.3	4.2	0	0	0.9	0.9	0	0	0	4.9	803000	3934700
42	1	2	0.7	0.7	0.7	1.3	2	3	2	0.9	1.1	2.8	2.2	5	0	0	0.9	0.9	0	0	0	6.98	803000	5604940
43	1	0	0.7	0.7	0.7	0	0.7	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.7	803000	2168100
44	3	2	0.7	0.7	2	1.3	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.32	803000	4271960
45	0	1	0.7	0.7	0	0.7	0.7	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.69	803000	2160070
46	0	0	0.7	0.7	0	0	0	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	3.14	803000	2521420
47	3	3	0.7	0.7	2	2	3.9	1	2	0.9	1.1	0.9	2.2	3.1	0	1	0.9	0.9	0	1	0.9	8.01	803000	6432030
48	2	2	0.7	0.7	1.3	1.3	2.6	1	3	0.9	1.1	0.9	3.3	4.2	0	0	0.9	0.9	0	0	0	6.86	803000	5508580
49	1	2	0.7	0.7	0.7	1.3	2	1	1	0.9	1.1	0.9	1.1	2	0	1	0.9	0.9	0	1	0.9	4.94	803000	3966820
50	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.66	803000	3741980
51	2	0	0.7	0.7	1.3	0	1.3	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	4.46	803000	3581380
52	0	0	0.7	0.7	0	0	0	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.04	803000	1638120

Appendix-10 ; Kcal requirement & adult equivalent convertion factor by sex and age

NO.	<14 age		Ave.Conv ertion		Adult Eq.			15--64 age		Ave.Con vertion		Adult Eq.			>64 age		Ave.Con vertion		Adult Eq.			Total Adult Eqv.	Kcal req. Standar ed	kcal req./year
	F	M	F	M	F	M	Tot al	F	M	F	M	F	M	Tota l	F	M	F	M	F	M	Tot al			
53	0	0	0.7	0.7	0	0	0	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.04	803000	1638120
54	1	2	0.7	0.7	0.7	1.3	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4	803000	3212000
55	1	0	0.7	0.7	0.7	0	0.7	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.7	803000	2168100
56	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
57	1	2	0.7	0.7	0.7	1.3	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4	803000	3212000
58	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
59	1	0	0.7	0.7	0.7	0	0.7	2	2	0.9	1.1	1.9	2.2	4.1	0	1	0.9	0.9	0	1	0.9	5.68	803000	4561040
60	3	2	0.7	0.7	2	1.3	3.3	1	2	0.9	1.1	0.9	2.2	3.1	0	1	0.9	0.9	0	1	0.9	7.36	803000	5910080
61	2	3	0.7	0.7	1.3	2	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.31	803000	4263930
62	3	1	0.7	0.7	2	0.7	2.6	2	2	0.9	1.1	1.9	2.2	4.1	0	1	0.9	0.9	0	1	0.9	7.65	803000	6142950
63	2	3	0.7	0.7	1.3	2	3.3	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	6.41	803000	5147230
64	1	1	0.7	0.7	0.7	0.7	1.3	2	3	0.9	1.1	1.9	3.3	5.2	0	0	0.9	0.9	0	0	0	6.49	803000	5211470
65	2	0	0.7	0.7	1.3	0	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.36	803000	2698080
66	2	2	0.7	0.7	1.3	1.3	2.6	2	3	0.9	1.1	1.9	3.3	5.2	0	0	0.9	0.9	0	0	0	7.8	803000	6263400
67	1	4	0.7	0.7	0.7	2.6	3.3	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	6.4	803000	5139200
68	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.66	803000	3741980
69	1	2	0.7	0.7	0.7	1.3	2	1	2	0.9	1.1	0.9	2.2	3.1	0	1	0.9	0.9	0	1	0.9	6.04	803000	4850120
70	2	2	0.7	0.7	1.3	1.3	2.6	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.76	803000	4625280
71	0	1	0.7	0.7	0	0.7	0.7	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	3.79	803000	3043370
72	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
73	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.66	803000	3741980
74	4	1	0.7	0.7	2.6	0.7	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.33	803000	4279990
75	2	3	0.7	0.7	1.3	2	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.31	803000	4263930
76	1	2	0.7	0.7	0.7	1.3	2	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.1	803000	4095300
77	2	3	0.7	0.7	1.3	2	3.3	1	1	0.9	1.1	0.9	1.1	2	1	1	0.9	0.9	1	1	1.8	7.11	803000	5709330
78	2	2	0.7	0.7	1.3	1.3	2.6	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.76	803000	4625280

Appendix-10 ; Kcal requirement & adult equivalent convertion factor by sex and age

NO.	<14 age		Ave.Convertion		Adult Eq.			15--64 age		Ave.Convertion		Adult Eq.			>64 age		Ave.Convertion		Adult Eq.			Total Adult Eqv.	Kcal req. Standared	kcal req./year
	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total			
53	0	0	0.7	0.7	0	0	0	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.04	803000	1638120
54	1	2	0.7	0.7	0.7	1.3	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4	803000	3212000
55	1	0	0.7	0.7	0.7	0	0.7	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.7	803000	2168100
56	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
57	1	2	0.7	0.7	0.7	1.3	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4	803000	3212000
58	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
59	1	0	0.7	0.7	0.7	0	0.7	2	2	0.9	1.1	1.9	2.2	4.1	0	1	0.9	0.9	0	1	0.9	5.68	803000	4561040
60	3	2	0.7	0.7	2	1.3	3.3	1	2	0.9	1.1	0.9	2.2	3.1	0	1	0.9	0.9	0	1	0.9	7.36	803000	5910080
61	2	3	0.7	0.7	1.3	2	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.31	803000	4263930
62	3	1	0.7	0.7	2	0.7	2.6	2	2	0.9	1.1	1.9	2.2	4.1	0	1	0.9	0.9	0	1	0.9	7.65	803000	6142950
63	2	3	0.7	0.7	1.3	2	3.3	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	6.41	803000	5147230
64	1	1	0.7	0.7	0.7	0.7	1.3	2	3	0.9	1.1	1.9	3.3	5.2	0	0	0.9	0.9	0	0	0	6.49	803000	5211470
65	2	0	0.7	0.7	1.3	0	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.36	803000	2698080
66	2	2	0.7	0.7	1.3	1.3	2.6	2	3	0.9	1.1	1.9	3.3	5.2	0	0	0.9	0.9	0	0	0	7.8	803000	6263400
67	1	4	0.7	0.7	0.7	2.6	3.3	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	6.4	803000	5139200
68	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.66	803000	3741980
69	1	2	0.7	0.7	0.7	1.3	2	1	2	0.9	1.1	0.9	2.2	3.1	0	1	0.9	0.9	0	1	0.9	6.04	803000	4850120
70	2	2	0.7	0.7	1.3	1.3	2.6	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.76	803000	4625280
71	0	1	0.7	0.7	0	0.7	0.7	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	3.79	803000	3043370
72	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
73	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.66	803000	3741980
74	4	1	0.7	0.7	2.6	0.7	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.33	803000	4279990
75	2	3	0.7	0.7	1.3	2	3.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	5.31	803000	4263930
76	1	2	0.7	0.7	0.7	1.3	2	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.1	803000	4095300
77	2	3	0.7	0.7	1.3	2	3.3	1	1	0.9	1.1	0.9	1.1	2	1	1	0.9	0.9	1	1	1.8	7.11	803000	5709330
78	2	2	0.7	0.7	1.3	1.3	2.6	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.76	803000	4625280

Appendix-10 ; Kcal requirement & adult equivalent convertion factor by sex and age

NO.	<14 age		Ave.Convertion		Adult Eq.			15--64 age		Ave.Convertion		Adult Eq.			>64 age		Ave.Convertion		Adult Eq.			Total Adult Eqv.	Kcal req. Standared	kcal req./year
	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total			
79	0	2	0.7	0.7	0	1.3	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.34	803000	2682020
80	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
81	1	2	0.7	0.7	0.7	1.3	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4	803000	3212000
82	2	2	0.7	0.7	1.3	1.3	2.6	1	1	0.9	1.1	0.9	1.1	2	1	1	0.9	0.9	1	1	1.8	6.46	803000	5187380
83	2	1	0.7	0.7	1.3	0.7	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4.01	803000	3220030
84	1	2	0.7	0.7	0.7	1.3	2	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	4	803000	3212000
85	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
86	0	1	0.7	0.7	0	0.7	0.7	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.69	803000	2160070
87	2	2	0.7	0.7	1.3	1.3	2.6	1	2	0.9	1.1	0.9	2.2	3.1	0	0	0.9	0.9	0	0	0	5.76	803000	4625280
88	2	1	0.7	0.7	1.3	0.7	2	1	0	0.9	1.1	0.9	0	0.9	0	0	0.9	0.9	0	0	0	2.91	803000	2336730
89	1	1	0.7	0.7	0.7	0.7	1.3	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	3.35	803000	2690050
90	0	1	0.7	0.7	0	0.7	0.7	1	1	0.9	1.1	0.9	1.1	2	0	0	0.9	0.9	0	0	0	2.69	803000	2160070
Total	136	132						110	144						2	8								

Fig 3. Rice Wedding, transportation and Market

Declaration

the undersigned, declare that the thesis is my original work, has not been esented for a degree in any other university and that all sources of material sed for the thesis have been duly acknowledged.

eclared by:

andidate

Confirmed by:

Advisor