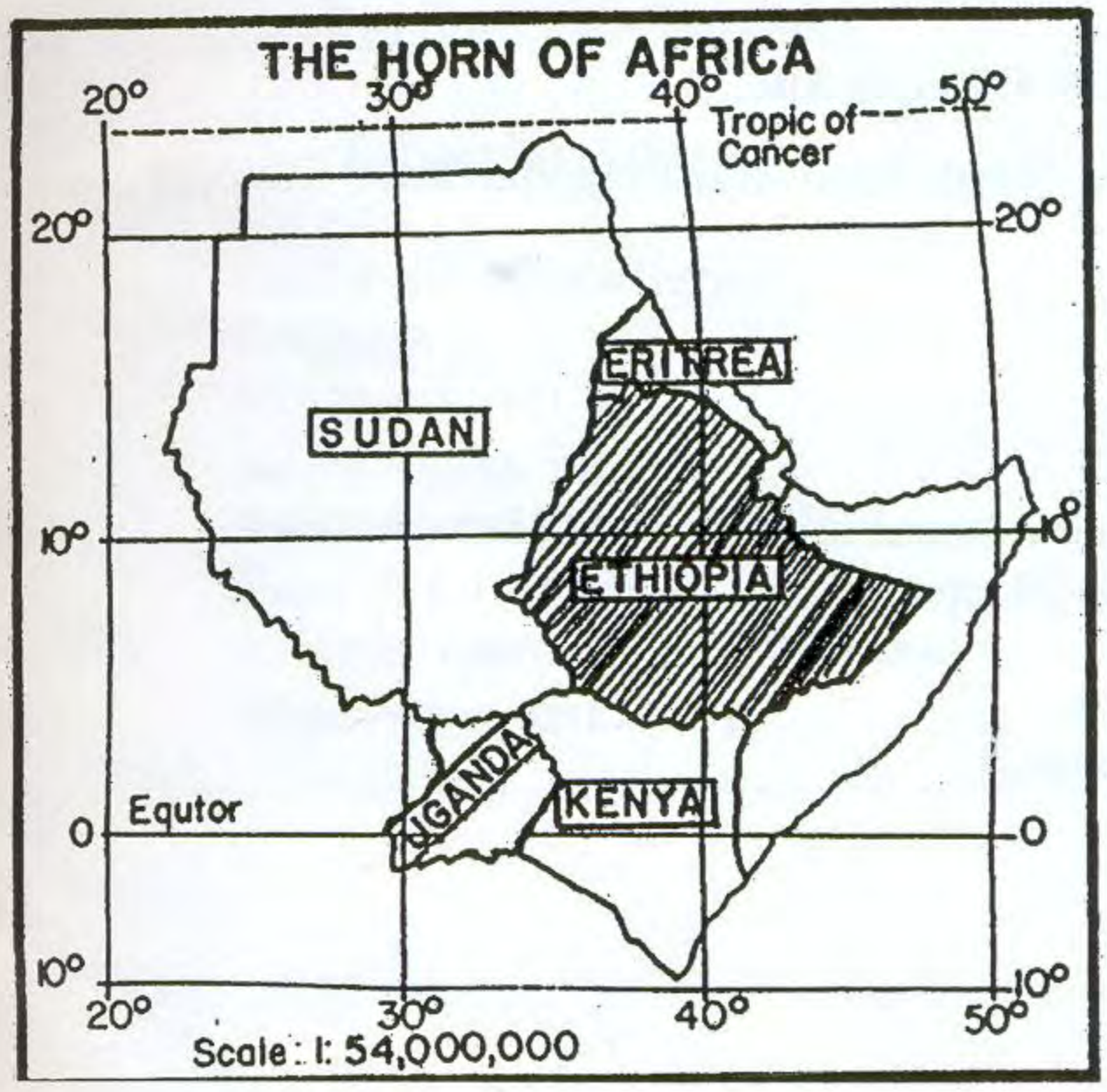
DRYLAND HUSBANDRY IN ETHIOPIA

Research Report

Edited by

Mitiku Haile
Diress Tsegaye
Tegegne Teka

DHP Publications Series No. 7, December 2001



OSSREA
Organization for Social Science Research in Eastern and Southern Africa

© 2001 Organization for Social Science Research in Eastern and Southern Africa (OSSREA)

All Rights Reserved Published 2001
Printed in Ethiopia

ISSN 1608-8891

Typesetting: *Selamawit Getachew*

This publication is the exclusive property of the Organization for Social Science Research in Eastern and Southern Africa (OSSREA). Any use, copy, reproduction, or quotation of any nature must be accompanied by the prior consent of The Regional Project Coordinator, DHP/OSSREA.

Cover photograph from DHP-Ethiopia Site:

Tegegne Teka, Aba'ala, North Afar, Afar Regional State, Ethiopia

Organization for Social Science Research in Eastern and Southern Africa
P.O.Box 31971, Addis Ababa, Ethiopia
Fax: 251-1-551399
E-mail: ossrea@telecom.net.et
pub.ossrea@telecom.net.et
http://www.ossrea.org

Tegegne Teka: Editor, DHP Publications Series &
Regional Project Co-ordinator
Dryland Husbandry Project

Regional Advisory Committee of the Dryland Husbandry Project

Prof. Abdel Ghaffar M. Ahmed (OSSREA, Ethiopia)
Prof. Anders Hjort af Ornäs (EPOS, Linköping University, Sweden)
Dr. Kassim O. Farah (PINEP, University of Nairobi, Kenya)
IGAD (Djibouti)
Dr. Hashim El Atta (University of Khartoum, Sudan)
Prof. E. N. Sabiiti (Makerere University, Uganda)
Dr. Nashon Musimba (University of Nairobi, Kenya)
Dr. Bisrat Gebru (University of Asmara, Eritrea)
Dr. Mitiku Haile (Mekelle University, Ethiopia)
Dr. Tegegne Teka (OSSREA, Ethiopia)

Editorial Address:

DHP Publications Series
OSSREA
P.O.Box 31971
Addis Ababa, Ethiopia
Tel: 251-1-551163/553281
Fax: 251-1-551399
E-mail: ossrea@telecom. net.et
http://www.ossrea.org

The Dryland Husbandry Project (OSSREA) acknowledges the support of the Swedish International Development Cooperation Authority (Sida/SAREC)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACCRONYMS AND ABBREVIATIONS

AIDS	= Acquired Immune Deficiency Syndrome
BoA	= Bureau of Agriculture
BoANR	= Bureau of Agriculture and Natural Resources
CAHW	= Community Animal Health Worker
CBPP	= Contagious bovine pleuropneumonia
CCPP	= Contagious caprine pleuropneumonia
CSA	= Central Statistics Authority
DHP	= Dryland Husbandry Project
DPS	= DHP Publications Series
ECA	= Economic Commission for Africa
FMD	= Foot and mouth disease
HS	= Haemorrhagic septicaemia
Kebele	= Administrative unit
MUC	= Mekelle University College
OSSREA	= Organization for Social Science Research in Eastern and Southern Africa
PPR	= Pest des petits ruminants
PRA	= Participatory Rural Appraisal
SCF/USA	= Save the Children Federation of the United States of America
UNDP	= United Nations Development Project
Wereda	= District

PREFACE

The regional Dryland Husbandry Project (DHP) works with pastoralists and agro-pastoralists in Ethiopia, Kenya, Sudan and Uganda in an attempt to change the quality of life of people in the drylands. It has been in operation at the field level since 1996 though the project was launched in 1995. The project focuses on action-oriented participatory research, employs extension methodology, and involves continuous dialogue between community people and planners and policy makers for a sustainable development in the drylands. DHP encourages a bottom-up approach and tries to utilize local knowledge in the development of pastoral areas. It gives priorities to those issues that members of the community think are most pressing and most useful and implements action-oriented development activities together with the community people.

Moreover, DHP is into capacity building that will help pastoralists and agro-pastoralists attain some potential to better manage their environment. Other activities include the introduction of improved grass species for cattle feed, better water harvesting and management, training members of the local population as paravets. DHP works on gender issues, though not an easy activity to implement. Existing cultural and institutional barriers, in some countries, did not encourage the subject to be discussed at the community level. However, DHP has trained agro-pastoral women as paravets or community animal health workers.

The Regional DHP Office (OSSREA) has taken the initiative to launch a DHP Publications Series (DPS) for the Dryland Husbandry Project with the view to exchange and share opinions and experiences on issues of dryland husbandry in general and in the DHP countries in particular. DPS is also a forum where researchers in the DHP present the results of their action-oriented and participatory research to people at the grassroots, to the research and academic community, and to policy-makers, to institutions and interested individuals. In addition, more ethno-veterinary practices in DHP countries, the training and practice of paravets or community animal health workers, workshop reports and the relevance and use of indigenous knowledge are to be published in DPS.

This publication contains five papers on DHP Ethiopia (Aba'ala, Afar Regional State) that narrate and discuss traditional crop production, social relations between lowlanders and highlanders, extension activities on the use of water harvesting and management and the diversion of river (flood water) and its impacts on production. Moreover, field trial results of maize in the drylands of Aba'ala and traditional veterinary practices in the Aba'ala pastoral community are also discussed.

DHP Ethiopia has produced a number of articles on different issues and activities in the project area. Some of them are on community education and sensitization, preparing a manual for paravet training. The Faculty of Dryland Agriculture and Natural Resources, Mekelle University has sent students to do field work to Aba'ala to prepare papers as part of their study programme. Despite the continued efforts that have gone into achieving positive results in DHP Ethiopia, there is a lot we expect from the project in informing us through written materials and in the replication of the action-based activities in the Afar Regional State and in other pastoral areas of Ethiopia.

Tegegne Teka
Editor

ACKNOWLEDGEMENTS

The Regional DHP Office/OSSREA would like to recognize the co-ordination provided by the national lead institution, Faculty of Dryland Agriculture and Natural Resources, Mekelle University, members of the National Steering Committee (NSC) of the Dryland Husbandry Project and those at the project area in Aba'ala District, Afar Region, Ethiopia. We especially thank Dr. Mitiku Haile, the National Co-ordinator and Mr. Diress Tsegaye, the Project Manager of DHP Ethiopia for the efforts they put in to make this publication possible. We are thankful to the technical reviewers of the papers and appreciate the language editing we got from Mr. Samuel Tesfamichael for this publication to have its present form.

TRADITIONAL CROP PRODUCTION SYSTEMS IN ABA'ALA *WEREDA*, NORTH AFAR

Addis Abraha[1], *Diress Tsegaye*[2], *and Mitiku Haile*[3]

1. INTRODUCTION

Rainfed crop production in the semi-arid areas is unreliable due to high evapo-transpiration, high run-off rates, delay onset, and early cessation of rains (Rowland 1993). Semi-arid areas, such as the Afar region of Ethiopia, have some potential of becoming arable land if development activities focus on water resource development for irrigation. Today, food self-sufficiency is a key issue at both national and regional levels. To achieve food security at the household level, sound extension services, specific farming oriented research, farmers' full participation at the grass roots and appropriate policies are important factors.

---

[1] Addis Abraha is at present undertaking an M. Sc. study in Agronomy at Alemaya University of Agriculture. He holds a B. Sc. in Dryland Crop Sciences and he is an employee of the Tigray Agricultural Research Institute, Mekelle, Ethiopia.

[2] Diress Tsegaye is currently a lecturer at the Department of Animal and Range Sciences at the Faculty of Dryland Agriculture and Natural Resources in Mekelle University, Ethiopia. He holds a B. Sc. in Animal Science and an M. Sc. in Range Management. He has been working as Project Manager for the Dryland Husbandry Project-Ethiopia in Aba'ala District of the Afar Region for the last four years. Prior to that, he was a senior livestock marketing expert in the Ministry of Agriculture and a Junior Expert in the former Development Project Studies Authority in Ethiopia. Tel: 251-4-407500; Fax: 251-4-409304; E-mail: diresst@yahoo.co.uk or mekelle.university@telecom.net.et

[3] Mitiku Haile is an Associate Professor of Soil Science at the Department of Land Resources Management and Environmental Protection of Mekelle University, Ethiopia. He is the National Co-ordinator of the Dryland Husbandry Project-Ethiopia at Aba'ala District of Afar Region. He has more than 20 years of university teaching, research and management experience. His research interest includes sustainable land management, indigenous knowledge on land management, water harvesting and action-oriented research on participatory technology development. Tel: 251-4-409228; Fax: 251-4-409304; E-mail: mekelle.university@telecom.net.et

To implement these, a study of the problems, opportunities, and indigenous knowledge under the existing farming conditions is important. In line with this approach, the study sets out to examine and assess factors affecting crop production in Aba'ala *Wereda* (District) of North Afar.

The study tries to assess the conditions related to dryland crop production in Aba'ala *Wereda* and to present baseline information for future agricultural development programmes in the area.

Specifically, the study has the following objectives: i) to identify the farmers' indigenous knowledge on crop production in the area; ii) to identify and characterise local landraces; iii) to assess the roles of gender and extension services in crop production; and iv) to identify crop production constraints.

2. METHODOLOGY

Among the six small administrative units (*kebeles*) of the *wereda,* Adiharamele, Wuhidet, Hidmo and Irkudi *Kebeles* were selected because most of the people in these *kebeles* are involved in crop production. The total number of households in the four *kebeles* was 1,914 out of which 96 sample households were selected. Participatory Rural Appraisal (PRA) techniques, semi-structured questionnaires, personal observation, and formal and informal discussions were used to collect data. Questions were addressed to individuals and groups of both sexes at meetings, at their fields, at market places and at their homes.

In most cases, farmers were interviewed randomly about variety extinction, for which older people were chosen. The questions dealt with issues concerning local landraces, farming systems, assessment of the flood diversion dike, crop production constraints, roles of gender and extension services in crop production. In addition, secondary data on the physical environment such as records of rainfall and temperature data were collected. Finally, the data were organised, analysed, and interpreted.

3. DESCRIPTION OF THE STUDY AREA

3.1 Location

Aba'ala *Wereda* is one of the seven *weredas* in Zone Two of Afar Regional State. It is located about 55-km southeast of Mekelle. It is bordered by Tigray Regional State in the west.

3.2 Climate

The study area is semi-arid receiving bi-modal rainfall. The long rains usually occur in mid-June to mid-September, while the short rains usually come in March and April (Gitte 1996; Diress 1998). Rainfall is usually high in July and August, leading to high run-off rates. The high run-off rates coupled with high evapo-transpiration rates make the rainfall insufficient for crop production. Instead, the agro-pastoral societies in the area highly depend on flood irrigation agriculture along the Aba'ala, Shugala and Murga flood plains to produce dryland crops. In general, the study area is hot with high diurnal temperature. However, there is no record of meteorological data for the last 10 to 20 years. However, to have an idea on the climate of the *wereda*, a record of meteorological data on temperature and rainfall from June 1997 to September 1998 is shown below in table 1 and a graph of mean annual rainfall in fig. 2.

Table1. Meteorological record of temperature and rainfall data of Aba'ala *Wereda*

Month	Temperature (^{0}C)		Rainfall (mm)*
	Maximum	Minimum	
1997			
June	38.0	15.0	33.1
July	36.2	9.0	15.0
August	35.0	7.0	20.0
September	33.0	14.0	17.0
October	35.0	11.5	26.5
November	35.0	9.0	40.3
December	32.1	14.5	0.0
1998			
January	36.4	14.0	28.0
February	33.1	11.2	0.7
March	35.5	16.0	0.0

April	35.6	14.6	32.1
May	39.0	15.3	12.0
June	37.4	12.0	3.3
July	35.5	10.5	51.4
August	35.5	10.1	48.2
September	39.8	10.8	7.4

SOURCE: Meteorological data record of Aba'ala town, Shiket Station, 1998.

Note: The rainfall data may not be reliable as there was no rain throughout the study year.

Fig.1.

Graphical reperesentation of the mean monthly temperature in (1998) at Aba'ala

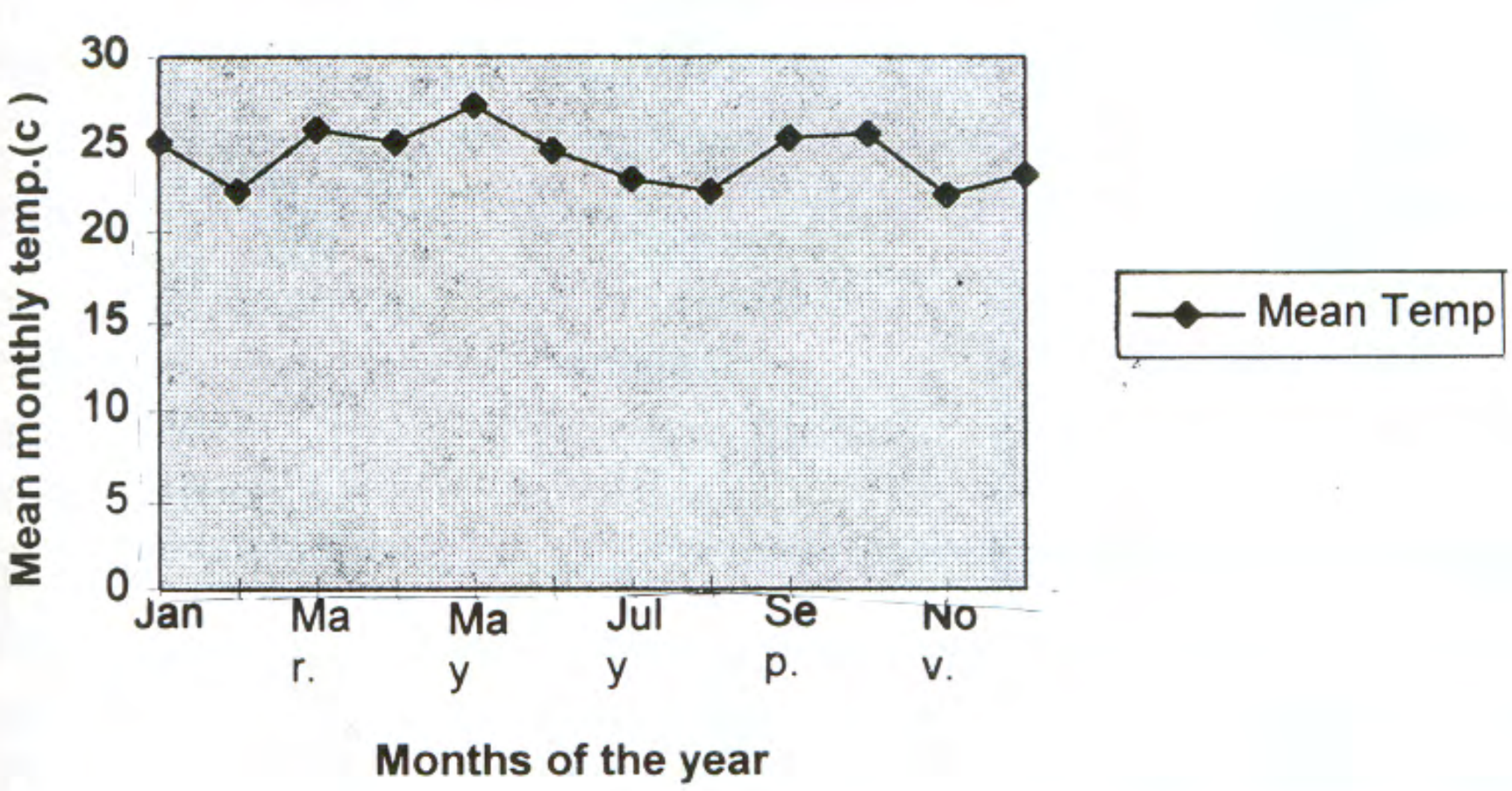
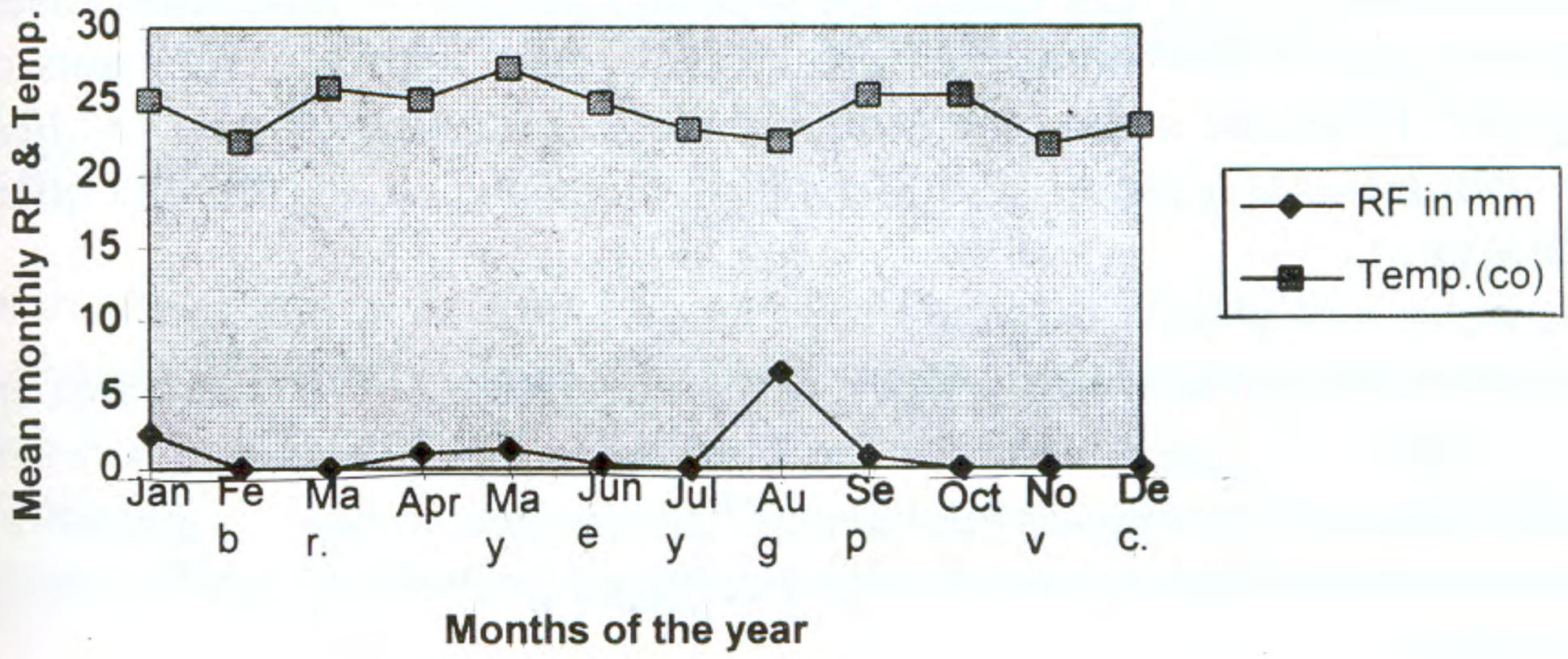


Fig. 2.

Grapical reperesentation of the mean monthly RF(mm) and Temp. (co) in 1998 at Aba'ala.



3.3 Topography

Most parts of the *wereda*, particularly the western part, are extensions of the rugged escarpment of the Rift Valley which runs from North to South bordering Tigray (Hurni 1986). The terrain of the escarpment includes deep gorges, steep slopes, and chains of hills and mountains. The study area consists of plains occasionally intercepted by hills and a series of elongated ridges, surrounded by high broken hills with very few outlets joined to other areas. The average elevation of the area is approximately 1,500 meters above sea level with a range of 1,300-1,700m (Diress 1998).

3.4 Soils

The soils of the escarpment are shallow except on depressions where they are relatively deep. Exposed rocks and stones dominate most of the hills and ridges, while alluvial deposits cover the plains. The dominant soil texture of the study area ranges from alluvial clay to sandy and silt. The pH level of the soil ranges from 7.5 to 9.0 (Shiferaw 1996). Farmers in the study area traditionally classify soils of the area as "*Baekel*", a fertile loam soil, light grey to black in colour, and "*Walka*", a fertile clay loam soil, brown to black in colour.

3.5 Vegetation and Wildlife

The total rainfall in a given area may reflect the type and density of vegetation cover. The hills and mountains of the study area are eroded rocks with few remnants of Acacia tree species. There are also some scattered *Acacia etbaica, Acacia nilotica, Acacia tortilis, Balanites aegyptica* and *Zizyphus spina-christi* in the flat plain farmlands of the area.

Some of the common indigenous plant species in the vegetation cover of the area are listed in table 2. Most of these plants are the main sources of feed for browsing camels and goats. *Balanites aegyptica* (Badano), *Zizyphus Spina-christi* (Kunshira), and *Dobera glabra* (Gersa) are important fruit trees used as food for human during prolonged dry season.

Table 2. Common indigenous plant species in the vegetation cover of Aba'ala.

Botanical name	Tigrigna name	Afarigna name
Acacia etbaica	Seraw	Sekakto
Acacia tortulis	Gumero	Aepto
Acacia. Nilotica	Kasal	Gessalto
Acacia melifera	Teklbe	Mekito
Acacia nubica	Ajo	Germoita
Balanites aegyptica	Badano	Odaito
Salvadora persica	Adaimamo	Adaito
Zizyphus spina-christi	Kunshira	Kusraito
Ficus cycomorurs	Shagla	Sublaito
Grewia tenax	Artatimato	Hidaito
Dobera glabra	Gersa	Gersaito

SOURCE: Diress, 1998.

According to the farmers, wild animals found in the area include porcupine (Kinfiz), *Anubis* baboon (Hebei), hyena (*zibie*), rabbit (*mantile*), antelope (*midaka*), warthog (*meflus*), klipspringer (*sesiha*), and guinea fowl (*zagra*), and reptiles such as python (*gebel*) and different species of snake (*tebem*). Some of these animals cause damage to crops; for example, porcupine and warthog eat maize during its maturity.

4. SOCIO-ECONOMIC ASPECTS

4.1 Population

The total population of Afar Region is estimated at one million while the population of Aba'ala *Wereda* is about 27,259 of which 14,724 are males and 12,535 females (CSA 1996). The majority of the people in the *wereda* are Muslims and a small number are Christians. The majority of the inhabitants rely on subsistence livestock rearing with a few engaged in cultivation and salt trade along with livestock rearing (UNDP/ECA 1998).

4.2 Land Use

The three main land use types in the study area are cultivation, grazing, and settlement. Cultivation is practised in the Aba'ala Valley plains while grazing takes place in all areas. Most of the settlement sites are located at the foot of hills or mountains. Land distribution in the area was undertaken before 30 years during the

reign of Emperor Haileselassie and since then, no land redistribution has been undertaken in the area. The Afar agro-pastoralists are the owners of the land and they lease their arable land to the Tigrayan farmers who have settled in the surveyed areas. The Tigrayan farmers cultivate the land on an agreement of sharecropping in which the Afar contribute seeds and labour during weeding and harvesting time. However, some Afar farmers cultivate their land by themselves in Irkudi *Kebele*, which may serve as a good example for the remaining Afar pastoralists.

4.3 Livestock

According to UNDP/ECA (1998), over 95% of the people in the *wereda* are pastoralists who derive their livelihood solely from livestock and livestock products, whereas the remaining 5% practice cultivation and salt trading together with livestock rearing (mixed farming). The livestock population of the *wereda* is estimated at 156,538 with a composition of 21,834 camels, 29,605 cattle, and 4, 441 donkeys (the figures are not results of a census).

4.4 Infrastructure and Social Services

Aba'ala *Wereda* is accessed by an all-weather road, east of the main Addis Ababa to Mekelle road at about 5-8 km before reaching Kuiha town. No roads are constructed to access each *kebele* from the *wereda* town. Due to political civil unrest and lack of investment, social services in the *wereda* are poor. There are three elementary schools, a junior secondary school, a clinic, and veterinary services.

5. TRADITIONAL CROP PRODUCTION SYSTEMS

5.1 Traditional Agricultural Implements

The traditional ploughing implements comprise a bent wooden beam (*newit*) connected to a yoke (*ar'oot*) by a rope or leather strip. The other end of the beam is slightly wide and with a vertical hole. To each side of the bottom half of the beam are attached irregular pieces of wood shaped like wings that act as a furrow opener (*doogri*). The "wings" are pinned to the beam forming a kind of sledge. During ploughing, the "wings" help to push the soil aside.

Through the beam hole (at the bottom end) a stick (*irffi*) is fitted in such a way that its upper end serves as a handle for the farmer. The metal plough point (*mahresha*) is

fixed to the lower part of the beam. The front pointed ends of the sledge (*doogri*) and the stick (*irffi*) with the plough point are held together by interlinked metal loops (*karfes*), the smaller loop being attached to the plough beam with leather strips. The plough depth is adjusted by the length of the strips and the position of the piece of wood (*wishal*) behind or in front of the handle (*irffi*) within the beam hole. The only parts of the plough that have to be purchased are the *mahresha* and *karfes* while the other parts are obtained from local trees. These traditional implements are portable, i.e., from the house to the farmland and back.

During ploughing, the plough does not turn the soil rather it breaks it. This operation has a tendency to leave unploughed strips between consecutive passes. Thus, the land has to be ploughed two to three times until the soil is suitably prepared. The penetration of the plough depends on the soil type.

5.2 Agronomic Practices in the Area

5.2.1 Land Preparation

Land preparation is carried out using oxen, pulling a plough (mahresha) to open the soil. This tillage is usually conducted during the dry months of February to June. Late season ploughing in the area requires high draught power, where local oxen usually have difficulty performing, due to their limited access to dry season feed.

The farmers plough their land for the following reasons: i) to enhance a better growth of crops; ii) to control weeds by exposing the roots; iii) to control insect pests; iv) to aerate the soil; and v) to enhance infiltration and to conserve moisture.

Farmers in the area have developed their own optimal ploughing frequencies for different crops depending on the purpose of the operation, the type of soil, the type of crops, the type of weeds, and the conditions of rain.

5.2.2 Planting

Rainfall is the most important environmental determinant of yield in dryland farming. Crops should be sown at the right time to provide the most available soil moisture regime. Sowing time should be adjusted in such a way that crops mature when the soil moisture reserves are depleted (Rowland 1993).

The farmers have their own planting calendar that depends on the amount and distribution of rainfall and the varieties of crops to grow. They sow usually after the

onset of the rainy season, which starts in June. Crops are broadcast - row planting is unknown to most of the farmers. In the well-prepared seedbeds, sorghum is planted in April and May. The assumption behind is that the soil moisture available at the planting time will suffice for the germination of sorghum seeds and reduce weed seed germination. The cropping patterns are given in table 3.

Table 3. Cropping calendar in Aba'ala *Wereda*

Crops	Frequency of ploughing	Planted	Harvested	Threshed
Sorghum	3-4	April - May	December	Dec. - Jan.
Maize	2-3	June - July	Nov. - Dec.	December
Teff	2-3	July - August	Oct. - Nov.	November
Barley	2-3	Sept. - Oct.	Oct. - Nov.	November
Chick pea	3-4	September	December	Dec. - Jan.
Vetch	2-3	November	December	

Farmers use different crop varieties with different maturity periods to spread risks, to lengthen planting periods, to ease labour shortages, and to produce different varieties. The crop with the widest diversity is sorghum, followed by maize, barley, *teff*, chickpea, and vetch.

5.2.3 The Farmers' Soil Fertility Management Practices

The farmers' soil fertility management practices are not well developed. In most parts of the lowland arable areas, farmers believe that the soil is fertile. However, the top fertile soil is being eroded by floods and hence soil fertility management practices are essential. The main factor that reduces soil fertility in the area is the seasonal run-off. that comes from the highlands of Tigray. Farmers do not use bunds and terraces to conserve soil and water in the area. They do not apply manure, and crop residues are mostly cut and carried home for feed. They use grass strips to conserve floodwater in their plots of land and to mark their boundary.

5.2.4 Weeds

Most of the farmers reported weeds as major problems that reduce crop yield. Crop production in the area is mainly dependent on flood irrigation, and the flood brings

weed seeds from the highlands. Crop losses caused by weeds are directly due to competition for limited resources and indirectly due to the presence of insect pests and disease organisms in the weeds (Yayock 1988). The farmers have indicated that their yield is declining due to weed infestation though no study has been conducted to indicate the extent of yield losses in the area.

A. Weeding Frequency

Frequency of weeding in the area depends on crop types and on the availability of household labour. *Teff* is weeded twice, while sorghum, maize, barley, chickpea and vetch are mostly weeded once. However, some rich households weed their sorghum, maize, barley, and chickpea twice.

B. Difficulties of Weed Control

The main difficulties that hinder the farmers' efforts to control weeds include: i) high density and rapid re-growth of weed seeds; ii) shortage of human labour; and iii) lack of herbicides.

C. The Farmers' Weed Control Methods

Hand weeding is the main method of controlling weeds in the area. Through the weak extension service, few farmers buy herbicides from Mekelle and use them for controlling some weed species. Some other weed control methods used by farmers are: i) repeated ploughing; ii) *golgal* – removal of weeds by women during ploughing; and iii) *gusia* – inter-row ploughing of maize and sorghum fields to reduce the density of weeds and improve water retention capacity of the fields. However, the efficiency of hand weeding is low due to delayed weeding frequencies. For instance, *gusia* has limited effect on the weed because it is done late and the broadcasting limits inter-row cultivation. Moreover, the practice damages a large number of sorghum and maize seedlings. The commonest economically important weed species in the area are given in table 4.

Table 4. The commonest economically important weed species

Botanical name	Tigrigna name	Remark/Type
Flaveria trinervia	Diha-Nekel	Broad leaf, dominant
Datura stramonium	Mestenagir	Broad leaf, dominant
Amaranthus spinosus	Hamili-Tilian	Broad leaf
Tagetes minuta	Chenawi-kotsili	Several divided leaflets
Commelina benghalengis	Gamale	Brood leaf

Argemon mexicana	Medafe Tilian	Spiny and incised broad leaf
Pigweed	-	Rough broad leaf and dominant
Cyperus esculentus	Hits-Hits	Long pointed leaf
Xathium spinosum	Milhas sebeity	Very spiny and difficult weed
Cynodon dactylon	Tahag	Horizontal creeping stem

5.2.5 Seed Supply Systems

The seed supply systems in the area were identified and ranked by farmers as shown in table 5.

Table 5. Seed sources in the area

Rank	Seed sources
1	Farmers own crop
2	Local market
3	From neighbour
4	Improved seeds from Wereda Bureau of Agriculture

5.2.6 Labour

Labour is one of constraints of crop production in the farming community of the area. The number of productive persons per household is small. In most cases, the farmers overcome the shortage of labour by: i) using family labour or hiring labour; ii) using labour exchange in different work days; iii) using *ofera* – working together by providing local drinks; and iv) leasing – poor farmers and Afar landowners lease their lands, based on an agreement of sharecropping. The study area has a seasonal labour calendar as depicted in table 6.

Table 6. Seasonal labour calendar in the area

Activities	Month											
	Jan.	Feb.	Mar	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
		x	x	x	x	x	x					
Ploughing				x	x	x	x	x	x			
Planting							x					
Gusia							x	x	x	x		
Weeding												
Bird scaring									x	x		x
Harvesting										x	x	x
Threshing											x	x
Straw Collecting												x
Herding	x	x	x	x	x	x	x	x	x	x	x	x

5.2.7 Harvesting, Threshing and Storage of Grains

In the study area, cereal crops are harvested with a sickle, and maize cobs are picked by hand. In most cases, legume crops are uprooted by hand. To avoid shattering, *teff* and barley are harvested before they are completely dried and after harvesting, the crops are left to dry in the field for some days before being piled. Threshing is usually done on a circular piece of land, locally called an "*Audi*", which is cleaned, compacted and plastered with mud. Oxen through trampling thresh the crops. Maize shelling is done by hand or more efficiently by using oxen or donkeys on an *Audi*. An estimation of yield obtained in a good cropping season in the area is given in table 7.

Table 7. Crop yield estimation in a good cropping season

Crop	Area (ha)	Planting time	Harvesting time	Yield (qt/ha)
Sorghum	1.0	April/May	December	36.0
Maize	1.0	June/July	November/December	28.0
Barley	1.0	June/July	October/November	18.0
Teff	0.5	July/August	October/November	4.5
Chickpea	0.5	September	December	6.0
Vetch	0.5	September	December	5.0

Crops are stored in traditional structures such as *Shirfa*, *Maeken*, *Godo*, and underground pits. *Shirfa* is made from bamboo and is plastered with mud. It is a safe storage for *teff*, barley, maize, or chickpea. *Godo* is made from cow dung and has a similar function as *Shirfa*. *Maeken* is made from mud and is used to store any grain.

Gudiguad is a well-prepared underground storage used for storing sorghum. It is safe from any rodent and weevil attack.

5.3 Sources of Water for Crop Production

Some farmers who have access to Aba'ala River water grow maize, vegetables and papaya using traditional irrigation practices in the dry season.

Though their potential is limited, Aba'ala and MyShugala Rivers can be used for small-scale irrigation. At present, the river water sinks into the sand before it reaches the cultivated area and thus it is mostly used for livestock and humans. Therefore, the main sources of water for crop production are flood irrigation and rainfall.

5.4 Crop Protection

5.4.1 Disease

There are some crop diseases in the area, but they cause insignificant yield losses. Smuts and rusts occur on sorghum and barley, respectively. The farmers reported that the control of rusts is beyond their capacity, as they do not have chemicals. However, some farmers remove infected heads (panicles) of sorghum.

5.4.2 Insect Pests

Unlike diseases, insect pests were found to be serious problems. They cause great yield losses in Adiharamele, Hidmo, Wuhidet, and Dergamo *Kebeles*. Some of the most economically harmful pests in the area, as described by the interviewed farmers are presented in table 8.

Table 8. Economically harmful insect pests and some field vertebrate pests

Tigrigna name	Common/English name	Crops attacked
Barnos	Army worm	All crops
Fenta	Grasshopper	*Teff*, sorghum and maize seedlings
Anbeta	Desert locust	All crops
Kurtim	Stalk borer	Sorghum and maize
Kubi	Shoot fly	*Teff*
Hansheka	Boll worm	Chickpea, vetch and maize
Nekez	Weevil	Maize, sorghum,
Kishkish	Aphids	Vetch, chickpea
Anchiwa	Field rat	Maize, barley

Kinfiz	Porcupine	Maize
Aewaf	Birds	Sorghum

Note: Shoot fly during the study season caused great damage on *teff* and no control attempts were made.

There is no well-established pest control system in the area. Farmers' traditional pest control methods are ineffective, and they do not get pesticides from the *Wereda* Bureau of Agriculture due to the weak extension service. However, some rich farmers purchase pesticides from Mekelle and they apply the chemicals on their fields; however, the results are not effective since the application is done without technical advice. Most of the farmers use some indigenous practices to minimise the extent of yield losses due to insect pests. Some of the methods are: i) driving cattle on fields infested with armyworms and making contour furrows around the crop field; ii) organising groups of farmers to use branches of Acacia trees to kill the armyworms; iii) planting late; and iv) using cool and aerated storage to prevent weevil attacks.

5.5 Major Crop Production Constraints in the Area

The farmers described some of the major crop production constraints and their consequences (table 9).

Table 9. Main crop production constraints and their consequences

Main constraints	Consequences
Shortage of rainfall	Extinction of late maturing varieties, reduction of yield and crop failure
Infestation of various weed species	Competition for soil moisture and nutrients with crops and reduction of yield
Occurrence of various insect pests (shoot fly, armyworms, grass hoppers, stalk borer, aphids, bollworm, and weevil)	Damage on different crops and reduction of yield
Lack of insecticides and herbicides	Inability to control insect pests and weeds at the right time
Shortage of labour	Late and inadequate weeding, inability to make flood diversion canals to protect crops
Lack of credit services and shortage of capital for investment	Less investment on agricultural inputs and implements

Shortage of animal feed during the dry season	Local oxen too weak to plough

6. IDENTIFICATION OF LANDRACES IN THE AREA

6.1 Genetic Erosion in the Area

The farmers explained that there are various sorghum varieties in the area, although some have become extinct. The main crops grown in the area are sorghum, barley, maize, *teff*, chickpea and vetch. Sorghum is widely cultivated crop with varieties locally called *Degalit*, *Humera*, *Kodem*, and *Wediaker*. Next to sorghum is maize, with varieties locally known as *Anjo*, *Berihu*, *Fetno* or *Arkibu*. *Teff* varieties grown in the area are *Ttaeda Teff*, *Keih Teff* and *Binne Teff*, while barley (*Saesaa*), chickpea and vetch have each only one variety (table 10).

Table 10. Crop varieties and their status

Crop	Variety	Status
Sorghum	Degalit	Under cultivation using flood water
	Humera	Popular in the farming system
	Wediaker	Under cultivation
	Jamuye	Endangered
	Kodem	Newly introduced and under cultivation
Maize	Anjo	Under cultivation
	Berihu	Popular and under cultivation
	Fetno or Arkibu	Under cultivation, newly introduced
Teff	Tsaeda teff (white teff)	Endangered
	Keih teff (red teff)	Popular in the system
	Binne-teff	Under cultivation
Barley	Saesaea	The only variety
Chickpea	shinbra	Under cultivation
Vetch	Engaya	Under cultivation

Note: The sorghum variety called *Jamuye* is near extinction because it is highly eaten by birds.

6.2 Factors for Varietal Extinction

Some crop varieties are endangered and few varieties had already been wiped out from the farming system. Some of the factors for varietal extinction are: i) replacement of early maturing varieties with late maturing varieties due to the short rainy season; ii) attack by birds and insect pests on certain varieties; and iii) displacement of one local variety by other local and/or exotic varieties.

6.3 Conservation of Crop Germplasm

The rich farmers have an opportunity of conserving any of the endangered crop varieties. The poor farmers usually seek seed from the richer farmers when they want a particular variety. Although the farmers face difficulties, they use different strategies at conserving their crop varieties: i) they usually keep small amounts of seed in storage as future planting material; ii) they alternate between cultivation and storage; iii) they grow late maturing varieties using irrigation; and iv) they partition the field to accommodate available varieties.

6.4 Farmers' Traditional Varietal Selection Criteria

The farmers follow a holistic approach towards selection of crop varieties when introduced from nearby regions or supplied to them by the *Wereda* Bureau of Agriculture. Some of their selection criteria are: i) adaptability; ii) yield; iii) resistance to insect pests, diseases, moisture stress, and birds; iv) food processing qualities such as taste, colour, digestibility and role in making local drinks; v) use and quality of straw; vi) labour requirement; viii) low dependence on external inputs; and ix) suitability to the local food processing.

Tables 11 presents the farmers' responses regarding the approaches employed to evaluate *teff* varieties. As depicted in the table, the red *teff* variety (*Keih teff*) is the best adapted and most popular in the area.

Table 11.The farmers' approach of evaluating teff varieties

Teff variety	Yield in good season	Yield in bad season	Biomass	Market price	Straw quality	Drought resistance	Adaptability to local soil
Tsaeda teff (white teff)	1	3	1	1	3	3	3
Keih teff (red teff)	2	2	2	3	2	2	1
Binne teff	3	1	3	2	1	1	2

Note: Straw quality is based on animals' preference.

Table 12 provides some characteristics of landraces for the different crop varieties grown in the area.

Table 12. Some characteristics of landraces

Crops	Varieties	Characteristics
Sorghum	Degalit	Compact panicle, late maturing, long stalk, high yielding, white grains, can be eaten by birds
	Humera	Medium compact panicle, early maturing, medium yielding, bird resistant and can tolerate moisture stress
	Kodem	Loose panicle, medium maturity, high yielding medium stalk and can be eaten by birds
	Jamuye	Compact panicle, early maturing, short stalk and high yielding but highly eaten by birds
Maize	Anjo	Late-maturing, long stalk, high yielding, big ear size, white seed colour
	Berihu	Early maturing, medium stalk, yellow to white seed, medium yielding
	Fetno	Short stalk, early maturing

Teff	Tsaeda teff (white)	Late-maturing, white seed, demands more fertile soil, long loose panicle,
	Keith teff (red)	High yielder, medium maturing, well adapted and popular in the area, not easily attacked by shoot fly and disease
	Binne	Extra early maturing, less yielding, than tsaeda and keih teff, but can give yield in less rainfall season.
Barley	Saesaea	Two-rowed, high yielding, white seed, can be affected by rust
Chickpea	Shinbra	High yielding, red and black seed, late maturing and can be attacked by boll worms
Vetch	Engaya	Medium yield, earlier maturing than chick pea, and can be attacked by aphids

6.5 Traditional Seed Selection Criteria

The farmers have their own traditional seed selection criteria. Men are mostly involved in the process because of their familiarity with the germination and yielding capacity of local varieties. Women are mostly involved in post-harvest activities such as storing seeds, cleaning, and buying seeds from the local market. Selection of seeds for the next cropping season is made from the previously harvested crops to avoid negative effects of storage.

Seed quality can be affected by such factors as weevil attack, weeds, storage, threshing site, and untimely rain. The farmers use the following seed selection criteria: i) seeds that are not attacked by insects, birds, diseases, and rodents; ii) seeds that maintain their original colour; iii) seeds that are free from weed seeds, chaff, soil, sand, etc.; iii) seeds that are from plants that have larger and more ears (for maize); iv) seeds that are from plants with large pinnacle, strong stalk and medium height (for sorghum); v) early maturing seed varieties; and v) seeds that have matured but not spoiled by excess moisture.

6.6 Methods of Seed Quality Maintenance

Some farmers strive to maintain the quality of their seeds using the following strategies: i) planting varieties in different areas and at different times; ii) cleaning threshing place; iii) crop rotation; and iv) smoking and mixing seeds with ash.

6.7 Women's Role in Seed Selection Process

The women inspect and clean the selected seeds and check their viability in the course of food processing and pass the information to their husbands. The women use the following techniques to check the viability of certain crop seeds:

i) Soaking in water - they usually soak larger seeds to separate poor quality or weevil attacked seeds and good seeds for planting.
ii) Malting - women malt maize, barley to prepare the local drinks like *siwa* (local beer), while malting, they test the germination capacity of seeds.
iii) Visual observation - if there is visible weevil attack on the seeds or colour change from normal.

6.8 Utilisation of Crops for the Household Consumption

The farmer's decision to cultivate local landraces, the land allocation for each, and other management practices seems to be associated with the role of the crops in every household. The varieties which are suitable for local processing, and which have more than one function, are given more emphasis in crop production systems of the area (table 13).

Table 13. Crops and their uses

Crops	Uses in local food processing, including local drinks (in Tigrigna)
Sorghum	Injera, Geat, Kollo, Tiktiko and local drink Siwa
Maize	Injera, Geat, Kicha, Tiktiko, Siwa, Kollo and Shewit
Barley	Injera, Kicha, Tihillo, Kollo, Beso, Kinkan, Siwa
Teff	Mainly Injera and some times Kicha and Geat
Chickpea	Shiro, Kollo, Tiktiko and Shewit
Vetch	Only Shiro

The men and women also made ranking of landraces (table 14). Cereals are highly preferred followed by legumes. The most frequently planted crops are sorghum, maize, barley, *teff*, chickpea and vetch in descending order. The main reason for preferring cereals is that they are suitable to prepare local stable foods such as *injera* and *geat*.

Table 14. Ranking of landraces by the Tigrayan men and women and the Afar women

Crop	Tigrayan men	Tigrayan women	Afar women
Sorghum	1	2	1
Teff	2	1	4
Maize	4	4	2
Barley	3	3	3
Chick pea	5	5	5
Vetch	6	6	6

7. EXTENSION SYSTEM AND GENDER ROLES IN CROP PRODUCTION

7.1 Extension System in Crop Production

Agricultural extension involves helping farmers to identify, analyse and deal with their production problems and to become aware of the opportunities for improvement (Adams 1992). Despite this, extension activities in Aba'ala *Wereda* are very weak. The only organizations involved in extension programmes are the Zonal Bureau of Agriculture and DHP-Ethiopia. The *Wereda* BoA has tried farm demonstrations in three *kebeles* in 1998, but the programme did not include many farmers.

In principle, the extension agents should live with or near to the farmers to identify the farmers' crop production problems and to help them overcome the problems. However, the extension agents in the study area are stationed in the *wereda* town and do not have weekly or monthly programmes to communicate and discuss with the agro-pastoralists. Generally, management systems of the *Wereda* and Zonal BoA towards the expansion and development of extension activities in the area are not well organised.

DHP-Ethiopia in 1998 has tried to introduce improved varieties of some crops on the DHP experimental site at Aba'ala. The improved varieties include ACV4, ACV3, ACV6 of maize, and DZ-Cr-37 of *teff*. The zonal BoA for comparison with the improved maize varieties also grew local maize in the experimental site. All these varieties were grown using DAP fertilizer, row planting and irrigation supply at two weeks' interval. The improved maize varieties were released for dryland farming by Awassa Agricultural College.

The adaptability and performance of the improved varieties were demonstrated for the farmers, Zonal and *Wereda* BoA staff, and representatives of the *wereda* and zonal administrative offices.

7.2 Gender Role in Crop Production

Women have significant role in crop production. The Tigrayan women in the study area participate equally with their husbands in farming activities. However, the Afar women face some cultural constraints; for instance, they do not share household property when they are divorced. In addition, the Afar women are involved in simple house construction without the help of their husbands - a result of their culture by which the female has to do more activities in the household. In the study area, there is no involvement of organisations, which encourage women's participation in rural development activities. Table 15 summarizes the gender based socio-economic activities in the study area.

Table 15. Gender based socio-economic activities

Men's group	Women's group	Old men and women
More Tigrayan and few Afar farmers prepare their land and grow different crop varieties	They prepare food for the family and participate in weeding and harvesting.	They keep house properties and they depend on children for food and clothes.
Tigrayan men make house from local woods, they also make fence and farm implements.	They fetch water, carry grain to mill, sell grains and buy goods from local market	Those who do not have children lease their land for equal share of the yield
Tigrayan farmers and few Afar farmers produce crops and keep cattle, goats and donkeys	The Afar women construct house, sell grains, buy salt	Very old and unable to do any work, and most are poor and do not have means of income
They participate in the	They also participate in	They do not participate in

community meeting and are member of men's association	community meeting and are member of women's association	meetings, but they are involved in conflict resolution

8. ENVIRONMENTAL CONSTRAINTS AND COPING MECHANISMS

The agro-pastoralists face a harsh environment characterised by high temperature, unreliable rainfall, sparse vegetation cover and frequent occurrence of drought, insect pest outbreak and livestock diseases. Based on the perception of interviewed household heads and key informants, the problems facing the agro-pastoralists in the study area are: i) shortage of water, pasture and forage; ii) animal health problems; iii) lack of extension services; iv) seasonal floods; v) lack of infrastructure; and vi) lack of markets.

Most of the farmers have their own techniques of overcoming some of the crop and animal production constraints. For instance, in the case of moisture stress, they do the following: i) leave some portion of the land unploughed as grass strips at certain intervals to conserve moisture; ii) Making furrows at about 2-5 metre intervals after sowing *teff* on a gentle slope; iii) divert floods by making canals (*Feleg*); iv) cultivate between maize and sorghum plants (*Gusia*); and v) plough the land after harvest.

In some cases of rainfall shortage, severe attack of insect pests and animal forage shortage, most of the farmers use the following mechanisms: i) bringing grass by cutting from far areas or taking the animals to areas where forage is available; ii) selling goods including grains and firewood; iii) working as daily labourers; and iv) migrating to towns in search of jobs.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The existing serious problems in the local farming systems are the results of the environmental constraints and unsustainable use of the natural resources. In addition, crop husbandry practices are traditional and backward. The seeds are poor and are broadcasted at high seeding rates. Hand weeding is usually carried out once, usually too late, and limited only to picking or cutting bigger weeds. Most of the farmers use

flood irrigation during rainy seasons. Soil and water conservation practices are weak in the area.

The numbers of crop varieties cultivated in the area are limited and some sorghum varieties are on the verge of extinction. Farmers have been making little or no attempt to conserve them. Crop yields are declining due to inadequate rainfall, insect pests, weeds and diseases. No effective pest control system is established at farm level. Crops are harvested manually, and threshed on open grounds using animals and stored in traditional storage structures.

The existing extension system of the *Wereda* BoA is weak Almost no research activity has been done in the area; however, DHP-Ethiopia has tried to introduce improved varieties of some crops such as *teff* and maize. There are no rural development interventions such as credit services and agricultural input suppliers.

9.2 Recommendations

To minimise the effects of crop production constraints and to increase productivity, the following interventions from the government and non-governmental organisations are recommended:

i) Developing water resources for irrigation to counter rain shortage and to conserve late maturing crop varieties;
ii) Providing credit service and technical support for the construction of flood diversion dikes and the maintenance of Myshugala Dike, water ponds and micro-dams;
iii) Raising the farmers' awareness regarding soil and water conservation practices and adoption of new technologies through extension programmes;
iv) Involving the farmers in participatory varietal selection programs and informing them about conserving local crop varieties and making improved grain storage structures;
v) Up-grading the knowledge of the development agents by conducting training programmes;
vi) Establishing institutions that encourage women's participation in rural development that provide credit services to overcome their problems; and
vii) Linking research and extension by conducting research trials and demonstrations of improved technologies and by giving technical advice such as on the use herbicides.

REFERENCES

Adams, M.E.1992. Agricultural extension in developing countries.

CSA.1996. Population and housing census of Ethiopia. A Central Statistical Authority report.

Diress Tsegaye Alemu. 1998. Impact of land use on vegetation resources with an emphasis on woody vegetation in semi-arid area of Aba'ala District, North Afar, Ethiopia.

Gitte Simonson. 1996. The Wossama Afar, a study of natural resource management of a pastoral group in North-Eastern Ethiopia.

Hurni, H. 1986. *Guidelines for development agents on soil conservation in Ethiopia*. United Nations Economic Commission for Africa, Community Forests and Soil Conservation Development Department in Warm Climates. London: Macmillan.

Rowland, J. R. J. 1993. Dryland farming in Africa. London: Macmillan.

Shiferaw Aliye. 1996. Dryland Husbandry Project, Shiket Ethiopia. Project progress report to Afar Regional State.

UNDP/ECA. 1998. Crop Protection Programme Zone.

UNDP/ECA. 1998: Livestock Development Programme Zone Two, Afar Regional State. A study by United Nations Economic Commission for Africa.

Yayock, J. Y. 1988. Crop science and production.