FRP TECHNICAL PAMPHLET NO. 12

COTTON IN NORTH OMO

BY

KEFALE ALEMU

Farmers' Research Project (FRP)
FARM AFRICA

P.O. Box 5746
Addis Ababa
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

OBJECTIVES OF THE SURVEY, METHODOLOGIES, AND AKNOWLEDGEMENTS

FARM AFRICA is a Non-Government Organization (NGO), registered as a charity in Britain, and in 1996 it worked on projects in Ethiopia, Kenya, Tanzania and the Republic of South Africa. One of the projects it is working on in Ethiopia is the Farmers' Research Project (FRP). The FRP's immediate objective is to build personal links, and linkages of understanding between farmers, researchers and extension workers and to enable researchers in particular to understand what farmers research priorities are. It is designed to carry out farmer-oriented research in which farmers play a leading role.

Early in the life of this project it became clear that one of the problems hindering Non-Government Organizations, both in their agricultural extension as well as in their research activities, is a shortage of basic information on many of the important crops of the North Omo region. It was therefore decided that one of the early activities of the project should be to produce a number of technical pamphlets on important crops and other farming issues about which it is difficult to obtain information from other sources.

A Technical Pamphlet (TP) is an in-depth study of the production of particular agricultural commodities or inputs, in several agro-ecological zones or production systems. The purpose of this pamphlet is to collect, analyze and present to government or NGO officials in research, development, or extension services, information about the importance of cotton production over a large part of North Omo, which they may find very difficult to obtain from other sources.

The survey was started in late 1992 and it has taken a much longer time than expected. This is because the author, and Stephen Sandford, were also involved in other important components of the project (e.g. trainings, on-farm trial research works, diagnostic studies, travelling seminars) and were unfortunately too busy to complete the study.

This TP describes the different production systems, then identifies the problems or constraints in each and summarizes the research that has already been carried out, whether on research stations or on-farm, that is relevant to the problems found in North Omo. The author also reviewed publications on tropical cotton production and travelled to different cotton growing areas of North Omo (Damota, Mirab Abaya, Arba Minch, Gardula, Kindo Koysha & Konso) at different cotton growing seasons. He also talked to weavers (men) in some very important cotton processing areas (e.g. the Dorze people in Sura [now Chencha zuria]).

Information was gathered from the above mentioned areas using the following enquiry methods.

GI	Group Interview
IRI	Individual Recall Interview
OSOI	On-Site Observation and Interview
GMR	Group Matrix Ranking
SD	Secondary Data

Interviewes with farmers (men and women, as individuals or in groups, usually of 10-15 people) and observations cotton farm lands in all areas were taken by the area BOA staff and the author. The semi- structured interviews with groups of farmers or individual case studies were gathered from different villages, farmlands, cotton processing areas, etc. The staff of the Bureau of Agriculture (BOA) in collaboration with the Farmers' Research Project facilitated the interviewing and observation of cotton plantations at different lowland areas of North Omo.

The author visited various market places (where cotton is sold) at Mirab Abaya, Lantie, Gato, Wozeka, Gidole, Chencha, Boditti, Welaita Soddo, and the Dorze market near Chencha town, to determine the price of cotton.

At the end of the pamphlet there are five appendices given to help readers not familiar with North Omo and/or Ethiopia. These are: a glossary; Ethiopian and Gregorian calenders; currency equivalents; government administrative hierarchies; and agro- climatic zones in Ethiopia.

Words that appear throughout the text in *italics* are words that are explained in the glossary.

In addition to a thorough review of the existing literature, the author interviewed a large number of farmers. These farmers are too numerous to acknowledge individually. As will be apparent from what follows, they should be acknowledged as the real authors and the author hopes that he has correctly interpreted their views.

Mr. Stephen Sandford (Co-ordinator of the FRP from 1991-1994) has contributed a considerable part of this work. The pamphlet was initiated by him and the early work on this pamphlet was a joint effort. The author is very grateful for his contribution and his considerable kindness.

In the preparation of this pamphlet the author was greatly helped by a number of people, including: Bureau of Agriculture staff of Sura, Kindo Koysha, Mirab Abaya, Arba Minch Zuria, Gardula, Konso etc., and the North Omo Agricultural Development Enterprise. Martin Bull (FRP Editor) not only edited and reviewed the pamphlet but also made a substantial contribution. Ato Ejigu Jonfa and Ato Alemayehu Konde are thanked for their useful comments and support during this work. The author takes this opportunity to express his gratitude and to acknowledge the significant contributions that they have all made.

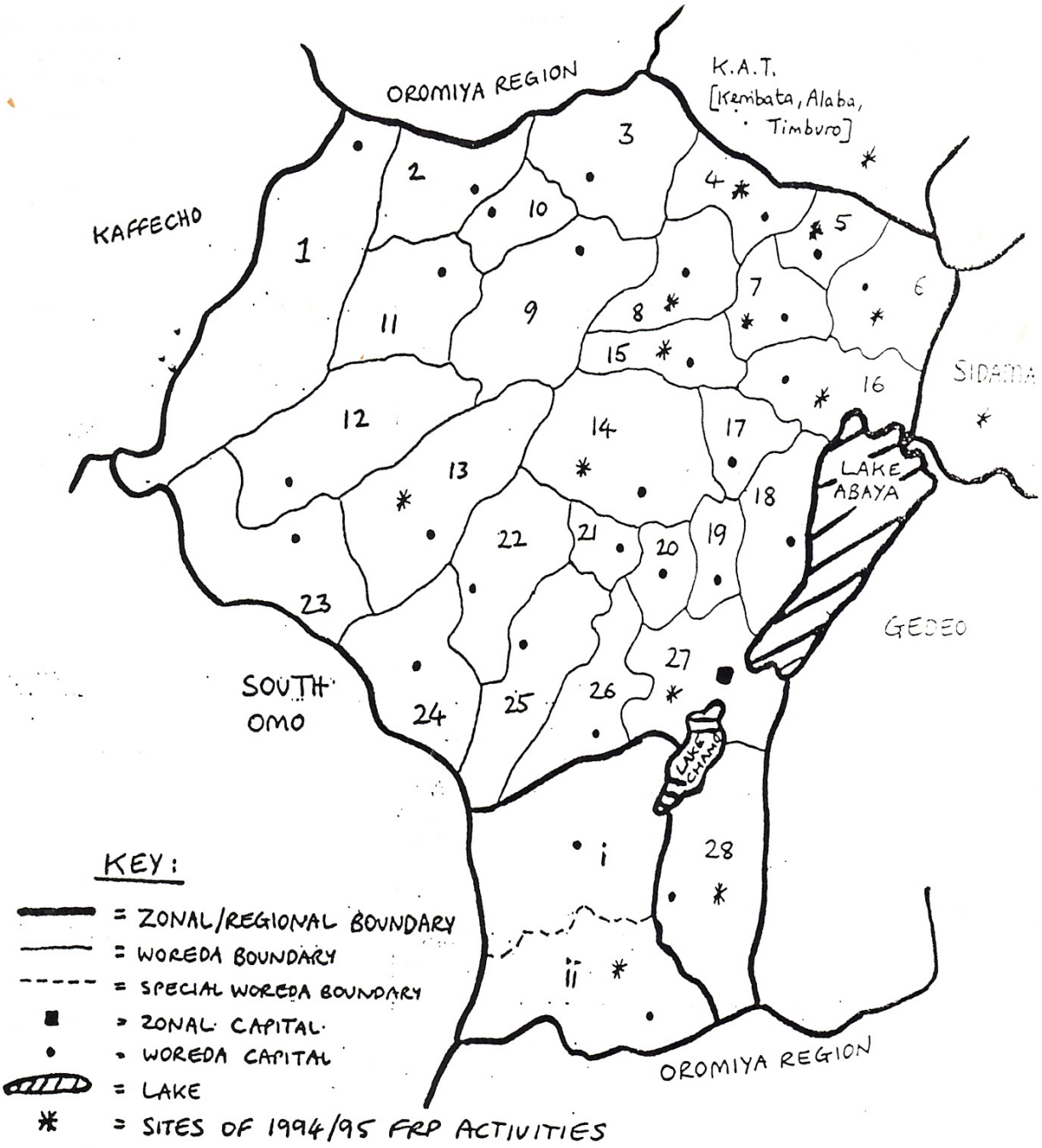
Comments on the final draft of this pamphlet were received from: J.H. Saunders, Stephen Sandford, Ato Gemechu Gedeno and Alemayehu Konde. These comments were very useful to the author who has made appropriate amendments in the final version. J.H. Saunders from UK has contributed a substantial work. The author has learnt a lot from his comments and is very grateful for his helpfulness. Grateful acknowledgements are also made to Dr. Zinash Sileshi and Wzt. Yemesrach Mamo who did an excellent work on the final draft of this TP. However, the author alone is responsible for any remaining errors and omissions.

Kefale Alemu

March, 1996


Moringa Tree

Fig 1. Map of North Omo



Wereda's of North Omo (with capital in brackets):

1: Ella (Amaya)	11: Esara (Bale)	21: Deramalo (Wacha)
2: Tocha (Tocha)	12: Melkoza (Leha)	22: Zala (Gelta)
3: Gena Bosa (Wolde Hana)	13: Goffa (Saula)	23: Basketo (Laska)
4: Bolosso Sorie (Areka)	14: Kucha (Selamber)	24: Beto (Ubamale)
5: Damt Gale (Boditi)	15: Ofa (Gesuba)	25: Kemba (Kemba)
6: Damot Weide (Bedessa)	16: Humbo (Tebela)	26: Bonke (Gerese)
7: Soddo zuria (Soddo)	17: Boreda (Zefne)	27: Arba Minch zuria (A.Minch)
8: Kindo Koisha (Bele)	18: Mirab Abaya (Birbir)	28: Gumaide (Segen)
9: Loma (Loma)	19: Chencha zuria (Chencha)	
10: Mareka (Waka)	20: Dita (Zada)	

Special wereda's:

i: Derashe (Gidole)	ii: Konso (Bekawle)

1. BACKGROUND[1]

The cultivated cotton belong to the genus Gossypium within the tribe Gossypieae in the family Malvaceae. The genus Gossypium includes 38 species and one sub-specie (Fryxell, 1979). Of these 6 are tetraploids and 32 are diploid. The cultivated lint-bearing cottons are 2 tetraploid (G. hirsutum and G. barbadense) and 2 diploid (G. arboreum and G.herbaceum). Cotton is a perennial small shrub plant (although normally cultivated annually) which grows to a height of 90 cm to 180 cm and above. Cotton plantation has been known since 3000 B.C. in India and China (Dolgodovorov, 1987).

The evolutionary history of the genus Gossypium poses a tantalizing problem of great interest (Saunder, 1961) and the exact origin of Gossypium species are still the subject of some debate. However, there has been a considerable and careful research dating from the end of the last century with remarkable studies in knowledge with the birth of cytogenetics which established the genomes of cotton species. The systematic of the genus has been exhaustively researched by Fryxell (1979).

All wild species of Gossypium are perennial and their natural spread is limited to frost areas. They are small trees and shrubs found in dry westland and desert margins. It seems likely that the new world early agricultural man discovered the use of lint from the plants (archaeological findings include primitive nets made of cotton fibres) and domesticated them. Diversification took place under the combined forces of nature and the spread continued into southern North America (USA today). Through man's selection the annual habit was established leading the way to the advent of the annual uplands of today (Saunders, 1961).

Cotton is distributed throughout the tropics and sub-tropics and production takes place between 37°N and 32°S in America and from 47°N and 30°S in the old world (Gibbon and Pain, 1988).

Of the cultivated species, two groups are important:

1. The old world (Asiatic) species G. herbaceum var. africanum is considered to be a truly wild diploid species indigenous to South Africa and is the only wild species to bear spinnable lint. It is considered to be the ancestral type which gave rise to the Asiatic cottons to be found in the middle east and China (arboreum and herbaceum varieties).

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[1] The author acknowledges Mr. J.H. Saunders for his constructive comments, that substantial changes were made on this chapter.

2. The evolution of the tetraploid linted cotton is thought to have been through chance hybridization between an A genome linted diploid (possibly G. herbaceum var africanum) and a D genome diploid (G. raimondii) in Northern or Central America (Saunders, 1961) and this event took place some million years ago. Forms of G. barbadense, all of which were perennial, spread after 1500 A.D. to West Africa, Sudan and Egypt and gave rise to the fine quality Egyptian and Sudanese cottons. Today, the largest and most important producer of the long staple varieties of G. barbadense is Egypt.

Another perennial tetraploid form, G. hirsutum had an early distribution in Central America. Then it migrated northwards towards Mexico and is the ancestor of the annual upland cotton grown in the United States (G.hirsutum var. latifolium). This is now the most important cotton grown in the world.

G. hirsutum is commonly called an American upland cotton. There are about 15 varieties of upland cotton. Acala 1517c is one of this group and it has spread to most cotton areas in Ethiopia (including North Omo). Another variety called Albar is also known by some farmers in the North Omo region, especially in the Abela and Bele areas.

Cotton fibres may be roughly classified into three large groups based on staple length.

1. Long staple fibres - the staple length is 2.5 to 6.2 cm, having a fine texture and good lustre. These are very important crops in Egypt and Sudan and fetch a much higher price in the trade. They are used mainly for fine fabric, yarn and hosiery.

2. Standard, medium or intermediate staple cottons - the staple length is between 1.2 and 5 cm and is coarser in texture. This group includes American upland cotton which has considerably higher yields than the long staple cotton but brings a lower price.

3. Short staple fibres - included in this category are Indian and other Asiatic cottons (0.95 - 1.9 cm) that are characterized by having short, coarse and lusterless fibres. They are mostly used to make coarse and inexpensive fabric carpets and blankets.

Cotton requires high sunshine, particularly at flowering, and needs adequate but not excessive moisture throughout its growth. In general, cotton plants withstand irregularities of rainfall better than cereals. At least 500 mm of available moisture is needed for the crop to develop fully, although this amount will vary depending on the potential evapo-transpiration. Cotton grows best on deep, well structured loam soils. The optimum soil pH lies between 5.2 and 7.0. Therefore, the most popular soils throughout the world for the growth of cotton are alluvium, with a good structure.

In Ethiopia cotton is the most important cash crop. It grows in the lowland part of Southern Ethiopia (especially along the Rift Valley), and the Awash and Robi valleys.

In North Omo, cotton landraces are grown in the lowland part of Gardula and Konso, and in the rainfed areas of Satusa and Arba Minch zuria, in mixture with other crops. In Humbo (Abela), Kindo Koysha (Bele) and some irrigable areas of Arba Minch zuria and Satusa weredas, better yielding improved (exotic) varieties of cotton are grown in pure stand. In this region there are cotton plantations (previously run by the State Farms) which get supplementary irrigation from the nearby perennial rivers. The amount of land under landraces (where cotton is grown in mixture with other crops) is very large when compared with the land under improved varieties (where cotton is grown in pure stand) but very much less in its production.

2. USES IN THE WORLD AS A WHOLE

Table 1 shows the various products of seed-cotton. The most valuable product of the cotton plant is lint. Lint is the hairs that grow from the seed coats. It can be spun into a yarn and throughout the world is the most important plant product used for textiles. Other uses of the cotton lint include absorbent cotton wool, special strong and durable paper, film (tape), plastic, nitre varnish and artificial leather.

Glucose, lignin, wooden type products and a protein-rich edible substance can be prepared from the husk (scale).

The cotton seed also contains many by-products (the secondary products), such as an extractable edible oil (Table 1). This oil constitutes 20 to 27% of the seed and can be used in cooking and margarine manufacture, and as a lubricant. After the oil processing, a seed cake remains. This is a valuable protein concentrate and is used to feed some types of livestock. However, the cake contains a toxic compound known as gossypol, so should only be fed in limited quantities. Soap can also be produced from the seed.

The short hairs on the seed coat (fuzz or linters), can be used in a variety of ways in manufacturing such as for felt, twine, carpets, rayon, plastics and paper.

From the leaves and the lower part of the stem different types of acids, unbreakable glass and artificial felt can be made.

Table 1. Different Products (kg) from One Tone of Seed-cotton

Primary products	Lint	Husk (scale)	Seed		
	340-350	210-230	570-580		
Secondary products (from the seed)	Linter (fuzz)	Oil	Soap	Cake	Others
	30-40	98-110	20	225-230	20-30

Adapted from Vavilove (1986).

3. PLANT CHARACTERISTICS

Roots - Most roots, in non-alluvium soils, are found in the top 30 cm of the soil. The tap roots however can penetrate up to a depth of 2 m. In the tropics, under favorable conditions, roots can be found as deep as 4 m.

Generally, landraces and some tree-like cotton plants in North Omo, have longer and stronger roots when compared to the newly introduced (exotic) cotton types. This could be one of the reasons why they are highly drought resistant.

Stem and Branches - The main stem of cotton has spirally arranged branches (dimorphic branching). In the tropics, depending on the formation or kind of branches, it is divided into monopodia (those at the base of the plant and which bear flowers only on their ramification) and sympodia (those higher up the stem or on the vegetative branches which bear flowers directly followed by bolls). The number of monopodia branches is between 15 and 40. The lower node of the main stem produces vegetative branches, usually called monopodia, while the upper nodes produce reproductive branches called sympodia.

The primitive and advanced perennial landraces observed in the Konso and Gardula areas have more branches and a thicker stem when compared to improved varieties.

Leaves - The form and size of cotton leaves (lamina) vary considerably, depending on the cotton type. Some leaves have small hairs on their lower surface which have made resistant them against jassid (an insect pest which feeds on the leaves). Hairless cotton varieties however are usually severely attacked by jassid.

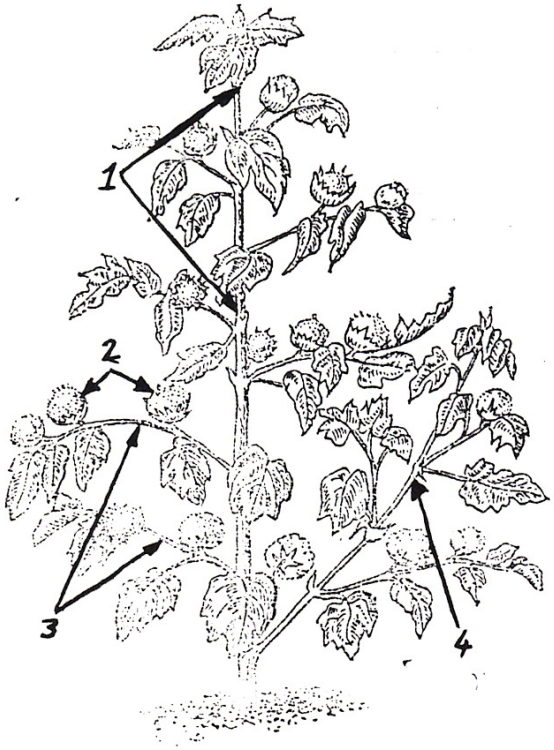
Squares (buds) - These are unopened flower buds. From germination to the formation of the first bud takes about 30 days.

Flowers - Flowering starts on the short stalks about three weeks after sowing. In cool weather flowering may be delayed until 12 weeks after sowing.

Bolls - Bolls are formed shortly after flowering, the fruits are laterally structured, and will split down the middle of each capel (locule) revealing the seed cotton. The number of loculus may depend on the type of landrace or variety. Usually there are four loculus in each boll (or sometimes three or five) and each contains about ten seeds surrounded by the fibers which grow from their seed coat.

The principal parts of the cotton plant is shown in Figure 2.

Fig 2. The Principal Parts of the Cotton Plant



1. Main stem 2. Bolls 3. Sympodia branch 4. Monopodia branch

Life Cycle - Cotton is a short perennial plant, growing continuously with a regular cycle of flowering, provided there is sufficient soil moisture. But in modern agriculture it is treated as an annual plant and usually removed from the field in less than a year. However due to conditions in North Omo conditions cotton often stays in the field for more than a year, especially as farmers usually grow cotton in mixture with other crops (maize, sorghum and other minor crops). When the plant reaches its 2nd or 3rd year, some farmers cut (prune) the plant (some days before planting other crops) at the lower part of the stem. The cutting height ranges from 25-30 cm above the ground. According to the farmers this is mainly done: a) to create favorable conditions for other new emerging annual crops (e.g. avoiding shade effects), b) to make land preparation, planting and management easier, c) because unpruned crops could create severe pest problem, and, d) because the newly re-growing reproductive branches give better yields. After two years farmers (e.g. in Konso and Gardula) usually destroy the whole plant by uprooting.

During the study, some tree-like primitive landraces were observed growing near margins of farmland plots and homesteads. These cotton types give some yield for five, or more, years without being cut.

The size of different cotton types vary quite considerably. These are average sizes, and the size of one and the same cotton type may vary depending on moisture availability, altitude, soil type and fertility status (Table 2). In addition to this cotton planted earlier in the months of Megabit or Miazia was found to be very big in size when compared with the Sene and Hamle planted ones.

Table 2. Average Height, Girth and Spread of Some Cotton Types in North Omo

Location	Varieties	Girth at ground level (m)	Height (m)	Spread (m)	Remarks
Konso (Fasha)	Primitive (landrace Elgo or shoa or boyte	0.25	3.50	4.20	Seeds are easily separable
Konso	Wild *Gossypium* spp.	0.02	2.15	1.05	Seeds are very rough
Konso (Gresele)	Local (landrace)	0.07	1.24	1.15	
Gardula (Gebene meno)	Local (landrace)	0.12	1.78	2.15	
Abela	Improved variety (Acala)	0.04	0.93	0.59	

Plant Development - The development stages of cotton are presented in Table 3. Usually when conditions are favorable, seeds emerge above the ground 5 to 10 days from the date of sowing. In Abela, where FARM-Africa (FRP) has been conducting cotton on-farm trials, seedlings were observed emerging 5 days after sowing in moist soils. Abela and Bele cotton farmers claim that the most important factors concerning the time of emergence are:

a) Planting depth
b) Moisture content of the soil (during planting)
c) Soil type
d) Rainfall: if heavy rains fall after dry planting, especially in black clay soils, or the rainfall delays for some days, seedlings cannot come through easily because of the formation of a crust at the upper surface of the soil.

According to Dolgodovorove (1987) the average minimum temperature (within 24 hours' time) for cotton to emerge is 14-15°C. During germination the tap root grows quickly and may extend to a depth of several inches before the young seedlings emerge. Following the emergence, growth becomes slow for about two to three weeks. Therefore, temperature and moisture are the most important factors for quick or late emergence. If there is an adequate supply of water (moisture), development can be enhanced.

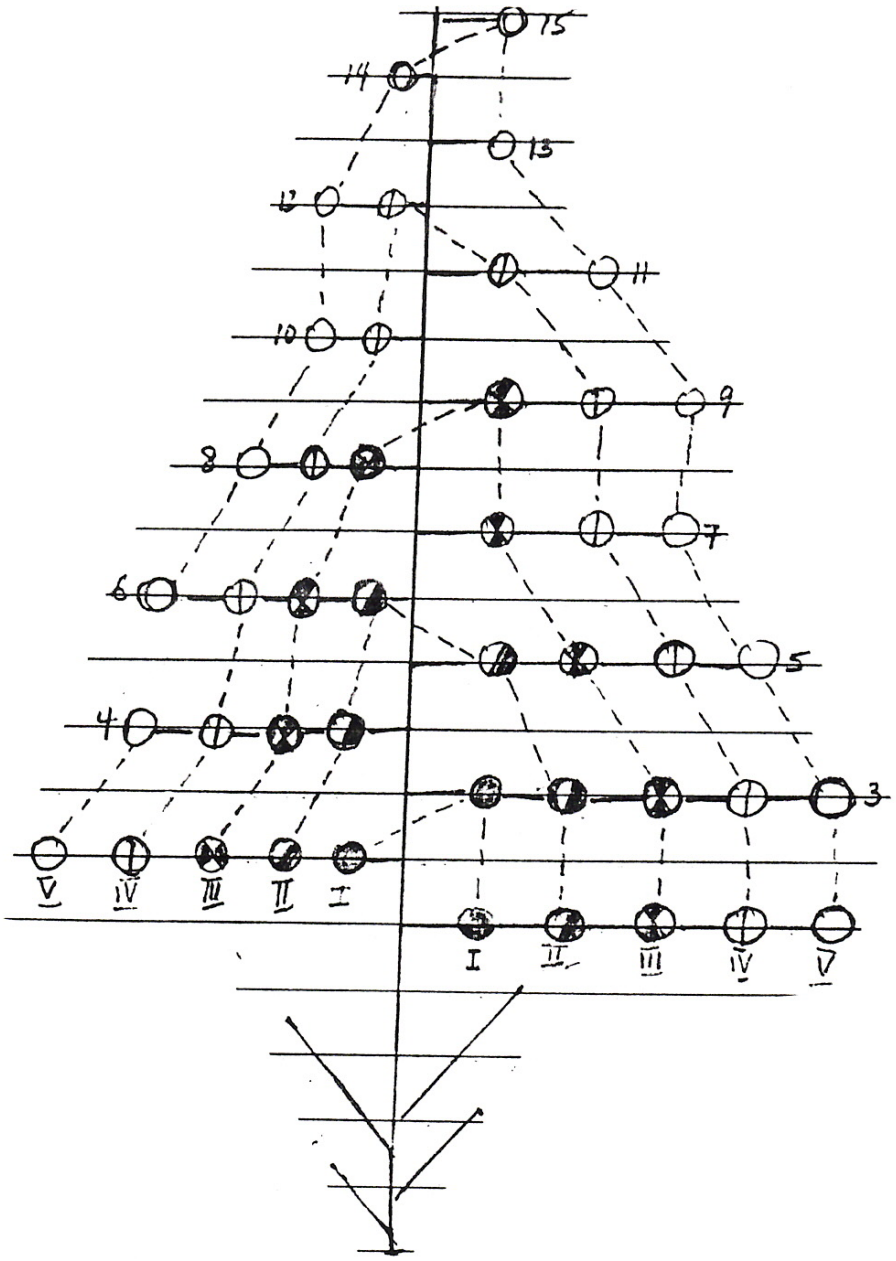
Figure 3 shows flowering plant and Figure 4 presents cotton flowering plant with branches

Table 3. Cotton Development Stages

Development stages	Days	Total Days
Planting to germination	4-6	4-6
Germination to the first flower bud formation	30	34-36
First flower bud to the appearance of first small flower	15-20	49-56
Flowering to fruiting	50-56	99-121
Fruiting to picking	15-20	114-141

Source: Ministry of State Farms Development, 1990.

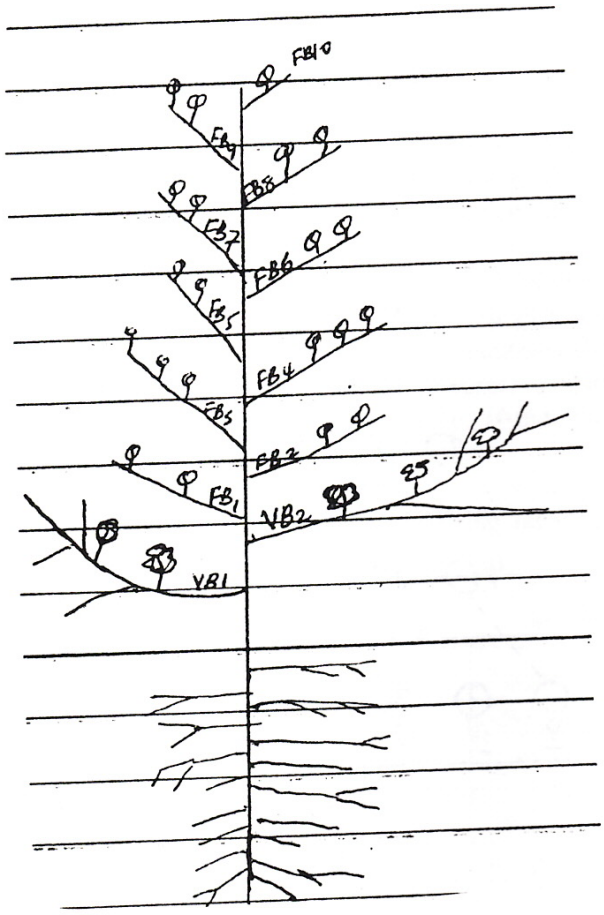
Fig 3. A Diagrammatic Representation of a Flowering Cotton Plant



The Roman numbers show the cone of flowering branches and the Arabic numbers the cone of vegetative and fruit-bearing branches.

Source: Vavilove, 1986.

Fig. 4. A Diagrammatic Representation of a Cotton Plant with the Vegetative branches



= Boll
= Cotton Flower

A Diagrammatic Representation of a Cotton Plant with the Vegetative Branches (VB) and the Fruit-bearing Branches (FB) Shown in the Order in which They Appear

Source: Sement and Gerard, 1988.

4. HISTORY OF COTTON IN NORTH OMO

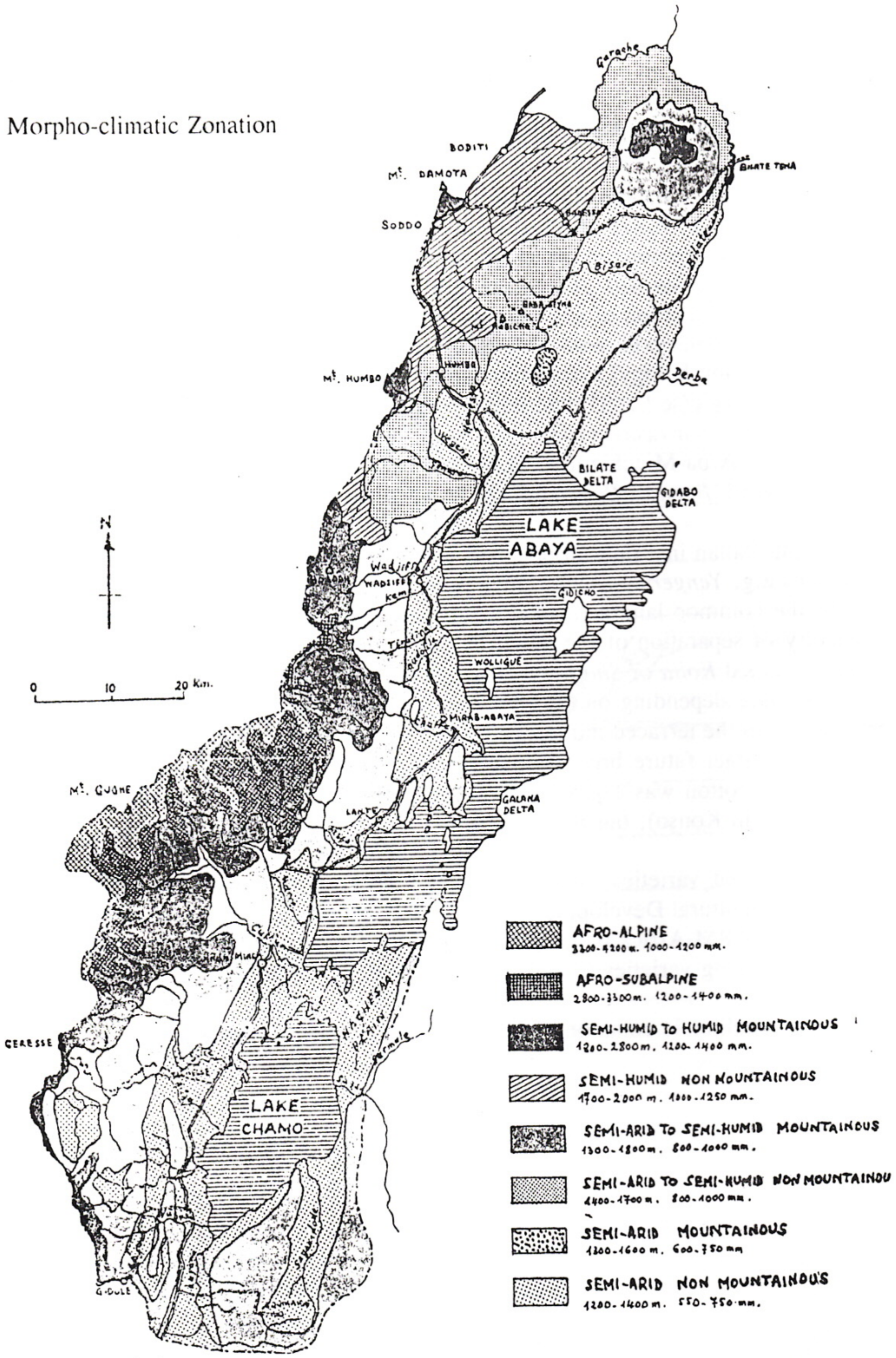
All farmers of North Omo claim that cotton plantation was known in the region long ago, before the introduction of maize. According to Konso farmers sorghum and cotton are among the first domesticated indigenous crops in the area. During the authors' field work in the Konso and Gardula lowlands he was able to see wild perennial shrub cotton plants. This may give some clues for the origination of some cotton types in the area. The wild cotton plant has small bolls, but many seeds per boll, and the cotton lint is very rough. This wild cotton plant is similar in appearance (morphology) to the Peruvian cotton type (Gossypium peruvianum) which is included under G. barbaderse L.. The introduction of new (exotic) varieties of cotton in the area started during the Italian invasion (1935 - 1941). Of these varieties one is still growing in the North and South of the Arba Minch zuria. They now call this variety *'Bonda'* which is derived from the Amharic word '*Banda*'. *Banda* was the name given to Ethiopians who served in the Italian army.

Before the Italian invasion farmers had only been growing indigenous cotton types of different landraces e.g. *Yengerie*, which is also called *Yeabesha Tit* in Welaita and Arba Minch zuria. In Konso the common landrace is known as *karatiita* meaning refuse to come out, indicating the difficulty of separation of the lint from seed. An attractive and unusual tree-like cotton plant, which is called *Kolta* or *Shoa*, was also sometimes observed in North Omo. Its size varies from place to place depending on the altitude and other factors, but in the higher altitudes of Konso (especially in the terraced mountains of Fasha) it is very big, bearing large and numerous bolls. This may attract future breeders and researchers to this variety. Konso farmers reported that *Kolda/Shoa* cotton was orginally obtained from Elgo, which is South of Arba Minch (*Kolda* means Elgo in Konso), but now it is rarely found in the Elgo area.

Other improved varieties such as English, Israel, Acala and Albar were introduced by the Welaita Agricultural Development Unit (WADU), State Farms and recent governors of Sidamo. At present FARM-Africa is conducting trials in Abela and Bele to identify some more adaptive and high yielding varieties (5 varieties being tested).

The Morpho-climatic zonation of North Omo is shown in Figure 5.

Fig 5. Morpho-climatic Zonation



Source: Raunet, 1978.

5. COTTON IN NORTH OMO

Altitude in North Omo varies from less than 500 meters above sea level (masl) in the West along the Omo basin, to over 3000 masl in the North Eastern parts of the region. Physio-graphically, the region is composed of strongly dissected, hilly to mountainous areas, developed on granitic rocks. The predominant soils are mainly reddish clay and clay loams with low natural fertility and high subsoil acidity.

The climate of the region is highly diversified, ranging from areas having no significant length of rainfed growing period, to areas where there are possibilities of having moisture throughout the year. Mean annual rainfall varies from 550 mm around the lakes in the center of the Rift Valley (1200 masl) to about 1400 mm in the higher mountain environment (above 2600 masl). *Bimodal* and *monomodal* types of rainfall exist in the region.

In the lowland part of North Omo, i.e. below 1600 masl, farmers grow various landraces and improved varieties of cotton. Each landrace is distinguished by its vernacular name depending on the morphology and other characteristics (lint, seed, etc).

Among the four species of cultivated cotton, i.e. G. arboreum and G. herbaceum (Asiatic diploid species) G. barbadense and G. hirsutum (new world tetraploid species), the last named (which is known in its most widely cultivated form as American upland) is cultivated in Ethiopia. A variety known as Acala 1517c has spread to most cotton areas in North Omo. Another improved variety of cotton which is familiar with the Abela and Bele farmers is Albar 637, however this variety is not as widely distributed as Acala in these areas. It can sometimes be found in cotton plantations in mixture with Acala.

For convenience, the cotton growing areas of North Omo are divided into three major groups:

The Recent Settlement Areas in Abela and Bele

These settlements have been undertaken by the Ministry Of Agriculture (MOA), the previous administrators of Sidamo and Gamo- Goffa and more recently by the Welaita Agricultural Development Unit (WADU). In 1958, the Abela settlement area was created at North of Lake Abaya in the Welaita Awraja by Dejazmach W/Semayat and in 1970 it was taken over by WADU. Farmers were assisted by supervisory services which covered extension work and banking, plus marketing and credit co-operatives. Substantial investments were provided for these rainfed cotton growing areas and the production of cotton was very high.

At present farmers mainly grow these introduced varieties of cotton (Acala and Albar, Table 4) which were obtained in the time of WADU. Because of the presence of WADU for some years in Welaita, farmers have already been exposed to new methods and technologies of agriculture. They know the names of the exotic varieties, plant in rows (in pure stand), use pesticides and fertilizers.

Table 4. Evaluation of Two Exotic Cotton Varieties by Six Abela Cotton Farmers

Variety	Seed/Lint Ratio (ginning percentage)	Market Demand	Insect/Pest Resistance	Yield
Acala	High (few seeds)	High	Low	High
Albar	Low (many seeds)	Low	High	Low

WADU ceased its development activities in Welaita in 1982. Thereafter, the yield of cotton declined substantially because of the scarcity of pesticides. High insect pest infestation has occurred from aphids, flea beetles and bollworms. In addition to these man-made problems, natural problems of drought incidence in the area have aggravated the problems of cotton production. Insect pests also caused major problems during the time of WADU, but it was easier to control because pesticides and sprayers were cheaper and available through cooperatives.

Improved varieties which were introduced before and during WADU's time may since have produced declining yields. This is probably due to loss of purity of varieties and no selective procedure to supply farmers with tested seeds - loss of resistance to pests and diseases can be due to deterioration in varieties and/or mutational changes in the pests and disease organisms.

Since 1992, based on the reports of diagnostic surveys conducted by FARM-Africa's "Farmers' Research Project" and its collaborators, three types of trials with 35 Abela and Bele farmers have been carried out to find an economic control method and to select new varieties which produce better yields, tolerate pest attacks and are adaptive to the area. These newly introduced varieties are Stonville 213, Bulk 202, Okra leaf 2, Arba, Deltapine 90 and Acala SJ2, which were obtained from Melka Werer research center. Varieties, introduced by WADU, were also included in the trials as control.

Arba Minch Zuria and Mirab Abaya

In the Southern lowlands of Arba Minch (Elgo, Shelic Mela, Kolashelie) and the North of Arba Minch (Chano Dorga, Chano Milie, Chano Chelba and Lantie Peasant Associations (PA's)) different exotic and indigenous cotton types are being cultivated under supplementary irrigation and rainfed conditions. Settlement at Shelie began in 1967 on the alluvial fans (cones) of the Sille and Elgo Rivers. To the North of Arba Minch (in Mirab Abaya) people settled, between 1966 and 1970, around river fans at the villages of Chano (Hare River), Lantie (Basso River), Mirab Abaya (Chaffe River) and Wajifo (Wajifo River). In these areas farmers mainly grow newly-introduced cotton types and maize, with gravity fed irrigation from the aforementioned rivers. However the increasing demand of water for irrigation (both by farmers and the two big

cotton producing State Farms) and the occasional decrease of water in the rivers because of drought, have become the most important limiting factors to cotton production in the area.

On the other hand, almost all farmers who grow cotton under rainfed conditions prefer to plant the indigenous, perennial landraces in mixture with maize, sorghum and other minor crops. Even though the landraces are grown in a larger overall area of North Omo their total production is low less because:

1) The landraces are low yielders;
2) Landraces are always grown in mixture with other crops (i.e. there are few cotton plants per hectare);
3) Due to intercropping no spraying against insects and other pests can be carried out; and,
4) The yield declines after the first years harvest.

In PAs like Fura, Peragossa, Doshie and the lowland part of Ocholo, farmers grow cotton in rainfed conditions, but also temporarily dig channels (as storms arrive) to divert flood water from the highland areas into their farmland. For better cotton production the rains in the highland part of Sura and Arba Minch zuria are very important for both rainfed and irrigated cotton plantations. In some years when the highland part of this area gets higher rainfall, the cotton production in the lowland areas will be very much improved, even if the rainfall is erratic in the lowland part. Rivers that are used for irrigation will increase their water level which consequently enables the farmers to irrigate more land sufficiently. Therefore farmers of these areas not only expect direct rains, but also look forward to floods from the Gamu Mountains. Some farmers have built small canals which will lead the water, by gravity, into their farm. But the fact is that when too much rain falls in the elevated areas, heavy flooding is inevitable at the bottom part of the Rift Valley. Sometimes a very heavy flooding can destroy field crops, or affect their performance because of water logging at certain locations.

Despite the effort of farmers in serious drought years, only the 2nd or 3rd years cotton plants can survive and give some yield, since emerged young cotton seedlings and other annual crops can die within a few weeks of continuous dry conditions. But it must be remembered that 3rd year plants are not preferred by farmers and few of them are cultivated. Therefore, farmers are more exposed to the risks that drought causes.

Fura farmers have planted some improved varieties to test their adaptability in the area. However, they were discouraged to adopt them because of their susceptibility to pest, disease and moisture stress. These tests were informal and very simple and farmers could not tell the names of the varieties tested. In general, farmers often call improved varieties *Bonda* (or yeferenji tit - after the word 'ferenji', which is the Amharic word for 'white foreigner').

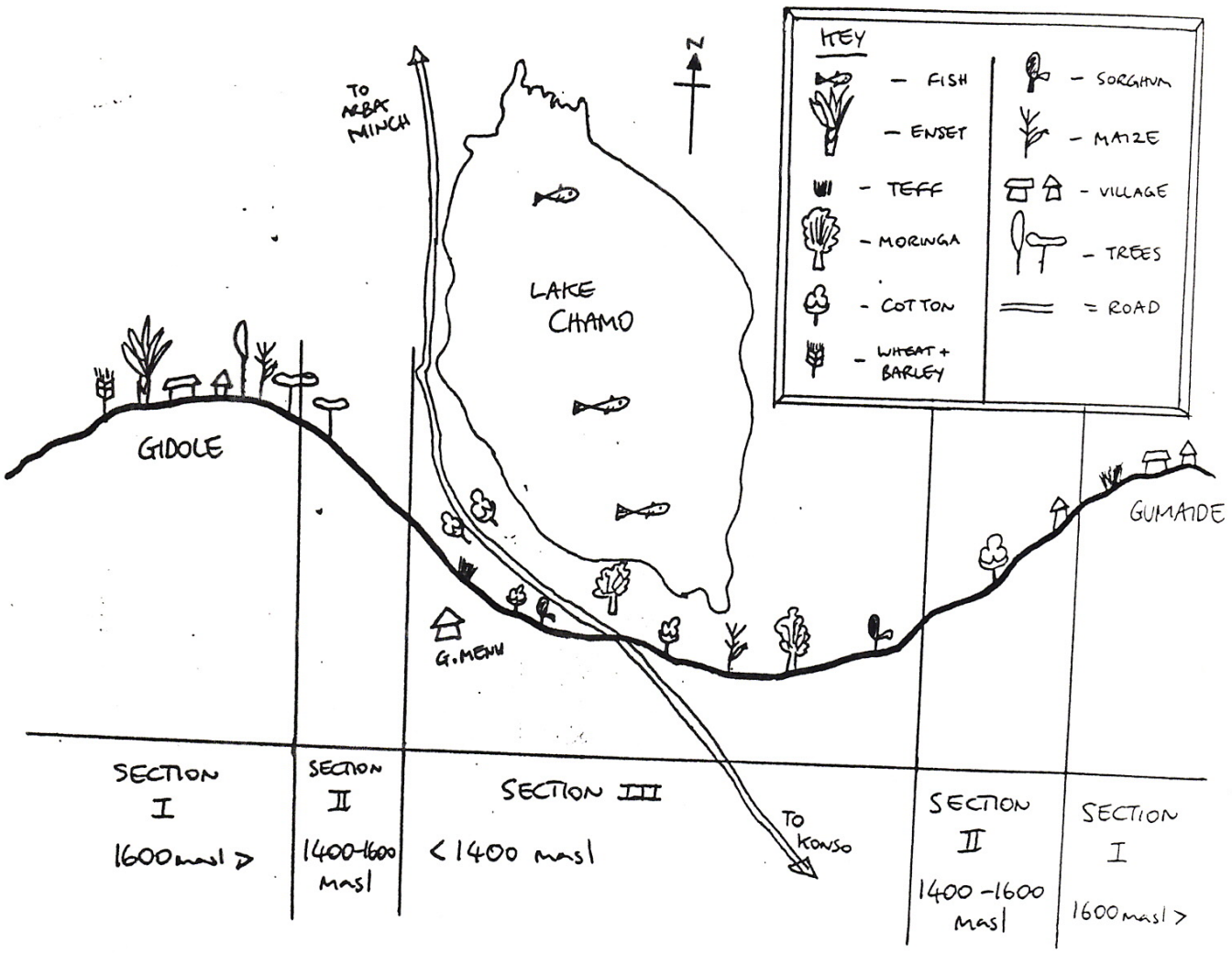
The Konso and Gardula Lowlands

In the Konso and Gardula areas (Figure 6) farmers grow a few cotton landraces, and only in mixture with sorghum, maize and other minor crops. These cotton landraces are perennial and always found in the farmers' fields in all seasons. Cotton is therefore grown over a wide area, but as it is intercropped it is difficult to indicate the exact area of land under cotton cultivation. Cotton is extremely important as a security crop during continuous drought years.

Farmers know at a glance which are older plants (usually above two years of age) and remove them from the field, either by cutting or uprooting them. Younger plants will also be uprooted if the density of cotton in a farm seems to be increasing above the normal ratio, because this will not only affect the growth of other crops but also the management, planting, harvesting, etc.

There are some wild Gossypium species which are found in the lowland parts of Konso and Gardula, where they occur as perennial drought enduring shrubs or small trees growing on the margins of farmlands and hillsides.

Fig 6. Transect Diagram of the Gardula Lowlands



Source: Author's Own Drawing

6. USES OF COTTON IN NORTH OMO

The most valuable product of cotton throughout the world is lint, which can be spun into cotton yarn. The fuzz (short hairs on the seed coat) the leaves, the cotton seed and the lower part of the stem are also used for various purposes.

In this chapter, attention is only given to the uses of cotton in North Omo. These are:

1) Clothing: Seed cotton is processed in villages for clothing for the family or be sold. The people of Konso and Gardula wear locally made cotton products such as shorts, skirts, shirts, *gabis* and *bulukos*. Beside using these garments themselves they also sell woven cotton products to other areas.

2) Cash crop: Seed cotton is one of the most important cash crops for the farmers of the lowland parts of North Omo. During drought years when other crops fail, cotton (from landraces) is the only commodity farmers sell in the nearby markets. This clearly shows us that it is a security crop which helps the farmers to cope with income shortages during bad (drought) years. Also women gin seed-cotton, spine and earn money from it to meet their minor house demands.

3) Forage: Farmers feed their livestock the green leaves of the old cut, or young thinned, plants.

4) Concentrate feed for animals: According to some farmers view raw cotton seed is good as animal feed especially for milking cows. However, it should be roasted (or ground) and mixed with other cereals or legumes. The roasting, and mixing of the seeds with other crops is most probably to decrease or avoid the toxic substance present in the cotton seed (gossypol) which can harm the animals. During the FRP conducted diagnostic survey of Gersale village (Konso woreda), inhabitants told the survey team that they fed unprocessed cotton seed to their livestock.

5) Fuel wood: The stem of the cotton plant, with its vegetative and fruiting branches, is uprooted or cut at ground level during its 2nd or 3rd year and then gathered at the periphery of the farmland. The dried parts are then used as a fuel wood.

6) For construction purposes: In some areas the stalks of some cotton landraces are used for house and fence construction.

7) Lubricant: Cotton seed cake is widely used as a lubricant *masesha* (Amh.) both in urban and rural areas (during the preparation of *injera* (Amh.)) to lubricate the clay tray *mitad* (Amh.) that is placed over the fire.

8) Food for humans: In some parts of North Omo, especially in the Gardula area, cotton seed kernel is used as a food in different forms, such as to make wat (Amh.), a sauce, a soup like dish called *muk* (Amh.) and also to be cooked with various other crops.

7. PRESENT PRODUCTION SYSTEMS IN NORTH OMO

Cotton production systems in North Omo, i.e. land preparation, planting dates, methods of planting, moisture conservation, soil fertility enhancement, weed control, protection and storage methods, vary even within *wereda*, depending on the type of cotton (landrace or improved), the topography of the area, and the growing conditions (rainfed or irrigated).

Field Selection:
In most rainfed lowland parts of Gardula, Konso, Arba Minch zuria and Mirab Abaya, farmers always grow perennial cotton landraces in mixture with other crops, like maize and sorghum. Therefore they do not usually select cotton fields and then plant separately, since it is common in almost all farmlands to grow cotton together with other crops throughout the year. The area farmers, however, do think that cotton grows better in gravelly black and drained soils.

Farmers believe that the slope of the farmland has a positive or negative impact on cotton production, depending on the amount of rainfall in a particular growing season, and the soil type. For example, during heavy and continuous rainy seasons waterlogging may occur in the depressed and levelled farms, which consequently will affect the performance of the crop. In such conditions moderately sloping and well drained soils are preferable for better production. However, at Fura (a rainfed area) regular and optimum rains from Megabit to Nehassie create a favorable condition for better cotton production.

Farmers in areas like Chano Dorga, Chano Milie, Kolashelie, Lantie, Elgo, Delbo, Wozeka and Wojiffo which get supplementary irrigation from nearby rivers and where most farmers grow improved varieties in pure stand, decide differently. Their major factor for cotton field selection is its proximity to the irrigation canal.

Abela and Bele farmers, identify and select good soils for cotton production. For example, Abela farmers say that the predominantly brown sandy textured soils of Abela sipa is a good cotton growing place, whilst the red soil area of Ela Kebela is considered to be a poor cotton growing areas.

Land Preparation:

In order to cultivate, particularly where annual crops are to be planted, the soil needs to be prepared, i.e. turned over and loosened. Deep ploughing (25-30 cm) creates cracks, fissures and pore spaces in the mass of the layer that has been tilled, enabling air and rainwater to penetrate more easily. Aeration encourages the development of micro-organisms and activates the processes of the organic matter decomposition. Large quantities of water can then be stored in the soil and can be extracted from the surface runoff. But due to a lack of agricultural resources deep ploughing is often not available in North Omo.

Konso and Gardula farmers only till or loosen a land initially or to bring fallow area back into cultivation. Thereafter traditional land preparation techniques are used. Tie ridges (soil, and stalks of sorghum and maize) and bench terraces are constructed and fields are always kept clean from annual and perennial weeds by frequently hoeing. In Konso they use a hand tool called a *siplota* (see Fig. 7), and in Gardula they use an *aileta* (totae).

In the dry months of Tahisas and Tir, Konso and Gardula farmers uproot *hagaya* (sorghum ratoon) and mulch it in rows vertically and horizontally across the farm (on the tops of tie-ridges) to form numerous rectangular plots (*potayas*) in the field. This uprooting is the area's method of land preparation.

Continuous rains in Tahisas and Tir are considered by most Konso and Gardula farmers to be a major land preparation constraint because:

1) It is difficult to uproot the sorghum stalk because of the muddy conditions on the farm, which as a result affects punctual land preparation.
2) The soil will be trampled and compacted during the uprooting of sorghum stalks by farmers, which will cause problems with aeration and the sun's heat.
3) Uprooting in a rainy time creates a favorable condition for the development of disease, insects and pests during that particular growing season.

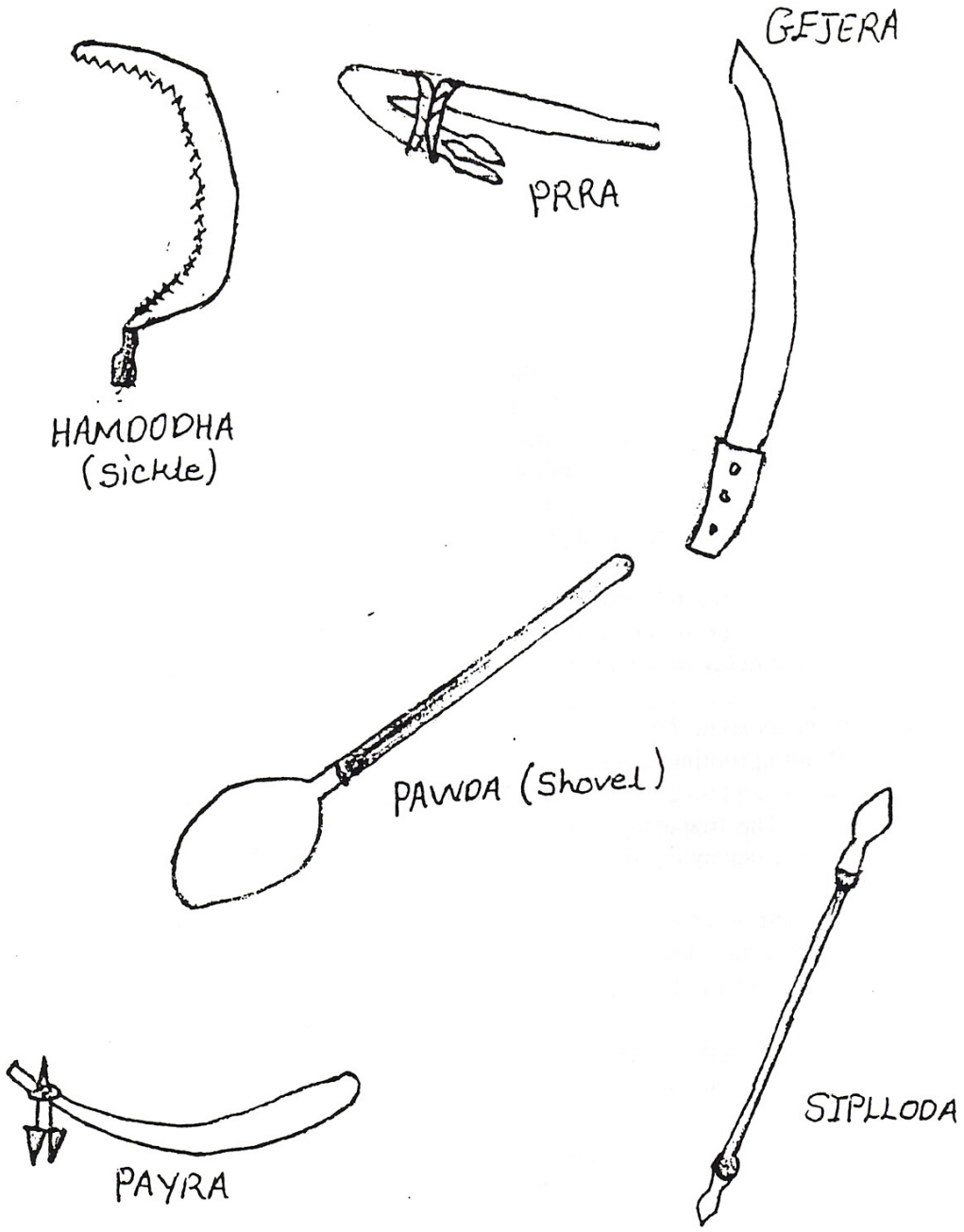
Due to the above three reasons some farmers plant new crop without uprooting the *hagaya*. Then, the *hagaya* is uprooted when the newly planted crops are vigorously growing. Consequently the delay in uprooting the stalks causes a considerable decline in yield.

During such years some farmers prefer to leave the stalks of the *hagaya* standing in the field (fallow) without uprooting them. In the North and South of Arba Minch, Mirab Abaya, Abela and Bele areas, even though there is a shortage of oxen, most preparatory cultivation is done by animal traction. The frequency and number of ploughings for cotton in the region varies much between farmers, depending on the following factors:

1) The condition of the land (fallow, virgin, cultivated for years etc.).
2) Soil type (clay, loam or sandy).
3) The status of the farmer (e.g. number of oxen owned, health).

It is observed that deep ploughing and turning over or loosening, are not practiced enough in most areas to achieve the optimum required conditions for cultivating cotton.

Fig 7. Farm Implements in Konso



Source: FARM-Africa, 1993

Planting Dates and Methods:

Generally there are two types of cotton planted in North Omo

1) The local landraces - Farmers usually intercropped with maize, sorghum, wheat, beans, barley or pigeon pea
2) The exotic (improved) varieties. These are planted
   a) in rainfed areas of Abela and Bele
   b) in areas where supplementary irrigation is possible from the nearby rivers such as Lantie, Shelie, Wajifo, Elgo and Hamessa.

In general, any variation in planting time is due to: a) growing conditions, e.g. rainfed or irrigated; b) type of cotton grown; c) shortage of inputs; d) shortage of labor (e.g. no oxen, health problems); and e) rainfall.

In places where perennial landraces are intercropped or mixed with maize, sorghum etc (especially in Konso and Gardula), usually there is no as such fixed planting date. Megabit and Miaza are the preferred months but the planting time depends upon the rainfall conditions, so planting can be extended from Tir to Ginbot.

In the lowland part of the Konso and Gardula areas, where local landraces are grown using cultural techniques, there is only an initial planting time. When farmers' plough a virgin land they sow sorghum, maize, beans and cotton in mixture (from Tir to Ginbot). The number of seeds per hole and their combinations vary very much, not only between farmers but also within each farm. Thereafter they never or seldom plant cotton because seeds will fall from the plant onto the ground and then with direct rainfall on a moist soil the seed will germinate naturally. Since the rainfall condition is not uniform in all seasons and years, seedlings of cotton appear at different times, whenever the conditions are favorable.

The planting date is especially important for Abela, Bele, Lantie, Shelie, Wajifo and Elgo areas where improved varieties of cotton are grown in pure stand. According to Abela and Bele farmers the proper planting time in their area is from Ginbot to Hamle. However farmers believe that planting from early Ginbot to Hamle 15 can only give a high yield if it is sprayed several times by the necessary insecticides. If farmers cannot apply insecticides due to various reasons, then they prefer late planting, i.e. from Hamle 15 to the end of Nehassie. Even though farmers understand that yield declines very sharply with a late sowing date, they deliberately delay the planting time to escape the critical disease/pest infestation seasons. Many farmers also pointed out that late planting decreases the level of weed infestations.

Researchers agree that an early planting date of cotton will enable it to form a large number of squares before the boll will be damaged. Delays in planting will hinder the formation of fruiting branches and late produced crops are affected by lack of moisture, which consequently reduces the yield by up to 70-80%. According to State Farm trials in the Arba Minch and Sillie areas the right planting date is Miaza.

Despite this evidence of correct planting date there are reasons for the farmers not to plant cotton at the proper time. These are:

a) Fear of insect pests and disease, and the lack of inputs i.e. pesticides and sprayers, to deal with them.
b) Labor shortage, because there are other also other food crops to be planted
c) The rainfall situation.

Table 5 summarises the cropping calendar of improved varieties and landraces of cotton.

Table 5. Cropping Calendar for the Two Different Cotton Types in North Omo

Area	Activities for both cotton types					
	Planting		Weeding		Picking (harvesting)	
	Landraces	Improved varieties	Landraces	Improved varieties	Landraces	Improved varieties
Konso	Tahisas & Tir**	----	All seasons	---	Tahisas to Megabit*	-----
Wajifo	Tahisas & Tir	Ginbot to Hamle	Hamle to Meskerem	Nehassie & Meskerem	Tahisas to Megabit*	Hidar & Tahisas
Gardula	Tir to Miaza**	----	All seasons	----	Tahisas to Megabit*	----
Elgo	Megabit & Miaza	Ginbot to Hamle	Nehassie & Meskerem	Nehassie & Meskerem	Tahisas to Megabit*	----
Lantie	Megabit & Miaza	Ginbot to Hamle	Hamle & Nehassie	Nehassie & Meskerem	Tahisas to Megabit*	Hidar & Tahisas
Bele	-----	Ginbot to Hamle	-----	Nehassie & Meskerem	------	Hidar & Tahisas
Abela	-----	Ginbot to Hamle	-----	Nehassie & Meskerem	------	Hidar & Tahisas
Shele	Megabit & Miaza	Ginbot to Hamle	Hamle to Meskerem	Nehassie & Meskerem	Tahisas to Megabit*	Hidar & Tahisas
Fura	Megabit & Miaza	-----	Hamle to Meskerem	-----	Tahisas to Megabit*	-----

KEY:

--- Variety is not grown

* Seed cotton from landraces is picked in almost all dry months (but mainly from Tahisas to Megabit)

** In the Konso and Gardula lowlands planting is conducted only initially (when virgin land is ploughed for the first time) and thereafter seedlings are obtained from the seed cotton.

Re-planting:

Seedlings of cotton may not emerge, or may die after emergence, because of problems such as insufficient moisture; late or heavy rains; planting too deep; destruction by wild animals (e.g. porcupines and bush bucks) in the early stages; and viability problems (e.g. use of poor/unsuitable seeds, poor germination). If this occurs the farmers will re-plant their land once, or twice, during the growing season. Re-planting is very important because cotton seedlings can not be transplanted from where there is a surplus to where there are destroyed areas.

Spacing and Density:

Since Konso and Gardula farmers always intercrop cotton with sorghum, maize and other crops, the perennial cotton landraces are found in pure stand only in dry seasons (i.e. after all the other crops have been harvested). The ratio of cotton, sorghum and maize plants varies from one field to another, however the average is 1:8:3, respectively.

The spacing between these crops will be determined by walking a defined distance following a zigzag pattern. In each tie ridge (*potaya*) the population of each crop will be controlled (adjusted) during different field operations. Cotton plants which are two years old or more are uprooted or cut down and the new spacing varies from farmer to farmer.

Spacing between plants and rows is important in areas where improved varieties of cotton are grown in pure stand. These area farmers use animal traction (oxen) to plough their land and they are experienced in keeping the same spacing between rows, i.e. by leading oxen a defined distance from the former furrow. In some areas the spacing between plants is determined by walking forward a defined distance (the average is 80 cm) along the furrow.

In Abela and Bele farmers believe that the spacing between plants and rows should be determined depending on the site and the type of cotton grown, i.e. by considering soil type, fertility, altitude and genotype.

Table 6. Spacings (between rows and plants (m)) and Plant Population desnsity (population/ha) in North Omo

Area	Between plants (m)	Between rows (m)	No. plants per hill	Plant pop./ha
Elgo	0.75	0.50	4.0	107000
Shelie	0.71	0.40	3.2	113000
Lantie	1.00	0.60	3.5	58000
Recommended	0.25	0.80	1.0	50000
	0.45	0.90	2.0	49000

Generally the number of plants can range from 107,000-113,000/ha, although as can been seen from Table 6 recommendations are around 50,000 per hectare. This is obtained from a seed rate of 15 kg/ha, or a spacing of 80 cm between rows and 25 cm between plants in one row. In some publications 90 cm x 45 cm with two plants per hole is recommended (Table 6).

However, the farmers in areas such as Elgo, Shelie and Lantie have their own planting methods in which the spacing between plants is wider than the spacing between rows. The average area per plant in the above places is 0.28 to 0.6 m^2 while the recommended one is 0.24 m^2.

The rate of planting of cotton seed varies with the quality of the seed. In sandy soils the planting rate increases up to 130-150,000/ha (97% seed purity and 85% germination capacity). Correct soil coverage is one of the basic conditions for obtaining high yields. This is achieved by having an adequate number of plants per unit of surface area and by the way in which they are distributed over the area. It is also important to ensure that the seed is not planted deeper than 2 cm.

Fertility Enhancement:

Sine the top 30 cm of the soil are very important as a source of mineral nutrients for plants, North Omo farmers have long been practicing different methods of indigenous knowledge, and more recently products of imported technology, to conserve the soil and water within this horizon and enhance its fertility. Among these, the common methods used are:

Indigenous knowledge:

a) Use of natural fertilizer (farmyard manure, household refuse and other residues).
b) Use of tie ridges (to increase soil fertility and protect from erosion).
c) Use of bench terracing (to protect soil from hill and gully erosion).
d) Use of cut-off drains (Yela in Konso), diverting and controlling run-off water.
e) Avoiding grazing and the destruction of perennial crops on the farm.

New technology:

f) Use of mineral fertilizer.

In North Omo in general, indigenous knowledge is more prevalent than new technology. Mineral fertilizers are used only in areas where improved varieties of cotton are grown in pure stand. For example, the Konso and Gardula area farmers hardly use mineral fertilizers. However, despite the farmers not using inorganic fertilizers, probably nowhere in Ethiopia do farmers worry more about their soil fertility status than in these two areas.

a) The use of natural fertilizer:

Usually women carry the farmyard manure on their backs, from the village to the fields situated far away, with a *kolata* (Kon.). A *kolata* is an animal skin which is used as a bag to carry different things. The transportation and application of the natural fertilizer usually takes place in dry months, i.e. in Tir, Yekatit and Megabit. When they spread the natural fertilizer on their farm they also uproot any weeds and leave them there to decay and increase the organic matter in the soil. In the evening (when they go back to their village) the *Kolata* will be used to carry fuel wood, forage for their animals (cut and carry), crop products etc.

Moringa spp. (*haleko* in Konso and Gardula) is a perennial tree which grows in most lowland areas of the North Omo Rift Valley and whose young leaves can be cooked and eaten as cabbage. Many farmers of the area also claim that it has a medicinal value. A few stands of this deciduous plant are observed not only on each and every farmland but also in homesteads of farmers. Besides its food and medicinal value, as a leguminous plant it can contribute to some extent in improving the fertility of the soil as nodules in the roots can fix free nitrogen from the air.

b) Tie ridges:

In some moderately level (mid-altitude), and most less sloping (lowland) areas of Konso and Gardula, farmers construct tie ridges, using soil bands and by mulching the stalks of sorghum and maize (Figure 8). Usually the whole farm is divided into many plots. *Targa* is a large portion of land which contain many *potayas* (plots). The plots of land inside the stalks (bands) are called *potayas* (Gid.) and the rows and columns which are made of the stalks of sorghum and maize are called *monas*. This indigenous agricultural technology not only improves the fertility of the soil but also controls erosion by decreasing the speed of run-off water. When the mulched stalks of sorghum and maize decay on the farm they increase the organic matter (humus) which helps to improve the soil structure and releases plant nutrients. The tie ridges entrap run-off and direct rain water into the plots therefore storing moisture in the field for drier days, as well as trapping eroded soil.

The mulched stalks which make the tie ridges, also decrease evaporation from the field by keeping the soil cool. The stalks also break the force of rainfall (reducing top soil destruction), encourage water seepage and protect the nearby crop roots from scorching sun.

Figure 8 shows land divided up with these tie-ridges. Within one *potaya* (depending on its size) it is found an average of 8-16 sorghum, 1-3 maize and 0-1 cotton plants.

c) Use of bench terracing ['kowata' in Konso]:

Bench terracing is common on Konso farmlands situated in the intermediate zones. These well built terraces protect against soil erosion. It would be difficult to imagine crop production surviving in these degraded mountainous hillsides without bench terracing.

d) Use of cut-off drains, diversion and controlling methods:

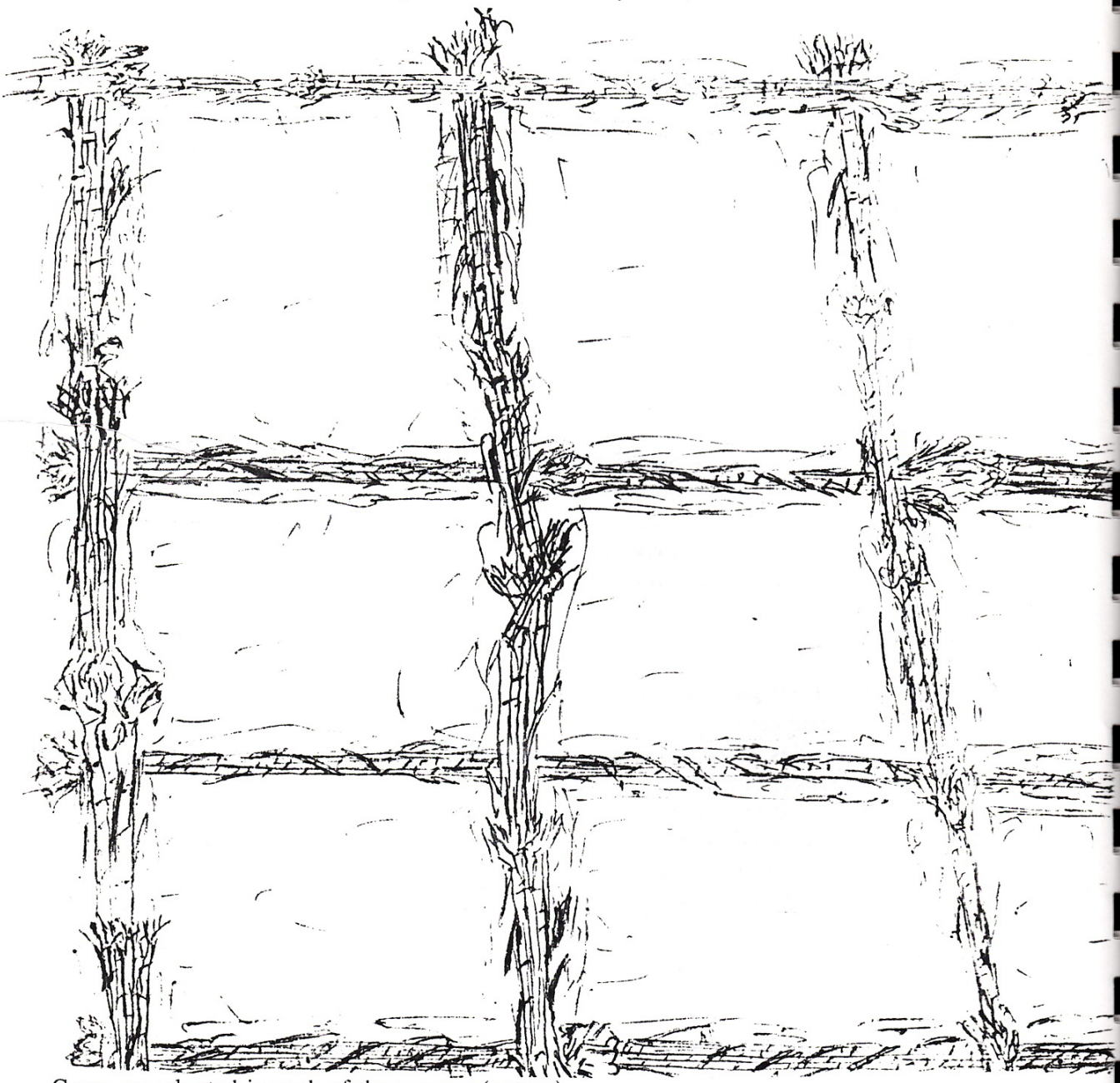
Run-off water, e.g. from roads or hill sides, can be diverted from its course into a well terraced land. At the upper margins of the farm small dams are constructed to hold back the flow of water and decrease its speed. The water is then let to flow gently and spreads slowly into the first bench terrace. There is an outlet for water from one bench to the next which assures the movement of water in a horizontal direction (zigzag across each bench). When the water moves slowly on the bench terrace the silt settles on the farm, water seeps into the soil, and then any excess water is released via the outlet. In Konso, farmlands that are situated next to these seasonal water courses, between two mountains or hills, or at the bottom of mountainous steep surfaces, are called '*Yela*' farms. Cotton is grown on *Yela* farms using sloping land, but on *Yela* farms situated at low points cotton does not perform well and farmers usually plant perennial crops such as banana, *papaya* and coffee.

e) Use of mineral fertilizer:

Mineral fertilizers (DAP and urea) are familiar in Welaita (e.g. Abela and Bele), and some supplementary irrigated cotton growing areas of North Omo, but are only used where farmers grow improved varieties of cotton in pure stand. The rate of fertilizer application varies depending on the fertility of the soil type and the capacity of the farmer. Some farmers cannot afford to buy the required amount of fertilizers. According to researchers cotton plants withstand irregularities in rainfall better than cereals so that their response to fertilizer is good (i.e. the extra yield obtained by using fertilizer). Recommendation of rate and method of fertilizer application generally varies depending on soil type, type of fertilizer and the crop rotation used in the field.

Konso and Gardula Farmers' Soil & Moisture Conservation Practices: Photo By Kefale Alemu

Fig. 8. Tie Ridges in the Gardula Lowlands
(soil and stalk band systems)



Crops are planted in each of the squares (potaya)

Source: Author's Own Drawing

Moringa Plants are One of the Main Components of the Mixed Farming in Konso and Gardula Lowlands

Table 7 summarizes fertility enhancement techniques used at various locations, along with all the factors involved.

Table 7. Condition of Growing, Methods of Soil Moisture Conservation and Cropping Systems at Different Locations

Location	Condition of growing	Methods of Soil moisture conservation and improving fertility	Cropping system	Varieties growing
Abella	Rainfed	Mineral fertilizer	Pure stand	Improved
Abela (Lesho)	Rainfed & supp. irr.	Mineral fertilizer	Pure stand	Improved
Bele	Rainfed	Mineral fertilizer	Pure stand	Improve
Konso	Rainfed	Natural (organic) fertilizer Tie ridges Terracing Yela (diversion of run-off)	In mixture	Local
Gardula	Rainfed	Tie ridges Terracing Natural fertilizer	In mixture	Local
Noth & South Arba Minch	Supp. Irr. and rainfed	Mineral & natural fertizers	Both in mixture and pure stand	Local & improved

But in some areas of North Omo, for example in Fura, soil fertility was not mentioned by the farmers as an important production problem. Here the most important, and widely recognized, cotton production problem is moisture stress.

Soil Moisture Conservation

Depending on the topography of the area, the agricultural system and the type of cotton grown in different areas, farmers have acquired different moisture conserving methods. Some of these are:

1) Making furrows (ploughing in a wider spaces) horizontally across the farmland to enable them to keep rain water (moisture) in the field for extra days. This is used in the North and South rainfed cotton growing areas of Arba Minch.

2) Diverting run-off water (flood water) of seasonal rivers from the highland areas of Gemo. This is an important practice in the lowland areas of Arba Minch zuria and the Mirab Abaya lowlands (Fura, Satusa, Foragossa etc). The farmers make canals which lead the run-off water from the highland part of the region into their cotton and other croplands. When heavy rain falls in the highland parts and the lowland farmers expect this run off water and prepare to irrigate their crops.

3) Terracing is well known in the area, especially in Konso and some parts of Gardula. Due to the nature of the landscape, the degradation of the soil and erratic rainfall, the area farmers have been practicing different terracing systems. Of these the most common ones are run off control terracing and channeling *(yela)*, ridge terracing (tie ridges), and bench terracing

4) Check-dams are built on seasonal river courses to use the flood water and moisture available. They are usually found between two chained mountains and at the bottom of steep slopes or cliffs. Run-off control terracing and check-dams are common in rocky and steep sloped parts of Konso where a large proportion of water moves rapidly over the surface, i.e. where only a small part goes into the soil because of low infiltration capacit

5) Covering the soil by small stones (stone mulch) - In some places of Konso shallow and poor farmlands are purposely covered by small stones to retain soil moisture. When the soil is covered by small stones it:

    a) Protects the soil from direct sunshine, therefore decreasing evaporation of moisture;
    b) Protects the soil from erosion, i.e. the stones reduce top soil destruction by direct rainfall and decreases the movement of water around the farm; and
    c) Encourages water seepage and protects the nearby crop roots from the scorching sun.

In addition, Konso (especially Gaho) farmers believe that soils which are gravelly are better than soils which contain no small stones. Before the soil is tilled, small stones will be picked and collected at the margin of each plot of land (i.e. between the terraces or tie-ridges). When the land is ready for planting the stones will then be spread on the farm as uniformly as possible. The reason for collecting the stones before tillage are because if they were not collected: 1) the

stones will become mixed with the soils and buried in the ground, which will make the stones difficult to collect for use with the next tillage; and, 2) tillage will be more difficult.

Water Supply and Irrigation:

Water for on-farm use can be obtained from surface sources such as rivers, streams, lakes and reservoirs, from underground sources such as bore holes, springs and wells, or by collecting rain water from house roofs. Of the above mentioned sources only some rivers are used for supplementary irrigation in North Omo and those rivers are the Wajifo, Chaffe, Basso, Harre, Kulfo, Sile, Hamessa, Hilgo and Wozeka. Along these rivers farmers grow improved varieties of cotton in pure stand, and landraces with other crops (usually maize). However the quantity of water decreases in dry seasons and is not enough to supply the need of all the nearby farmers. Up to now Lake Abaya and Lake Chamo have not been used for irrigation. According to Raunet (1978) these two lakes are moderately alkaline. Their salinity is slightly lower than that of Lake Awassa and substantially lower than that of Lakes Langano, Abiyata and Shala. This is due to the fact that since Abaya and Chamo are very near the mountainous escarpments, they receive much more water from the large rivers which flow into them than the other lakes, which are in wider parts of the Rift Valley. Another reason is that these two lakes have an outlet (River Segan) so the water is renewed. This is not the case for the other lakes with more closed basins. The water of Lakes Abaya and Chamo can therefore be used, but with caution, for irrigation on permeable soils. The soils of the present alluvial fans are generally suitable, but it may be advisable to carry out a few preliminary trials first.

Crop Rotation:

It has already been mentioned that at Abela, Bele and other supplementary irrigated areas, farmers grow improved varieties of cotton in pure stand. Farmers of these areas understand very well the importance of crop rotation and therefore maize, and other crops, are deliberately cultivated between cotton cropping. This practice agrees with the comments found in many text books on cotton, i.e. that growth of cotton on the same land for more than one season should be avoided. However, the rotation time and space depends upon the interest of each farmer. Maize may be grown up to two times, and sometimes cotton fields may be planted with beans, pepper, sweet potato, sorghum, teff etc, as rotation crops.

Farmers also realize that some crops are good precursors whilst others are poor, depending on the type of crop which is to follow on from them. Leguminous crops are said to be the best precursors for cotton. However maize is the common precursor crop in North Omo. In rainfed areas beans are often grown in mixture with cotton landraces and other crops. Farmers also understand that rotations can reduce risks, so spreading the work load is not the only reason for diversifying the crops grown.

The rotation is decided by farmers mainly according to how much of each type of product they wish to obtain, within the range of crops that it is possible to grow locally. They also know that crops must be rotated as much as possible in order to obtain better yields. As there are so many possible combinations, no single definite rotation pattern exists and hence farmers may follow one of the following alternative rotations, especially those who plant cotton in pure stand.

Cotton ---> Maize ---> S.potato ---> Cotton
Cotton ---> S.Potato ---> Maize ---> Cotton
Cotton ---> Teff ---> S.potato ---> Cotton
Cotton ---> S.potato ---> Teff ---> Cotton

Association and mixed cropping:

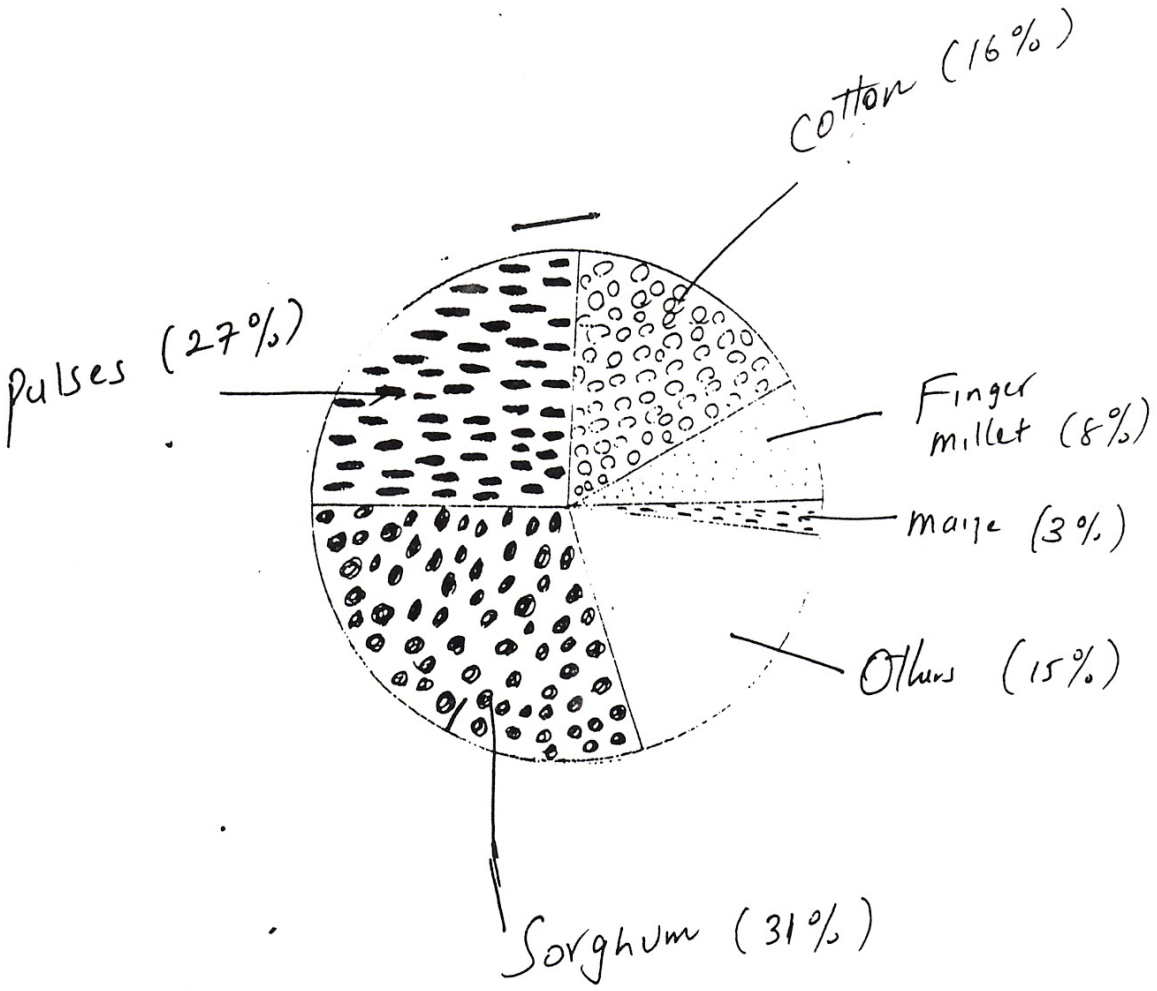
This is practiced traditionally in various forms. Most Konso and Gardula farmers practice mixed cropping with crops such as sorghum, maize, cotton, pigeon pea, pepper, wheat, barley, *moringa* spp., and varieties of beans. Since the perennial cotton landraces are usually grown in mixture, there is no crop rotation in this cotton growing area.

When the major crops (maize and sorghum) are harvested, a few cotton plants remain in the field, together with some minor perennial plants such as *moringa* spp. and pigeon pea. Inter-cropping can offer a number of considerable advantages over pure stands, especially if the crops are mixed so that they mature at different times (short cycle crops are often used). It can reduce climatic risks, provide more complete and longer lasting ground cover and better subsoil exploitation. All this encourages both plant production and maintenance of fertility, and reduces weed infestation and losses of water through run-off. At the same time it has an impact on reducing erosion and nutrient leaching.

A diagnostic survey (FARM-Africa, 1993) conducted in Gersale village (in Duraite PA, Konso wereda) provided information about the proportion of land occupied by different crops and presented in Figure 9. It can be seen from Figure 9, that cotton occupies the third highest land use area and that inter-cropping is practiced.

The Gersale survey also confirmed many of the features of Konso cropping strategies that have already been mentioned. A wide diversity of crops are cultivated as a security strategy, many of the crops are early maturers ('drought escapees'), bench terraces and tie-ridges are used, and if the first planting fails crops will be replanted.

Fig 9. The Proportion of Land Occupied by Different Crops



N.B. Crops are not found in pure stand planting. Inter-cropping is normally practiced.

Source: Proportional piling done by six farmers in Gersale. FARM Africa, 1993.

Treatment of Seeds:

In modern agriculture, the treatment of seeds destroys disease causing micro-organisms, storage and soil born pests. Products used are a fungicidal/insecticidal combination. Farmers of North Omo use neither indigenous nor newly introduced technology to treat their cotton seeds before sowing. This is because diseases of cotton are not an important production problem in the area (see the 'Production Constraints section).

Thinning:

Thinning of seedlings should be done when the number of seedlings are greater than the desired final density. The opinion of North Omo farmers differs from one area to the other because of various factors in different localities. Even though farmers at Bele accept the importance of thinning they do not usually eliminate surplus seedlings from their farm because of termite and other pest attack. However if the number of seedlings between plants goes above an obviously excessive amount, thinning is inevitable. Termites attack the roots and the stem at ground level at all stages of cotton development. On the other hand farmers of Abela, Shelie and Lantie think that more than two plants per hill can affect the good performance of the crop and they prefer to keep only two plants per hill.
Farmers do not have a fixed thinning time as such and the operation can be done late, or on time. However, according to researchers this operation should not be carried out in less than ten days after emergence, because the risk of death as a result of disease or insect attack is higher with younger plants. It must not however, be done later than 20 days after emergence, otherwise the seedlings which are left after thinning will already have suffered competition from those that are removed or will suffer plant root damage by the pulling out of neighboring seedlings.

Farmers say that the weakest seedlings (usually those that emerge last) should be weeded out, so that the strongest seedlings (those which are most ahead in their growth) are retained.

In the Konso and Gardula lowlands seeds are propagated naturally, direct from the perennial cotton landraces. Thinning and destroying older plants during soil preparation, tie ridging and weeding, are two very important operations to keep up the desired number of cotton plants in the field throughout the year so that they do not affect other crops which grow with them.

Weeds and their control

Various annual, biennial and perennial weeds affects production in the lowland cotton growing areas of North Omo. Many weed species can be found in a particular cotton growing site but only the most common ones are mentioned below.

Some common weeds which were observed at the area are: Launae cormuta, Striga spp., Potulaca oeracea, Amaranthus spp., Chemopodium spp., Echenocloa spp., Setoria spp. and Hibiscus spp..

In the Konso and Gardula lowlands farmers try to keep their farm clean from weeds, and weeding is carried out throughout the year. Even between the end of harvest and the next

planting season farmers fight against weeds, i.e. when they maintain terraces and build new tie ridges. However, some species have rhizomes (a horizontal underground stem) which make them very difficult to control.

Shilshalo and Kutkuato:

Shilshalo (Amh.) and *kutkuato* (Amh.) are traditional weed controlling techniques which are commonly used in most cotton growing areas of North Omo.

In some areas where improved varieties of cotton are grown in pure stand, *shilshalo* is conducted to fight against weeds and loosen the soil. *Shilshalo* is conducted by animal traction and saves time and is easy to operate (in comparison to *kutkuato*), but during this operation both oxen and *maresha* (Amh. - a traditional plough) can damage the roots and upper part of the plant.

Kutkuato is the most common weed controlling method in North Omo. It is also considered by farmers to be the best operation not only against weeds but also in loosening the soil. During *kutkuato* the farmers use a hand-held hoe, and therefore avoid getting too close to the rows of cotton plants, so that neither the roots nor other parts of the plants are damaged. However, this operation is very tedious and time consuming.

The most effective weeding is done when the weeds have just emerged. Right from the start cotton plants are very sensitive to competition from weeds, and this will have a significant effect on yields. The younger the weed, the easier to destroy it. Farmers know that it is necessary to hoeing and weeding should be done in relatively dry weather and that the wet weather makes these operations more difficult and less effective.

Hand Weeding:

Weeding by hand (uprooting of weeds and destroying them) is a difficult and laborious operation. But it is still used as one of the common weed controlling methods in almost all areas of North Omo. In the Konso and Gardula lowlands hand weeding is supported by a simple tool called a *siplot* (Figure 7).

If farmers could not afford to apply herbicides, *shilshalo*, *kutkuato* and hand weeding and earthling up are useful operations from the point of view of controlling weeds.

Herbicides:

Only very few farmers of Abela and Bele use herbicides, as well as some farmers in supplementary irrigated areas where they grow improved varieties of cotton in pure stand. As discussed earlier, these products are valuable aids in the fight against weeds but are expensive and delicate.

One farmer can use his sprayer for different chemicals and crops or several farmers can exchange a single sprayer among themselves. But they may spray without washing or cleaning

very well and the inappropriate use of these different products sometimes brings a heavy destruction on some crops. This was observed during Farmers' Research Project (FRP) facilitated trials in Abela when three cotton On Farm Trials (OFTs) were damaged considerably because of the application of a herbicide mixed with remnants of Dimacron and Thiodan (insecticides often used on cotton).

Herbicides must be effective against weeds and safe to the target crop. These products do not all work in the same way. Some act only by contact with the leaves and they are applied post-emergence (after the plants have emerged). Others act principally through the soil onto germinating weeds. These "soil acting" herbicides are applied before emergence (pre-emergence treatment). Others must be mixed with the top layer of the soil prior to sowing. At the present time there are no post-emergence herbicides (also known as 'contact herbicides') which are selective in respect of cotton plants. Only those used as pre-emergence herbicides are selective. Unfortunately these herbicides are also selectively ineffective with regard to certain weeds. These weeds that are not killed develop and multiply quickly because they are no longer subject to competition from the susceptible weeds. This problem may be alleviated by means of crop rotation or supplementing herbicides with the other methods.

In general, some weeds with rhizomes, bulbs or tubers are particularly difficult to control (e.g. *Imperata, Cynodon* and *Cyperus*).

On family-run holdings the use of herbicides should only be considered in situations aggravated by excessive weed infestation and where the area under cultivation is too large to be able to be weeded. Under no circumstances can it replace other methods of prevention and control, although it does enable those methods to be applied more easily and more effectively.

Integrated Weed Control:

This involves combining a number of control methods which make it possible to protect the crop against competition from weeds.

The integrated weed control method is not generally used by poor North Omo farmers who grow cotton. Very rarely some Abela, Bele and supplementary irrigated area farmers (i.e.farmers growing cotton in pure stand) use more than one weed controlling method during one growing season. According to the farmers, combining a number of control methods is expensive and usually impossible. Most small holdings are not large enough to use this method and most small farmers do not have the necessary labor or time.

Weeding is particularly necessary during the early stages of growth. Once flowering has commenced, the cotton plants will need very little attention, since they will cover the ground completely, preventing weeds from growing. If the overall farming system is considered, and not just the cotton plant, mention may be made of other practices which tend to restrict weed growth, such as; rotating crops on the same land; covering the soil with the residues of the preceding crop; and, if possible, inter-planting cotton with various crops.

In the Gardula lowlands there are two weed controlling methods: uprooting (destroying) weeds in the field; and burning. If the field stays without weeding throughout the year and is highly

infested (because of climatic problems or other unfavorable factors) then the remnants of the previous crops and weeds will be collected together and burnt in the field in order to destroy on-farm diseases, pests, and weed seeds.

Harvesting (picking) and Harvesting Losses

Picking is a difficult and time consuming operation. Internationally, it is the norm for a worker to pick 20 to 70 kg of seed cotton per day, and sometimes as much as 80 kg. In tropical Africa however, the norm is between 15 and 40 kg per person, per day. Some rich North Omo farmers employ daily laborers during the picking seasons, where they pay 0.10-0.15 ETB/kg for cotton picking.

The picking figures vary according to circumstances such as: how plentiful the ripe bolls are; whether it is the first, or a subsequent pick; how quickly the morning dews dry up; and, the type of cotton (boll size and number of seeds per loculus).

Delays in picking are bound to have an effect on the quality of the harvested product. The longer the period between when the boll opens and the cotton is picked, the more the cotton is exposed to rain, contamination (from dust, bush fire ashes, and honey dew from insects), dew in dry periods, and, wind, which can make some of the cotton drop off. It will therefore be subject to losses in terms of weight and quality, and it is best to start picking within three weeks of the opening of the first boll, even if this means picking the cotton two or three times from the same field. However some farmers fields are picked late (i.e. only once) because of labor shortage.

North Omo farmers say that they can pick more seed cotton (in a given time) from the improved varieties than from the landraces. This is because the landrace bolls are much smaller than the improved varieties and because some landraces are tall in height which makes picking the seed-cotton difficult.

During picking from cotton landraces, farmers take the bolls together with the dried petiole and bractioles. When the loculus are pulled out and collected the petioles and bractioles are discarded. Farmers believe that if they pick only the seed-cotton, the dried petiole and bracteoles that remain on the fruiting branches will affect the next years' bud formation and flowering.

In each growing season farmers often pick seed-cotton from landraces throughout the dry season. From improved varieties they usually pick up to 3 times. Both males and females (including young boys and girls) participate in cotton picking but many farmers believe that women's hands are quicker at cotton picking than men's. There are different frequencies and periods of picking for the two common cotton types. Improved varieties are usually picked in Tahisas and Tir, but the landraces are picked several times starting from Yekatit up to Ginbot.

Table 5 shows the activity months for three different activities (including harvesting) for both improved varieties and landraces of cotton, in many areas of North Omo.

Picking by hand yields the highest quality cotton though hand picking results in low yield when compared with machine picking. In a number of important producing countries picking is carried out by machine, but this method is not used in Ethiopia.

Storage and Packing:

Normally cotton should be well dried before it is packed, otherwise it might be spoiled. Since many North Omo farmers do not produce a lot of cotton, storage is not a very important problem in the area. In different areas of North Omo farmers use different locally made containers to store their seed-cotton, and sacks which are made from fibers are often preferred (Table 8).

Table 8. Different Types Containers Used to Store Cotton Seed in Different Areas of North Omo

Area	Storage
Abela	Sacks and clay made containers
Bele	Sacks and clay made containers
Lantie	*Kirchat* (made of bamboo), clay made containers
Fura	Sacks and *selen*
Elgo	*Gotera* and clay made containers *Dibignt* made from mud
Konso	Sacks & *ingulo*

If cotton is stored in *kirchat* (a container made of bamboo) for a long time it usually shrinks. The remedy for this is to take it out of the container and spread it in the sun until it returns to its previous form and size. The major storage problems in North Omo are rats, which destroy the seed cotton by eating the seeds.

On-farm Livestock Management:

In areas where farmers grow the local landrace in mixture with other crops (especially in Gardula and Konso) animals are often kept, and made to graze away from farmlands. They never let their animals into their farmland in any seasons because:

1. Animals destroy the cotton plants, since the landraces are inter-cropped and perennial (i.e. always standing in the field).

2. Animals also destroy the tied ridges and terraces:

   a) They spoil the tie-ridges by trampling them or eating the stalks of the sorghum and maize.

   b) They destroy the well built stone terracing when they move around the farm.

On the other hand, there are some farmers in Gato (at the border of Konso) who raise more animals and do not grow cotton with other crops. They usually intercrop only maize and haricot beans, and use animal traction. When they harvest these crops they let the animals into the stubble to graze.

8. THE ROLE OF WOMEN IN COTTON PRODUCTION AND PROCESSING IN NORTH OMO

In North Omo, women play a big role in cotton production and processing. The extent of their participation in production depends on:

a) The cotton type grown in the area
b) The season
c) The agricultural system of the area
d) Culture and customs

In Gardula and Konso men and women work together equally in almost all seasons. However, men may go to their field earlier in the morning and women may return home earlier in the evening. This allows the women to cook food, grind grain and fetch water for the family. In areas where improved cotton varieties are grown in pure stand women have a considerable workload during weeding and harvesting. In Gardula and Konso women carry out planting of virgin land together with men. In other areas, where improved varieties of cotton are grown in pure stand, men plough their land by oxen and women drill the cotton seeds in the furrow. Where farmers are growing only landraces (especially in the Konso and Gardula lowlands) women are more involved in cotton picking. Farmers believe that women are quicker and more efficient in cotton picking than men.

Cotton landraces are found in farmlands throughout the year and when women go to their fields to harvest root crops, pigeon pea, *morinaga* spp. etc, they also usually pick the available opened bolls. Women also carry farmyard manure to their farmland (especially in Konso), make tie ridges and participate in thinning and weeding.

Before raw cotton is spun into yarn and woven it must pass through a number of processes such as spreading in the sun, removal of dirt, leaf fragments and other foreign matter, and ginning. Ginning is done in two different ways depending on the type of seed-cotton: by hand which is called *filkeka*, or using a simple mechanical ginning apparatus called *medamecha*. Spinning (*likakit* making) and *mag* making (a bundle of threads) then follows. All the above processes are usually women's tasks. According to the women of the surveyed areas even if there are some varieties which can be ginned easily the separation of fibre from the seed is quite tedious work. In Konso, unlike other areas, every member of the family (male and female, young and old, of all castes) is engaged in ginning and spinning. However, men are specialized weavers. Old men especially spend most of their time in cotton processing (ginning and spinning).

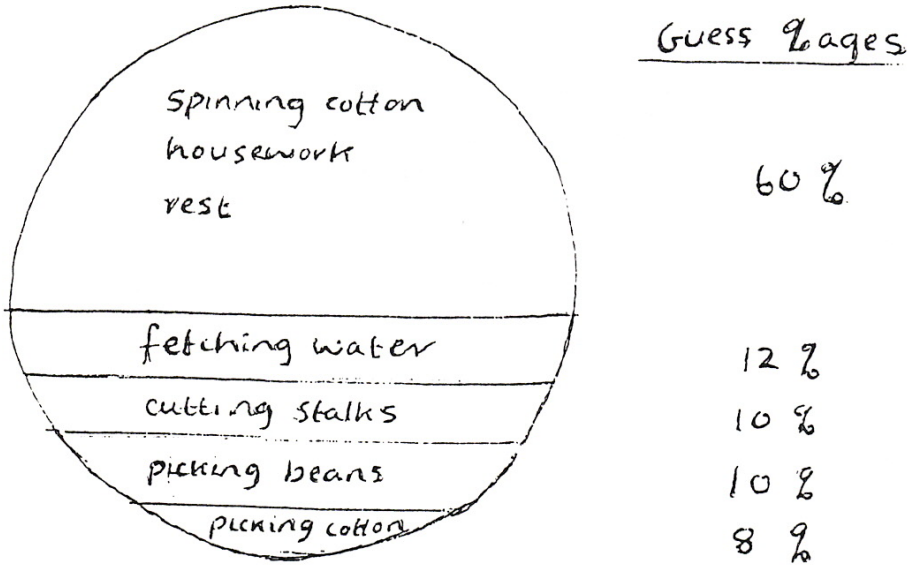
Spun yarn (thread), i.e. *likakit* and *mag*, is the major income source of many North Omo women. Women sell spun thread to weavers or other traders in the markets. They also order certain sorts of garments to be made, by supplying spun thread to weavers of the locality. Those who do not produce enough seed-cotton for home production buy from the nearby markets. In Sura women are able to supply the big Dorze cotton industry with enough processed and spun threads.

Men have the decision making power over most of the seed-cotton production, especially in areas where farmers grow improved varieties of cotton in pure stand. Here, men are especially

interested in controlling the whole production process because of the high cost of pesticides and other inputs. Sometimes the decisions can be made together, for example, how much should be processed at home and how much should be sold in the markets. In Konso and Gardula both men and women are involved in cotton processing and picking. In all other areas of North Omo however only women are involved in cotton processing and decide on spun thread and cotton seed. The generated income will often be spent on household needs for children and others, and sometimes to buy clothes for women.

In areas where improved varieties of cotton are grown, after the 3rd picking women are allowed to pick and keep the remaining seed cotton. The women can then decide how to spend the money which they obtain from the sale of this harvest

Fig. 10. Division of Konso Women's Labor During Off Seasons



Source: FARM Africa, 1993. The figure was drawn on the ground by 2 women (young & old).

Figure 10 shows that during the off season, women of Gersale village (Konso *Wereda*) will often pick and spin cotton as there no major agricultural activities that required their assistance.

Fig. 11: Daily Timetable for Women in Konso

Grind Grain	Fetch Water	Make breakfast /prepare lunch			Take lunch to fields	Work in field with husband					Prepare supper		
5 Am Time	6	7	8	9	10	11	12pm	1	2	3	4	5	6

Source: FARM Africa, 1993.

What is important about Figure 11 is that in Konso "working in the field" is synonymous with some work on cotton because cotton is always in the field, all year around. Therefore, it shows again how Konso women are enormously involved in cotton production.

Table 9. Division of labor in Konso, by age and sex (individual and group interviews)

Men only	Women only
Clearing new land/forest	Grinding grain
Weaving cotton lint/thread	Fetching water
Building house	Caring for children
Bee keeping	Cooking
Wage labor in other areas	Collecting wood
Sewing	Collecting grass
	Making alcohol
	Housework
	Making butter

Children	Everyone
Herding goats & cattle	Spinning cotton
Collecting wood & grass	Working in the fields/farming
Looking after smaller children	Bird scaring
Helping with housework	Building terraces & mulching
Fetching water	

Source: FARM Africa, 1993

Table 9 shows how in Gersale village (Konso) only men weave thread, but that everybody spins cotton into thread. The Gersale report comments that "all members of the household, male and female, young and old, spin cotton" (FARM Africa, 1993).

9. COTTON PROCESSING, CASTE SPECIALITIES AND PROCESSING INDUSTRIES IN NORTH OMO

Caste Specialities in Cotton Processing

In some parts of North Omo certain social groups (e.g. the Dorze people), or castes, are specialized in cottage industries. These cottage industries include weaving, pottery, blacksmithing and different handicrafts.

The famous Dorze weavers are found in 11 PA's of the highland part of Sura *wereda* (now called Chencha Zuria *woreda*), in the vicinity of Chencha town. Of the area people almost every man is engaged in weaving (only men weave in this area). However, almost all weavers are also involved in some agricultural activities. Enset plantation is seen in all weavers homesteads and many of households own small patches of land away from their houses. The men decrease their weaving activities by up to 50% during land preparation, planting and harvesting periods. There are some Dorze weavers who employ daily labourers from the neighbourhoods of Bonkie and Ezo. Previously only the Dorze people were engaged in weaving but now many other nearby people have started weaving in their own localities. Only a few Dorze people are specialized in making wooden weaving machines (mechanical apparatus) and in agriculture. The area people say that when people grow old they usually leave weaving and engage themselves in agriculture. The reason which they give is that weaving is difficult for old people, especially making *tibeb* (a fine embroidery), which requires good eye sight.

As the Dorze people are found in the highland part of Sura they do not themselves grow cotton. Different types of seed-cotton are therefore obtained from the South-East lowland areas of North Omo.

In the Dorze market women are usually involved in buying and selling of the seed cotton, whilst the men buy the spun material (as *likakit* or *'Tuba'* (Amh.) - both are measures of spun thread; (*Tuba* is a larger measure). The amount of seed-cotton being sold is not determined by its weight. The seller simply takes some portion in his hand and tells the price by estimation. However, the price depends on the quality and variety of the seed cotton. For example, the retail price for 1 kg of *Bonda* (*Yeferenji*) and 1 kg of *Yengere* (*Yabesha tit*) during a survey was 4.5 and 3.60 ETB, respectively (Table 10). Between *Bonda* and *Yengerie* there is not such a difference in volume, but there is a considerable difference in weight. The reason is that *Yengerie* contains many seeds per boll (i.e. less cotton lint).

The weavers say that almost all women in their area spin cotton lint. Women take their spun material, in the form of *Tuba* or *likakit*, and sell it to the weavers at the Dorze market. Even though the quality of cloth from the local varieties is better and longer lasting, women usually prefer to buy *Bonda* because it is easier to separate the seed from the lint during ginning.

The weavers said there has always been a harmony between the supply of spun material, and the demand of the weavers in the market. Dorze weavers claim that the quality of their products are very high when compared with other weavers' products in the region.

The people of Konso produce all sorts of garments and materials (such as shirts, shorts, *gabis* and *bulukos*) to meet the local demand of clothes and also to sell these products to other areas.

Traders (both local and those who come from other areas) buy nearly all of the *gabis*, *bulukos*, *netela-kemis* and *tibebs* produced in the Dorze area and take them to different parts of Ethiopia, or export them abroad.

In Welaita, especially in Damot Gale (Bala Koisha, Olola and Worbira) and Damot Woide (Sake area) many people are engaged in weaving. The most important product for these areas are *buluko's*. The products are mainly sold in the Sidama and Arsi regions.

The Cotton Processing Industry

At Arba Minch there is a modern textile factory and a ginning machine. The Arba Minch textile factory uses improved varieties of seed cotton, usually from State Farms/the ADE, but in 1994 they began obtaining cotton (lint) from the United States of America. At present the ginning machine is owned by the North Omo ADE (i.e. it was previously owned by the State Farm). Cuba donated the ginning machine to Ethiopia during the Derge regime and was installed at Arba Minch in 1984. According to the staff of ADE, it has a ginning capacity of 2,400 kg of seed-cotton per hour. The ADE charges 25 ETB to gin 100 kg of seed-cotton. The cotton owner receives the ginned lint and the seed. The seed can be sold to oil factories at an average price of 65 ETB. per 100 kg (1995 price) and this can be arranged by the Arba Minch ADE if so desired.

10. YIELDS, LINT QUALITIES, AND OTHER IMPORTANT CHARACTERISTICS OF DIFFERENT COTTON TYPES

Farmers in Fura say that landraces which grow in mixture with maize are low yielders. The yield varies depending upon the ratio of maize to cotton plants in the field, the rainfall condition and the age of the plant (i.e. whether the plant is in its 1st, 2nd or 3rd year stage). According to many farmers estimations, 1-2 quintals (1 quintal = 100 kg) of seed-cotton can be obtained from a hectare of land where landraces are grown in mixture. Here it is important to note that landraces contain more seed per loculus, which increases the weight (and therefore reduces the percentage of lint).

Therefore the ratio of lint to seed (as a percentage of the entire seed cotton) can be larger in improved varieties as opposed to landraces (Table 10). The real yield of cotton is expressed as the weight of lint per hectare and it is calculated by the ginning outrun (GOT) or the percentage of lint in relation to the entire seed. In the production of cotton both yield and lint quality must be taken into consideration although quality is also important.

There are two types of fibres. One is known as lint and is separated from the seed in the ginning process. The other is known as fuzz, which remains attached to the seed. We are therefore concerned here with the lint. The main factors that determine quality of lint are: a) length; b) uniformity; c) fibre strength (and therefore yarn strength); d) texture; e) colour; and f) absence of damage.

Table 10. The Ratio of Lint to Seed (in %) of Two Common Cotton Types at the Dorze Market Near Chencha Town, 1994

Cotton type	Average sample taken/g	Seed (g)	Lint (g)	Lint (%)
Landrace (*Yengere* or *yeabsha*)	315	230	85	27
Bonda (Yeferenji)	152	95	57	38

NB: *Bonda* is an improved (exotic) variety

Source: Sample taken during 1994 market survey in North Omo.

Some of the most important characteristics of different cotton plants, using two local (landraces) and two introduced varieties (exotic) are indicated in Table 11. They were ranked by 11 Lante farmers in 1994 based on their maturity time, yield, quality of seed cotton, farmers' preference in planting the cotton type, traders' preference in purchasing them, ease of processing, resistance to diseases/pests and drought. For example, the *Botey* landrace is easily processable especially during ginning so is ranked as best (No.1) for that category, but at the same time it is the late maturing among the varieties, so is ranked 4 for that category.

Table 11. Ranking of Four Different Cotton Types According to Eleven Lantie Farmers

Cotton type	Characteristics of Each Cotton Types							
	Maturity	Yield	Strength quality	Farmers pref.	Traders pref	Easily proce-ssed	Resistance	
							D&P	Dro-ught
Botey (landrace)	4	4	2	4	4	1	2	2
Yengere or Yabesha (landrace)	3	3	1	3	3	4	1	1
Bonda or Yeferenge (exotic)	1	1	3	1	1	3	3	3
Israel (exotic)	2	2	4	2	2	2	4	4

N.B.: D & P = Diseases and pests.

SCORING KEY: 1 = Best variety for category; 4 = Worst variety for category.

Based on the interview with farmers and visual observation in fields the author has perceived the following differences between landraces and improved varieties of cotton in North Omo (Table 12). For example, farmers strongly believe that clothes from landraces (*yeabesha tit*) are preferable and long lasting. Even though clothes from landraces are not as white as from improved varieties the color improves and shine after repeated washing. In addition these clothes are heavier in weight and warmer when they are worn. However, farmers still prefer to grow the improved varieties because of the following reasons: 1). early maturing, 2). high yielding, 3). high market demand, and 4). higher price/kg

Table 12. Differences Between Landraces and Improved Varieties of Cotton in North Omo Based on Visual Observation in the Field and Interview With Farmers

Landraces	Improved varieties
Grow under lower input conditions	Require high level of inputs (pesticides/fertilizers etc.)
Usually grown in mixture with crops	Grown in pure stand
Low yielder	High yielder
Perennial	Grown as an annual crop
Drought resistant (security crop)	Less drought resistant (are not dependable during bad weather)
Insect/pest resistant	Insect/pest resistant
Security crop (during serious drought years)	Are not dependable during bad weather conditions years
High lint strength (clothes made from landrace cotton are long lasting)	Less lint strength (clothes made from improved varieties cotton do not last long)
Short lint length (not preferred by textile factories)	Longer lint length (good for textile factories)
Low ginning percentage, i.e. many seeds per loculus	High ginning percentage, i.e. less seeds per loculus
Late maturing	Early maturing
Lower market demand and price	High market demand and price

11. PRODUCTION CONSTRAINTS IN NORTH OMO

The principal constraints to cotton production are diseases, insect pests, wild animals, shortages of land, drought, low soil fertility and shortages of labour and draft power.

Diseases:

North Omo farmers did not mention disease as a serious production problem. Also individual farmers cannot tell the type of diseases affecting their plants. State Farms however reported more about diseases and classified the different types of diseases that affect cotton production in the area. This section is therefore more for informative purposes than actually relating the situation in North Omo.

Cotton plants are attacked by numerous micro-organisms that are responsible for diseases. These weaken them and in some cases destroy them or render them sterile. The well known diseases are (Sement, 1988):

a) Bacterial blight:- The symptoms of this are oily spots followed by browning, either of the seedlings or of the stems, leaves or bolls.

b) Damping off:- This is rotting of the seeds or seedlings, resulting in large gaps at emergence.

c) Root and collar rot:- This may occur even on adult plants.

d) Fusarium and verticillum wilt:- These two diseases cause plants to wilt and wither and are very common in tropical Africa, but are absent from West Africa, Cameroon and Chad.

e) Boll rot:- This is caused by various micro-organisms that develop under very wet conditions, or are introduced via insect stings or perforations.

f) Leaf disease:- This is seldom serious and is usually identified by means of small spots either, round and brown (as with fungus *Alternatia*), or square and whitish (as with the fungus *Ramularia*).

g) Virus or mycoplasma disease. These are normally transmitted by insects from affected cotton plants or various other plants or weeds. Examples of these are African leaf crumple and mosaic virus spread by Bemisia, "blue" disease by Aphids and floral virescence by leafhoppers. These cause changes in the plant that are specific to each of the diseases, finally resulting in complete sterility. This seriously affects yields, depending on the number of seedlings inoculated. The disseminated varieties of cotton plants are relatively tolerant of these diseases, except floral virescence.

Insects and Pests

According to Sement (1988), some 480 species of insects, mites, mayriapods and nematods which live off cotton plants have been recorded in Tropical Africa and a large number of these are harmful to the crop. They attack different parts of the crop, either by eating them, sucking the sap, or introducing into them toxic saliva, germs, diseases or rot. The most widespread pests in Africa are listed below according to the parts of the plant which they attack and the nature of the damage they cause. They are referred to by their latin names in cases where those names are in widespread use.

a) The inner part of the seeds in the ground may be eaten by wireworms.
b) Young plants are eaten or sheared by crickets, grasshoppers and millipedes, or sucked and deformed by Thrips and aphids.
c) The roots are destroyed by termites, Siagrus and Agrate larvae, or stung by subterranean cochineals and nematodes.
d) The stems are stung or eaten away by Earias larvae.
e) The leaves are eaten by spodoptera sylepta and cosmophila larvae and by locust, and stung or sucked by lygus, Bemicia, Jassids, aphids and mites (polyphagotarsonemus and Tetranychus).
f) The flower buds are stung and destroyed by lygus or Heliathis, Diparopsis or Earias larvae.
g) The bolls are destroyed when they are young, or damaged at a later stage of their development by Heliothis, diparosis or Earias larvae.
h) The fibre itself can be contaminated by honey dew secreted by Bemisia or aphids when they are on the plants in large numbers, after insecticidal treatment has ceased.

Of the above mentioned insect pests Heliothis (American boll worm), aphids and flea beatles were identified by FARM- Africa/North Omo on farm trial, as very important cotton production problems especially in the Abela and Bele areas. Small termites also destroy cotton plants at different growing stages. This is found to be a very important production problem especially in Bele (Kindo Koisha). During field work sucking insects/pests such as jassids and Earias larvae were also observed in the Konso and Gardula lowlands.

Wild Animals:

In North Omo wildlife destroys a considerable amount of cotton plants. Monkeys, porcupines, bush bucks, wild pigs, birds and other animals damage cotton plantations at different growing stages. Monkeys and baboons feed on immature bolls and also destroy open bolls by eating the seeds. Bush bucks graze on cotton plantations, especially at the early growth stages. A bird called *zukay* in Welaita and *sorma* in Elgo (most probably the mousebird) also damages the green fruits (bolls).

Shortage of Land:

Since the population densities of the lowland cotton growing areas (especially in rainfed areas of Wolaita, Arba Minch zuria and Mirab Abaya) are not as high as in the mid-altitude areas

(*enset* growing area), land scarcity is not as such a serious production problem. However it was mentioned as a problem in Konso, Gardula and in areas where perennial rivers are used for irrigation to grow cotton and other major crops.

Drought:

Cotton is a tropical plant and performs best in a high temperature with an adequate amount of water. Drought is one of the most important cotton production problems in North Omo. Due to insufficient rainfall cotton plantations especially of improved varieties have been either totally destroyed or had the yield greatly reduced. The perennial cotton landraces which are growing in Konso and Gardula lowlands are found to be very drought resistant and farmers say that these landraces give good yields in drier years. In years of heavy rain only the vegetative part grow well and the yield declines considerably. In addition during long dry seasons, rivers can drastically lose their water content, which will affect supplementary irrigation.

Soil Fertility Problems:

Due to the nature of the plant, improved varieties of cotton respond well to deep fertile soils which are well drained. Cotton also grows well on loose fertile soils which are supplied with sufficient amount of organic matter and moisture.

Cotton landraces in North Omo can perform well without any application of fertilizer and farmers in this area did not regard soil fertility as a major constraints to cotton production.

Labour and Draft Power Shortage:

In the lowland areas animals are dying of diseases (e.g. trypanosomiasis) and people are suffering from the high disease infestation (e.g. malaria). As a result of this there is a labour shortage and usually a considerable part of each farmers' land remains fallow (uncultivated).

Ranking of Production Problems by Farmers

Thus insects/pests and drought were the most important problems of production in the region (Table 13). It is important to notice the difference between supplementary irrigated and rainfed areas. In supplementary irrigation areas drought is sometimes ranked lower as compared to rainfed areas. For example, the Silie area uses supplementary irrigation and drought was the second most important constraint, whereas in Satusa (rainfed) it was the most important constraint. However, it is useful to point out that the importance of the above mentioned problems may vary from year to year depending on various factors (e.g. rainfall, temperature and insect/pest infestation condition). In some part of Setasa, Arba Minch Zuria, Elgoe and Bele wild animals are found to be very important problems of cotton production.

Table 13. Ranking of production constraints by the farmers

Area	Water sources	Type of cotton	Constraints					
			Insect/ pest	Disease	Draught	Wild life	Land shortage	Soil fertility
Abela	Rainfed	Improved	1	5	2	4	6	3
Bele	Rainfed	Improved	1	5	2	3	6	4
Elgo	Supplem. irrigation	Improved & landraces	1	6	2	3	5	4
Fura	Rainfed	Landraces	2	N	1	3	N	N
Gardula, lowlands	Rainfed	Landraces	1	N	2	5	3	4
Konso	Rainfed	Landraces	1	N	2	5	3	4
Lantie	Supplem. irrigation	Improved & Landraces	1	N	3	5	2	4
Satussa	Rainfed	Improved	2	N	1	3	4	5
Silie	Supplem. irrigation	Improved	1	N	2	5	3	4
Wajifo	Supplem. irrigation	Improved & landraces	1	N	2	4	3	5

N.B.:-Number 1 tells us the problem is judged to be the most important of all problems and number 6 tells us the problem exists but it is considered to be the least important of all the mentionusus ed problems.

N = Negligible. The 'problem' was not mentioned or recognized by the farmers. Note that most of North Omo farmers do not usually mention or recognize diseases.

During the FRP/IIED 1991 training course in Rapid Rural Appraisal (RRA) much information on cotton was learnt from farmers in Abela Sipa PA (IIED/FARM-Africa ,1991) and is reproduced in Box 1 below.

Box 1: IIED/FARM-Africa DIAGNOSTIC SURVEY IN ABELA

Cotton is the most popular cash crop in Abela Sipa PA. Three cotton species were introduced to the area in (1966) by the then administrator. WADU assisted with fertilizer and pesticide in (1967). Farmers buy seeds at local markers when they need them. These three varieties have continued to be used since then.

Cotton grows best on black soils but yields low on red soil nad need fertilizer than other types of soils. Sandy soil need normal rain to yield and under normal rainfall conditions is the best soil on which to grow cotton, even if there are pests.

Farmers' preferences vary according to their income, as inputs for cotton are a major constraining factor on production and were found to influence choice of variety. The three varieties are *albara, acala* and *bonda*. Interviews were conducted with a group of low to medium income farmers in village 2 (5 men) and a relatively wealthy farmer in village 1. Ranking exercises were carried out to compare their preferences and the results of the first group were shown to the richer farmer after he had made his preferences for comment.

continued/.....

Continued...Box 1: IIED/FARM-Africa diagnostic survey in Abela

Ranking of cotton varieties by different income group members:

Variety	*Bonda*		*Albara*		Acala	
Wealth category	low	high	low	high	low	high
Good colour	1	3	3	2	2	1
Market demand	1	3	3	2	2	1
Good yield	1	3	2	1	3	2
Drought resistant	2	3	1	2	3	1
Wind resistant	2	3	1	1	3	2
Pest resistant	2	-	1	-	3	-
Overall choice	2	3	1	2	3	1

The lower income group chose *albara* as their preferred variety on the ground that it was the most resistant. The pest problem is the major issue in this area and these farmers were not able to afford the amount of insecticide that is required, so chose this variety as it is more able to withstand attack by drought, pests and wind. It also gives a fairly good yield in the absence of pesticide and fertilizer. The problem with *albara* is that it scores badly on market demand due to its color, although there was a difference of opinion between the two types of farmers on this and many other criteria. These differences of preference and perception regarding what may appear to be 'objective' criteria are interesting.

From the discussions it emerged that less wealthy farmers are not sowing on time because of the pest problem, so yields are lower than they should be. The farmers said that the problem of pests was a seasonal one. There is no local method or treatment to control the pests, only through weeding and pesticides. It is difficult to grow cotton in very fertile places and manure cannot be used as a fertilizer due to the number of insects. Cotton cannot be grown around the homestead unless there is enough pesticide.

The wealthier farmer commented that he would expect poorer farmers to dislike *acala* as the amount of money which is spent on inputs is more than most people can afford. His choice was based on the criterion of high market demand and he argued that amount invested in inputs repaid in income from the acala crop. Pest resistance was not an issue for him as he had sufficient funds to provide the required amount of pesticide and was making his choices based on different major criteria.

12. PROTECTION OF COTTON AGAINST INSECTS, PESTS AND DISEASES

In Abela, Bele, Mirab Abaya and Arba Minch zuria, where farmers grow improved varieties of cotton, Thiodan, Dimacron, Roger, DDT and Sevin (which are all toxic to pests) are used to protect cotton. However, in 1993 the price of pesticides increased by about 100% which discouraged cotton production in the area.

Researchers regarded resistance to insects is one of the important criteria in selecting crop varieties. Growing resistant or tolerant varieties can decrease the problems caused by a number of insect/pests and diseases. Selection of cotton plants with very hairy leaves is a means of control against certain biting or sap sucking insects (such as jassids) and this method has been used for a long time in Tropical Africa. Abela and Bele farmers confirmed this statement during our field work in the areas. For example Albar is a hairy and insect tolerant variety.

Insect pests can also be controlled by biological methods, such as releasing useful insects or mites which decimate them or live on them as parasites, or releasing viruses which transmit diseases to them. Nowadays the increase in pesticide resistance has developed research into the use of pheromones to monitor and control insect pests for both cultivation and storage of agricultural products. Pheromones are non-chemicals produced by one animal that has an effect (behavioral or physiological) on another member of the same species. This method can be used to attract a member of the opposite sex indicating readiness to mate (sex pheromones) or to attract individuals of the same species to suitable food source (aggregation and trial pheromones). They can be used to warn members of an insect colony of an imminent attack by a predator (alarm pheromones).

In North Omo these biological methods are not used. The type of control measure that can be practiced by the farmers depend on availability and cost. Farmers did not mention diseases as an important production problems but the past experiences of State Farms revealed that damping off, verticillum and bacterial blight attack growing cotton plants in the region.

Spraying Cotton Plants with Insecticides

One of the principal methods of pest control is the spraying of cotton plants with insecticides. However, this is very difficultfor just an individual plot . It is even more difficult for a locality or a small region to spray plants as they will consist of a large number of plants which vary considerably according to the time of sowing, soil conditions and cultural practices.

For farmers who grow improved varieties in pure stand, timing of application is not based on the economic threshold levels or according to the growth cycle of the cotton plant. They tend to believe the application of insecticides each week up to 10 times per season will help the plant to perform well. However it is recommended by researchers that the first application is made when the cotton plants are 45 days old (often later in areas where growth is slower), and the second during flower bud formation (56-70 days). In Abela where flea beatles are an important problem, spraying can be done before 45 days time, depending on the infestation level. If spraying is delayed the emerged small seedlings can be totally destroyed.

During FARM-Africa's research at Abela and Bele, damage by termites and beetles after emergence was serious and resulted in the death of seedlings at an early stage. Consequently, replanting and spraying of cotton plants immediately after emergence are now unavoidable tasks in these areas.

However, it is thought that under poor cultural practices a programme of four to seven applications will probably not economically viable. In such cases depending on the ecological zone, it is recommended that the first application be delayed (used for example in the Central African Republic where parasitism is less virulent at the start than at the end of the season) or to call a halt to spraying earlier (for instance where there are not many young bolls left to protect; at about the 110th day after emergence).

Depending on the zone, this means cotton plants with low production potential are not sprayed more than three to five times during the season. The grower and extension worker should be able to assess whether or not a final spray is justified, according to when the plant ceases to bear fruit.

According to Bele and Abela farmers the rainfall condition is also very important in determining the spraying frequency. For example, during continuous rainy weeks cotton infestation by aphids and beatles decreases and therefore spraying may not be necessary. However, spraying can be done if the infestation level increases (i.e. if it becomes economical and necessary to spray).

Keeping the chemicals safely in their small tukuls (houses), determining the appropriate type and dose, and the actual spraying, are not always easy for North Omo farmers. Chemicals can be dangerous to both the farmers and the surrounding areas. There are farmers who mix some chemicals like Malathion and DDT with their grains to protect it from weevils, which is extremely dangerous. Besides this, farmers usually cannot afford to buy goggles, gloves, masks and other protective materials which they should use during the preparation and spraying of chemicals.

Taking these conditions into consideration FARM-Africa gives briefings on labour and environmental protection to the farmers collaborating in on-farm trials and warns them to follow the instructions about chemical storage, different formulations, spraying, cleaning, removal of residues and the consumption of inter-cropped crops. It is true that some farmers have accidentally destroyed their cotton plantations by wrongly preparing the emulsion (mixture). This is often due to the concentration being very high or by mixing it with other (unwanted) chemicals.

The type and dosage of insecticides are determined by the type of pest and its development. The phyrethroids (deltamethrin, cypermethrin, fenvalerate etc.) are highly effective against the principal pests affecting the flower buds, flowers and bolls. They are moderately effective against leaf eating moth larvae, but are inadequate against the leaf and stem stinging/sucking pests (jassids, mites, bemisia, etc.)

The pyrethroids must therefore be combined with a product to make them effective against these difficult pests. Thus the insecticides distributed to the growers are mixtures of phyrethroids and organo-phosphate compounds with an acaricidal effect (triazophos, profenophos, chlorpyriphos

etc) in areas where mites are rife, or a mixture of phyrethroids and demethoate in aphid infested regions.

The products or mixtures distributed may not be the same ones used for earlier or later treatment because of changes that may occur in the parasite problem during the season.

Control by Agronomic or Prophylactic Means

This means breaking the reproductive cycle of certain pests or diseases by simple means, because the longer the period without cotton plant vegetation, (i.e. without a host) the more difficult it is for them to maintain themselves and proliferate. Thus, the older cotton plants should be destroyed as soon as possible after harvest if it is intended to bury the cotton plants by ploughing directly, i.e. without first chopping them up. This can only be done after the rains have returned. In the meantime it is a good idea to graze animals on the crop residues as much as possible, as this gets rid of the unpicked parasite infested bolls as well as those parts of the plants which are still green. In the terrace and ridge systems of the Konso and Gardula lowlands where second or third year cotton plants are always found on the farm animals are not allowed to graze in the crop residues. Thus, the insect/pest and disease infestation levels may be pronounced in these areas. It is clear that the Konso and Gardula farmers do not use agronomic or prophylactic means.

Parasitism may also be reduced by:

a) Crop rotation

b) Late planting. Abela and Bele farmers claim that late planting, in Sene and Hamle, decreases the level of insect infestation on the cotton plants. However the delay in planting affects the development of the plant and decreases the yield considerably.

c) Removing harvested seed cotton from the cultivated areas and the margins of the farm as completely as possible. Left-over seeds should be buried soon after sowing time because some seeds may contain pink bollworm chysalides from which moths will emerge and infest the following cotton plants by laying their eggs on them.

d) Keeping young cotton plants as weed free as possible since weeds will encourage attacks by jassids and other stinging and sucking insects.

13. LARGE SCALE COTTON PLANTATIONS IN NORTH OMO

In North Omo, the previous State Farms owned large scale cotton plantation sites at four locations: at Sille (1,600 ha); Arba Minch (1,100 ha); Abaya (1,204 ha); and Bilate (1100 ha) (Figure 12). However, with the fall of the Derge Regime all the corporations within the State Farms were dissolved in August 1993, and re- organized as Agricultural Development Enterprises (ADEs). At present the North Omo ADE comprises of the Arba Minch and Abaya sites, and the Omo basin farm. The latter was initiated by a Ethio-Korean joint venture and after the Koreans left, the farm was included into the North Omo ADE.

All the above mentioned cotton plantations are found near perennial rivers (Figure 11) and they plan to irrigate up to six times in one farming season. The Arba Minch site and the Abaya farm have been growing different improved or commercial varieties of cotton such as Acala 1517/70, Acala SJ2, Deltapine 90, and Melkawerer 1984.

According to the ADE (personal communication), optimum cotton planting time is from Miazia 15 to Sene 10, though during heavy rainy years they often plant earlier, i.e. before Miazia 15. Both fertilizer types, i.e. Urea and DAP, are applied at the rate of 100-150 kg/ha but most of the time only Urea is applied to the farms.

The major cotton production constraints at the North Omo ADE (personal communication) are:

1) Climate - cotton needs high temperatures and sunshine, but in some years the area is covered by cloud for many days, which affects the development of the plant.

2) Water shortage - the water level in the perennial rivers decreases during drought years, causing shortages in irrigation water. Moreover, the ADE also competes with local farmers when using the river water.

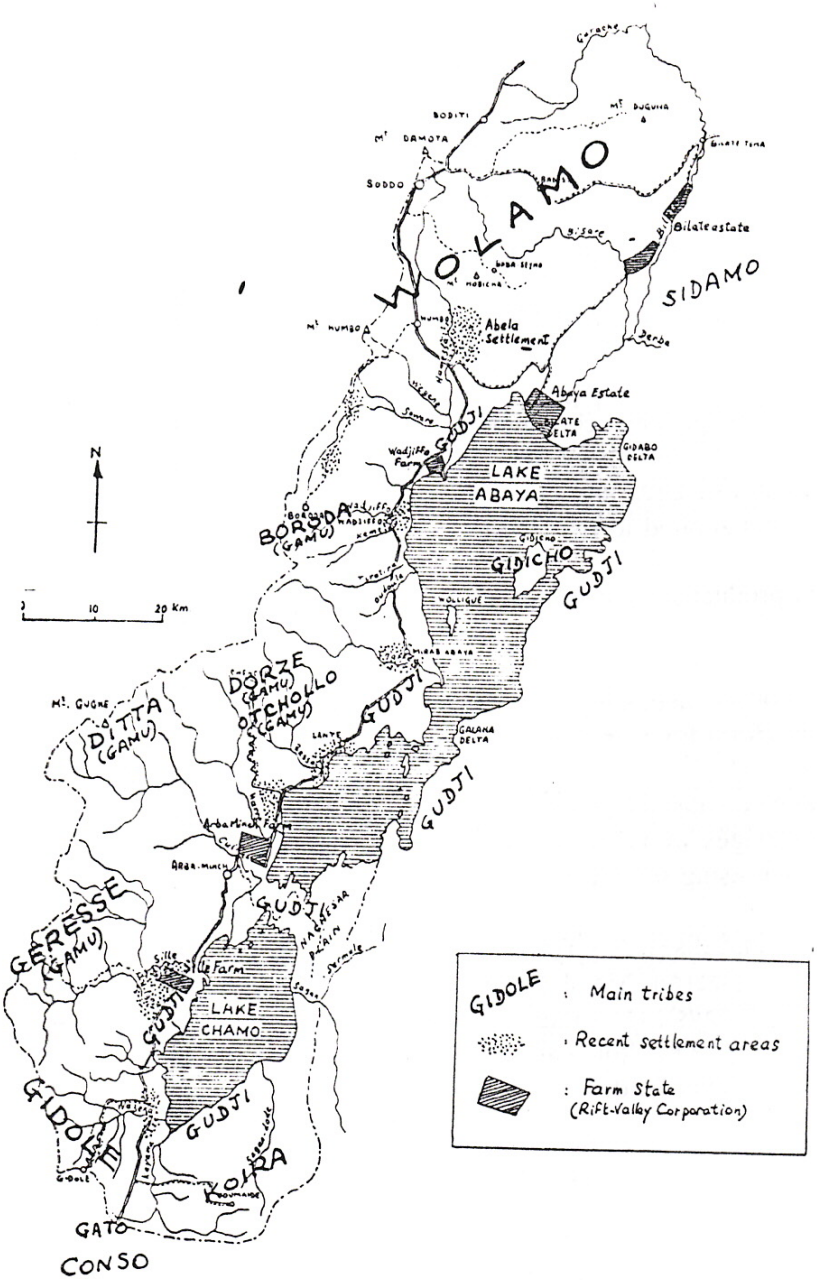
3) Insects/pests and diseases - To combat these, the ADE sprayed various chemicals, such as Thiodan, Dimacron, Marshal and Carati. Spraying is done after the formation of buds (between 20-25 days). Damping of Verticillua disease and insects/pests such as American boll worm, Egyptian cotton leaf worm, Aphids, Jassid and White fly are observed in the previous state farms field.

4) Weeds

5) Machinery and labour

During harvesting they will pick two or three times. The first picking will comprise of 65% of the total cotton yield obtained from one field in one growing season, the second picking 25% and the third picking 10%. The yield varies from year to year depending on the variety grown, weather conditions, quality of management etc. When the cotton is ginned it gives on average: 35% lint; 63% seed; and 2% impurities (waste).

Fig. 12. Location of the Previous State Farms in North Omo



Source: Raunet, 1978.

The State Farms reported that they experienced harvesting losses of 3-5% for handpicking. These losses included seed cotton lost to the ground and that left in the burr. Losses could be higher when picking is not done on time.

Table 14 shows area, production and yield for the North Omo State Farms. Over the years basically the amount of land under cotton production was increased and in general yields per hectare declined. It also shows how yields can fluctuate substantially between years.

One might also comment that "management" in these years would have been a critical factor since social politics played a large part in how such estates were run. Variety and climate (rainfall irrigation) would also have been important. Increases in the area under cultivation may also involve the inclusion of land suitable land for optimising the yield of cotton.

Table 14. Area, Total Production and Yield of Seed Cotton in the Rift Valley State Farms, 1973-1985 G.C.

Year	Bilate-Abaya			Wajifo			Arba Minch-Sille		
	Area (ha)	Total Prod. (qt)	Yield (qt/ha)	Area (ha)	Total Prod. (qt)	Yield (qt/ha)	Area (ha)	Total Prod. (qt)	Yield (qt/ha)
1973/74	-	-	-	500	5800	11.60	-	-	-
1974/75	125	2132	17.06	400	8716	21.79	730	24017	32.90
1975/76	1386	27709	19.99	290	4588	15.82	1349	31243	23.16
1976/77	1506	21266	14.12	245	3548	14.48	1414	38744	27.40
1977/78	2002	24430	12.20	285	4643	16.29	1473	23129	15.70
1978/79	2322	24878	10.71	495	6826	13.31	1551		16.01
1979/80	2278	24879	10.92	495	6588	13.31	1706	35600	20.87
1980/81	2298	28690	12.48	495	4485	9.06	1971	51741	26.25
1981/82	1917	22967	11.98	505	4616	9.14	2068	31695	15.33
1982/83	2163	19381	8.96	500	6150	12.30	2202	22256	10.11
1983/84	2362	10103	4.28	495	6088	12.30	2200	26934	12.24
1984/85	2312	28718	12.00	496	3924	7.90	2171	29288	14.00

Source: Ministry of State Farms Development, 1986.

The State Farms/ADEs have been conducting cotton trials in North Omo. These trials were initiated in conjunction with the Institute of Agricultural Research (IAR) and included:

State Farm/ADE initiated trials	IAR initiated trials
- Sowing date trials	- National variety trials
- Fertilizer trials	- Farmers' verification trial
- Spacing trials	- Pre-national variety trial
- Weed competition trials	
- Irrigation trials	
- American boll worm chemical control trials	
- Growth regulator trials	

It was not possible to obtain the results of all the above mentioned trials; only results of two cotton national variety trials at Bilate and Arba Minch. These are presented in Tables 15 and 16.

Table 15. Results of Cotton National Variety Trials at Bilate, Seed Cotton Yield - qt/ha

Variety	1980/81	1982/83	1983/84	1984/85	Mean
Acala 1517/70	23.07	23.27	25.42	36.3	7.0
Albar 637	22.06	-	-	-	-
Reba B 50	16.25	-	-	-	-
Acala 1517 BR	22.60	19.53	25.52	35.2	25.71
HAR 444-2-70	19.19	22.65	25.00	34.1	25.24
AMS 1(74)	24.38	23.72	22.50	31.3	25.40
Acala 1517/75	23.18	-	-	-	-
La Super Okra Leaf 2	14.21	-	-	-	-
L-299-29-71	28.34	23.05	19.27	38.1	17.19
L-299-10	34.32	19.93	27.08	39.06	30.23
Acala 1517V	21.74	-	-	-	-
BJA	18.40	-	-	-	-
La Okra Leaf 2	19.77	16.65	26.04	31.2	23.24
AMS 1.34.2	24.49	-	-	-	-
AMS 1.39.1	21.56	23.85	28.13	38.1	27.91
Paymaster 3	18.98	-	-	-	-
Coker 310	-	27.38	25.10	34.9	29.13
G.L. Acala 63-64	-	17.20	22.71	37.2	25.70
Dixie king III	-	21.50	29.48	38.5	29.83
Coker 5110	-	17.95	24.48	36.2	26.21
Stonville 88519G.L.	-	21.53	20.10	36.5	26.04
Deltapine 25	-	24.25	25.00	34.7	27.98
Stonville 213	-	24.23	21.67	38.2	23.03
La Frego Bract 2	-	25.00	27.19	41.1	31.10
Mean	22.03	21.98	24.67	36.29	27.26
S.E.	3.10	3.57	1.0		
L.S.D. at 0.05	6.27	N.S	N.S		
C.V.%	19.91	23	23.83		
Design	RCB4	RCB4	RCB4	RCB4	
Plot size	24m^2	24m^2	24m^2	24m	
Planting date		15/6/82	15/6/83	26/5/83	

Source: Ministry of State Farms Development, 1986

Table 16. Results of Cotton National Variety Trials at Arba Minch, Seed Cotton Yield - qt/ha

Variety	1980/81	1981/82	1982/83	1983/84	1984/85	Mean
Acala 1517/70	44.55	22.62	18.98	21.29	30.0	26.68
Albar 637	43.66	-	-	-	-	-
Reba B 50	37.05	-	-	-	-	-
Acala 1517 BR	42.23	24.09	18.56	19.33	26.2	26.08
HAR 444-2-70	41.76	26.46	18.56	21.46	33.0	28.25
AMS 1(74)	36.02	23.32	20.24	22.88	31.0	26.69
Acala 1517/75	38.92	-	-	-	-	-
La Super Okra Leaf 2	32.23	-	-	-	-	-
L-299-29-71	48.14	23.90	19.00	21.17	27.8	28.00
Acala 1517V	37.81	-	-	-	--	
BJA	43.48	-	-	-	--	
La Okra Leaf 2	35.93	24.92	17.61	16.29	28.8	24.71
AMS 1.34.2	39.86	-	-	-	-	-
AMS 1.39.1	38.24	26.87	16.82	22.63	26.9	26.29
Paymaster 3	41.07	-	-	-	-	-
Coker 310	-	28.32	15.84	21.09	28.8	23.51
G.L. Acala 63-64	-	20.21	20.82	17.63	29.2	16.91
Dixie king III	-	24.07	16.23	22.63	32.5	23.86
Coker 5110	-	29.61	18.35	22.13	26.0	24.02
Stonville 88519G.L.	-	25.90	20.00	18.92	33.3	24.53
Deltapine 25	-	22.33	15.61	17.88	27.1	20.73
Stonville 213	-	25.70	13.98	21.29	29.8	22.69
La Frego Bract 2	-	26.70	24.22	20.88	33.6	26.35
Mean	40.21	24.93	18.40	20.54	29.83	24.93
S.E.	2.98	0.43	3.47	0.5		
L.S.D. at 0.05	6.01	3.63	N.S	N.S		
C.V.%	10.5	10.2	27	14.34		
Design	RCB4	RCB4	RCB4	RCB4		
Plot size	24m^2	24m^2	24m^2	24m^2		
Planting date	28/5/81	17/7/82	24/7/83	5/6/84		

Source: Ministry of State Farms Development, 1986

14. EXISTING MARKETING PATTERNS IN NORTH OMO

The marketing pattern of cotton varies between years, seasons and areas. Generally farmers sell their seed cotton to itinerant traders from other areas or to the local women. These traders perform the function of buying, organizing and transporting the cotton.

In almost all locations traders reported that the average price of landrace seed cotton in 1995 was 2.50 ETB per kg (i.e. the traders' price). The retail price of small amounts of seed cotton is different and this is on average above the traders' price. It is estimated by hand and sight measurements in the markets. According to Mirab Abaya and Gato traders there is not as such a fixed price for the improved varieties since they receive them in mixture with landraces.

From Table 17 it can been seen that the price of seed cotton increases as we proceed to the North of the region. For example, at Konso a kg of landrace seed cotton costs only 0.79 ETB, while the price at Mirab Abaya is 2.47 ETB. This is because of the type of seed cotton, transportation and other service expenses being
included. The prices in Sura are higher, probably reflecting the difficulty of traders in getting to this highland area, and the high demand from the area. Prices in Soddo and Damot Gale are even higher.

Table 17. Cotton Market Price in North Omo, 1995 (ETB/kg)

Woreda	Market area	Cotton type (ETB)	Retail price/kg
Damot Gale	Boditti	Improved	5.00
Damot Gale	Boditti	Landrace	4.00
Soddo zuria	Soddo	Improved	5.00
Soddo zuria	Soddo	Landrace	4.40
Sura	Dorze	Improved	4.50
Sura	Dorze	Landrace	3.60
Sura	Chencha	Improved	4.54
Sura	Chencha	Landrace	3.70
Satusa	M.Abaya	Improved	4.44
Satusa	M.Abaya	Landrace	2.70
A/Minch zuria	Lantie	Improved	5.00
A/Minch zuria	Lantie	Landrace	3.00
Gardula	Gato	Landrace	2.47
Gardula	Wozeka	Landrace	1.32
Gardula	Gedale	Landrace	1.79
Konso	Bekawle	Landrace	0.79

Source: Author's 1995 Market Survey in North Omo

Table 18. Percenatage of Seed-cotton as sold in different forms

	Percentage of Seed-cotton			
	Sold raw in market	Sold as spun thread	Used for clothing	Cotton type
Konso	30	50	20	Landraces
Elgo	94	3	3	Both
Shelie	95	2	3	Improved
Lantie	96	3	2	Improved
Abela	97	2	1	Improved
Bele	98	1	1	Improved
Gardula (Gebene meno)	70	20	10	Landraces
Fura	80	15	5	Landraces

Source: North Omo farmers

As we see in Table 18, in Konso the percentage of seed-cotton sold as raw, sold after processing (spun thread) and used for local clothing, is 30, 50 and 20% respectively. This indicates the following realities:

- Of the amount produced about 50% is processed indicating that many people are engaged in cotton processing.

- In addition to local *bulukos* and *gabis*, Konso and Gardula people wear locally made traditional shirts, skirts and shorts.

On the other hand, in areas where farmers grow improved varieties of cotton in pure stand the percentage of seed cotton sold in markets is considerably higher, whereas seed cotton that is used for local clothing or sold after being processed is very little. This indicates:

- Much more seed-cotton is produced in these areas.

- Less people are engaged in cotton processing.

- People wear more clothing produced by modern textile industries rather than local small industry.

15. PAST AND PRESENT RESEARCH ACTIVITIES IN NORTH OMO

What follows is a review of some of the more important past research activities on cotton production in North Omo (some results from the previous State farms have already been presented in previous chapters). This is divided into three sections:

- WADU cotton trials
- Action Aid Ethiopia cotton variety trials
- FARM-Africa on-farm cotton pest trials

WADU Cotton Trials

Most of the research on cotton (in North Omo) in the past was conducted by WADU. The experiments can be classified into four groups:

- Variety trials
- Spacing trials
- Fertilizer trials
- Sowing date trials

The crop and pasture section of WADU conducted a series of field experiments from 1970 to 1981. These trials mainly dealt with cultural practices, identification of suitable varieties, and national yield trials. These trials were undertaken at different agro-ecological zones. The following information on cotton was obtained from the lowland parts of the area (Bele, Abela and Ajega).

The principal results of each group are briefly presented below. All dates indicated are in the Gregorian calendar.

Cotton National Variety Trial (NVT)

Location	Abela, Belle
Experiment	Cotton NVT
Layout	RCBD * with 6 reps
Plot size	5 rows x 0.8 m x 10 m = 40 m^2
Useful plots	3 rows x 0. 8 m x 10 m = 24 m^2
Sowing date	Abela 29/5/74
	Bele 28/5/74
Spacing	25 cm between plants
Fertilizer	Abella 100 kg DAP + 100 kg urea/ha
	Bele = 10 kg DAP /ha

* RCBD = Randomized Complete Block Design (Type of experimental design

Table 19. Cotton National Variety Trials (seed cotton yield qt/ha), 1974/75

Varieties	Locations	
	Bele	Abella
Acala 151BR	7.3	11.5
AMSI (70)	8.9	9.9
AMSI (74)	9.8	9.7
AMS 1.34	10.8	9.6
AMS 1.39	12.0	9.3
AMS 1.48	9.7	13.0
Albar 637	14.0	14.6
A333-57	12.6	12.8
Location mean	10.5	11.3
S.D.	2.2	2.0
LSD (5%)	2.3	n.s.
LSD (1%)	3.2	n.s
C.V (%)	19.6	34.1

Source : WADU, 1971-1977

Cotton Variety Trial

Location	Ajeja
Experiment	Cotton variety trial
Layout	RCBD with 2 Reps.
Plot size	5 m x 5 m (5 rows 5 m long)
Useful plots	3 central rows
Spacing	100 cm x 20 cm
Fertilizer	200 kg urea/ha + 100 kg DAP/ha
Sowing date	27/5/74

Table 20. Cotton Variety Trial Yields (seed cotton yield qt/ha), 1974/75

Varieties	Yield (qt/ha)
Acdala 1517C	3.7
Acala 1517BR	8.5
AMSI (70)	3.9
HA (8)	2.2
Albar 637	7.0
BPA 68	10.6
ASA (65)38	7.6
SA (66)44	7.0
A33 57	4.0
Reba 50	6.4
AC 134	6.9
AP 12-8	3.9
Location mean	6.0
S.D.	2.5
LSD (5%)	n.s
LSD (1%)	n.s

Source: WADU, 1971-1977

Cotton Yield Trial at Abela and Bele

Location	Abela, Bele
Design	RCBD with 4 replications
Plot size	Elementary 4 x 10 m (5 rows 10 m long)
	Harvest area 2.4 x 10 m (3 rows 10 m long)
Spacing	80 cm between rows & 25 cm between plants/hole
Fertilizer	Abella - 100 DAP + 150 urea kg/ha; Belle - 150 DAP + 100 urea kg/ha
Seed rate	5 seeds (hole thinned to single plant/hole)
Sowing date	Abella 27/5/77 and 16/6/78
	Belle 1/6/77 and 13/6/78 (plant material was received late during 1978)
Pest control	Spray DDT 25 and Dimicron alternatively every 7 days

Table 21. Cotton Yield Trial, 1976-1978.

Varieties	Locations						Variety mean
	Abela			Bele			
	1976	1977	1978	1976	1977	1978	
1	12.7	16.7	11.4	28.7	8.0	13.1	13.8
2	11.6	15.2	11.2	23.0	10.5	14.3	14.3
3	13.1	16.8	12.6	21.7	10.4	13.2	14.6
4	12.8	15.7	10.3	21.8	11.6	11.7	13.9
5	15.3	13.7	13.7	25.3	8.6	15.2	9.2
6	13.7	13.1	14.0	25.0	6.3	11.9	14.0
7	-	12.9	15.3	-	9.5	10.2	11.9
8	-	10.1	11.0	-	6.8	9.5	9.4
9	-	Failed	16.6	-	3.6	0.2	10.1
10	-	13.6	-	-	7.7	-	10.6
11	-	-	13.3	-	-	10.5	11.9
12	-	11.0	13.2	-	7.0	9.4	10.2
13	13.9	12.8	10.4	18.2	7.1	9.6	11.9
Mean	13.3	13.7	2.8	23.4	8.1	11.6	
S.D.	4.2	5.2	1.6	1.9			
LSD (5%)	n.s	n.s.	2.4	2.7			
LSD (1%)	n.s	n.s	3.2	3.6			
C.V (%)		38.7	20.3	16.2			

Source: WADU, 1971-1977

Cotton Fertilizer Trial

Foliar and soil application of urea on cotton

Location	Ajeja
Design	RCBD 4 Reps
Plot size	Elementary - 5 m x 10 m = (5 rows, 10 m long)
	Useful - 3 m x 10 m = (3 rows, 10 m long)
Variety	Albar 637
Seed rate	5 seeds/hole
Planting date	20/5/74
Treatments	Urea at 3 levels, soil and foliar

Table 22. Fertilizer Trial I, 1974-1975

Treatment (kg/ha)	Yield (kg/ha)
Check	11.4
65.2 kg urea (soil)	9.9
130.4 kg urea (soil)	12.1
195.6 kg urea (soil)	7.9
32.00 kg urea (foliar)	12.9
65.2 kg urea (foliar)	9.5
97.8 kg urea (foliar)	11.0
Location mean	11.0
S.D.	1.9
LSD (5%)	n.s
LSD (1%)	n.s
C.V. (%)	8.7

Notes 1. Foliar and soil application is to be done 40-45 days after sowing.
2. Apply 100 kg TSP/ha on all plots at sowing.

Source: WADU, 1971-1977

Cotton Fertilizer Trial

Location	Abella, Belle
Design	RCBD 6 Reps
Plot size	Elementary - 5 m x 6 m = 30 m^2 (5 rows, 6 m long)
	Useful - 3 m x 6 m = 18 m^2 (3 rows, 6 m long)
Spacing	20 cm between rows
Variety	Albar 637
Planting date	25/5/74
Treatments	DAP at 5 levels

Table 23. Fertilizer Trial II, 1974-1975

Treatments (DAP)	Locations	
	Bele (qt/ha)	Abella (qt/ha)
0 kg/ha	12.2	13.4
50 kg/ha	11.2	12.6
100 kg/ha	10.2	13.9
200 kg/ha	7.6	12.8
400 kg/ha	9.6	15.1
Location mean	10.0	13.5
S.D.	1.8	1.0
LSD (5%)	n.s	n.s.
LSD (1%)	n.s	n.s
C.V (%)	33.4	15.8

Source: WADU, 1971-1977

Cotton Sowing Date Trials

Location	Abela, Ajeja, Belle
Design	RCBD 6 Reps, 5 sowing dates, 15 day interval
Plot size Elementary	Abella and Belle = 4 m x 5 m (4 rows); Ajeja = 5 m x 5 m (5 rows)
Spacing	100 cm x 20 cm
Seed rate	5 seeds/hole
Fertilizer application:	Abella 150 kg urea + 150 kg DAP/ha; Ajeja 200 kg urea + 100 kg DAP/ha; Bele 100 kg urea + 100 kg DAP/ha

Table 24. Sowing Date Trial, 1974 -1975

	Sowing date		
	Abella	Ajeja	Bele
1st	16/5	22/5	6/3
2nd	1/6	11/6	1/6
3rd	16/6	26/6	16/6
4th	30/6	10/7	30/6
5th	15/7	25/7	15/7
	Yield (qt/ha)		
	Abella	Ajeja	Bele
1st	11.9	5.0	15.5
2nd	17.2	4.3	17.6
3rd	7.9	3.5	16.9
4th	4.9	2.7	9.8
5th	3.7	-	4.6
mean	9.1	3.9	12.9
S.D	5.5	1.0	5.6
LSD (5%)	5.3	n.s	6.5
LSD (1%)	7.3	n.s	8.8
C.V.%	48.3	50.3	41.5

Source: WADU, 1971 - 1977

Cotton Spacing Trial

Location	Bele, Abella
Experiment	Cotton spacing trial
Variety	Albar 637
Layout	RCBD with 4 Reps
Plot size	Bele = 5 m X 6 m; Abella = 1. (1,4,7) = 5.25 m x 6 m; 2. (2,5,8) = 5.6 m x 6 m; 3. (3,6,9) = 7 m x 6 m
Fertilizer	10 kg DAP + 100 kg urea/ha at both sites
Sowing date	Bele 24/5/74 Abella 27/5/74

Table 25. Yields for Cotton Spacing Trial, 1974 - 1975

	Bele (qt/ha)	Abella (qt/ha)
75 x 15	18.6	9.2
80 x 15	19.1	8.7
100 x 15	20.3	13.1
75 x 20	18.0	14.8
80 x 20	17.9	10.3
100 x 20	16.4	13.0
75 x 25	18.1	8.5
80 x 25	19.9	9.6
100 x 25	18.9	9.4
Location mean	18.6	10.2
S.D.	1.2	2.3
LSD (5%)	n.s	n.s
LSD (1%)	n.s	n.s
CV %	16.1	34.4

Source: WADU, 1971 - 1977

Action Aid Ethiopia Cotton Variety Trials

In 1994 Action Aid-Ethiopia conducted variety (adaptation) trials on six improved varieties and one local cotton type at its Koysha (Dawro) project area. 13 farmers participated in carrying out these on-farm trials. The results are summarized in Tables 26 and 27.

Table 26. Average Stand Count, No. of Bolls/plant Damaged Bolls

Varieties	Stand count	No.bolls/ plant	Damaged bolls/ plant	Plant height (cm)	Yield (qt/ha)
Stoneville	122.2	45.33	5.0	0.5933	22.06
Arba	118.5	44.33	5.4	0.5267	22.34
Lokra	134.7	52.17	4.0	0.5650	23.34
Local	114.5	42.83	6.5	0.6533	16.03
C.V. (%)	25.5	16.50	51.3	20.10	21.70
SE mean	12.76	3.10	1.10	0.0479	0.9287
SE diff.	18.04	4.39	1.55	0.6879	1.3130
F test (5 %)	0.71 (ns)	0.20 (ns)	0.47 (ns)	0.33 (ns)	0.05 (ns)

Table 27. Average Stand Count, No. of Bolls/plant, Damaged Bolls/plant, Plant Height and Yield of Four Cotton Types

Varieties	Stand count	No. plant	Damaged bolls/ plant	Plant height (cm)	Yield (qt/ha)
Acala	119.4	40.29	10.0	0.5957	21.08
Deltapine	116.6	39.00	10.0	0.5329	25.26
Bulka	117.3	45.29	9.6	0.4957	22.85
Local	129.6	39.86	11.9	0.6929	16.85
C.V. (%)	23.5	18.30	24.9	10.3	17.30
SE mean	10.71	2.85	0.97	0.0225	0.6876
SE diff.	15.15	4.03	1.38	0.0319	0.9724
F test (5 %)	0.82 (ns)	0.42 (ns)	0.38 (ns)	0.00 (ns)	0.00 (ns)

Source: Action Aid-Ethiopia, 1994.

FARM-Africa On-Farm Cotton Pest Trials

Three pest trials have been carried out by FARM-Africa's "Farmers' Research Project" at Abela and Bele since 1992. The 1992 and 1993 results were published in FARM Africa (FRP) Annual Research Reports (On Farm Trials In North Omo - Report for 1992; 1993). Information from the latest Research Report (for 1994) is only presented next.

The 1994 trials were conducted on thirty five farmers' farms in Kindo Koysha (1120-1220) and Humbo (1400-1550) weredas.

Cotton On Farm Trial

Location — Humbo, Kindo Koisha

Experiment — Insecticide applications

Layout — RCBD * with out reps; the farmers were taken as replications

Plot size — 4 m x 4 m

Fertilzer — DAP 100 kg/ha

Spacing — 1 m between plots; each farm were separated from each other by 3 m

Varieties — Trial I and II six varieties obtained from the Melkawerer Institute of Agricultural Research (IAR).

The varieties were:

Stoneville 213
Bulk 202
Laokra leaf 2
Arba
Deltapine 90
Akala SJ2
Local

Treatments — Trial I - no chemical pesticide was applied

Trial II - all the seven plots were uniformly sprayed with Thiodan within each farm but with varied frequencies between farms

Trial III-1.Manufacturer'Rates of application
2.Farmer's application
3. Thiodan 45-90 days after planting (dap).
4. Dimacron as recommended and Thiodan 45-90 days after planting
5. Dimacron only.
6. Control (no chemical application)

Measurements

a). Number of plants damaged by flee beetles (Podagrica spp.) per 10 randomly selected plants per plot. Measured once between 10-20 days after planting.

b). Number of leaves with aphid colonies per plant on 10 randomly selected plants per plot.

Measured once between 30-60 days after planting.

c). Number of shed flower buds per plant on 10 randomly selected plants per plot. Measured once between 60-90 days after planting.

d). Number of damaged bolls per plant on 10 randomly selected plants per plot. Measured once between 75-120 days after planting.

e). Yield in kg/ha.

The results were evaluated by farmers and analyzed statistically by a researcher. The 1994

Table 28. Farmers evaluation criteria compare varieties.

Criteria	Bele			Abella			total
	G1 n=6	G2 n=3	G3 n=4	G1 n=6	G2 n=7	G3 n=5	
1 Emergency	x	x	x	x	x	x	6
2 Vegetative growth	x	@	@	@	@	@	1
3 Branching	x	x	x	x	x	x	6
4 Flower bud shed	x	x	x	x	x	x	6
5 Tolerant to moisture stress (low)	x	x	x	x	x	x	6
6 Tolerant to pest	x	x	x	x	x	x	6
7 Ball size	x	x	x	x	x	x	6
8 Ball number	x	@	x	x	x	x	5
9 Earliness	x	@	@	@	@	@	1
10 Ease for picking	@	@	x	x	@	@	2
11 Yield	x	x	x	x	x	x	6
12 Market demand							
-quality	x	x	@	x	@	x	4
-heaviness	x	@	@	x	x	x	4

@=not considered, x=considered G1 to 6=subgroups 1 to 6
n=size of a subgroup

Table 29. Yield (Kg/ha) differences of the improved varieties over Local of Trial I and II in Bele area (Kindo Koysha).

Variety	Trial I		Trial II		% increase of trial II over trial I
	Yield (kg/ha)	% increase over local	Yield (kg/ha)	% increase over local	
Stoneville 213	457.10	4.0	574.18	27.4	25.6
Bulk 202	431.43	-1.8	535.68	18.9	24.2
Laokra leaf-2	466.72	6.2	542.10	20.3	16.2
Arba	447.47	1.8	575.78	27.8	28.7
Deltapine 90	510.02	16.1	599.84	33.1	17.6
Akala SJ2	425.02	-3.3	502.00	11.4	18.1
Local	439.45	0	450.68	0	2.6
Mean SE CV (%)	540.04 29.13 19.31		540.04 30.08 24.09		

Table 30. Yield (Kg/ha) differences of the improved varieties over Local of Trial I and Trial II in Abella area (Humbo woreda).

Variety	Trial I		Trial II		% increase of trial II over trial I
	Yield (kg/ha)	% increase over local	Yield (kg/ha)	% increase over local	
Stoneville 213	475.38	-9.5	646.00	6.1	35.9
Bulk 202	508.74	-3.2	650.52	6.8	27.9
Laokra leaf-2	542.10	3.2	729.75	19.9	34.6
Arba	642.18	22.2	763.11	25.3	18.8
Deltapine 90	554.61	5.6	783.96	28.8	41.4
Akala SJ2	533.76	1.6	700.56	15.1	31.3
Local	525.42	0	608.82	0	15.9
Mean SE CV (%)	542.10 0.98 31.90		696.39 0.13 32.41		

Table 31. Yield (kg/ha) of Trial III of Abella and Belle areas

	Abella		Bele	
	Yield	% increase over check	Yield	% increase over check
Thiodan IX (45-90 days)	579.63	-3.5	556.53	4.5
Thiodan (45-90 days) and Diamacron IX	554.60	-7.6	452.28	-15.1
Diamacron IX	583.80	-2.8	502.00	-5.7
Check	600.48	0	532.48	0
Mean	579.63	510.82		

16. CONCLUSIONS AND RECOMMENDATIONS

As the report clearly points out the practices of farmers have evolved over a very long period of time. They are consistent with their lifestyle and economic means. Any 'improvements', e.g. new varieties, changed cultural practices and so on must be consistent with their concept of what is good and practical. Perennial cottons need disease and pest resistance/tolerance and the ability to persist in impoverished soils. As Saunders (1961) commented on this problem, cultivated cotton types of Albar 637 seems to be suitable since it is hardy, bacterial blight resistant has some hairiness to protect it from jassid, and is prolifically small-bolled which would be ideal for protracted picking and recovery from loss which might not occur so easily with a big-bolled short fruiting season type such as the Acala.

The application of artificial fertilizer is always difficult with poor resource farmers. They are at the mercy of the market price, and their style of cultivation (e.g. inter-cropping etc.) may not lend itself to the economic application of chemicals. In general farmers are practicing different methods at different cotton growing areas of North Omo. Consequently, production problems vary from place to place depending on the type of cotton grown and the growing conditions (such as it being a rainfed or irrigated cropping system). Therefore it is easier to divide the area in to two distinct categories.

1. The Konso and Gardula lowlands.

Most cotton farmers of these areas grow various crops in mixture in one field at the same time. This type of farming has both positive and negative impacts on production.

Positive impacts are: a) Leguminous crops (usually beans) and cereals perform well together since the former fix nitrogen from the air to supply the latter; b) The field is planted with annual and perennial crops (there is at least one crop in all seasons) which decreases evaporation (i.e. the plants serve as a wind-break, decreasing the velocity of the wind, and shade the earth from the sun); c) Protecting the soil from erosion.

Negative impacts are: a) The total yield obtained from a hectare of land is very low. Even though farmers are aware of soil fertility problems and spend much of their time on soil and moisture conservation it seems that soil fertility is still decreasing from time to time. As the area farmers do not use artificial fertilizers at all, the amount of organic matter supplied on their farm may not be sufficient; b) The intensity of pest infestation in a continuous mixed cropping regime is high because diseases and pests co-evolve as there is no disturbance of their life-cycles. Since there is no crop rotation the host can exist in the field each year.

It would be very difficult to imagine crop production for the previous centuries without such indigenous soil and moisture conservation methods. Although the farmers' indigenous knowledge is appreciated, to achieve any sort of food production increase in these marginal areas indigenous methods need to be developed or changed very carefully by introducing improved technology and practices into these areas.

Farmers usually tend to adapt new technologies only if they can be applied at their conditions. Therefore, to introduce appropriate technology the following preliminary and participatory trials could be conducted:

a) Cultural practice trials - It would be essential to compare current farmers' practices with improved practices (generally associated with improved varieties), for example on soil preparation, cropping patterns and planting methods.

b) Variety trials - To test different improved varieties and to compare their performance with the best indigenous landraces. This will also give a further possibility for breeders to help produce adaptive and dependable varieties from the existing primitive and wild gene pools.

c) Fertilizer trials: To test the response of the area's soil to various fertilizers. This in turn will help to look at the economic benefits of different treatments.

The results of the above trials and of the farmers' responses may well challenge the long existing agricultural system of the areas. Such a challenge (e.g. deciding to use improved agricultural practices) could challenge the entire agricultural system (e.g. improved varieties and the inputs that go with them, such as ploughing, fertilizers and pure stand planting, will challenge the traditional soil and water conservation practices) and therefore need to be very carefully thought about.

2) The rainfed areas of Welaita (Abela and Bele), Mirab Abaya, Arba Minch zuria, and supplementary irrigated lands.

Because of the development work done by WADU and some energetic administrative governors of the area, Abela and Bele farmers are familiar with new technologies. The topography of the area and the introduction of new technologies make the problem less complicated than the problems in Konso and Gardula.

The four most important problems which are recognized by both farmers and researchers are: insects/pests, planting seed shortage, drought, and labor shortage. To help alleviate each of these problems the following suggestions is forwarded:

a) Insects/pests: (i) Grow tolerant varieties; (ii) Supplying sprayers and the right amount and type of pesticides on time; (iii) Pesticides, sprayers and other necessary protective materials may need to be subsidized by the government to encourage cotton production; (iv) Farmers need to get agricultural inputs on credit.

b) Planting seed shortage: Cotton seeds should be effectively distributed to farmers through the AISCO (Agricultural Input Supply Corporation) of the BOA.

c) Drought: (i) Drought tolerant varieties for rainfed areas should be grown; (ii) Further study and planning is required to use the two lakes of North Omo (Abaya and Chamo) and perennial rivers like the Omo River for irrigation.

d) Labour shortages: (i) GO/NGOs must fight against human and animal diseases; (ii) There should be a GO, NGO or private firm tractor hire service to operate in areas like Abela and Bele.

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APPENDICIES

APPENDIX 1 - GLOSSARY

AFFA (Gar. and Kon.): A large portion of farmland divided up with tie-ridges, which contains many targa's.

AFFA MONA (Gar. and Kon.): The line which divides the farmland into affa's.

BIMODAL RAINFALL: In the Southern part of North Omo and part of the Omo basin there are two rainy seasons (two growing periods). The first growing period starts in March/April at the earliest and has a dependable length of about two months and a median length of almost three months. Then after a short two or three week gap, the main rains continue until September, or sometimes October.

BONDA (Wel. and Gam.): Exotic cotton type which was introduced into the area during the Italian invasion.

BULUKO (Amh.): A locally made cotton blanket (usually thicker and heavier than a gabi).

DIBIGNT (Amh.): Made of mud, or mud and wood, to store various products. Usually it is smaller than a gotera and found inside the house.

FILKEKA (Amh): Cotton ginning by hand.

GABI (Amh.): Cotton made cloth. In Ethiopia both men and women use gabis as a wrap-over clothing, especially during cold and rainy times.

GOLDA (Kon.): According to Konso farmers this is a cotton landrace introduced from the Elgo area.

GOTERA (Amh.): A granary made of wood and mud, usually placed outside a house.

HAGAYA: (Kon. and Gid.) Sorghum ratoon.

HALEKO (Kon. and Gid.): The local name given to a tree called *Moringa* spp.. The young soft leaves are edible when cooked like a cabbage. It is also believed to have medicinal value. The stem and the roots are also used to purify water.

INGULOA (Kon. and Gid.): A container made of bamboo and other plants.

INJERA (Amh.): A soft, thin and large Ethiopian traditional staple food made from teff.

KAWATA (Kon.): Bench terracing.

KEMIS (Amh.): A traditional cotton made Ethiopian dress used by women especially in rural areas and during holidays.

KERETITETA (Kon.): An indigenous cotton type in Konso.

KIRCHAT (Amh.): A container made of wood or bamboo and used to store various products. u=3

KOLATA (Kon.): An animal skin used as a bag to carry things.

KUTKUATO (Amh.): Loosening the surface of the soil and eradicating weeds mainly by the use of a hoe.

LANDRACES: According to Melaku "landraces are crop populations that have not been bred as varieties by scientists but which farmers have adopted to local condition through years of natural and artificial selection. They could also be referred to as 'talk seeds' to reflect the role of local communities in selection and innovation". (Melaku Worede, 1991)

LIKAKIT (Amh.): An oval shaped spun thread.

MARESHA: Ethiopian traditional plough used to make furrows or to losen soils by animal traction.

MASESHA (Amh.): Women make a type of cotton seed cake (without extracting the oil) and use it during injera preparation. A small portion of the cake is dropped on the hot mitad and spread around it. This lubricates the mitad and means the injera will be able to be lifted easily from the mitad and will not stick to it.

MEDAMECHA (Amh.): A simple mechanical apparatus. A flat piece of stone (usually well shaped) and an iron stick (25-30cm) is used to gin seed cotton.

MITAD (Amh.): A clay made tray that is placed over a fire and used to make injera.

MONOMODAL RAINFALL: As the term implies, there is only one main rainy season (growing season).

NETELA: Cotton made cloth men and women use it as a wrap over.

POTAYA (Kon. and Gid.): The smallest plot within a targa (one single tie ridge)

POTAYA MONA (Kon and Gid.): The line which makes the potaya's.

SELEN (Amh.): Container (to wrap seed cotton) made of the leaves of wild date palms.

SHILSHALO (Amh.): Shilshalo is conducted by animal traction. It is aimed mainly at loosening

the surface of the soil, but it also eradicates weeds. During shilshalo oxen and maresha usually damage plants.

SHOA (Kon.): A cotton landrace believed by farmers to have originated in Shoa region and later introduced to the Konso area.

SIPLOTA (Kon. and Gid.): A spear-like tool used for weeding, planting, etc.

SORMA (Gid.): What the people of the Elgo area called the zukay bird.

TARGA (Gid.): One targa contains many plots (potaya's)

TARGA MONA (Gid. and Kon.): The line which makes the targa's.
u=59
TIBEB (Amh.): A colourful, well designed and finely embroidered strip that is added to the edges of women's traditional costumes (In Amharic tibeb means wisdom).

TUBA (Amh.): A bundle of spun thread (i.e. a larger measure than likakit).

WOLDESEMAYAT G. WOLD: A popular governor of Wolaita who has initiated and accomplished useful development activities in Wolaita.

WEREDA (Amh.): A woreda is one of the components of the government administrative hierarchy in Ethiopia. One woreda consists of many Peasant Associations (PAs). At present each woreda has its own administrative councils, police station, BOA office, etc.

YEABESHA TIT (Amh.): Another name for Yengere.

YELA (Kon.): Farmland that is found between two mountais (hills) or at the lower part of mountainous steep surface.

YENGERE (Wel.): An indigenous cotton type in Welaita and Mirab Abaya

ZUKAY (Wel.): A bird that damages young cotton bolls. In English it is known as the mousebird.

APPENDIX 2 - Ethiopian and Gregorian calendars

In the Ethiopian calendar (based on the Julian system) there are 13 months. Twelve of these contain 30 days each and the 13th month (Pagume) contains 5 days (or 6 days in a leap year). The Ethiopian year begins on Meskerem 1. In general there is a 7 years, 8 months and 11 days difference between the Ethiopian and Gregorian calendars. Below is a guide to how the months in the two calendars coincide.

ETHIOPIAN CALENDER	GREOGRIAN CALENDAR
Meskerem	11 September - 10 October
Tikimt	11 October - 9 November
Hidar	10 November - 9 December
Tahisas	10 December - 8 January
Tir	9 January - 7 Feburary
Yekatit	8 Feburary - 9 March
Megabit	10 March - 8 April
Miaza	9 April - 8 May
Ginbot	9 May - 7 June
Sene	8 June - 7 July
Hamele	8 July - 6 August
Nehassieh	7 August - 5 September
PagumeP	6 September - 10 September

N.B. - In leap years Pagume has a sixth day, so the dates in the equivalent Gregorian calender will change by one day up until the end of February when the dates given above fall back into line with each other. For example Pagume will be 6th September - 11th September, Tahisas 11 December - 9 January and Yekatit 9 February - 9 March.

APPENDIX 3: Currency equivalents

The Ethiopian currency is the Ethiopian Birr (ETB), which is split into 100 santim (cents). The following is a guide to currency exchange rates between the ETB and both US$ and Pounds Sterling, in the last few years. Readers will notice the large devaluation in the value of the ETB in October 1992.

Date	ETB for $1	ETB for £1
24.03.1992	2.82	3.53
23.09.1992	2.98	3.55
06.10.1992	7.33	8.52
29.08.1994	6.18	9.10
15.09.1995	6.29	9.73

These currency equivalents may lead a foreign reader to think that an item costing (for example) 20 ETB (just $3/£2) is very inexpensive. But due to very low wages in Ethiopia this sort of currency equivalence cannot be easily made. The daily wage for an unskilled daily labourer is currently (August 1995) about 5 ETB. A kilo of sugar is about 6 ETB, a 100gram pack of Ethiopian tea is 2.25 ETB and an Ethiopian meal out will cost somewhere between 1.50 ETB (very basic, no meat) and 10 ETB.

The World Resources Institute "World Resources 1990-1991" book quoted the Ethiopian Gross National Product (GNP) as $126 per capita in 1987. UNICEF reported the GNP per capita (in 1992) as $110. Although GNP figures will now be complicated by the large devaluation of the ETB, it is clear that Ethiopia is an immensely poor country by any economic standards.

APPENDIX 4 - Government Administrative Hierarchy

In Ethiopia's recent history the government administrative hierarchy structure has tended to change with each government, and also within government phases. Below are the hierarchy structures from Emperor Haile Selassie's regime to the Transitional Government of Ethiopia (TGE). It is too early to say exactly what changes the recently inaugurated government of the Federal Democratic Republic of Ethiopia will make, although they have started making changes.

Emperor Haile Selassie (--> 1974)	Col.Mengistu Haile-Mariam's rule (1974 - 1991)		
Ethiopian Imperial Government | Province (Tellaigizat) | Awraja | Wereda | M/Wereda | Atbia	Ethiopian Provisional Military Government | Province (Kefle Hager) | Awraja | Wereda | Kebele (PA)	Ethiopian Peoples' Democratic Republic | Autonomous Region* | Awraja | Kebele (PA)	Ethiopian Peoples' Democratic Republic | Adiministrative Region | Awraja | Kebele (PA)

* Autonomous regions wer more authoritative than Admin regions

EPRDF	
1991-1995	1995- todate
Tansitional Government of Ethiopia | Klili / \ / \ Zone Special | Wereda | | Woreda Kebele | (PA) | Kebele (PA)	FDRE | Klili / \ / \ Zone Special | Wereda | | Woreda Kebele | (PA) | Kebele (PA)

TGE = Transitional Government of Ethiopia
PA = Peasant Association
EPRDF = Ethiopian Peoples' Revolutionary Democratic Front (a front of opposition groups formed in 1989 and who became the leaders of the TGE after the overthrow of Mengistu in 1991).
FDRE = Federal Democratic Republic of Ethiopia

All dates in G.C.

APPENDIX 5 - Agroclimatic zones in Ethiopia

Ethiopia is well known for its diversity in topography, climate, soil, vegetation and similar features. Agroclimatic zones in Ethiopia are differentiated on the basis of climate, soil and farming systems homogeneity. In each zone agricultural potentials and constraints can be highlighted from the prevalence of the conditions.

This diversity has been classified in a number of different ways by different institutions but the author has used the classification by the Community Forests and Soil Conservation Development Department (CFSCDD, 1986) and SIDA's Regional Soil Conservation Unit (Azene Bekele-Tesemma, 1993). The latter book enlarges on the work of the former. It includes an additional agroclimatic zone (namely Wet Kolla) for places such as Tepi that are 1,500 masl and receive over 1,400 mm of annual rainfall (please see the following page). To make the figure fit the North Omo cotton production conditions the author of this pamphlet has inserted an asterisk to indicate the four agroclimatic zones that grow cotton.

The Bereha zone is below 500 masl.

The Kolla belt (500-1,500 masl) has dry, moist and wet classifications. Dry is defined as having less than 900mm of annual rainfall, moist as having between 900 and 1,400 mm of annual rainfall and wet as having over 1,400 mm of annual rainfall.

Three zones are in the Weyna Dega belt which has an altitude of 1,500-2,300 masl. These zones are dry, moist and wet.

The Dega belt (2,300-3,200 masl) has moist and wet zones.

The Wurch belt (3,200-3,700 masl) is also subdivided into moist and wet zones.

The High Wurch zone is above 3,700 masl and only has a wet zone.

The North Omo zone of Ethiopia (in this case 'zone' means administrative unit and NOT agroclimatic zone) is located in the South West part of Ethiopia between 5 and 7 degrees North of the Equator and 36 and 38 degrees East of Greenwich. Its altitude varies from less than 500 metres above sea level (masl) in the West (long the Omo Basin) to over 3,000 masl in the South Western parts of the area and directly West of Arba Minch. Many parts of the zone are over 2,000 masl. Physiographically the region is composed of strongly dissected, hilly to mountainous areas, developed in granite rocks.

FARMERS' RESEARCH PROJECT

Introduction

This publication has been financed under the work programme of the Farmers' Research Project. This project which is designed and coordinated by FARM Africa, a British-registered charitable organisation, is focused on North Omo zone in south-west Ethiopia. The project started in early 1991 and is expected to last five years.

Objectives of the project

The wider objective of the project is to increase, in a sustainable way, the incomes of resource-poor households in North Omo and ultimately, by demonstration effect, in Ethiopia as a whole. The underlying assumptions are that improved agricultural technology is the key to improved productivity and incomes, and that "farmers' participatory research", i.e. research in which peasant farmers play leading roles in identifying and designing research as well as in carrying it out and evaluating it, is a cost-effective way of generating and spreading improved agricultural technology.

The immediate objectives of the project are designed to promote farmers' participatory research (FPR) and are:-

i. Better linkages and understanding between farmers, researchers and extension staff.

ii. A better knowledge about ways in which FPR can be conducted in Ethiopia

iii. Enhancement of the capacity of GOs (government organizations) and NGOs to enable farmers to do FPR.

iv. Incorporation by GOs/NGOs of FPR into their own activities.

Further information

Further information about this publication and the Farmers' Research Project can be obtained from:

Either

* FARM Africa, P.O. Box 5746, Addis Ababa, Ethiopia. Telephone (251-1-55 34 15, Fax 251-1-552143)

or:

* FARM Africa, 9-10 Southampton Place, Bloomsbury, London WC1A 2DA, UK. Telephone (44-071 430 0440, Fax 44-071 430 0460)

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