Christian Relief and Development Association

Training Programme on Crop Production

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1. INTRODUCTION TO CROP PRODUCTION

1.1 General

Crops constitute the dominant portion of human diet. Hence, crop production has been a major preoccupation of mankind since "hunting - gathering" was given up for settled agriculture" by our early ancestors. It could be assumed that the practice of crop production in those early days could have advanced very little from the practice of harvesting what happens to grow in the wild. But, with time, this has to improve because of increased demand for food brought about by population growth in the emerging human settlements. Thus, farming practices in the great centers of civilization of Mesopotamia, the Indus-Ganges Valley of India, the Nile Valley of Egypt, etc..., have attained a relatively high levels of sophistication some 5,000 years ago.

However, these great advances in the practices of crop production came about more from observations and trial-and-error activities by keen observers and/or farming practitioners than from results of systematic experimental results. It can be said that organized agricultural experimental activities (research) with measurable impact on crop production and productivity commenced with the establishment of the world's first experiment station at Rathamsted, England, in 1843, although some research work has been carried out by gifted amateurs, working on their own initiatives, since the early 16th century.

The practice of crop production today, particularly in the industrialized north, is a highly sophisticated business, supported by great scientific and technological institutions and involving multi-billion dollar investments. Crop production in the so called "Third World" in general and Ethiopia in particular, however, is still based more on "art" than on "science". Thus, age old tools and practices transmitted by word of mouth from father to son are still the norm, despite the fact that there are more and useful information for improving crop production and productivity.

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Therefore, the objective of this introductory part of the training course is to briefly review the broad aspects of crop production viewed from a management perspective. For ease of dealing with this wide and complex subject, it is necessary to organize the coverage along some coherent subject units. Accordingly, the discussions of this broad topic will be along the following eight headings:-

- The crop environment
- Sustainable production
- Cropping systems and practices
- Soil fertility and plant nutrition
- Water management
- Crop hazards and their mitigation
- Crop production technologies
- The economics of crop production

It should be noted from the outset that the practice of farming is a systematic process of utilizing climatic, soil and water resources in a sustainable manner for the production of crops needed for human (and animal) use. Such utilization can be influenced, both positively and negatively, by human interventions through technological innovations and socio-economic factors. There are also a large number of natural factors that hinder success in such efforts. Thus, the management of crop production enterprizes requires broad understandings of the various and complex interacting factors. The word **AGRONOMY** is used to describe the study of the management of crops under such complex interacting processes.

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1.2 The Crop Environment (23,25)

1.2.1 Climate

- Light and crop performance

Crop performance is affected by a number of environmental factors, chief among which is the climate. Although there are several components of climate that have measurable effect on crops, we shall briefly mention only a selected few because of their relatively greater impact.

As every student of biology knows light, received in the form of radiant energy from the sun, is the basis of life on earth. The process of PHOTOSYNTHESIS, carried out in every cell of green plants, is not possible without light. Therefore, the practice of successful crop production must rely in optimizing the photosynthetic performance of individual plants or crop communities through the manipulation of light reception and utilization. Although a lot can be said with respect to light - crop interactions, we need to focus more on the following points as far as crop management is concerned:-

- Geographic location and light - the geographic distribution of plant species is greatly determined by their PHOTOPERIODIC response. Some crops like maize and sorghum perform better under long days (or rather short nights) while others like wheat and barley are better suited to short days (or more properly long nights). These days, breeding efforts have to a large extent succeeded in producing day length "neutral" varieties, but still one must not lose sight of such issues in crop selection. Of course, Ethiopia's tropical/sub-tropical situation may also be an added advantage in this regard.

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- Plant density/distribution - Obviously, plant population per unit area as well as its distribution make a great difference in the amount of light received by individual plants and this will have an impact on the yield and/or quality of the produce. Higher population density per unit area, up to a certain limit depending on the nature of the crop, can be expected to result in higher production per unit area, but yield and/or quality of produce per plant may be lowered. Similarly, spacing between plants could have an impact on crop productivity and/or quality. It is generally accepted that equidistant spacing is more productive than other forms of spacing. It should also be mentioned that weed competition, and hence damage due to weeds, is highly minimized under higher plant density. This has an impact not only on yield but also on cost of production.

- Plant ideotypes - there are efforts at engineering the morphology or shape of plants for more effective and efficient interception of light. In some crops (eg. maize) plants with narrow and erect leaves are said to be more efficient than those with broad and horizontal leaves. The former types are assumed to be more effective under higher population densities than the latter because of less mutual shading among plants.

-Temperature and plant growth

We are well aware of the importance of temperature on plant growth. Extreme temperatures, both on the low and high sides, curtail crop performance. Temperate (cool season) crops like wheat and barley withstand lower temperatures better than tropical (warm season) crops like maize and sorghum, both of which can tolerate the effects of higher temperatures better than temperate crops. The specific range of heat tolerance for each

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crop or crop group varies and will have to be ascertained under growth chamber or field conditions.

However, temperature as a limiting factor to crop productivity, is not very pronounced in the tropical/sub-tropical climates in this country except under extreme altitudinal conditions. But, it will be a useful concept to keep in mind, especially in relation to crop introductions from other parts of the world. There are cases where "winter wheats", that require chilling for flower initiation (vernalization) were used by some farmers with disappointing results. Fruit crops like apple, plumes, etc. requires relatively cool temperatures to flower and, therefore, have to be grown under highland conditions.

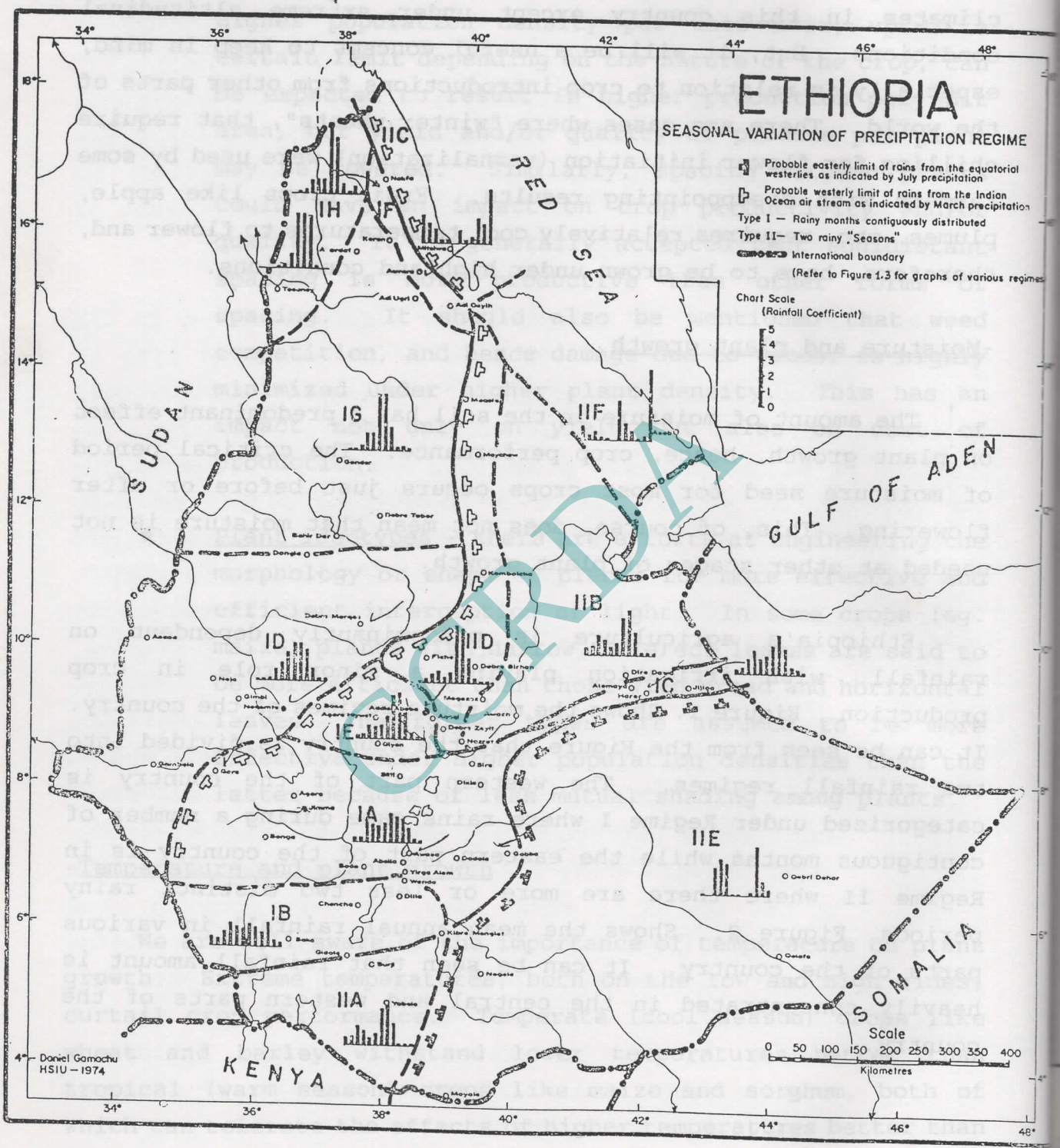
-Moisture and plant growth

The amount of moisture in the soil has a predominant effect on plant growth, hence, crop performance. The critical period of moisture need for most crops occurs just before or after flowering. This, of course, does not mean that moisture is not needed at other stages of plant growth.

Ethiopia's agriculture is predominantly dependent on rainfall, with irrigation playing a minor role in crop production. Figure 1. Shows the moisture regimes of the country. It can be seen from the Figure that the country is divided into two rainfall regimes. The western part of the country is categorized under Regime I where rains came during a number of contiguous months while the eastern part of the country is in Regime II where there are more or less two distinct rainy periods. Figure 2. Shows the mean annual rainfall in various parts of the country. It can be seen that rainfall amount is heavily concentrated in the central and western parts of the country.

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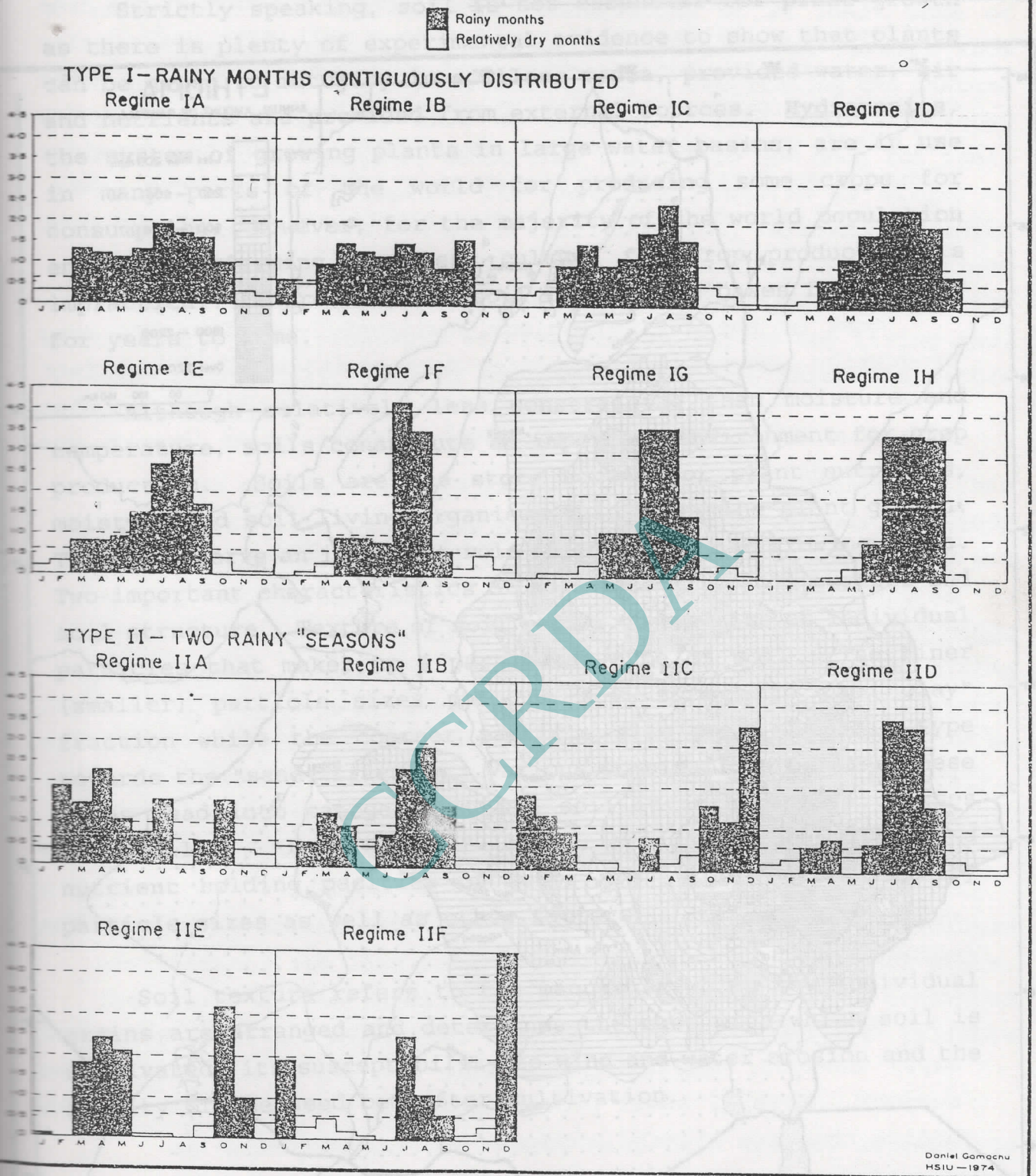
Figure 1. Rainfall Regiems in Ethiopia



Source: Daniel Gemechu, 1977

TYPES OF PRECIPITATION REGIMES IN ETHIOPIA

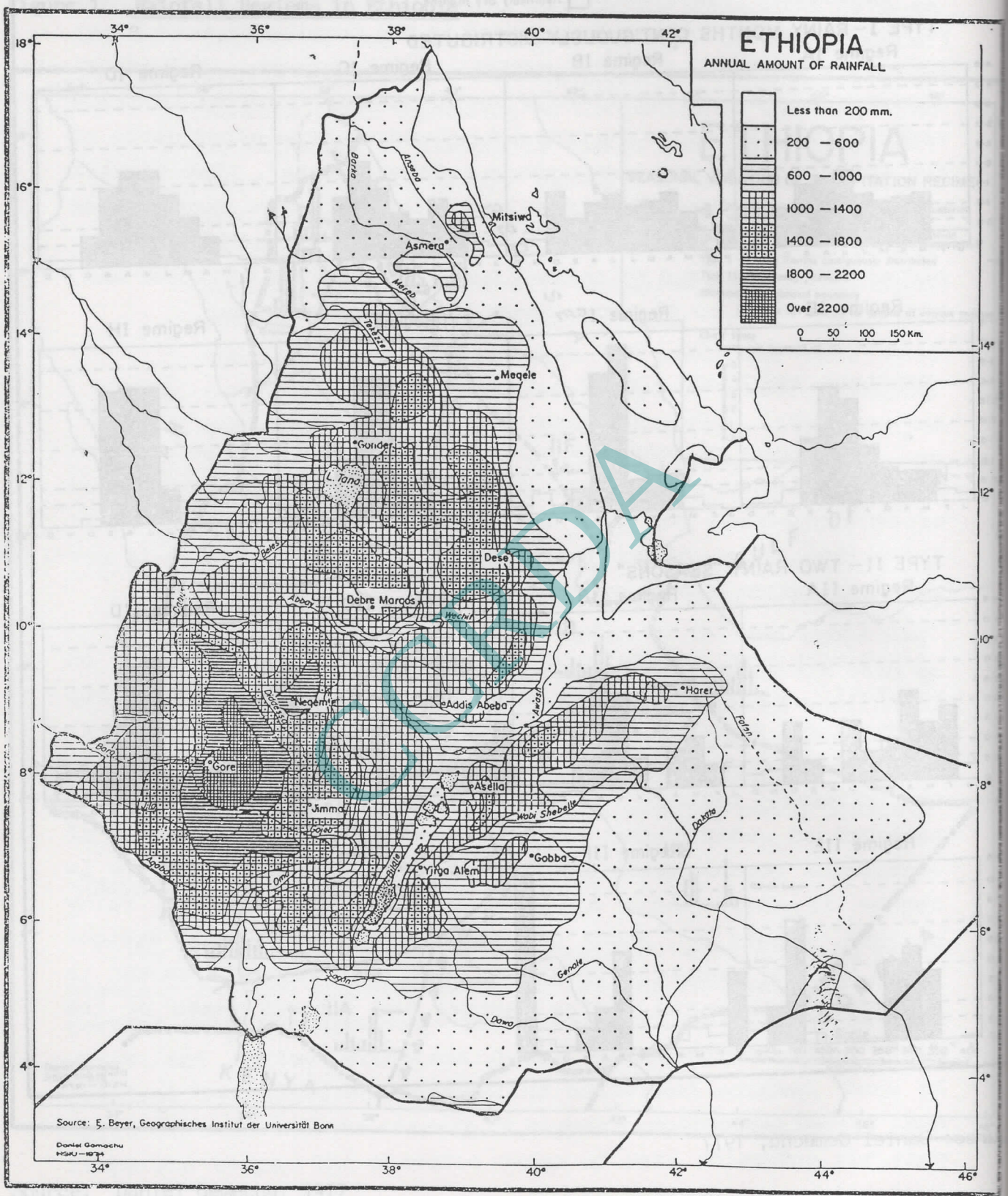
(Refer to Figure 1.2 for location of regimes)
(Ordinates of graphs are coefficients of precipitation)



Source: Daniel Gemechu, 1977

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Figure 2. Mean Annual Precipitation in Ethiopia



Source: Daniel Gemechu, 1977

-Soil and Plant growth

Strictly speaking, soil is not essential for plant growth as there is plenty of experimental evidence to show that plants can be grown to maturity in soilless media, provided water, air and nutrients are provided from external sources. **Hydroponics**, the system of growing plants in large water basins, are in use in many parts of the world for producing some crops for consumption. However, for the majority of the world population engaged in farming, soilless culture for crop production is impractical. Therefore, the soil remains the bases for farming for years to come.

Although relatively less constraining than moisture and temperature, soils constitute an important environment for crop production. Soils are the store houses for plant nutrients, moisture and soil living organisms that determine plant growth. They also serve an important role in anchoring the growing plant. Two important characteristics of soil relate to soil texture and soil structure. Texture of soil refers to the size of individual particles that makes up a particular type of soil. The finer (smaller) particle sizes put the soil type into the "clay" fraction while the coarser particle size puts the soil type towards the "sand" fraction. Various combinations between these sizes lead into categorizing the soil in intermediate classes such "silts", "loams", "silt-loams", etc...,. The moistureand nutrient holding pacities of soils are largely determined by particle sizes as well as other factors.

Soil texture refers to the manner in which the individual grains are arranged and determines the ease with which soil is cultivated, its susceptibility to wind and water erosion and the quality of the seed bed after cultivation.

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Biotic factors and plant growth

Soil organisms constitute another important part of the crop environment. In fact it is said that a soil does not usually develop until the inorganic material is invaded by various kinds of organisms such as bacteria, fungi, protozoa, algae, nematodes and other worms and insects. We should, of course, consider higher organisms such as vertebrates animals (monkeys, rats, birds and even humans) and higher plants as part of the crop environment.

Most of the soil organisms positively contribute to crop production through organic matter decomposition, plant nutrient fixation and improving soil aeration. However, there are also some biotic groups that negatively affect plant growth and development.

1.3 Sustainable Production (16,17,26,31)

1.3.1 Defining sustainability

The issue of "sustainability" has attained critical significance in any project development, particularly in the fields of agriculture and natural resources.Needless to say, this is a justified concern. In the particular case of Ethiopia, centuries of heedless exploitations of farm, grazing and forest lands have resulted in serious degradation of the country's resource bases for future growth in agriculture, which is the mainstay of the national economy.

Various authorities define "sustainable" growth in various ways; however, all are agreed on the general scope of the subject. Here, I shall provide versions from two famous world bodies that are closely concerned with the issue:-

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It would be unwise to assume that Ethiopian farmers, like their counterparts in other parts of the world, are totally unaware of the environmental consquences of at least some of their farming practices. We can be certain that farmers know that deforestesting the natural forest or overgrazing the pasture lands increases the risk of erosion. They also know that applying animal manure, which they convert to cow dung for fuel, to the land will improve its fertility. Thus,in an effort to ensure the current survival of their families, farmers compromise long term sustainability for short term security. They continue to apply these destructive practices despite "advises" to the contrary, simply because of pressures of day-to-day living and, most importantly, lack of better alternatives which are within their means.

This subject has been given a good deal of attention in this country for some time. The Ethiopian Highland Reclamation Study of 1984, for example, has produced volumes of documentation and useful recommendations. One of the concepts related to sustainability is contained in the so called **CONSERVATION BASED DEVELOPMENT** In essence, this refers to using and exploiting natural resources BUT on the basis of their optimum (not maximum) production potential so that current production is tempered by measures aimed at sustaining or enhancing future productivity.

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1.3.2.2 Knowledge of production potentials

It is common knowledge that more agriculturally favorable environments are less prone to degradation than marginal areas. Therefore, a more intensive form of production can be attempted under such environments. This, however, requires reliable information on natural resources potential.

As mentioned earlier, there have been several attempts to gather reliable information on the production potentials of the country. The Ethiopian Highlands Reclamation Study (EHRS) has divided the Ethiopian highlands (i.e, above 1,500 meters above

- The World Commission on Environment and Development, otherwise known as the Brundtland Commission, defines sustainable development as "... development that meets the needs of the present without compromising the ability of the future to meet their own needs."

- The Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) defines sustainable growth as "...the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources".

1.3.2 Basic issues in sustainability

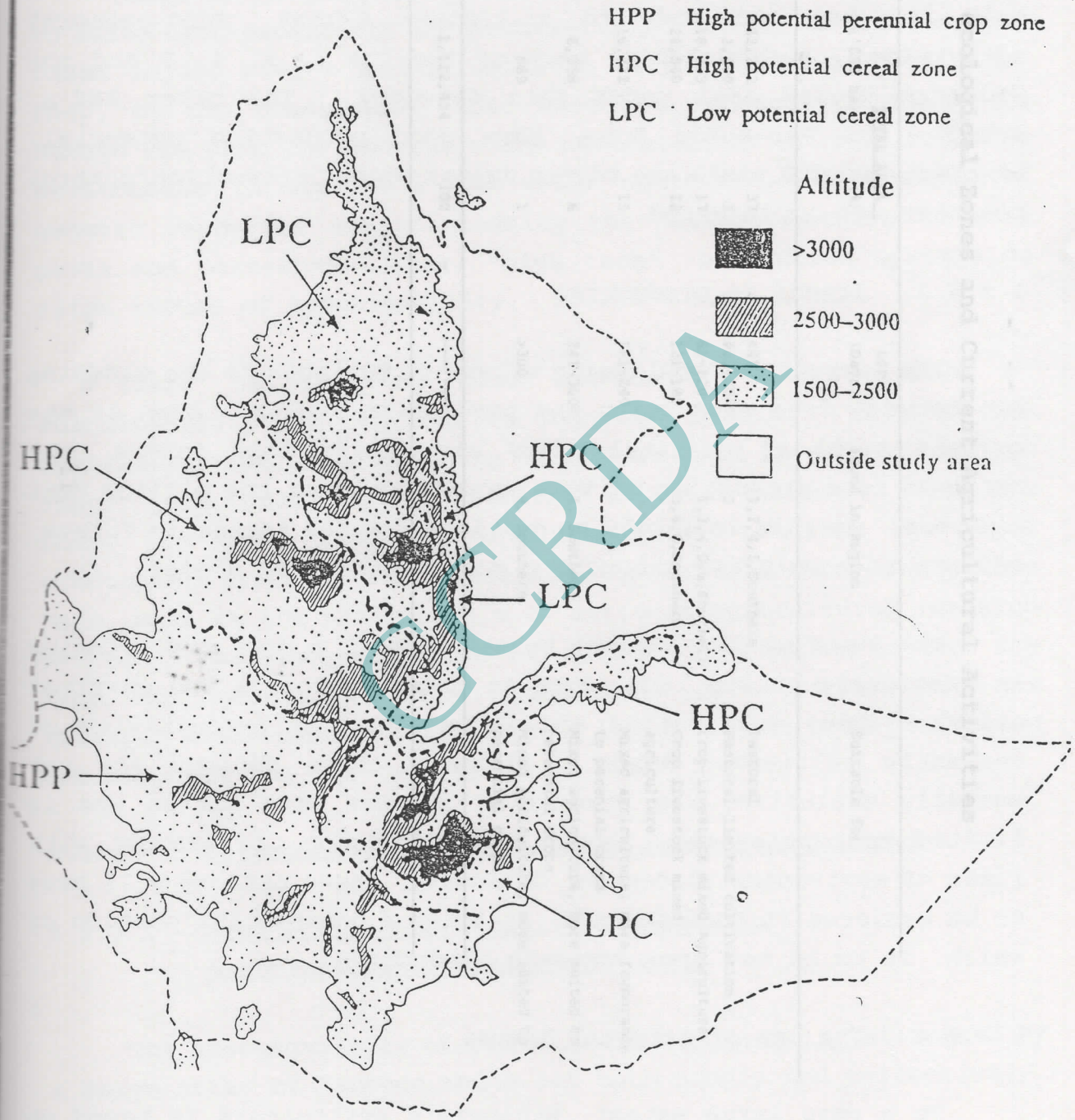
However it is defined, there are some basic and often conflicting issues that need to be considered in relation to sustainability while raising or improving crop production and productivity. It must not be assumed that there is unanimous agreements among concerned stakeholders on the ways and means of dealing with this important subject. Thus, production (project) managers need to be aware of at least the important issues.

1.3.2.1 Balancing present needs with future requirements

Agriculture in general and crop farming in particular are activities essentially aimed at exploiting natural resources such as land and water to meet human (and animal) requirements. The degree of exploitation is accelerated by rapid population growth and urbanization. Obviously, such exploitations, in the absence of effective alternatives and regulating mechanism, lead to environmental degradations that negatively affect sustainable production.

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FIGURE 3 **MAJOR AGROECOLOGICAL ZONES ETHIOPIAN HIGHLANDS**



Source: Technical Committee for Agroforestry in Ethiopia and ICRAF, 1990

sea level) into three broad agro-ecological zones (AEZ) as shown in Figure 3.

But, a more recent study has identified that the country can be divided into 18 AEZ's and 62 sub-zones grouped into seven major categories (Table 1)

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Table 1 The Agro ecological Zones and Current Agricultural Activities

Catagories of Major AEZ's	No. of Sub. Zones	TOTAL AREA ('000 ha)	TOTAL AREA (%)	LGP (Days)	Found in Region	Suitable for
Arid	8	42,272	37	<45	1,2,4,5,Southern	Pastoral
Semi-Arid	6	2,900	3	46.-60	3	Pastoral-limited cultivation
Sub-moist	11	18,963	17	61-120	1,3,4,5,6,Southern	Crop-livestock mixed Agriculture
MOIST	15	24,540	22	121-180	3,4,6,Southern	Crop livestock mixed agriculture
Sub-Humid	11	16,732	15	181-240		Mixed agriculture, more favourable to perenial crops
Humid	8	6,358	6	241-300	4, Southern	Mixed agriculture, more suited to perennial crops
Per-Humid	3	669	1	>300	4, Southern	Mixed agriculture, more suited to perennial crops
Total	62	1,112,434	100	-	--------	

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The identification of these AEZ's is based on three major factors:- the length of the growing period (LGP), thermal regimes and land forms (physiography). Table 1 also shows the total area under each AEZ, the administrative regions where these AEZ's are found and the traditional agricultural activities undertaken. Thus, with the current level of technological development about 40% of the country (i.e, arid and semi-arid zones) can be used only for pastoral and, to a limited extent, agro-pastoral activities. A substantial part of Regions 1, 2, 4, 5 and the Southern Region fall under this category. The other AEZ's, except, the Per-humid Zone, have good production potential, however, erosion risks are severe unless proper prevention/control measures are implemented.

1 3.2.3 Trends in production

The current and continuing crises in Ethiopia is the widening gap between food production and population growth. Even at the current level of marginal daily per capita food intake, the national food production deficit amounts to about one million tons per year. As this is likely to continue for the forseable future, efforts to accelerate production must be taken as a goal.

The two possible options to attain such a goal are bringing in previously unused land (such as grazing, forest and marginal areas) under cultivation and increasing the productivity of currently cultivated lands. Although these options are not mutually exclusive, the chances of success with option one is limited and option two, though more promising, is fraught with risks of environmental damage. Obviously, these options will have to be explored if food demands, at least a substantial portion of which, is to be met from domestic production.

1.3.2.4 The use of external inputs

To a very large extent, Ethiopia's agriculture is based on traditional knowledge and uses precious little of perchased

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agricultural inputs and services. According to current information, the annual use of chemical fertilizers, crop protection chemicals, improved varieties and other so called modern inputs can be considered marginal, although it has been on the increase since the late 1960's.

There is an irony in relation to the use of external inputs to raise crop production and productivity. While, on the one hand these inputs have a proven value in raising crop productivity, they, on the other hand, also have the inherent potential to damage the crop environment which ultimately translates to human environment through soil and water pollution, destruction of genetic resources and eliminating the natural enemies of crop pests and parasites. Thus, "high tech" production systems do raise issues of sustainability.

There is also an added dimension to the issue of sustainability in relation to external inputs. This is the question of continued capacity of farmers (and indeed nations) to import such inputs at high cost from external sources. There are those who argue that the development and transfer low input production systems, and especially those that have indigenous base, must be the ultimate aim of national agricultural research systems. The big question is can such systems enable to meet the food and industrial crops requirements of a country such as Ethiopia where population growth is likely to out pace production not only now but for many years to came?

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1.3.3 Determinants to Sustainable Agriculture Growth

1.3.3.1 Need for a comprehensive approach in planningagricultural development

The sustainability of growth in agriculture is influenced by a large array of factors which act both singly and collectively.

It is, therefore, necessary to take these into account in the agricultural development process. It is also important to note that the achievement of sustainability in agricultural development ultimately depends on the attitudes of peoples, hence the need for sensitization, education and promotion (through incentive schemes) of people to care for the environment and act accordingly.

The planning process must also consider ways and means of encouraging the development and adaptation of novel production systems more suitable for a given environmental situation. Good examples of such systems could be the Broad-Bed and Furrow system in the extensive highland vertisol areas or Alley Cropping and Agro-Forestry systems in mid-altitude and highland areas with soil erosion problems, particularly in relation to mixed farming conditions.

1.3.3.2 Biological Determinants

The following are some of the major biological factors that are important in determining the sustainability of agricultural production.

- Destruction of genetic resources

  Ethiopia is well endowed with a diversity of genetic resources, both crops and animals, that could play a significant role in the sustainability equation. However, these resources are being rapidly deciminated by the combined forces associated with poverty, illiteracy, "modernization", inadequate government laws/regulations and lack of incentive schemes. There is an undeniable truth in the adage that says "there is safety in diversity", particularly in relation to pest outbreaks. However, one must not associate "conservation" with museum type of work, but with rational utilization of resources with the future in clear focus.

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- Crop pests build up

Among the preconditions for intensifying crop production include the increased use of such inputs as fertilizers and high yielding varieties. But, it is a common experience among countries that those factors that favor increased productivity also favor the rapid build up of pests, including insects, disease and weeds. The use of uniform varieties across a contiguous wide area under high fertility conditions could be a recipe for disaster unless adequate attention is given to breaking pestdevelopmentcycles. Smallerrorscould result in loss of yield stability in the short-term and sustainability in the long-term.

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1.3..3.3 Physical Determinants Land resources

Table 1 shows the potentially available land and its sustainability for agricultural production under the current level of technology. However, the total area used for crop production in any one crop season has never exceeded seven million hectares (or 48%) of the potentially available land for annual crops and one million hectares (53%) of the land potentially available for perennial crops. There would, thus, seems to be quite a significant potential for "extensification"; however, this has to be taken cautiously because much of this areas may have limitations in land forms, endemic diseases, difficult soil characteristics, etc.

The great issues in sustainability in this respect, however, are associated with soil erosion, the depletion of soil fertility and the poor water holding capacity of some soils. Needless to say, these are brought about by inappropriate land management practices by small holder farmers and, to a lesser extent, by commercial/semi-commercial farmers such as state farms and the

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former producer cooperatives. It must be mentioned that there are no lack of suitable techniques for minimizing the risk of soil and water loss. The challenge is how to get these widely known and properly adopted by farmers.

1.3.3.4 Water Resources

Because of its relatively abundant rainfall and extensive highland plateaux, Ethiopia is sometimes referred to as the "water-tower" of Eastern Africa. However, this abundant water resource has negatively contributed to the sustainability of Ethiopia's agricultural growth. The intensity of rainfall over a relatively short rainy period has exacerbated the intensity of soil loss through various form of erosion. Farmers' inability or unwillingness to introduce already available water and soil management techniques continues to contribute to the degradation of the environment.

Irrigated agriculture in Ethiopia today can be considered at its infancy. The issue here is not the limitation of water for irrigation but rather the availability of suitable land for irrigation. According to the Ethiopian Highland Reclamation Study, the total potentially irrigable land in Ethiopia is estimated at 3.15 million hectares, about 200,000 hectares of which is found in the highlands (i.e. elevation about 1,5000 masl).

So far, not more than 200,000 ha is developed both for small-scale as well as for medium and large-scale irrigation in the whole country. Because of poor design and/or construction , many of the medium/large scale schemes are contributing to the degradation of the environment due to waterlogging, i/e.; rising water table, salinization/alkalization and disease/parasite build up. It is also reported that water-use efficiency is very poor in many of the irrigation schemes or construction.

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1.3.3.5 Atmospheric resources

This topic may not constitute an urgent issue in the Ethiopian context at this time, but it is a subject that planners and developers must keep in mind in contemplating sustainable growth in agriculture. Pollution of the environment through toxic gas emissions into the air by industries and vehicles should not be taken lightly. The global warming brought about by increased carbon-dioxide and other gases in the atmosphere creates a condition known as the "green house" effect and is considered a potential threat to sustainability in the longer term.

1.3.3.6 Hazardous chemicals and energy

A large amount of energy is needed in the production and utilization of modern agricultural inputs and machinery both of which are crucial ingredients for intensive agriculture. These energy demanding inputs have side-effects that have negative consequences for sustainable growth. Besides their high costs, they also contribute to environmental degradation through soil and water pollution. The uses of biocides (insecticides for example) and fertilizers in large and indiscriminate amounts are known to affect surface and ground waters and could enter the "food-chain" with determental effects.

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1.3.4 Socio-Economic and Legal Determinants

1.3.4.1 Need for Vigorous Agricultural Development

Experiences clearly show that it is the poorer and less developed countries that are facing the worst environmental degradation problems. Ethiopia, as one of the least developed countries with a per capita GDP of around USD 120, is no exception to this. Its predicament is greatly aggravated by its rapidly growing population, estimated to grow by 3.1% per year.

It is, therefore, necessary to find ways and means of accelerating the economic development of the country so that adequate resources could be deployed to alleviate at least some of the constraints to proper environment management. It is obvious, in the Ethiopian context, that sustainable growth can not be contemplated without a well planned and vigorous agricultural development, at least in the forseable future. The TGE's Agricultural Development Led Industrialization (ADLI) policy says as much; however, its commitment to the implementation of this policy remains to be seen!

1.3.4.2 Inappropriate economic policies and market infrastructures

During the past two regimes in Ethiopia, it has been stated that Agriculture, as the backbone of the national economy, will be accorded high priority in terms of administrative and political support, particularly in financial allocation. However, hindsight proves otherwise. In fact past policies have consistently tended to work against growth in agriculture, particularly the small-holder sub-sector which forms the dominant portion. Lack of continuity in policy, lack of land and tree ownership rights, negative terms of trade, regimented marketing and pricing policies, restricted markets and inadequate marketing infrastructures are all examples stiffing sustainable growth in agriculture.

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1.3.4.3 Inadequate inputs and credit supplies

As indicated earlier, intensification of agriculture for higher productivity and total production depends on adequate and sustained use of improved agricultural inputs such as high yielding varieties, fertilizers, pesticides and improved farm machineries and implements (Not necessarily tractors!). These have never been available in adequate quantity or quality. According

to recent statistics from the MOA,not more than 20% and 10% of farmers use fertilizers and improved varieties, respectively, on a regular basis. Even those that use these improved inputs on a regular basis use them at sub-optimal levels, i.e., below recommended rates. The MOA reports that some 200,000 MT of fertilizers were imported for the 1994/95 crop season. Admittedly this is the highest level of importation so far but this is equivalent to no more than a meager 8 kg for each hectare of cropped land in the season.

Another major constraint to the intensification of agricultural production, particularly in the peasant sub-sector, is the extreme inadequacy of the formal credit system. The main source of formal credit to the farming community is the Development Bank of Ethiopia which has only 32 offices (including its head office) to serve about 8.5 million rural households. Added to this is the stringent loan eligibility criteria that discriminates against the small holder and food producer farmer. In the past, at least, most of the loans from DBE went to state farms and Producer/Service Cooperatives, particularly those engaged in the production of export or cash oriented produces, mainly coffee.

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1.3.4.4 Weak institutions for technological support

As is often said, Ethiopia's agriculture is overwhelmingly traditional. Attempts to generate and introduce improved technologies started, even if in a modest scale, only in the late 1940's or early in the 1950's. Although a significant stride has been made since then, the current institutional set up is much too inadequate to satisfy the requirements for accelerated growth.

The national agricultural research services are a too few, poorly staffed and equipped and inadequately integrated. Even the limited number of technologies currently made available through the research services are not made available to farmers in

adequate quantity, quality and at the time and place they want them. The main constraints associated with these are 1) inadequate number of organizations engaged with the multiplication and dissemination of improved technologies and 2) the weak institutional and manpower base of the extension service responsible for the demonstration and popularization of these innovations. It can also be stated that the constraints related to a largely inaccessible public credit scheme, the poor transport and marketing infrastructures as well as the general lack of attention by concerned agencies all exacerbate the already difficult situation.

1.3.4.5 Problems of land tenure

The ownership or use rights of landed property has always been a major bottleneck to agricultural development in Ethiopia. The feudal land holding arrangements before the 1974 Rural Lands Proclamation denied small farmers the fruits of their labor. Although the "nationalization" of rural lands effectively eliminated this injustice, it introduced negative elements that discouraged farmers from applying themselves to developing land by injecting insecurity of tenure. Other laws also introduced dis-incentives that frustrated further efforts. This issue is not settled even now. Until farmers have full rights to their land and any development thereon, the issues of sustainable growth in agriculture will remain an unattainable dream.

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1.3.4.6 Inadequate/inappropriate laws/regulations

The protection of Ethiopia's resource bases from wanton and/or irrational exploitation requires not only the promulgation of laws and regulations on the use of natural resources but also their effective enforcement. Needless to say, there are major weaknesses on both scores. The destruction of forests and the wildlife in the them, the uncontrolled increase of livestock that denude the potentially productive grazing lands, the cultivation of steep slopes that results in massive soil and water loss, the

over-fishing of some of the lakes, etc. are cases in point. It is difficult to over emphasize the fact that the future generations of this country will be left without sustenance if the past and present trends of over exploitations are allowed to continue unabdated.

1.3.4.7 Inadequate or total lack of participatory approaches

It is agreed that "development" has no meaning unless it is designed for and targeted at the people. This can make sense only if the target populations are active participants to the development process. Past experiences in planning in this country rarely involved the rural communities in relation to their needs and priorities in development; but rather planning was the domain of urban based decision makers and intellectuals. Thus, over fifty years of planning exercises have very little to show in terms of improving the living standards of the rural masses of Ethiopia, despite spending billions and billions of local and foreign money in the process.

One, of course, can not deny the building up of some important infrastructures and the improvement in human capital, but the fact remains that the contributions from these to the welfare of the rural poor is negligible in real terms. Hence, planning development at the grass roots levels and enlisting the active participation of those for whom the development is intended is a must. It must be noted that this has been started, particularly by some Non-Governmental Organizations (NGO's) as well as by Community Based Organizations (CBO's), but, this process need not only be further encouraged but also government organizations must make such an approach their **modus operandi**

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1.3.4.8 Gender related issues

As in the case of participatory approach to development, the issue of women in development has not been accorded the attention it deserves. This issue has now become a hot topic in many planning and discussion forums and it is to be hoped that careful attention to the needs, priorities and contribution potentials of women can be made a part of the planning exercise.

It will not be easy to anticipate how the WID issue will evolve over time in the Ethiopian context, particularly in the short to medium period. However, the role of women in public (government) and family affairs needs careful balancing. Considering the family is the foundation for a healthy and disciplined society and considering the traditional responsibility of women in the development of such societies, it would require careful analysis as to how this dual role can be met by present generation of women, especially with the advantages provided by expanding education opportunities.

1.3.5 Human Resources

One of the main resources of any nation is its human capital. While the number of people in a country can either be a bonus or a curse, depending upon a number of factors, the determining factors are the health, education and resourcefulness of the people.

In the Ethiopian context, the human capital requires further development to realize its latent potential. The health, education and resources status of our population is much below what is needed to enhance sustainable economic development. This bad situation is likely to worsen unless properly targeted actions are implemented.

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1.4 Cropping Systems and Practices

Cropping systems refer to the sum total of activities undertaken by farmers in the process of crop production. These activities range from defining land use plans to harvesting and storage of produces. Actually, these range of activities are quite complex, although they appear easy and natural because of inherited traditions or long years of experience. Despite this, however, these activities determine the final outcome of farming operations. A summary of these activities and their impact on crop production and productivity will be discussed below.

1.4.1 Identification of land use systems (8-10, 9, 23)

The first task in farm operations is the identification of the appropriate land use for a given piece of land (family farm) in case of individual farmers or the community land in cases where communal farming is practiced. Small scale peasant farmers have developed, over long years of practice, their own scheme of land use plan, which under low population and environmental presures, have served them well to meet their subsistence needs. But, with increased demand and environmental presures, these schemes are increasingly becoming inadequate and are requiring reconsiderations.

Traditionally, Ethiopian farmers have assigned lands for crop production (cultivation), grazing and tree production, in addition to assigning land for building homesteads and other non-production purposes. There are evidence to date that their traditional basis for deciding land use, in many cases, can be made more appropriate for their environmental conditions. current uses do not only increase the risk of land degradation through erosion, it is also not the best use that can be made of the land interms

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of economic gains. Therefore, there is a need to carry out land classification studies not only for soil conservation purposes but also to determine land capability so that optimum use can be of the land.

There are detailed methodologies and tools for conducting soil classification and land capability studies (see the various references listed). Obviously, the factors determining land capability include climate, soil, physiography and socio-economics. For land classification, the most important features to observe in the field are those directly or indirectly related to soil erosion such as 1) slope, 2) soil depth, 3)past erosion, 4) waterlogging, 5) infiltration, 6) topsoil texture and 7) surface stoniness and rockiness.

Once land classification/land capability studies are concluded, the next step will be to identify cropping patterns that not only fit the environmental conditions but also affords the best mix of enterprises for optimizing economic gains for the family or community. Field visits to many parts of the country show that farmers grow a number of crops on their farms. It does not require much expertise to conclude that farmers' crop selection is not entirely based on optimization of income nor on maximizing the conservation of the environment. Obviously, farmers have their own logic for the cropping pattern they prefer. Thus, project managers with the aim of improving farmers' practices on cropping patterns, indeed on optimizing land use, have a lot to do if they wish to reach their aim.

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1.4.2 Tillage systems (23, 25)

Tillage refers to all activities undertaken to prepare and manage the soil for crop production. This is an age old practice common to both traditional and modern crop production systems. The objectives of tillage are to prepare a suitable seed bed, to eliminate/minimize weed competition and to improve the physical condition of the soil. In arid and semi-arid regions, tillage

system may have an additional objective of improving soil moisture storage.

The type and intensity of tillage operations to undertake are much dependent on the climatic and soil conditions of the area as well as on the type of cropping patterns selected. Since these operations tend to be costly both with respect to time and labor, the choices of operations have to be given serious considerations. The most obvious of these considerations include:- the quality of seed bed required, the timing and frequency of tillage and the type of farm machinery and/or implements to use.

It should be noted that there is no unanimous agreement among experts on the need for cultivation, if weed control can be achieved through other means such as with weed killing chemicals. There are experimental evidence that show that yield reduction under reduced tillage is minimum (about 10-15%) as compared to "normal"tillage practices. This, obviously, has impact on cost of production.

There are those who still advocate deep and frequent plowing. But, there are experimental evidence to show that deep plowing has no significant effect on improving permeability or improving aeration, even in heavy soils. Frequent disturbing of the soil surface only increases the risk of soil erosion by wind and water.

The type of implements for use in initial seed bed preparation and in later cultivation operation is an import issue. There is no lack of information on this subject, but this is largely an academic subject for the majority of Ethiopian farmers as they do not have the necessary financial power to use them, except in a few cases where government tractor-hire services or private farmers can make them available. But, there is no denying the fact that these modern machines and implements can make significant savings in time and labor in farm operations.

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1.4.3 Seeds and seeding (14, 19, 25, 28)

There is no question that the use of high quality seed of improved varieties adopted to local conditions is the cheapest way of increasing crop production per unit of land. This has been sufficiently substantiated by a number of experimental results under both "on-station" and "on-farm" conditions. The IAR and the Sasakawa Global 2000 field demonstration programs have clearly shown the advantages of good seeds of improved varieties over traditional varieties under Ethiopian conditions. Similar results have been obtained from other programs in the country.

Plant breeders at the Institute of Agricultural Research (IAR), the Alemaya University of Agriculture (AUA) and the Awasa College of Agriculture (ACA) of the Addis Ababa University (AAU) have produced a large number of varieties of various crops that are suitable to many locations in the country. However, many of the varieties have not been in use by farmers for reasons beyond the control of the above institutions. Also, some of the varieties have been known to fail for several reasons, chief among which are diseases and pests and use in environments for which they are not selected.

There are only two organizations in the country engaged in the multiplication of "released" and/or "recommended" varieties. The Ethiopian Seed Enterprise (ESE) is the biggest of the two producing close to 50,000 tons of "processed" seed annually. The ESE, according to its 1994 publication, produces seeds of 55 varieties of various field food crops. It does not deal with vegetable fruits, fiber, stimulant and pasture crops. The second organization in seed multiplication activities is the Ethiopian Pioneer Hi-Bred Seed Company. This is established more recently and produces a much less quantity of hybrid seed of maize, sorghum and sunflower.

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Seeding methods are among the crucial management tools for improving crop performance. The crucial elements in this respect include time of seeding, depth and uniformity of seeding and seed rates. Among these, seeding time is the most crucial and the chance of increased yield is improved with early planting, if rainfall condition is reliable and seed bed preparation can be completed in time.

Depth of seeding is important under moisture limiting conditions; however, maintaining uniform seeding depth under such circumstances could be difficult, especially by using the traditional broadcasting system of Ethiopian farmers. Seeding depth affects plant emergence and consequently maturity time.

Finally, seeding rates ultimately relate to plant density per unit areas. The effect of plant density, as mentioned earlier, depends upon whether or not we require quality on quantity. As there is a trade-off between these two criteria, one can not generalize on its effect. But the general recommendation these days is towards increased plant density (up to a point) in order to maximize productivity per unit of land rather than productivity per plant, if quality of the produce is not the objective.

1.4.4 Cropping intensity (6, 19, 25)

Except in the sub-humid and humid AEZ's of Southern and South-Western Ethiopia, the traditional practice of land use is to take in one crop a year, where soil and water conditions permit. In fact, in some of the highlands (eg. Northern Shewa and part of the Arsi highlands), crop cultivation is restricted to only two or three harvests in 7-14 years due to heavy soil and waterlogging conditions. This of course, does not mean that land is not used at all, since it is used for communal grazing.

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Although there are only limited data and information on intensifying land use under Ethiopian conditions, there is plenty of reliable evidence from international sources on the ways and means of increasing land use intensity in a sustainable manner. It is entirely possible that such data from the East African highland areas like Kenya and Northern Tanzania can be applicable to our conditions and should be a basis for encouraging large scale adaptation trials.

One of the methods for increasing cropping intensity is intercropping, where two or more crops of distinctly different growing habits are grown together on the same plot of land. This is a common practice in many parts of the world, including Ethiopia, under humid, sub-humid as well as semi-arid conditions. For example, Ethiopian farmers intercrop perennial crops like coffee and enset (sometimes along with annual crops like maize) under humid/sub-humid conditions while highland farmers are known to inter crop teff with safflower. But these practices are quite haphazard and unsystematic.

More systematic intercropping systems have been developed in many countries, although systematic work on this subject is quite limited in Ethiopia. Research work at Bako, Jimma and Wonago (all under IAR) has produced useful results for intercropping maize with pasture forage crops, maize with phaseolus beans and enset with coffee. But studies in countries like Kenya, Tanzania, Malawi, India have clearly shown the possibility and feasibility of intercropping cereals (mainly maize, sorghum and millets) with leguminous crops as an effective method of increasing land use intensity.

Relay-cropping is another system used for increasing land use efficiency. This is a system where two crops are dove-tailed in such a manner where the last crop matures on the residual nutrient and moisture from the first crop. Experiment at the Jimma Research Center on relay cropping maize with teff seems to

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indicate the utility of this system under high rainfall and red soil (reasonably well draining) conditions.

Double cropping is a system of high land use intensity under adequate moisture conditions, especially in irrigated areas. But, in areas of high rainfall such as western Ethiopia, this seems possible. However, we need further experimental work in relation to methods and tools to promote such activities.

1.4.5 Conserving land resources (13,25)

This is a subject of great interest to the country and has been given great attention, both by the Government and donor community. Much has been done at field level to sensitize farmers and to implement corrective programs. However, the problem is much broader than the resources allocated to it.

Ethiopia's current "grain basket" are the highland (i.e above 1500 m.a.s.l) areas of the country. It is estimated that over a quarter of the highlands area is seriously eroded, with at least 4% of the total are beyond recovery. Some 20% of the total area is considered more or less free from erosion hazards. According to the Soil Conservation Research Project (SCRP), about one billion tons of soil is washed away every year and this will increase substantially as the years go by. There is a large body of information and data on soil loss in Ethiopia and some of these are shown below.

There are various biological and mechanical means for effective soil erosion control (Table 2, Table 3 and Figure 4). Some measures are relatively cheap while others are not so cheap, but all require strong commitment by all concerned to implement and, most importantly, to maintain them. Some of the mechanical methods of soil erosion control are actually traditional in the country - eg. step terraces using stone retaining walls in the Konso area.

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Attempts at introducing these methods to farmers, mainly in drought affected areas of Ethiopia, by many Non-governmental Organizations (NGO's), need to be further assessed for their impact and sustainability. According to research station results from the SCRP, IAR and others obtained from various parts of the country, faithful implementation of biological and mechanical methods of control are not particularly difficult to implement and could pay handsome dividends in a relatively short period.

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Table 2 - Effect of Different Soil Covers on Soil Erosion, Holetta Research Centre/IAR

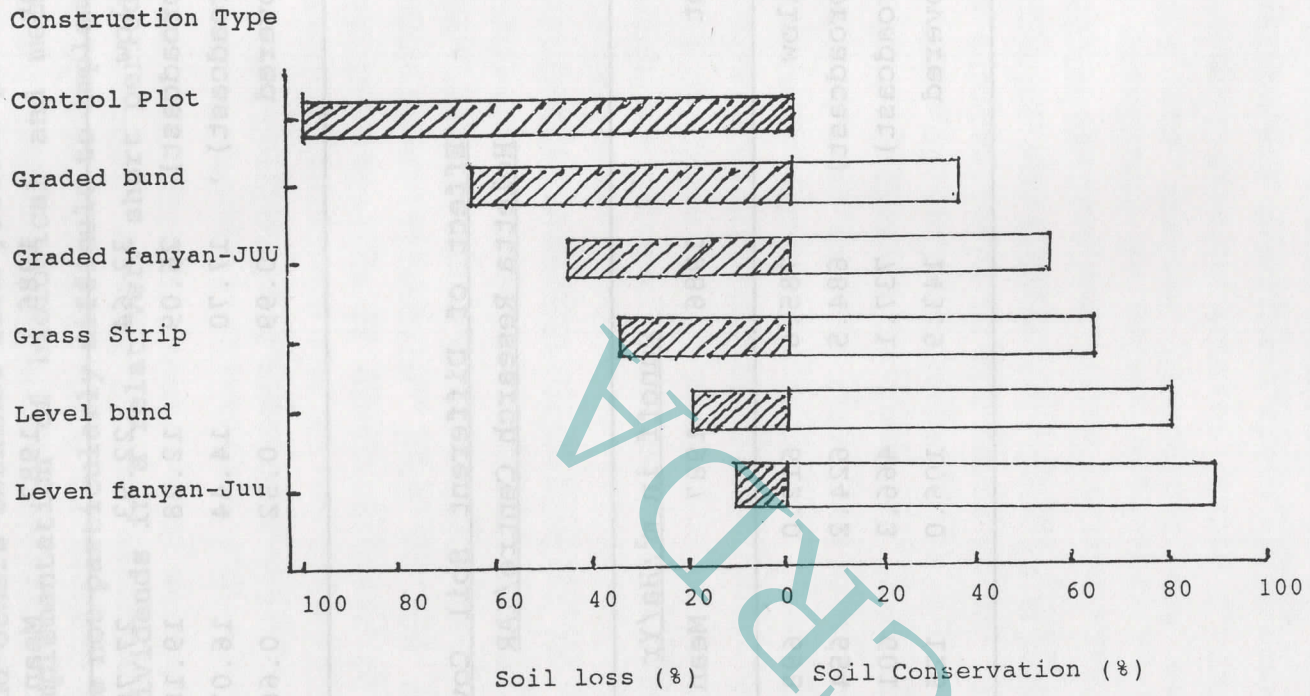
Treatment	Soil erosion in Tons/Ha/Yr 1986	1987	Mean	Factor increase
Bare-fallow	32.64	22.93	27.78	42.10
Wheat (broadcast)	26.09	12.28	19.18	29.10
Teff (Broadcast)	17.70	14.44	16.07	24.35
Grass covered	0.99	0.32	0.66	-

Table 3 - Effect of Different Soil Cover Against Runoff, Holetta Research Centre/IAR

Treatment	Runoff in m^3/Ha/Yr 1986	1987	Mean	Factor increase
Bare fallow	785.6	612.0	698.8	5.6
Wheat (broadcast)	684.5	624.2	654.3	5.2
Teff (Broadcast)	737.1	466.3	601.7	4.8
Grass Covered	143.9	106.0	125.0	-

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Figure 4. Effect of Various Soil Conservation methods



Source: Soil Conservation Research Project

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1.5 Managing Soil Fertility (1-5,9, 25, 27, 32, 34)

1.5.1 Factors influencing soil fertility

As indicated elsewhere in this text, the main function of the soil in relation to plant growth, besides anchoring, is to serve as the store-house for plant nutrients and soil moisture. Therefore, efficient farming means the application of techniques for effective extraction (mining) of plant nutrients stored in the soil for maximum crop production. However, it should be noted that continued extraction without replenishing will exhaust the store-house sooner or later and must be counteracted through appropriate measures to guarantee long term sustainability of production.

The main factors that influence soil fertility are:- 1) the level of plant nutrients present in the soil, 2) the soil reaction (PH), 3) the organic matter content of the soil and 4) the type and amount of applied fertilizers. These factors collectively will be influenced by the soil characteristic and the climate as well as by human interventions.

The level and type of plant nutrients available will be conditioned by the kind of soil, which is determined by the parent material or base rock. There are various kinds of soil, especially in "mature" crop production areas of the world. The major types of soils found in Ethiopia, the total area they cover nd their geographic distribution in the country are indicated in Table 4.

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Table 4 -Soil Types Found in Ethiopia

Soil Type	Characteristics	Area of the country covered (%)
Lithosols	Lithos = stone (Greek)	17.0
Nitosols	Nitidus = shiny (Latin)	12.2
Cambisols	Cambiare = change (Latin)	11.6
Regosols	Rhegos = Blanket (Greek)	10.9
Vertisols	Verto = Turn (Latin)	10.0
Fluvisols	Flavius = River (Latin)	8.3
Xerosols	Xeros = Dry (Greek)	4.8
Solonchaks	Sol = Salt (Russian)	4.8
Acrisols	Acris = very acid (Latin)	4.5
Yermosols	Yermos = desert (Spanish)	2.8

Source: Berhanu Debele, 1989

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The concentration of hydrogenions in the soil, known as soil reaction (pH), affects plant growth both through primary and secondary effects. Studies show that plant growth is generally satisfactory at pH range of 4-8. Plant growth below pH_3 is directly constrained due to root injury while inability to absorb phosphates at pH above 9 will also have a direct effect. The secondary effects of high acidity (or low pH) is brought about by shortages of Calcium and sometimes Phosphates and Molybdenum on the one hand and excess of soluble Aluminum, Manganese and perhaps others which interfere with plant metabolism. It should be noted that all crops do not react uniformly to soil reaction. Some like cotton tolerate alkaline soils (high pH) while crops like wheat may withstand moderately high acidity.

Another factor affecting soil fertility is the level of organic matter in the soil. Obviously, increased level of Organic matter not only improves soil fertility but also improves other characters of the soil such as soil structure and its water holding capacity.

The addition of fertilizers to soil through various means also improves the fertility status of soils. Traditionally, farmyard manure has been used for this purpose. Green manuring and crop rotation, using leguminous crops, have also been known to do a good job. More recently, i.e., relatively speaking, inorganic forms of fertilizers have taken a predominant position in improving soil fertility. But, the issues of cost and environmental pollution are being forwarded to counteract increased utilization of these forms of fertilizers. These days the practice of "Organic Farming" or "biological fertilization" is forwarded as a motto for sustainable farming! There are pros and cons to this suggestion. While the use of organic forms of soil fertilization has positive value in terms of minimizing soil and water pollution as well as enhancing sustainability on the one hand, there is considerable skeptmism with respect to its practicability as well as its feasibility to raise crop production

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to a level to meet the requirements of a rapidly growing population, on the other hand.

We all know that most leguminous plants meet at least part of their nitrogen requirements through symbiotic relations with the Rhizobium bacteria that fixes atmospheric nitrogen in root nodules. There has been considerable effort to strengthen such processes in legumes that will be used in rotation with cereals. Such a scheme can leave a large dose of soil nitrate in the soil so that the following cereal crop can produce satisfactory yields without adding chemical fertilizers. Advances in molecular biology, Biotechnology and genetic engineering may result in transferring such characteristics to cereals.

1.5.2 Fertilizers and fertilization

Whether we like it or not, the use of chemical fertilizers to enhance soil fertility will continue to increase for the forseable future. This trend is universal and Ethiopia will be no exception to this. Therefore, it is necessary to develop ways and means for an efficient and effective use of these chemicals. As indicated earlier, the main reasons for efficiency in fertilizer use are the high costs involved in fertilizer procurement and handing and their potential impact on the environment.

Three main consideration for improving the efficiency and effectiveness of fertilizer use are:- 1) the correct determination of fertilizer requirements, 2) the selection of the types of fertilizers for use and 3) the design of fertilizer application systems. We shall next briefly discuss each of these.

- Methods for determining fertilizer requirements

The determination of fertilizer requirement for crop production can be done through visual observation of crop growth,

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laboratory testing of either soil samples or plant tissues and by carrying out actual experimentation. As one can expect, the determination of fertilizer needs through visual means by recognizing "hunger signs" in crops is the most handy and least expensive. Traditional farmers have been using this technique for generations. We know that the deficiency of certain plant nutrients can be identified relatively easily. The following description can be used as a general guideline:-

Deficiency Indicator	Deficient Element
- Plants stunted, leaves pale green	Nitrogen
- Plants stunted, leaves dark green or tinted with purple	Phosphorus
- Plants stunted, leaves bluish or dark green, margins and areas between veins scorched or brown	Potassium
- Older leaver chlorotic between the veins	Magnesium
- Leaf margins rolled upward	Calcium
- Chlorotic mottling or striping, especially in calcareous soils	Iron
- Chlorotic mottling and small discolored spots or lesions	Manganese
- Root crops with decayed crown, distorted leaves, and hollow or decaed root	Boron

However, the use of visual symptoms has at least the following drawbacks:- 1) it is not consistent across all crops and 2) it only indicates deficiency, but not how much fertilizer is needed to correct it.

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Besides, many years of field experience with various crops under various environmental conditions is needed to attain a workable level of expertise to use the system with relative proficiency.

The next level of reliable system for identifying fertilizer requirements is the use of soil and/or plant tissue analysis. Soil testing for determining the type and level of nutrient requirements is commonly used in many countries with reliable results. However, the use of such a system requires good expertise, adequate laboratory facilities as well as adequate field experimental results for correlating soil test results with crop responses under various environmental conditions. The use of soil testing for recommending fertilizer requirements in Ethiopia can be said to be at its infancy. The current status of Ethiopia on the subject is reported recently and amply substantiates this statement.

The most reliable system for identifying fertilizer requirements for crop production is actual experimentation which can be done under field or laboratory conditions. The use of pot tests, using relevant soil type from the area for which the resulting recommendations are intended, is generally limited to exploratory type of work. In other words, such tests are more appropriate to indicate whether or not additional type(s) of plant nutrients are needed for a given type of crop grown in the area. Once this is ascertained, actual field level experiments must be conducted to determine the amount of fertilizers (or rather plant nutrients) needed and the fertilizer application systems most appropriate for the crop, soil and environmental conditions. Such experiments must be conducted for a sufficient number of years (usually not less than 3) to obtain sufficiently reliable results.

Obviously, this is an expensive undertaking, especially for a relatively large country like Ethiopia with very diverse climatic, soil, topography and socio-economic conditions. It should also be noted that soil fertility conditions are not

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static, as they change with time due to soil fertility management and cropping conditions. Therefore, repeating such trials over large areas at pre-determined frequency (say every 10 years, for example) is not sustainable. A short cut approach with sufficient reliability is needed. This can be achieved by combining field/laboratory experimentation with soil testing. Such combination should lead to developing and deploying crop **response curves** for use in predicting plant nutrient requirements using soil testing data. This system is also useful in determining optimum (economic) level(s) of fertilizer applications for a given level of crop economic and/or biological yields.

- Selection of fertilizer types

The selection of the type(s) of fertilizers to use is a very important factor not only because of cost considerations but also because of nutrient content and rate of solubility in soil, impact on soil reaction and ease of handling and storage. Not all of these factors are given equal considerations. In most cases, nutrient content and rate of solubility in soil (i.e, availability to plants) are given greater consideration. The major type of fertilizers as well as some of their characteristics are shown in Table 5. Many of the fertilizers indicated in the Table have been tested under Ethiopian conditions in the past. Because of mainly cost considerations (i.e, unit of plant nutrients per unit of cost), Diammonium phosphate (DAP), Urea and Potassium Chloride (Kcl) are widely recommended as a source of N, P_2O_5 and kcl respectively. In terms of quantity, DAP is the largest amount used while urea follows a distant second with kcl with the least amount used, as most Ethiopian soils are believed to be rarely deficient in potassium.

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Fertilizer Name	Chemical Form	% Available			Impact on Soil reaction
		N	P_2O_5	K_2O	
Ammonium sulphate	$(NH_4)2SO_4$	20.5.21	-	-	acid forming
Ammonium nitrate	NH_4NO_3	32.0-33.5	-	-	" "
Sodium Nitrate	$2N_aNO_3$	16.0	-	-	neutral/salinity alkaline
Monoammonium phosphate	$NH_4\ H_2PO_4$	11.0	48.0	-	acid forming
Diammonium phosphate	$[(NH_4)_2HPO_4$	18.0-21.0	46.0-54.0	-	" "
Urea	$[CO(NH_s)_2]$	45.0-46.0	-	-	" "
Single Superphosphate	$[3Ca(H_2PO_4)_2$	-	16.0-20	-	neutral/slightly alkaline
Double superphosphate	$[10C_a\ (H_2PO_4)2]$		44.0-48.0	-	" " "
Rock Phosphate		-	5.0-17.0	-	" " "
Bone meal		-	20.0-28.0	-	" " "
Potassium chloride	KCL	-	-	50.0-62.0	
Potassium sulphate	K_2SO_4	-	-	48.0-50.0	
Potassium nitrate	KNO_3	13.0	-	44.0	

- Fertilizer application systems

Three important considerations in fertilizer application systems are 1) the rate of application, 2) the time of application and 3) the method of application.

The amount of fertilizer to apply for a given crop type and environmental conditions will have to be determined through soil testing and/or field experimentations. Once this is determined, it is important to apply all the amount for a given area at the recommended time(s) and with the recommended method of application to obtain maximum benefits.

As indicated earlier, the currently used method for determining fertilizer requirements in Ethiopia is mostly field experimentation. There have been and still are all sorts of fertilizer rate recommendations for various crops and soil types from research centers including agricultural colleges and universities and from the Agricultural Development Department/National Fertilizer and Inputs Unit (ADD/NFIU).

Needless to say, these recommendations are not uniform across crops and locations. The ADD/NFIU field trials program, carried for several years on various crops and across various environmental conditions, is the most extensive todate and has resulted in specific recommendations for various crop-environment combinations. It has also developed response curves (i.e, prediction equation) to determine economic optimum rate (EOR) for a given value-cost ratio (VCR). More recently, the Sasakawa Global 2000 (SG2000) has used a moderately high rate of N and P_2O_5 to carry out a large number of half-hectare demonstration plots on various crops in various parts of the country. The recommended rates (kg/ha) of fertilizers by ADD/NFIU and SG 2000 and the mean grain yield obtained across the country from the various crops are shown below.

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Crops Type	ADD/NFIU Recommendation			SG 2000 Recommendation		
	DAP (kg/ha)	Urea (kg/ha)	Yield at EOR (q/ha)	DAP (kg/ha)	Urea (kg/ha)	Yield (q/ha)
Teff	95	70	12.3			
Barley	100	25	16.1			
Wheat	150	100	21.0	100	100	35-55
Maize	150	85	30.1	100	100	14-26
Sorghum	65	45	11.8			

The above indicates blanket recommendations for cases where specific information are lacking. However, the ADD/NFIU has detailed recommendations for the five indicated crops under various soil conditions for various regions of the country and should be consulted whenever possible.

Once the rate of fertilizer application is determined, the next factor to consider is when to apply. This is important because the nutrient requirement of crops may be variable during their stages of growth. Also, some forms of plant nutrients are highly water soluble and can be leached down very fast or are volatile and can be laot through evaporation. A large number of experiments in this country have not given conclusive results with respect to single or split-application of the recommended doses of fertilizers. Thus, single application at planting of DAP, in particular, is generally advocated. Urea may be split applied at planting and at later stages, especially for row planted crops. Experience todate shows most farmers are not well disposed to split applications.

Finally, the methods of applications should be considered for optimum utilization of plant nutrients. There are a large body of experimental data to show that fertilizers have to be placed reasonably close to plant roots for easy access. Thus, band application slightly below the seed at planting or row application close to growing plants in cases of top-dressing is universally accepted, especially for row planted crops. Broadcasting application is generally applied for non-row planted crops. But, all depends on the availability and/or accessibility of the proper farm machinery and/or implements, particularly to small scale peasant farmers.

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1.6 Water Management for Crop Production (11,18,22,23,25)

1.6.1 The scope of water management

Water is an important requirement of life and therefore, need to be managed as rationally as possible. Water used to be considered as an inexhaustible resource in any part of the world, except in the dry arid/semi-arid and desert areas where it is permanently in short supply. But, this no more true and water supplies are not only exhaustible but also rendered unusable due to agricultural and industrial activities, especially in the industrialized world.

In terms of crop production, the issue of water management can be considered from three perspectives:- irrigation, conservation and drainage. Although these are interrelated, they, nevertheless, can be identified as distinct disciplines in crop production activities. Crop production in the Arid and, to a large extent, semi-arid regions, which make up almost 40% of Ethiopia"s land area, can be carried out reliably only with irrigation, provided there is water in sufficient quantity and quality. It is estimated that close to three million hectares of land can be developed in the country. The type of irrigation systems to use will have to be determined on the basis of available technologies and financial and human resources. Obviously, it would be very important to carefully identify the types of crops to produce under such circumstances.

The process of draining excess water is an important issue in crop production. Needless to say, no irrigation scheme is complete without the installation of drainage systems, the lack of which ultimately results in the lose of land for production due to the accumulation of salts, excessively raising the water table and/or facilitating the breeding of harmful insects and parasites. A good case in point in this country is the Awash River Valley where a significant amount of good land is taken out of production every year.

Drainage of excess water is of even greater significance in the Ethiopian Highlands where around 12 million hectares of land are vertisols or with vertic properties. The potential usefulness of these lands can be greatly improved with the installation of appropriate drainage systems. This subject will be more extensively dealt with in another section of this training course and will not be discussed further in this section.

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1.6.2 Crop Water requirements

Plants require water (H_2O) for their basic photosynthesis process as shown by the following generalized equation:-

$$6\ CO_2 + 6H_2O + \text{sunlight} = C_6H_{12}O6 + 6O_2$$

Thus, a vast amount of water is needed to run this process. The higher the light intensity, temperature and carbon-dioxide (CO_2) availability (upto a central point), the greater the rate of photosynthesis and, hence, the greater the water requirement.

Plants lose as water vapor almost all of the water they take in through a process called TRANSPIRATION. This loss takes place from any part of the plant not covered by cuiticle or barkk, but most of it is through stomata located on leaves. Transpiration benefits plants through cooling of leaves, rapid conduction pf sp;ites amd ,pre rapid dissolving of carbon-dioxide. However, researchers believe that the benefits confered by transpiration are far outweighed by its harmful effects which include wilting of plants and exhaustion of soil moisture. The following conditions influence the rate of transpiration:-

- the supply of water available to leaves
- the influence of climatic factors such as humidity, wind, light and temperature
- the number of stomata and the size of openings
- any modification of plant parts that affect water loss through leaves (eg. sunken stomata, reduced plant parts, thickened cuticle)

The amount of water transpired by crop plants in the process of producing dry matter (i.e, total biological yield) varies from crop to crop under a given environmental condition. It is estimated that the water requirement of crop plants, which is termed TRANSPORTATION RATIO, (eg., kilogramme of water transpired for every kilogram of dry matter produced) ranges from 200-1,000. This variation is brought about by the level of crop adaptability to a given environment, the level of soil fertility as well as the volume of soil in which plant roots can feed in addition to the other factors mentioned above. It should also be mentioned that the amount of water used by plants is directly affected by planting dates. Thus early planted crops use more water than late planted crops during normal crop cycle.

I am not aware of crop water requirement studies carried out in Ethiopia, except possibly for crops like cotton under irrigated conditions of the Middle Awash. As a result, I have to use the following data from another country (Akron, Colorado) to illustrate the level of water requirement (WR) for some crops and other species which are also known in Ethiopia:-

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Crop	WR	Crop	WR
Sorghum	271	Flax	783
Millets	287	Potato	575
Maize	372	Cotton	562
Wheat	372	Crested wheatgrass	678
Barley	521	Bromegrass	828
Oats	635	Sweet Clover	731
Cowpeas	574	Alfalfa	858
Soybean	646		
Bean	700		
Field pea	747		

It could be noted from the above data that the warm season cereals (sorghum, millets and maize) have the lowest crop water requirements per unit of dry matter produced, followed by temperate cereals (wheat, barley and oats), pulse and oilseed crops in that order.

It must be emphasized that the transpiration ratio is not necessarily a measure of the ability of a crop to perform well under water stress (drought) conditions. It simply measures the amount of water used (transpired) by plants under optimum water supply. The issues of drought resistance/tolerance is a subject that has received a lot of attention for many years. The management of crop production under soil moisture limiting conditions is generally approached through the selection of appropriate crops and varieties and/or through the application of moisture conservation techniques.

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It is known that crops have great variability in their response to drought, with some crops better adapted than others. The adaptability of crops to drought depends upon:-

1) the evoluation of drought escapement or evasion characteristics, where-by they complete their cycle before the exhaustion of soil moisture (early maturity).

2) the evolution of mechanisms that enable plants to withstand water stress until such time that favors plant growth is reestablished. This is a drought tolerance mechanism well displayed by sorghum and millets. In this case, plants roll their leaves to reduce water loss and they stop further growth.

3) Some plants (eg. cotton) have developed a means for adjusting growth to the level of water supply. They also have evolved a means of reducing their water requirements by shading off fruits, flowers and/or leaves depending on the severity of stress.

Finally it must be mentioned that water requirement is not uniform throughout plant growth. In fact, it varies greatly depending upon the stage of plant growth. Water requirement is greatest at flowering and fruit setting than at other stages of plant growth.

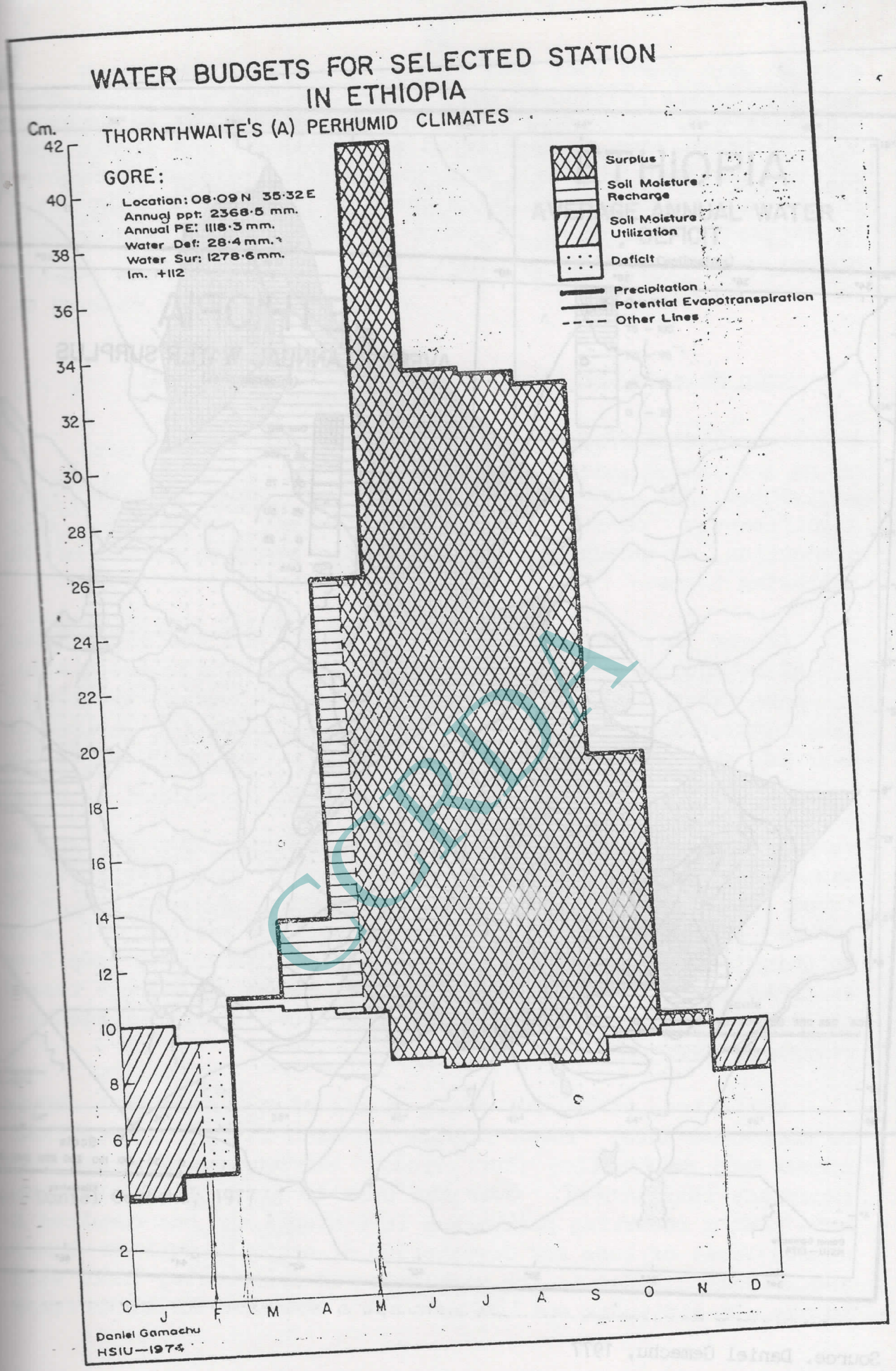
1.6.3 Soil, water and plant relations

The length of the growing period (LGP) of crops is determined by 1) the amount of rainfall, 2) the water storage capacity of soils, 3) evapotransiration and 4) temperature. Since each of these play a deciding role in crop production, it would be useful to briefly consider some of their effects, especially in relation to water conservation issues.

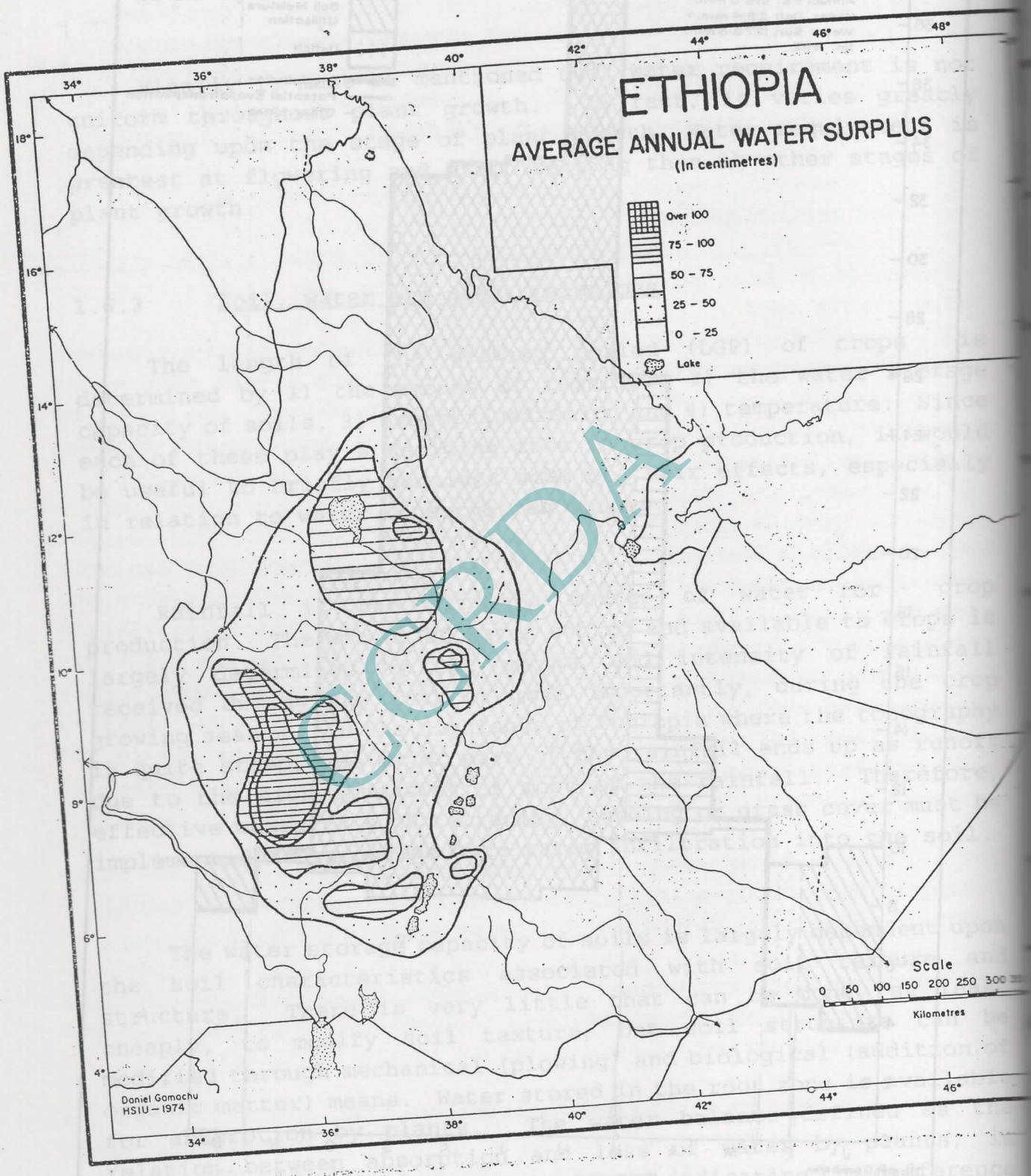
Rainfall is the ultimate source of water for crop production. The amount of water stored and available to crops is largely determined by the amount and intensity of rainfall received during the year or most importantly, during the crop growing season. In the highlands of Ethiopia where the topography is quite steep, the major part of the rainfall ends up as runoff due to the high intensity of most of the rainfall. Therefore, effective measures such terracing, bunding or grass cover must be implemented to encourage more water infiltration into the soil.

The water storage capacity of soils is largely dependent upon the soil characteristics associated with soil texture and structure. There is very little that can be done, at least cheaply, to modify soil texture, but soil structure can be modified through mechanical (plowing) and biological (addition of organic matter) means. Water stored in the root zone is available for absorption by plants. The water balance defined as the relation between absorption and loss of water by plants, is determined by the so called WATER BUDGET indicating the difference between "effective" rainfall and "evapotranspiration". An example of calculated water budget for selected cities in the sub-humid climates in Ethiopia is shown in Figure 4.

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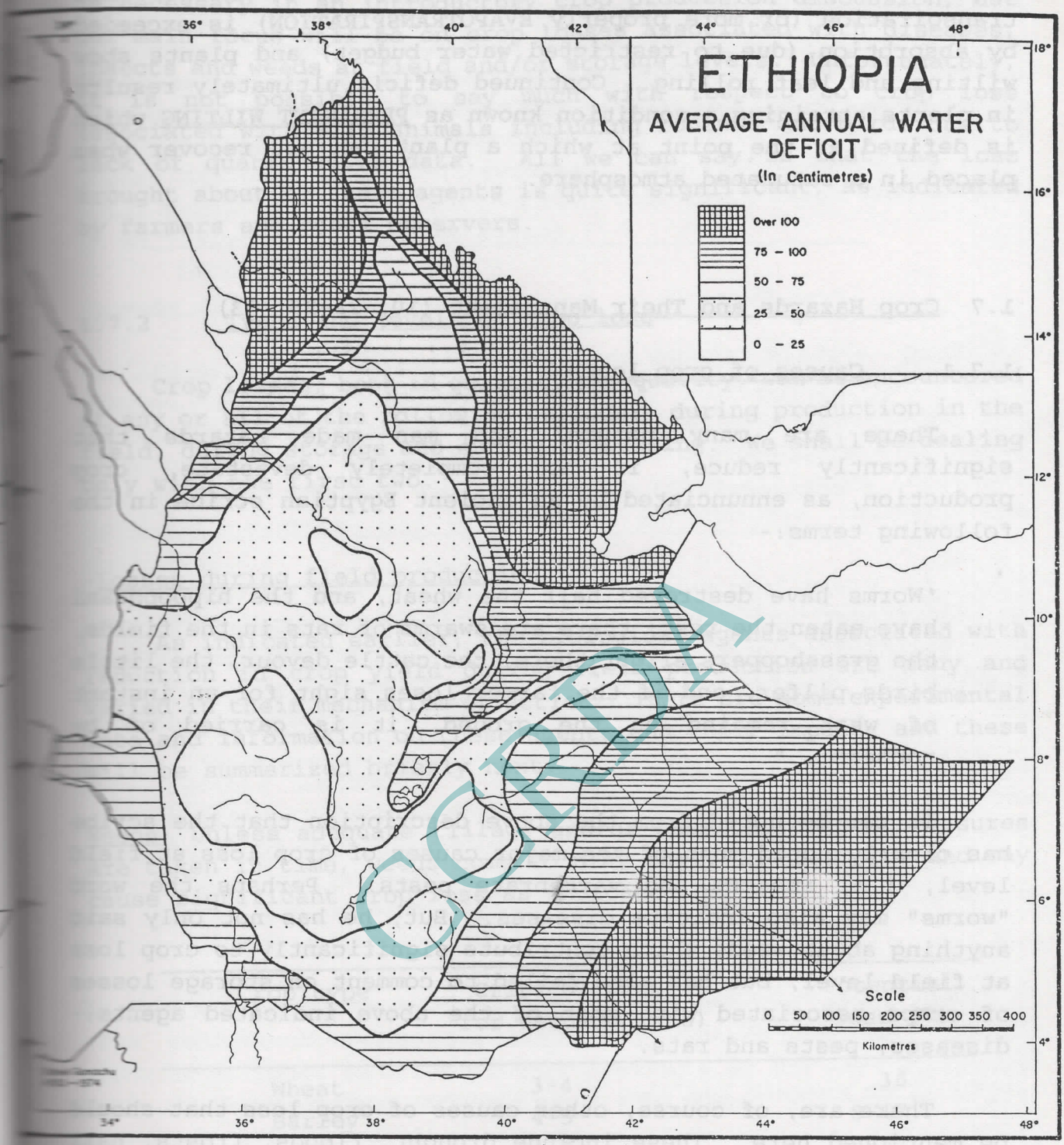


Source: Daniel Gemechu, 1977



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Source. Daniel Gemechu, 1977



Daniel Gemechu, 1977

Obviously, there is a deficit in water balance when transpiration (or more properly EVAPOTRANSPIRATION) is exceeded by absorbtion (due to restricted water budget) and plants show wilting and leaf rolling. Continued deficit ultimately results in plants attaining a condition known as PERMANENT WILTING which is defined as the point at which a plant can not recover when placed in a saturated atmosphere.

1.7 Crop Hazards and Their Management (10, 23-25, 33)

1.7.1 Causes of crop loses

There are many natural and man made hazards that significantly reduce, if not completely devastate, crop production, as ennunciated by an ancient Egyptian scribe in the following terms:-

> 'Worms have destroyed half the wheat, and the hippopotami have eaten the rest; there are swarms of rats in the fields, the grasshoppers alight there, the cattle devour, the little birds pilfer, and if the farmer loses sight for an instant of what remains on the ground, it is carried of by robbers...".

It can be noted from the above description that the scribe has clearly noted most of the major causes of crop loss at field level, i.e, insects and vertebrate pests. Perhaps the word "worms" may also indicate diseases. But, he has not only said anything about weeds which contribute significantly to crop loss at field level, but has also failed to comment on storage losses of crops associated with most of the above indicated agents:- diseases, pests and rats.

There are, of course, other causes of crop loss that should be mentioned here. These include drought, floods, frosts, hail storms and desiccating (hot) winds. Obviously, some are more important than others. Over the past 30 or so years, droughts have been a recurring phenomenon in Ethiopia and has resulted in untold level of loss and devastation of crops as well as humans and animals. Frost in the highlands and desiccating (hot) winds in the mid-altitudes and lowlands are a constant threat to crops.

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Therefore, at least a cursory look into these crop hazards is necessary in an introductory crop production discussion, but our main focus will be on crop losses associated with diseases, insects and weeds at field and/or storage levels. Unfortunately, it is not possible to say much with respect to crop loss associated with wild animals including rodents and birds due to lack of quantitative data. All we can say is that the loss brought about by these agents is quite significant, as indicated by farmers and other observers.

1.7.2 Types and levels of crop loss

Crop losses, both in quantity and quality, can be encountered at any or all of the following periods:- during production in the field, during storage and during processing. We shall be dealing only with the first two.

-Losses during field production

As indicated earlier, the biological agents associated with reduction in crop yield during field production are many and varied in their mechanism of action. There are some experimental data and information on these agents and their impact, and these will be summarized briefly next.

Weeds: Unless adequate tillage and/or chemical control measures are taken in time, weeds come to play early in crop life and may cause significant crop loss as indicated below:-

Crop type	Critical time for weeding (Wks)	Potential loss (%)
Wheat	3-4	36
Barley	4-5	8-17
Teff	4-5	8-52
Maize	4-6	58
Sorghum	4-6	42
Faba bean	4-8	24
Field pea	4-8	15

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-Plant diseases: particularly on small grains, are critically important and cause great damage unless appropriate prevention and/or control measures are taken in time. Examples of the level of potential crop loss are shown below for selected crops and diseases:-

Crop Type	Disease	Potential loss (%)
Barley	Scald	21-67
Teff	Rust	10-25
Wheat	Stripe rust	96
Stem rust		61

Insects:- yield loss due to insects in the field is reported to be significant, unfortunately quantitative data are hard to come by. Examples of crop loss for two major crops by the indicated insects are shown below:-

Crop Type	Insect Pest	Potential loss (%)
Teff	Red worm	10-30
Sorghum	Stem borer	24

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The above indicated crop loss data for various crops are, of course, obtained under controlled experiment conditions and, therefore, may not be a perfect approximation of actual loss under field production conditions. As may be easily expected, crop losses due to the various agents indicated above may vary significantly from year to year and from place to place, depending upon environmental and crop management conditions.

It is unfortunate that most field surveys on crop damaging insects and diseases are limited to gathering qualitative rather than quantitative information. Certainly, there is a whole list of important diseases, insects and weeds, but their negative impacts on production under farmers' conditions are not quantified to any degree. Therefore, national crop loss levels due to these agents are only "educated" guesses. Thus, it is estimated that total annual production loss in the field could range from 10-15% in an "average" production season.

-Losses during storage

Crop storage losses are of three general kinds:- physical damage, weight loss and nutrition loss. There are other losses associated with quality and marketability, both in local and foreign markets, but these will not be discussed further here. Storage data obtained from farmers in three different locations (E.Shewa, N.Shewa and E.Hararghe, in Ethiopia indicate the following:-

-Physical damage:- physical disfiguration and discoloration of grain crops occure during storage, the level of damage varying significantly depending upon crop type, climate, storage type and duration of storage, as indicated below:-

1. cereals in general and small grains in particular suffer relatively less physical damage than leguminous crops, the level of damage ranging from 0-34% (average 9%) for cereals and 5-40% (average 20%) for legumes. Teff and emmerwheat among the cereals and roughpea (Guaya) and lentiles among the pulses suffer much less damage than the rest.

2. high altitude locations are less conducive to damages in stores than lower altitude sites and this could be associated with temperature levels, as the highlands are cooler and less conducive for pest and disease development.

3. interms of traditional storage, well constructed and plastered (with clay or cow dung) stores such as "GOTERA" result in lesser grain damage than "underground pits" commonly used in Eastern Ethiopia.

4. needless to say, physical damage in stores increase with time, unless corrective measures are taken as frequently as required.

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-Weight loss:- all crops suffer weight loss during storage, however, the degree of loss varies from crop to crop. It is also influenced by pre-harvest infestation in the field. Data from the above indicated field study suggest that leguminous crops as a group seem to suffer less than cereals as a group, although there are individual variations. Emmerwheat among the cereals and lentils, roughpea among the pulses suffer less damage than the rest.

-Nutrition loss:- it would be logical to assume that physical damage and weight loss in storage would also result in the deterioration of the nutritional quality of the stored grain. This, indeed, is true as evidenced by the storage studies mentioned above. Such deterioration is associated with the following two factors:-

- insects boring into the grain, mould growth and excreta from rodents very much affect the internal structure of the grain thus affecting its nutritional status.

- observations made at the initial and final periods of storage seem to indicate that the Calcium, Iron and Vitamin C contents of grains are severely affected, with the legume crops as a group sustaining the greater damage than the cereals as a group.

The total amount of crop loss in stores at national level has remained a contentious issue even up to the present time. Estimates vary from a low of 5% to a high of 35%, but most "experts" believe it should not exceed 10%. This seems a low figure, however, a 10% loss of the annual cereal, pulse and oil crops production represents a collsal amount, by Ethiopia's standards.

1.7.3 Crop loss management systems

"Management", in this context, refers to the application of appropriate mechanisms for the prevention or control of crop losses due to weeds, pests and diseases both at field and storage levels. There are various systems identified as useful in reducing crop loss and these are summarized below:-

- Quarantine system:- this is a legal instrument aimed at controlling the free transfer of "infected" and/or "infested" planting materials usually from one country to another. Although difficult to implement, the practice of "internal" quarantine has

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a useful role to play. For example the spread of the striga weed in most sorghum growing regions of the country illustrates the need for internal quarantine.

- Seed health testing:- the practice of seed testing for microscopic pathogens as well as for weed seeds and insect eggs has a major advantage. in prevention This requires availability of effective laboratories and the necessary facilities for seed treatment. The seed companies are expected to provide such service, at least for the seeds they sell.

- Cultural systems:- this is a broad subject covering activities ranging from seed-bed preparation to post-harvest management of crop residues. A large number of experiments, carried out both within and outside Ethiopia, have conclusively demonstrated the effectiveness of these methods. In fact, these are the cheapest way of reducing crop loss. Adequate plowing to kill weeds, seeding at the appropriate time to escape disease and/or insects depending upon the biology of the pest and host, using appropriate plant densities to smother weed growth, burning or plowing in crop residues etc. are some of the practices Ethiopian farmers can deal with with the currently available technologies.

- Biological systems - this is a somewhat more complex system, but not beyond the capability of farmers who wish to use them. In simple terms, this, in most cases, refers to the use of resistant/tolerant varieties and diversification of the crops in use (to a certain degree though!). However, this concept also includes the introduction of natural enemies (parasites and/or predators) against persistent insects, but this may not be justified at individual farm level.

- Physical system - this, in simple terms, means the construction of effective stores and maintaining sound environmental hygiene for prevention of infection/infestation and/or for facilitating the application of control measures.

- Chemical systems:- this is both an expensive and environmentally unfavored system for use. However, it can be said that this is the most widely used system todate, particularly in the industrialized countries. There are a range of chemicals in various forms available for almost all pathogens, pest and weeds, and quite a number of them have been tested and found effective against their target pests and unfortunately) non-target creatures as well.

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- Integrated pest management (IPM) system:- this is a system that is being advocated at the present. This simply means the deployment of several of the systems indicated above in appropriate combinations for the prevention and/or control of target diseases and pests. Obviously, this system has a good deal of merit in that it combines various approaches without relying on any single approach to the exclusion of others. But, it requires expertise, facilities and finance to employ.

1.7.4 Application issues

It is obvious that there are a range of crop protection systems for use and are applicable to most parts of Ethiopia. It is also known that the level of crop loss, both at the field and in storage, in the country is staggering. For example, if the amount of annual crop loss due to these agents were to be taken at 15% and the potential annual production were to be taken at 60 million quintals, the expected crop loss will be 9 million quintals. Saving this will result in food self-sufficiency for the country.

However, this is easier said than done. The main problems limiting the applications of crop loss prevention and/or control systems are associated with the unavailability or inaccessibility of the technologies, farmers' (even development agents') lack of awareness of what are available/accessible, lack of expertise, financial resources and/or a lack of incentives.

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1.8 Technologies in Crop Production (7, 15, 17, 23,29)

1.8.1 Basic concepts in technological change

I suppose there is little or no disagreement in the basic definition of "technology". In simple terms, it refers to tools and/or processes that facilitate or enhance human/animal performance and is developed through careful observation (study) of natural laws. We should note here that the study of natural laws is termed "science" while the application of scientific results for use is termed "technology". But this distinction between "science" and "technology" in terms of which is used first is quite blured these days since technological tools and processes are being used to generate scientific data which will be used in the development of new technologies and processes.

On the basis of this understanding, we have to conclude that human beings have always generated and utilized technologies to attain a certain end, although the level of sophistication of such technologies can be considered backward by current (20th century) standards. In the field of agriculture, for example, the early farmers have used their observations, and sometimes their intuitions, to select better performing crops, animals and tools (sharp sticks, stones and iron) for crop seeding and animal hunting, etc... to meet their subsistant requirements.

As time moved on, however, those "primitive" tools and processes had to change to enable meet growing demands. Thus, before the early scientific and technological institutions were established in Western Europe by the 17th century, the level of sophistication of the technological tools and processes in agriculture had already attained quite a respectable level. These days, we call these group of tools and processes "traditional" technologies and a large percentage of agriculturalists and pastoralists in many part of the world, including Ethiopia, rely on them.

1.8.2 Institutional development for agricultural research

- Levels of agricultural research

As indicated earlier, "institutionalized" research for the generation of agricultural technologies with measurable impact on agricultural production did not emerge until the early 17th century. Since then, agricultural research establishments have proliferated in leaps and bounds, especially in the 20th century. At present, there are no country in the world without such organizations, although the number and capability of these organizations greatly vary from country to country. The phrase "National Agricultural Research Systems (NARS's)" has been coined in recent years to connote all the organizations engaged in agricultural research in individual countries.

Before reviewing the role of various establishments for research, perhaps we should mention the various levels of research, although such distinctions may not be appropriate under many situations.

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- Basic/fundamental research is essentially aimed at advancing the horizon of knowledge, with no economic gain as an objective.

- Strategic research is mainly geared towards identifying solutions for known constrain(s) in a wide agro ecological zone (mega environment), usually crossing various political boundaries.

- Applied research is conducted to identify ways and means of converting information from basic and strategic research for economic goals.

- Adaptive research is almost similar to applied research, but it is for a very narrowly focused set of conditions, eg. tea production at Gumaro.

- Maintenance research is carried out to maximize the gains from previous research by maintaining or slightly modifying an already developed technology.

-Roles of various bodies in research

The question of who can and should be engaged in the conduct of agricultural research deserves some attention, as this has serious implications in the availability and cost of agricultural technologies required in crop production. The following is the general situation so far in the organization and management of research:-

-Farmers/farmers' organizations:- initially, farmers have been doing simple selections and developing management systems to meet their own particular requirements. Later on, at least in some countries of Western Europe, they organized themselves to finance research by institutions of higher learning. But, this did not go far because of cost implications and farmers' insistence for immediate results. However, the current trend is to encourage farmers to participate actively in the research process rather than own or be responsible for organized research.

- Public sector:- this includes national or regional (within country) research institutes or stations, universities and colleges as well as government development organizations engaged in research. These have been the traditionally prominent organizations for research and still continue to be so for almost all the third world and the former eastern block countries.

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Technologies developed by the public sector, as the name implies, are public properties and are available for all users without protection through patents, intellectual property rights, etc.

- Private sector:- in most industrialized countries, a great deal of agricultural research is carried out by private companies. Research in seeds and seed production, agrochemicals, animal health drugs and vaccines, biotechnology are increasingly being taken over by such organizations. The technologies generated by such companies are protected through patent and other laws from duplication and distribution by other agencies for a given period of time.

- NGO's:- there are non-governmental organizations in the traditional sense, that support agricultural research, but are not usually engaged in the actual conduct of research. In the Ethiopian context, some NGO's are known to be doing surveys and "adaptive" type of trials at relatively low level.

- Regional organizations:- these are formed by the association of a number of countries with common interest within a given geography. Most of these associations are engaged more in financing and coordinating the activities of research centers in member countries, but some have manpower and research facilities for specialized research.

- International organizations - agricultural research at international agricultural research centers (IARC's) has reached a significantly high level in terms of both quantity and quality, although it represents less than 5% of the global output. The technologies developed in the IARC's are actually aimed at the third world countries and are freely available for direct multiplication and/or use for further research work.

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1.8.3 Process in technology development

It should be emphasized that agricultural research aimed at generating improved technologies for use in crop (livestock) production is an issue directly tied with national security. A country unable to guarantee its people its basic needs can never feel secure. Hence, investment in research can not be considered a luxury and, therefore, every effort should be made to ensure that research is well targeted, sustainably resourced and properly motivated.

There is a time tested process in attaining the above indicated aims in research and this is summarized below:-

- Research policy and strategy formulation: - This simply means that the first step in organizing a national research scheme is the ennunication of a policy framework and the development of a strategic approach based on the ennunicated policy. This is the responsibility of the national government. We must note also that an agricultural research policy should be a component of an agricultural development plan which itself must be an integral part of the national development plan. All members of the NARS must operate within the formulated agricultural policy and strategy to ensure the attainment of the nationaly desired goal.

- Problem identification and prioritization:- this second stage is essential, but its scope and content varies from organization to organization. Hence, each research organization in the NARS, be it an institute, university, NGO, etc, must go through this exercise and ensure that its researchable problems and priorities are known by others to avoid duplications and, possibly, eliminate gaps.

- Research program development:- the development of research programs and experiment protocols within programs is the next step. Here, the researchability of the subject, the identification of the target client, the technical and financial competence of the researcher or research group as well as the economy in time and space are considerations to be given adequate attention.

- Resources allocation:- without sufficient and sustained allocation of manpower, finance, logistics, etc..., initiated research programs will not yield the desired results. Discontinued or suspended programs, because of insufficient resource allocations, should be considered as inappropriate and wasted investment.

- Technology dissemination:- once research is completed and verified, the results must be transmitted to all concerned in the shortest time possible. This could be done through publications, seminars, trainings and the mass media. Non-transferred or exessively delayed research information is a wasted resource and can not be justified.

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1.8.4 Support services and linkages

Research systems in all developing countries, including Ethiopia, are generally "weak", and the situation is further worsened by the poor development of support services as well as by weak linkages between the research and the support services. The following are a list of services required for efficient and effective performance of the research service -

-Education institutions:- which are the backbone in the development of skilled human resources.

- Extension service:- which is the necessary bridge between the researcher and producer. The number and quality of human resources as well as finance and logistics are the major limiting factors in extension activities in this country. NGO's have a major role in this area because of their grass root contacts and better endowment of resources.

- Seed Production:- improved varieties and animal breeds need to be multiplied in sufficient amount and made available to users in order to benefit from investment in research. Needless to say, seed supply in this country is much limited (averaging about 10 kg/ha at national level), although improving somewhat in recent years. However, the current seed supply is limited mainly to field food crops and coffee, with very little supply in relation to root/tuber crops, fruits and vegetables, and pasture/forage crops.

- Agro-chemical supply:- some types of fertilizers and crop protection chemicals are available, but their use is much limited (eg. less than 30 kg/ha of plant nutrients at national level).

- Farm machinery implements:- again this is limiting production, as the supply of small farm tools, implements and machinery through the limited number of "rural technology centers" of MOA, the factories under the Ministry of Commerce and Industry, and by some private establishment hardly meets national needs.

- Credit facilities:- farmers' ability to procure seeds, fertilizers, oxen, etc. is generally constrained by lack of cash. The availability of "institutional" credit to alleviate this limitation hardly needs emphasis. The Development Bank of Ethiopia, the Commercial Bank of Ethiopia, as well as some NGO's are engaged in providing such facilities. But the number of farm families benefiting from these are limited because of

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accessibility and technical problems associated with bank formalities.

- Storage systems:- this will have to be considered as research support service as they have a role to play in enhancing gains from increased production, which must be stored for one reason or another for a given period of time.

The issue of linkages between research and extension has been a big issue for many years. Various mechanisms have been tried in this country, but none have worked satisfactorily so far. Thus, a more formal linkage approach is needed.

More to the point for this training course is the "research - NGO"linkage. Aside from personal contacts for one reason or another, I am not aware of a sustained formal/informal linkage system established between the research services and NGO's. There may be some exception in the case of FARM AFRICA, but even here more effort at genuine cooperation and collaboration is needed.

Linkages between research and industry is even more tenuous, if at all, than the linkages between the above mentioned organizations.

Needless to say, there is a strong and urgent need to establish sustained linkages, through appropriate mechanisms, between the research and the support services.

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1.8.5 Available technologies for increased crop production

As indicated earlier, institutionalized agricultural research in Ethiopia is about 30 years since its establishment. The main research outputs to date can be summarized as follows:-

- improved varieties have been "released" or "recommended" for the major crops used by farmers.

- Crop husbandry systems for major crop producing areas have been identified.

- Crop protection techniques, both cultural and chemical, have been recommended.

-Fertilizer and fertilization systems for many crops under various environmental and socio-economic conditions have been identified.

- Soil and water management techniques have been recommended, both for rainfed and irrigated conditions.

Further details of these recommendations can be found in various publications such as progress reports, annual reports, technical/research reports, proceedings of training seminars and workshops. However, it must be carefully noted that these results are mostly strategic in nature because of the fact that they are based on results from a few (although well selected for representativeness) locations. As indicated earlier, strategic information may need to be adopted to specific environmental and socio-economic circumstance for actual verification. The research services, even in the rich countries, can not have the manpower and resources to undertake adaptive trials all over the country.

In the Ethiopian context, a large number of adaptive trials have been undertaken by the ADD/NFIU, particularly in relation to fertilizer use, in many parts of the country. More recently, SG2000 has started laying out half hectare demonstration plots in some regions. Results from these trials are quite encouraging and indicate the general applicability of results from the national research services.

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2. AGRICULTURE IN THE ETHIOPIAN ECONOMY

2.1 Review of the State of Food and Agriculture

2.1.1 The role of agriculture in the Ethiopian economy

In Ethiopia, agriculture is the basic means of livelihood for the majority of the population. It provides about 85 per cent of the total employment. Agriculture generates about percent of the gross domestic product of the economy and 80 per cent of the export earnings. Only 16 per cent of the total cultivable land is under cultivation. Through its variety of climatic conditions, practically all tropical and temperate zone crops can be grown somewhere in the country. The climatic variations influence the cropping pattern and the distribution of its livestock population. The bulk of the cultivated land as well as the peasant population is found in the rainfed highlands.

Barley and wheat dominate the highland areas while maize, sorghum, cotton and groundnuts grow in the lowlands. Teff, flax noug, wheat, peas and beans grow in between. Coffee, the most important crop, grows in the south western and eastern highlands. Livestock production is found both in the highland and lowland area which, although sparsely populated, consist of large grazing areas with good pasture lands scattered in various parts. Despite recent adverse climatic conditions that dessimated large herds of the animal population in these regions, a large proportion of the country's estimated 27 million heads of cattle is found in the lowlands and managed under semi-nomadic conditions. Since ploughing and threshing are performed by animal power, cattle production serves several purposes. Sheep, goats, poultry are raised for food production and donkeys, mules, horses and camels are raised for transportation.

Economic development can be manifested in the ways in which resources are combined and in the relative proportions of goods demanded by the individuals in the economy. Economic development results from changes in beliefs, institution present in the economy, size of the population and quality of the labour force. The role of agriculture in economic development can

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be discussed in terms of the rapidity with which these factors are changing and the stages of economic development: traditional society, preconditions for take-off, take-off into self-sustaining growth, the drive to maturity and age of high mass consumption. Agriculture has a prime importance in the first two stages which characterize the economies of the less developed countries (LDCs). In the early stages of development, the proportion of the gross national product generated by agriculture or the percentage of the labour force employed in agriculture are high. If agriculture is to be used as a vehicle for economic development, the following preconditions are essential: efficient use of available resources, development of appropriate skills in the agricultural labour force, careful use of the limited capital available, development of new technology. Given these, agriculture is expected to contribute the following: (a) expanding food supply, (b) increasing exports, (c) increasing capital for investment in non-agricultural sectors, (d) releasing labour from the agricultural sector and (e) increasing demand for non-farm inputs. These generally accepted contributions of agriculture to economic development cannot be obtained in the absence of certain conditions in the economy; an increase in the effective demand for agricultural products, availability of non-farm inputs, efficient land tenure system that guarantees the efficient allocation of land and security to use it, coordinated research, extension and marketing systems, improved transportation and communication systems and development of educational facilities are essential. These inter-relationships between agriculture and the other sectors of the economy have to be taken into account in seeking to improve the productivity of agriculture in the economy. Whether these requirements to accelerate agricultural development are met or not in the case of Ethiopia will be examined by reviewing the nation's general development strategy and the constraints to agricultural development

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2.1.2 Review of the performance of the agricultural sector

Endowed with considerable agricultural potential, Ethiopia has been self-sufficient in staple foods and was classified as a net exporter of food grains till the late 1950s. It was evidenced that the annual export of grains to world market was to the extent of 150,000 tons in 1947/48 (Alemayehu 1988). However, since the early 1960s, the reverse situation continued to happen and domestic supply failed to meet the food requirements of the people. Even though

sufficient amount of food has been produced in most of the good years, the average food production during the last decade remained almost stagnant and attributed to multiple problems; recurring drought, limited access to improved technologies, inadequate economic and social services and poor infrastructural development.

Since the beginning of mid-1980s, both food production and per capita food availability has exhibited very low level of growth. Total domestic food production on average increased by only 0.5 percent per annum leaving uninterrupted dependency on food imports. Similarly, the level of per capita food production drastically dropped by 3.05 percent. This situation is very alarming when it is compared to the population growth rate of 3.0 percent in the early 1990s. Particularly, sharp decline has been observed during the period 1984/85 (116 kg), 1985/86 (124 kg) and 1991/92 (123 kg). It was only possible to produce a maximum of 204 kg in 1979/80 which was still far less from the recommended rate of 2100 calorie per day per person (Table 1). Along with this decline, the food self-sufficiency ratio has also decreased almost by one percent every year. By 1980, it was about 97 percent but beginning in the 1990s it reduced to about 88 percent, indicating that the performance in per capita food production is deteriorating through time. In Combination with other factors, this trend has long been challenging the food security status of the people since the major impact on food security comes from domestic food production.

Based on the above recommended food intake, the deficit in the last deade was estimated to be 0.6 to 4.0 million tones of food grain equivalents per annum. Even with the RRC estimate of 1700 calories per day for an average person domestic production was unable to meet the requirement in almost all years (Table 1) . This gap, with an increasing rate, has been partially fulfilled both by food aid and commercial imports. As a result, the import volume has significantly increased from a low of 177.8 thousands tons to as high as one million tons between 1979/80 and 1991/92. The per capita food import was raised from 5 kg in the early 1980s to a level of 24 kg during famine period in mid 1980s and 19 kg in early 1990s.

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Table 1: Per Capita Food Production and Availability, 1979/80-1991/92 (in thousands metric tonnes)

	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92
1. Domestic Supply													
1.1 Cereals and Pulses	7409	6458	6206	7671	6237	4499	5039	6861	6514	7450	6698	7331	7059
1.2 Net Cereal and Pulses	6298	5489	5275	6520	5301	3824	4283	5832	5537	6333	5693	6231	6000
1.3 Enset & Root Crops (CE)	580	580	580	580	580	520	530	550	570	570	570	600	620
1.4 Milk (CE)	305	305	305	305	305	150	200	280	290	300	273	285	300
1.5 Total Domestic Supply	7183	6374	6160	7405	6186	4494	5013	6662	6397	7203	6536	7116	6920
2. Cereal Import													
2.1 Commercial Imports	66.4	127.4	120.3	37.0	38.0	126.7	163.0	242.0	100.6	75.0	0.0	0.0	10.0
2.2 Food Aid	111.4	221.4	184.4	331.3	161.9	858.4	802.9	299.0	894.7	310.1	465.4	790.9	1000.9
2.3 Total Cereal Imports	177.8	348.8	304.7	368.3	199.9	985.1	965.9	541.0	995.3	385.1	465.4	790.9	1010.9
3. Export of Pluses	34	25	36	36	28	28	11	4	13	12	29.2	16.9	0.9
4. Totai Availability	7327	6698	6429	7737	6358	5451	5968	7199	7379	7576	6972	7890	7930
5. Population (millions)[4]	37.7	38.8	39.9	41.0	42.8	44.2	45.7	47.2	48.6	50.2	51.7	53.4	55.0
6. Per Capita Production (Kg/hd)	190.5	164.3	154.4	180.6	145.6	101.7	109.7	141.1	131.6	143.5	126.4	133.3	125.1
7. Per Capita Availability (Kg/hd)	194.4	172.6	161.1	188.7	148.8	123.3	130.6	152.5	151.8	150.9	135.4	148	144.2

Notes:- Net Cereals and Pulses is less of 15% for seeds and losses

- CE = Cereal Equivalents

Sources:- 1. World Bank, 1990; FAO/WFP Crop and Food Supply Assessment Mission, 1992.

2. John Aylieff, 1993

3. World Bank, 1990; Oil Seeds and Pulses Export Corporation

4. Office of the Population & Housing Census, 1991.

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The overall estimate made so far may, however, be extremely discouraging when every variable is considered at national level. Arising from disparities in the distribution of land and non-land resources, food crop by regions appeared to be dominantly produced in few areas of central Ethiopia (Arsi and Shewa) and North West Ethiopia (Gojjam). These three regions alone generate more than half of the country's grain produced every year. The per capita production in 1987/88, for example, was the highest in Arsi (325 kg) followed by Gojjam (242 kg) and Shewa (194 kg) (IFAD 1989). Apart from these regions, Wollega, Bale, Gondar and Keffa are

considered as areas of food self-sufficient while the remaining are categorized as chronically food deficit areas.

2.1.3 Review of the performance of the marketing system

With the decline of the competition of Ethiopian grain in the World market the Ethiopian Grain Board in 1950 and the Ethiopian Grain Corporation in 1960 were established. After the 1974 socialist revolution, an intervention was further enhanced by setting up the Agricultural Marketing Corporation (AMC) with the aims of reducing inter-annum price variations, narrowing marketing margins, ensuring proper grading and providing marketing services to farmers. During this period, parallel to the AMC, other public agencies, such as Ethiopian Domestic Distribution Corporation (EDDC) and a number of cooperative shops were established both at urban and rural areas to deliver food and industrial goods at fair prices. These public agencies were not able to address their intended objectives due to different socio-economic and political problems. Particularly, the direct state intervention carried out through the AMC was discouraging to agricultural production. The prices offered by the marketing corporation were very low and not able to cover the increasing cost of production. The system had not only created sever disincentive to producers but had resulted in persistence decline in food production in the country.

With the evolution of the AMC, the role of the private traders, except in few cases, was markedly declined. Their activities were gradually decreased with the intensity of the state intervention in marketing as well as regulating prices. Depending on the places of grain origin, they were either obliged to provide 50-100 per cent of their purchases to the AMC or completely prohibited from participating in the market. Despite these measures and other forms of restrictions, private traders were able to operate till the early 90s. It was reported in 1986, for example, that out of the total estimated grain marketed in eleven regions, the share of private traders was about 75% (IGADD 1989). At a later times, the AMC was of course able to capture a significant portion of the marketed surplus. However, it was not able to meet the demand of all its distribution outlets. Some evidence indicates that between 1980/81 to 1984/85 the total grain supply to the residents of Addis Ababa averaged only 94 kg per capita which is nearly half

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of the requirements (Maxwell 1986). This apparently suggests that most consumers were driven to face the higher prices of the open market.

In the final analysis, the cumulative effects of these marketing and pricing policies coupled with other economic variables had aggravated both the rise of consumers' prices and food shortages. The price index rose dramatically from 100 in 1981 to over 220 in 1985 (Webb 1991). Bulti (1986) on the other hand estimated that 35 per cent of the food shortage in the country was accounted by the government food grain marketing and pricing policy. To correct these weaknesses, the Transitional Government of Ethiopia issued a New Economic Policy in 1991. It is indicated that the government will support free markets with the state to play only a role of preventing unhealthy effects of price fluctuations. The restriction on grain movement, quota and fixed price systems were abolished in March 1990 and further reforms were made by the present government by changing the AMC to the Ethiopian Grain Trade Enterprise. The Enterprise is mandated to stabilize grain markets and prices both to encourage farmers' production and to protect consumers from unfair grain price increases.

2.1.4. Major issues and constraints

. The land tenure system in place did not provide security of tenure. While this has now by enlarge been overcome, there is the need for legislation guaranteeing security of tenure.

. Small scale agriculture was heavily burdened by over taxation and government pricing policy that heavily discriminated against agriculture. This has now been changed with the institutions of free market prices and the cancellation of many and hoc taxes levied on the peasantry. But the absence of cooperative marketing mechanisms and other supports continue to prevent the peasants from getting appropriate returns from their output and fair prices for inputs.

. The policy of collectivization of the previous government has among other things undermined the confidence of the peasantry in cooperative activities such as marketing endeavours. As a result and coupled with managerial problems of the marketing cooperatives, most of them have now been dismantled, creating a major gap in the institutions of rural development.

. The extension service available is very flawed. Its spread is very low and unbalanced. The quality of personnel is low. The level of agricultural research is low and not properly linked to the requirements of small scale agriculture. The situation calls for urgent deployment of science

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and technology that can accelerate the transformation of agricultural productivity, especially at the peasant farm level, through indigenous capacity building.

. There is no meaningful system of providing credit to small scale agriculture, which among other things is hindering the utilization of modern inputs in the sector.

. The level of utilization of modern inputs and its availability is very low, and its spatial distribution is very skewed.

. While the rhetoric of community participation in rural development has been there for a long time, in practice the excessive centralization of power and undemocratic and corrupt governance has stifled all efforts of community participation.

. A total absence of integration in agricultural development has been there. The development of small scale agriculture was not dealt with in the context of integrated rural development as a result of which the provision of economic and social infrastructural services (roads, schools, clinics, water supply, etc.) was neglected. There was no intersectoral coordination among government institutions involved in rural development. Appropriate attention to the growth of off farm employment in the rural sector (rural cottage industry, etc.) was not given proper attention.

. Linkage between industry and agriculture was absent. Industrial development aimed at processing products of small scale agriculture was very poorly developed, and industry's contribution to the provision of modern inputs was almost nil.

. Large scale private farms were replaced by inefficient state farms, and they were allowed to expand not only by cultivating the previously uncultivated land but also by dislocating small scale farmers.

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2.2 Reveiew of Food Security and Nutritional Status

2.2.1 Concepts of food security

In mid 1970s, food security was conceived as adequacy of food supply at global and national levels. This view favored merely food production-oriented variables and overlooked the multiple forces which in many ways affect food access. As available evidence indicates, there has been an increasing trend in per capita food output in the world in the last two decades. In contrast, a significant proportion of the population in the Third World have been suffering from

hunger and malnutrition. In 1990, for example, at the global level the calorie supply was more than 110 percent compared to the total requirement. However, in the reference period above 100 million people were affected by famine and more than a quarter of the world's population were short of enough food (UNDP 1992). These facts indicate that availability and acquisition of food at global or national levels do not guarantee food access at household levels.

The notion of equating national food security with food self-sufficiency may similarly lead to a wrong assertion when comparison is made between different countries. Many nations considered to be self-sufficient in food have failed to achieve improved food security because they either lack an efficient food system or the capacity to raise the level of food entitlement. Countries that are food deficit, on the other hand, have been able to exercise a considerable level of national food security through promoting food imports. These countries may also possess both the capacity to build sufficient foreign exchange and improve the efficiency of marketing operations. Hence, in this context, attaining food self-sufficiency alone neither implies achievement in food security nor necessarily improves it. The conceptual development in food security has progressively expanded along with the deteriorating economic situation in developing countries and particularly with the increasing condition of hunger, famine and malnutrition in these countries. The concept got recognition in early 1980s after the debate on 'access' to food and particularly after the focus of the unit of analysis shifted to household and individual levels. The newly developed concept and definition of food security has also led to two additional major shifts in thinking; from a food first approach to a livelihood perspective and from objective indicators to subjective perceptions (Maxwell 1994:1). These shifts gave way to a dynamic development in the area which in turn served as an instrument through which the ultimate goals of human-beings are effectively addressed.

Conventionally, food security is defined as 'access by all people at all times to enough food for an active and healthy life' (World Bank 1986:1). From this definition, the core concept has been identified as 'secure access at all times to sufficient food' (Maxwell and Smith, 1992: 2). This definition explicitly focuses on four core concepts:'a) 'Sufficiency' of food, defined mainly as the calories needed for an active, healthy life; b) 'access' to food , whether by production, purchase, exchange or gift; c) 'Security', defined by the balance between vulnerability, risk and insurance; and d) 'time', where food insecurity can be chronic, transitory or cyclical' (Ibid: 4). The first two elements, 'sufficiency' and 'access', determine the food security

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situation of a given country or household. 'Sufficiency' indicates enough supply of calorie including necessary intake of proteins and micro-nutrients (Christiaensen 1994: 8) and 'access' marks the ability of households to get command over these supplies. Level of intake are in turn determined by physical patterns of activities, body size, age and cultural aspects of the people. For sufficient calorie intake, food availability at certain place and time, may be a necessary but not a sufficient condition for it does not guarantee effective demand over food. The recent argument rests on the consensus that a decline in food availability does neither create hunger nor does necessarily improve household food security. Hence, 'access' to food plays a crucial role in securing control over food which in turn is determined by production, exchange or transfer.

The argument on 'access' in the early 1980s was a turning point to the progress of the concept and assessment of the various food security-related problems. The concept was developed as a result of the increasing development of modern economic relationships which has caused significant changes and new ways in the systems of food acquisition. Particularly, the 'entitlement'[1] approach has given an impetus to the development of the concept of 'access', drawing more attention to the 'decline of food entitlement' than to the 'failure of food availability'. This approach views hunger and famine as the incapacity of specific groups in the society to obtain adequate food by legitimate economic means (Bohle 1993: 20). That is, lacking physical, human or social resources would cause people's access to food supplies to fall below their subsistence needs. In connection with this shift, Swift (1989) identified three important sets of asset in the framework of famine vulnerability analysis: investments, stores and social claims. In his model, he argued that the multiple sources of 'entitlement' could be transformed to different forms; asset formations, production or consumption depending on the degree and characteristics of food situation in a household. More importantly, these resources can be converted into capabilities to acquire food at time of extreme food crisis .

'Securing' access to sufficient food is another situation associated to the existence of risk varying from natural to man-made dimension. Deterioration in natural resources, disruption in food systems, lack of accessibility to productive capital and employment, and distortion in state policies are some of the conditions that contribute to the deterioration of food entitlement . The level and fluctuation of food prices, for example, make serious impact on poor consumers since food comprises significant share in their gross expenditure. The price falls can also affect poor households whose income is mainly dependent on sale of food items (Anderson 1989: 13).

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Risk to food insecurity is not only related to the nature and intensity of its occurrence, but also associated with the defence mechanisms or reaction of households against stress or crisis. Incorporating the views of Bohle and Watts (cited in Bohle 1993: 18) and Alexander (1992) , risk to food insecurity is a function of the risk of exposure to crisis or shocks, the magnitude or consequences of crisis or stress and households' vulnerability to crisis. The latter dimension, which Chambers (1989: 2) categorized as an internal side of risk, is determined by the adequacy of households' capacity to cope with the stress. From this perspective, Oshaug (cited in Maxwell and Smith, 1992) identified three kinds of households: 'enduring households' (which maintain food security on a continuous basis), 'resilient households' (which suffer shocks but recover quickly) and 'fragile households' (which become increasingly insecure in response to shocks). These differential responses, particularly within the crisis of 'structural' processes indicate that the level of resources raised inside and outside households significantly determine the coping ability of the households. It is at this junction that the question of 'who owns what' arises and the ability of the households to withstand the shocks is revealed.

'Security' is not only governed by the magnitude and intensity of the risk or the state of exposure to risk or resilience but also by the extent of risk perception to future food crisis. This issue is highly related to the broad concept of 'livelihood security'. The tendency to sacrifice current consumption for future livelihoods, to diversify source of income and develop different insurance mechanisms are some of the strategies linked to risk perception against expected crisis. It is highly affected by the ability to judge its causes and anticipate events that may disturb the 'normal' process in flow of food. Understanding of food security also includes the 'time' dimension which clearly describes the intensity and characteristics of household food insecurity. Food insecurity can be 'chronic' or 'transitory'. A constant failure to food 'access' is distinguished as 'chronic' food insecurity while a temporary decline is considered as 'transitory' food insecurity. The former is a sign of poverty and illustrates a long term structural deficit in production and lack of purchasing power. It in most cases occurs where poverty, vulnerability and malnutrition are overlapped (Maxwell 1989; Transitory insecurity, on the other hand, implies a short-term variability in food prices, production or incomes. Food security in general is an integrated concept and requires improvement in both micro and macro economic situations. Its attainment demands an overall considerations in the chain of the whole food system. The success in the food

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system (production through distribution to consumption) plays an important role in influencing the nutritional well-being of an individual or a society at large.

2.2.3 Reveiew of nutritional status

. Rural areas

The 1992 nutrition surveillance report of CSA indicated that about 64 percent of all children aged 6-59 months were chronically malnourished. Similarly, about eight percent were in a state of wasting indicating acute malnutrition while 47 percent reflected underweight. At the time of the survey, all the three characteristics of malnutrition were the highest among children between the age of 12-23 months, possibly due to feeding problems during weaning period. Regional prevalence of stunting ranged from 49 percent in South Omo to 75 percent in South Gondar. As Table 2 depicts, this was also the highest in north and north west part of the country, ranking in descending order: West Gojjam, East Gojjam and North Wello. Similarly, wasting was also observed to be higher in Tigray, East Gojjam and Borena, while underweight was significant in Tigray and Sidamo.

Available sources further show a general trend of deterioration in all forms of malnutrition; except in the case of wasting (8.1 percent in 1983 and 8.0 percent in 1992). Particularly, general malnutrition increased from about 37 percent in 1983 to a high of 47 percent in 1992. In the same reference periods, prevalence of stunting has also increased by 4.2 percent, from 59.8 to 64 percent. Both parameters appeared notably in regions of Sidamo, Arsi, Gojjam, Keffa and Illubabour. This situation, if not exaggerated, indicates that food related problems are aggravated through time in the country.

A comparison between level of nutritional status and performance of food production shows insignificant relationship across each region . This indicates that stunting is not only a function of performance in food production. Gojam, for example, among all regions score highest in per capita food production next to Arsi, but the level of stunting among children aged below five years was among the highest. Even in Arsi, the prevalence of chronic malnutrition was higher despite its highest per capita production in cereals. This discrepancy shows that food self-sufficiency can not be equated with food security and nutrition. Such outcome demonstrates that

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Table 2: **Prevalence of Stunting, Wasting and Underweight in Rural Areas by Region**

Regions	Stunting		Wasting		Underweight	
	Percent	Number	Percent	Number	Percent	Number
Arsi	62.7	941	4.6	933	41.1	939
Bale	55.0	745	4.4	743	9.2	751
N.Omo	60.7	1385	6.9	1384	48.5	1382
S.Omo	49.2	444	6.6	445	35.9	440
E.Gojjam	68.9	1052	13.3	1044	54.1	1063
W.Gojjam	73.6	992	8.1	991	53.8	995
Metekel	57.2	483	6.7	482	42.6	482
N.Gonder	66.4	985	7.7	982	52.9	987
S.Gonder	74.5	537	9.9	534	62.0	539
Illubabor	67.1	1207	9.1	1204	52.5	1217
Keffa	60.9	1102	7.3	1097	38.2	1104
N.Shewa	56.7	450	5.1	452	31.1	450
E.Shewa	57.6	768	5.7	767	40.2	770
W.Shewa	62.1	1122	5.3	1119	39.8	1125
S.Shewa	66.1	1275	6.3	1261	44.4	1285
A.Ababa	55.5	989	5.1	988	33.3	989
Sidamo	67.2	1346	10.2	1337	55.0	1356
Borena	55.9	731	12.8	722	45.4	734
Tigray	67.9	1272	14.2	1268	59.9	1284
Welega	59.2	854	10.8	853	51.6	856
N.Wello	68.6	867	8.7	805	53.0	811
S.Wello	62.3	746	5.2	743	47.3	751
Total	64.2	20233	8.0	20154	47.6	20310

Note: Number of children in the sample are slightly different to those noted in other similar tables. This insignificant discrepancy was due to differences in not stated and/or missing cases.

Source: CSA Rural Nutrition Survey, 1992.

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food security and nutrition are affected by a range of factors beyond the adequacy of food availability.

. Urban centres

The most recent household food security survey on four towns (Awassa, Bahir Dar, Dire Dawa and Jima) also reported that the prevalence of stunting, wasting and underweight was 36.4, 12.3 and 24.2 percent respectively (FNU/ MoPED 1994: 79). Malnutrition in children was worst in Bahir Dar and Jimma compared to other urban centres (Table 3). The level of wasting in these towns was found to be higher than in the rural areas (8 %) indicating that acute malnutrition at the time of the survey was relatively serious in urban centres. This result indicates that nutrition in urban areas is relatively at lower state. The household food security survey in Addis Ababa (ENI 1993) further indicated that the prevalence of stunting, wasting and underweight rated 31.9, 4.5 and 20.2 percent respectively. All forms of malnutrition were by far lower in Addis Ababa than in the other four towns in rural areas. The degree of severity of the three forms of malnutrition were also found significant in almost all towns including Addis Ababa (Table 3). Severity in chronic malnutrition varied from a low of nine percent in Awassa to high of 19 per cent in Bahir Dar. Similarly, those with severe forms of acute malnutrition varied from two percent in Jimma to a high of 13.2 percent in Bahir Dar. General malnutrition was also reported to be highest in Bahir Dar (13.75%) followed by Dire Dawa (13.3%), while it was lowest in Awassa (2.6%) followed by Jimma (3.8%) (FNU/MoPED 1994). The finding is highly related to the prevalence of each form in the 1992 rural survey of west Gojam and South Gondar.

Available statistics suggest that nutrition condition is seriously threatened by different factors mainly related to food intake, care and health. It was reported by Elias (1992) that diarrhoea associated deaths were about 45 percent of the total deaths for children under five years. Kwashiorkor and Marasmus in children aged 6-36 months were also observed to be two and four percent respectively due to nutrition related diseases. Though nutrition is not the only decisive factor, infant and child mortality rates are also reported to be 110 and 160 per 1000 live births respectively (Elias 1992). Infant mortality rate vary from 77 in Addis Ababa to 145 in Bale and this rate is higher when compared to the current estimate of 103 for Africa (FAO 1992). The other nutrition related factors which are linked to safe water and health services indicate that they are at a low state of development. Particularly in rural areas, only 11 percent

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oftheruralpopulation have access to safe water and 21 percent to latrine. The distribution of health facilities and personnel across the size of the population is also very low. The ratio indicates that one medical doctor stands for over 30,000 people while the ratio to hospital beds is more than 4000 people .

Table 3. **Prevalence of Stunting, Wasting and Underweight, and Degree of Severity in Selected Urban Centers**

Urban Center	Stunting		Wasting		Underweight	
	No	%	No	%	No	%
1. Awassa	114	28.1 (8.8)	115	7.0 (3.5)	116	10.3 (2.6)
2. Bahir Dar	88	42.0 (19.3)	88	22.7 (13.6)	95	38.9 (13.7)
3. Dire Dawa	133	35.8 (17.3)	134	13.4 (5.2)	135	27.9 (13.3)
4. Jima	104	41.3 (16.3)	101	7.9 (2.0)	106	22.6 (3.8)
Total	239	36.4 (15.2)	483	12.3 (5.7)	452	24.6 (8.4)
5. Addis Ababa	580	31.9 (11.6)	576	4.5 (5.0)	580	20.2 (4.7)

Note: Figures in brackets indicate degree of severity

Source: ENI (1993); FNU/MoPED (1994)

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2.2.2 Characteristics of food insecurty

A number of studies confirmed that there is a severe food insecurity situation in Ethiopia covering a wide range of areas and affecting a greater number of people. Though there is significant differences in measuring techniques and application of indicators, most reached almost the same level of estimation and conclusion to the present state of food insecurity in Ethiopia.

Out of the estimated size of food insecure in Sub-Saharan Africa more than 40 percent is found in Ethiopia, Nigeria and Zaire (Anderson 1989). The IGADD study (1992) also indicated that Ethiopia stands first comprising the highest number of food insecure in the IGADD region. The International Fund for Agricultural Development (IFAD) (1989), for example, asserted that nearly 19.0 millions people (equivalent to 43 percent of the rural population) were below poverty line. Its estimate was based on an intake of 500 gm of grain equivalent across different income groups in the country (Table 4). Furthermore, evaluating about 14 important socio-economic indicators (such as level of inputs and credit uses, possession of oxen, nutrition status, infant mortality rate, etc), five regions (Wello, Gamo Gofa, Illubabor, Hararrghe and Sidamo) were identified as the most deprived areas. Shoa, Arsi, Gojjam and Wollega were comparatively categorized as regions with reasonable access to resources, goods and social services. The extreme high estimate made by Maxwell (1991), on the other hand, claimed the food insecure people to be about 38 million based on the 1983 nutrition survey and population estimate of 1991. The resource poor farmers, people living in marginal areas, poor nomads, war affected, refugees and urban poor were identified to be the most food insecure social groups in the country. Other estimates made in, for example, Food Security Study of World Bank and Social Dimension of Aadjustment of MoPED lie between the two extreme estimates of IFAD and Maxwell. Both concluded that the food insecure to be between 21 - 27 million.

All these estimates have also been strengthened in vulnerability profile and risk mapping study by further defining the characteristics of food insecurity and including other social groups, such as the displaced in the category. The study estimated the food insecure people to be about 27.0 millions of which by far the greatest number residing in rural areas under chronic poverty. The food security study in four towns supported some of these findings referring to the size of urban food insecurity. Considering an intake of 1700 calories per person per day and the

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minimum food cost prevailing in each location, households with insufficient purchasing power were identified to range between 29 percent in Dire Dawa to 57 percent in Bahir Dar (FNU/MoPED 1994). On average, those who cannot afford to buy sufficient food were half of the total population of the four urban centers and these were households whose income rated below Birr 199/month. Moreover, a study made in Addis Ababa similarly indicated that nearly 41% of the population were with insufficient income to acquire enough food (ENI 1993). Both urban focused surveys confirmed the estimates made by MoPED (1992) and Debebe and Maxwell (1992) which argue that more than half of the urban population could currently be vulnerable to food insecurity.

In general, irrespective of the diverse approaches and measurement in food insecurity, the estimate and ranking procedures indicate that the size of the problem is highly concentrated in structurally deficit regions. All estimates range between 19 to 38 millions and largely refer to the resource poor households in the rural areas which are always liable to economic and environmental problems. They are concentrated in almost all regions except in some pocket areas of the surplus regions; Gojjam, Arsi, Shoa and perhaps Wollega. Similarly, those who are low income households employed in informal sectors and those groups outside the labor markets (elderly, disabled) are also the most affected people in urban centers .

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Table 4. Estimate of food insecure in Ethiopia **(in millions)**

Studies	Regions	Social Category & Size			
		Category	No.	% Totl	% FI
IFAD Poverty Analysis (1989)	Regions except Gojam, Shoa, Wollega, Arsi	-	18.9	43.0	-
Food Aid & Food Security (1991)	-	Rural			
		Resource poor	25.5	47.7	67.1
		Marginals	5.5	10	14.5
		Poor nomads	2.0	4	5.2
		Urban			
		Urban poor	0.75	1.4	1.9
		Others (war affected,refugees	4.1	7.5	10.7
World Bank Food Security study (1992)	Tigray, N. Gondar Wello, NE Shoa, Hararrghe, Arsi,Bale	Rural			
		Resource poor, Pastoralists, Farm settlers,	20.7	38.0	97.2
		Urban			
		Urban poor & unemployed (disabled, aged, etc.)	0.6	1.0	2.8
Social Dimension of Adjustment (1992)	All (with different proportions)	Rural			
		Very poor	8.8	16.0	32.5
		Poor	3.8	7.0	14.0
		Vulnerable	7.4	13.4	27.3
		Nomads	2.2	4.0	8.1
		Urban poor	4.9	9.0	18.1
Vulnerability Profile & Risk Mapping (1992)	Wello, Tigray, Sidamo, Hararrghe Gamo gofa	Rural			
		Chronic	13.5	24.5	50.5
		Transitory	6.5	12.0	24.3
		Urban			
		Unemployable	0.2	0.4	0.01
		Employed	3.8	7.0	14.2
		Others (Refugees, Displace,etc)	2.75	5.4	10.2

Note: The '% totl' and '% FI' refer to proportion of the total population and food insecure people respectively

Source: Debebe, 1993

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2.3 Overall Agricultural and Marketing Policy

2.3.1 Agricultural objective and strategy

Objectives

- Improvement of the quality of life of the rural population through the generation of higher incomes and reduction of poverty, promoting higher standards of nutrition and health, greater equity progress in education and personal freedom.
- To increase the production of food supply both quantitatively and qualitatively so that members of the sector will be adequately fed, while the population in the other sectors will also be supplied with adequate food at affordable prices.
- To increase and diversify the production of raw materials for industry and to promote strong linkage with the industry sector.
- To increase and diversify production for export and maximize the country's foreign exchange earnings from agriculture.
- To make agriculture the driving force for economic development. A dynamic growth in agricultural production with raised income which will be followed by increased demand for products and services from the other sectors of the economy.

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Strategy

Growth in the Agricultural Sector could be realized through: (a) the improvement of productivity of smallholder agriculture and (b) commercial scale extensive and intensive agriculture.

Small scale agriculture

Food crop production , and ruminant animal production is the foundation of the small scale agriculture system. The integrated production of the two, crops and ruminant animals, under the prevailing conditions of the small scale farms appears to manifest a certain degree of conflict, since both compete for the same resources, land, labour, etc. On the other hand, it is also known that the two are promoting each other through recycling of resources. In general this interdependence of crops and ruminant animals influencing the productivity of the

small scale agriculture has been ignored, and both the research and extension services have failed to see the system as an integrated complex whole.

There are two ways in which the productivity of the small scale farmer can be raised. These consist of combining the resources of the farmer, ie. land, labour and capital, in a better way, and introduction of new techniques of production. Within the same agro-ecological zone, farmers are known to combine their resources differently to produce the same crop all of these resource allocations are not equally productive. By improving the allocative efficiency of farmers, therefore, productivity can be raised in smallholder agriculture. Over the past decades the land/labour ratio has decreased quantitatively and qualitatively, and so has the capital/labour ratio, though not to the same extent. At the farm family level, the landholding has shrank, and the number of oxen available for farming have decreased. In other words the mix of resources has changed. In this process of change, the allocation of resources of the smallholder has become progressively inefficient because of the increasing under utilization of labour in agriculture which at any rate was not compensated by off-farm engagement. As the size of landholding diminished the labour input of the farm family decreased since the technique of production remained constant.

One arm of the strategy to reverse this long-term trend and put smallholder agriculture on the path of development is to improve the efficiency of the resource mix of the farmer. However, this cannot be done, in any significant sense, without the other arm of improvement of the production techniques which entail biological, chemical and mechanical technologies as well as cultural practices. Thus, both allocative and technical efficiencies have to be improved together.

Agricultural activity is location specific. The complexity of the problem of increasing the productivity of small scale agriculture in a semi-arid environment with a heavily degraded soil has to be appreciated and need not be reduced to the very simple problem of lack of certain inputs as in other agro-climatic zones with favourable production environment.

For several reasons, however, emphasis will be placed on improving the resource mix at the initial stage of the agricultural development. First, the least-cost method of raising productivity from where Ethiopia stands now is to increase the labour input of the farm family through the application of better cultural practices. Because the man hour input per farm family is presumably quite low, notwithstanding the significant variations that are likely to

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exist among the various farming system, the irksomeness of additional labour input to the farm household is small relative to the additional output (income) to be obtained. Put differently, the preference for leisure over income is low. It is, however, well known that traditional agriculture uses relatively low material and technological inputs both in terms of quality and quantity and usually obtains extremely variable harvests as set by the conditions of the weather, pests, diseases, etc. It appears that a large part of the population should continue to be engaged in agriculture for some time to come. Thus reliance on increment of labour input provided it is supported by appropriate science and technology is viable as a strategy.

Second, increased utilization of labour within the agricultural sector tends to reduce the migration to towns, which is desirable in the first instance of the ALI strategy of Ethiopia. Third, attainment of appropriate resource combination lays a firm foundation for long term growth of productivity through adoption of modern biological and chef production at small scale agriculture the search for technical mechanisms and conditions that will increase the availability and allocative efficiency of the resources similar technologies. In view of the dwindling and limited resources to overcome the constraints simultaneously is an urgent task. Once income is raised, it becomes more difficult for the farm family to increase its utilization of labour so as to improve cultural practices, as the irksomeness of farm labour so as to improve cultural practices, as the irksomeness of farm labour increases with higher income level. The preference for leisure, even if low, begins to increase. Furthermore, urban migration could be encouraged due to the increase of surplus labour, paradoxically with higher expectation of wages than otherwise. Fourth, effective diffusion of biological and chemical technologies requires development of competitive domestic marketing system, agricultural banking for rendering services and farmer associations as recipient mechanisms.

In order to help address the complex technical problems of the small scale agriculture and develop it into a thriving production sector with accelerating and environmentally sustainable growth the following specific strategies have been drawn. The main focus of these strategies will be on creating the conditions that will bring about rapid transition from the predominantly traditions to modern agricultural production system.

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2.3.2 Strengthening institutional support

Wide ranging institutional support is required for the development of the sector, i.e. for the small scale agriculture, and the commercial scale extensive and intensive commercial agriculture. Chief among are research, extension, credit, and farmers association. Special attention will be given to create and strengthen the appropriate institutions to develop and sustainably increase the productivity of small scale agriculture.

- Expand and broaden agricultural research facilities and activities, redirect the agricultural research to areas that are relevant to the development of small-scale agriculture and forge close links between agricultural research and extension service.
- Improve over time the extension agent to farmer ratio, provide continual training to extension agents to upgrade their skills and to familiarize them with new research findings, consolidate the various extension service providing organizations and gear extension service to the requirements of the various agricultural production system of the country.
- Promote the creation of marketing cooperatives on a purely voluntary basis and provide training and other assistance to overcome their managerial problems. such cooperatives could undertake activities such as marketing of all types of their agricultural produce, processing, supply of agricultural inputs, and provision of veterinary services and credit facilities. The voluntary grouping of pastoralists will be encouraged to enhance their participation in development by taking into account their traditional values, social norms and the different life styles. Training will be provide to both cultivators and pastoralists to raise their capacities in the intervention to improve the productivities of the production systems.
- Promote the development of rural development banks and the provision of appropriate credit service to the rural areas.

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2.3.3 Strengthening agricultural research and extension service

In order to make peasant agriculture productive there is no choice other than overcoming the defects of the traditional production system and transforming it through the infusion of scientific techniques. The success of transfer of any modern technique, however, will depend on its performance under conditions that could reflect the economic realities of the farms. In general, the capacity in research has to develop and its objective has to be to provide economically optimum package of production techniques to small holders operating in the different farming systems and suited to the specific agro-climatic zone.

2.3.3.1 Promote research on the development of improved production techniques suited to the different agro-climatic zones and focused on farmers problems and needs.

The low and erratic rainfall mainly in drought affected regions places a premium on the development of crop varieties with increased drought tolerance and early maturity. While developing high yielding varieties special attention will be given to the development of varieties and cropping systems that match to the conditions with limited and erratic rainfall, and where dry farming methods have to be practice.

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Carry out epidemiological studies and strengthen research, diagnosis and control activities on economically important animal diseases. In order to exploit the potential in livestock production, nutritional research will be emphasized to develop a feeding system that will allow the matching of supply of nutrients according to the various stages of growth, production and reproduction of the animals. The effective use of the various industrial and on-farm agricultural by-products and forages will be determined and promoted. Cross-breeding research programs will be given due attention to improve the productivity of the animals in milk, meat and draught power, particularly for use at the peasant production level.

The advantages of coffee production in Ethiopia is the existence of the widest genetic base (in the world) of arabica coffee. This undoubtedly provides great opportunities of the develop through selection, breeding and biotechnology higher quality coffee and

with natural resistance against pests and diseases. In order to sustainable exploit this internationally unique gene pool the capacity of coffee research, and in association with other high value exportable crops for diversification, will be developed further. Diversification programs for export will be designed to be flexible and always consider the trend in world market.

- Develop irrigation research capacity to develop techniques for efficient use of water particularly for conditions with limited supplies of irrigation water in the dry-land farming systems.

2.3.3.2 Extension will be designed to have maximal impact in diffusion of new techniques through effective transfer of knowledge and skills on a broad front. The activities of the agricultural extension service shall be to introduce and promote research based and tested modern agricultural methods, and a more efficient use of inputs from within and outside the production system. Small scale farmers do recognize that creating favourable conditions in general does improve the performance of both crops and animals. However, the conditions that they could create are limited by several internal and external factors. The extension service shall, therefore, ensure that the technology it extends is responsive to the demands of the small scale farmer and fits into the economic realities of the farms.

- The traditional knowledge of farmers where both crops and livestock are mutually benefiting from the closed nutrient cycle must be developed and properly utilized. The effective intensification of the traditional crop-livestock production system through multiple cropping with the incorporation of leguminous crops is of vital importance and will be encouraged. The extensive, judicious and efficient use of inorganic and organic fertilizers and soil amendments will be promoted. Inorganic fertilizer as one of the essential components will be used in combination with organic fertilization and packages of technologies such as improved seeds, recommended agronomic practices, soil conservation techniques and appropriate water management practices. Since low cost organic fertilizers can be used as supplements to the high cost inorganic fertilizers the production of organic and bio-fertilizers based on agricultural and agro-industrial wastes, slaughter house by-products, and other organic wastes will be encouraged and

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promoted. In the short and medium terms, the continued importation of agricultural inputs such as agro-chemicals is unavoidable; and this would place too great strain on the country's balance of payments for it to be continued without any supplementary domestic production. In the long run, therefore, the production of inorganic nitrogenous and phosphatic fertilizers from indigenous raw materials will be established to increase and ensure sustainable supply with minimized burden on foreign exchange requirements.

- Ensure the extension of the use of improved seeds. The use of inputs such as fertilizers, pesticides, improved farm implements is essential for the full exploitation of the genetic potential of high yielding improved seeds. The extension service will, therefore, encourage farmers to use such cultivars in association with the appropriate use of the complimentary production inputs. In moisture stress areas, it is the frequency and timing of the rains within the rainy season that remains to be the critical constraint for agricultural production than the total amount of rainfall. Due attention will, therefore, be given to the dryland grain production system to incorporate short cycle and drought tolerant crop varieties, known for their performance under moisture stress conditions. This will be supported by the introduction of techniques that will improve the retention of moisture in the soil. In order to ensure the availability of seeds in the locality secondary seed multiplication and cleaning centres and reserve seed stocks for the different classes of seeds will be promoted in various regions.
- traditional agriculture in the grain producing areas, where rainfall is highly variable, attempts to reduce the risk of losses in dry years, but always loses the benefits that it could accrue during good rains. This is mainly due to the absence of adopted and improved technology to feasibly harvest and store runoff water from the rains at least for supplemental irrigation. There is a general lack of tradition in irrigation practices in most peasant level production systems. The repeated failures in production at times of inadequate rainfall, however, have repeatedly shown the weakness of the rainfed subsistence base in many areas. Therefore, promotion of development of small and medium scale irrigation and water harvesting to increase productivity in all areas but with the focus on those with erratic rainfall or where there is shortage of rainfall is a

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serious concern for immediate intervention. Support will be rendered for country wide spring development, river diversion and small scale irrigation development schemes.

- Promote improved veterinary services and the production and utilization of improved animal nutrition in both the settled agricultural and nomadic areas with the view to rationally exploit the huge animal resources of the country. This will include the improvement of the indigenous cattle breeds through breeding programmes for milk and meat production. Establish core animal breeding stocks at strategic locations to serve as the basis for building up improved herds and as sources of supply to farmers. Feedlot operations to produce higher grade slaughter animals under stall feeding conditions supported by quarantine and proper veterinary services will be promoted.
- In areas where communities are dependent on fishing special attention will be paid through extension services to develop the fishing industry which has remained virtually unexploited. The development of fisheries associated with small and medium scale irrigation schemes will be encouraged.

2.3.4 Promote integrated and conservation based approach to rural development.

- Ensure that rural development is based on the conservation and rational utilization of natural resources. Give special attention to afforestation and reforestation programmes, water and soil conservation and appropriate watershed management and catchment development.
- promote inter-sectoral linkage by making sure all government institutions involved in rural development have an integrated plan of action, and close coordination in the implementation of their programmes.
- Carry out an extensive programme of building and rehabilitating rural roads, schools, clinics, water supply systems and other economic and social infrastructural services.

2.3.5 Create a supportive policy environment.

- Pass land use legislation that ensures security of tenure and land use for the peasantry.
- Maintain the policy of market determination of prices of agricultural inputs and outputs; assist the peasantry to sell their outputs and buy their inputs at fair prices

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through the promotion of marketing cooperatives; and continue to avoid over-taking the countryside.

2.3.6 promote community participation in rural development.

- Continue with the policy of devolution of power so that the districts at the grass-roots level will have the necessary power to participate fully in the design and implementation of their development programmes.
- Promote the creation of community based organizations engaged in rural development, consistently respect and protect their autonomy and independence and encourage their participation in the decision making process, especially at the grass-roots level.

2.3.5 Marketing Policy

There are two issues of price stability that are likely to persist for some time in Ethiopia arising from , on one hand, droughts, and on the other hand, fragmented markets. To cushion the price shocks associated with droughts, stocks will be held by the Ethiopian Grain Trade Enterprise (EGTE), a food marketing parastatal. The alternative of commercial imports of food is less viable for Ethiopia which is a severely debt distressed country. Considering the possible impact of food price shocks on inflation, the importance of consumer price stabilisation in such events cannot be overstated. It underpins the macroeconomic stablilisation of the country. Market fragmentation due to excessively high transport cost is another problem in areas which are potentially surplus producing. A high level of output leads to a sharp fall in producer prices which constitutes a disincentive for production in the following season, bringing about a fall in output and a rise in producer prices. The farmer remains trapped by fluctuating prices unable to realise his potential of surplus production. In such specific situations producer price stabilisation measures will be effected through stock holding to unlock the attainment of localised surplus production potential, whilst at the same time the structural constraints of transport will be removed through road construction. This scheme will in turn be linked with the national food stock holding to guard against possible price shocks that could attend droughts. It is like killing two birds with on stone. As a guide,

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import parity prices will be used in determining the stablisation prices to be offered to producers in the specified localities, which are likely to be lower than producer prices in other parts of the country.

2.4 Agricultural Policies and Strategy

2.4.1 Agricultural research policy and objectives

Objectives

The overall objective of the agricultural research policy is to give a clear direction that guides agricultural research & application of its results so as to develop agricultural science & technology. The following are specific objectives:-

- To choose and generate agricultural technologies which improve the productivity of the agricultural sector and which enables the country to be self-sufficient in food production.
- To direct & coordinate agricultural research programs on various areas, so as to solve major agricultural problems & produce sustainable agricultural production based on environmental protection & development.
- To build the country's agricultural research capability
- To improve the existing coordinating functions among various research institutions; to organize agricultural research activities undertaken by different national & regional research institutions and to disseminate their research results to users thereby contribute to the national economy.

Policy

The following are major policy statements which enable to fulfill the above mentioned agricultural policy objectives.

- In the effort to raise the productivity of the agricultural sector and to be self-sufficient in food production, agricultural research shall focus on generating and choosing technologies that will enable to improve peasant agricultural production in quality,

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quantity and diversity as the major part of agricultural production is derived from it.

- To be able to raise the productivity of the sector in all dimensions, private investors are encouraged to invest on large and modern farms. Thus, agricultural research shall be conducted to supply these farms with necessary technologies.
- Undertake research to generate and choose technologies which fulfill the demand for agricultural raw materials of existing industries and undertake research on agricultural products which will be used potentially as industrial raw materials.
- Conduct research to enable the production or substitution of agricultural products that are not domestically produced or are in short supply but are imported for their domestic demand.
- A greater emphasis will be given to raise the quantity and quality of exportable agricultural products which generate foreign exchange earning. Undertake research to raise the quality of exportable agricultural products as it is the main determining factor in the world market competition.
- Conduct research to improve or generate indigenous technologies and knowledge based on the country's agricultural system and practice.
- Conduct research to reduce both pre- and post-harvest losses due to backwardness technologies. Conduct research to generate & choose food and other technologies which improve the shelf-life and utilization of agricultural products.
- Conduct research to choose and generate technologies which will enable to conserve, protect and sustainable use the country's agricultural natural resources.
- Conduct research on how best the country's natural resources, human and animal power be utilized to improve the living standard of the rural community.
- Undertake research to introduce, choose & utilize appropriate R and D results or knowledge developed in other countries with similar climate.
- To resolve urgent problems of the economic sector within short period of time, agricultural research activities shall focus mainly on applied research and on programs that will bring change within short period of time. In addition, research will be conducted on basic, strategic and new and emerging technologies (biotechnology etc). as deemed necessary.
- Conduct research to generate and substitute imported agricultural inputs such as crop

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varieties, animal breeds, fertilizer, pesticides (herbicides, insecticides, fungicides & others), agricultural machinery and other inputs.

- There is wastage and environmental pollution due to the improper usage of costly imported inputs such as artificial fertilizers, pesticides and farm machinery. Conduct research that would enable to identify improved inputs suitable to the type of crop and ecological zone; to identify proper time of application, economical and safe ways of their usage.
- In addition to the research on highly expensive agricultural inputs, conduct research on less expensive agricultural inputs and local land races based on the country's economy.
- To build-up the national agricultural research capability and coordinate research activities, the government shall allocate the necessary budget.
- Establish agricultural research institutes in different parts of the country to generate and choose technologies which will resolve major agricultural problems of the various agro-ecological zones and farming systems.
- Give training opportunities to agricultural researchers to build their capability, create good working environment and necessary incentives.
- Agricultural researches undertaken by Governmental research and higher learning institutions and local and foreign non-governmental organizations shall focus on major priority problems of the sector in different areas based on short, medium and long term programs. For its implementation, the coordination of various researches, the documentation of information and popularization of research results shall be coordinated by one agricultural research council.
- Evaluate any research result generated by national or foreign institution for its productivity and applicability before it is released to users. For this certification, establish regulating bodies.
- Multiply and distribute to users those traditional practices or research results released by appropriate research results releasing bodies.
- To create well established organizational linkages both during research project approval and distribution of results, the committee shall be composed of representatives from the extension service, users i.e, farmers (including women), industries, exporters.
- Establish a national agricultural research council that will implement this policy.

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2.4.2 Structure and organization of agricultural research

Although agricultural research has generated important findings, its contribution to the development of the sector was not satisfactory since these results were not disseminated to farmers. Attempts were made at various times to establish a higher body that coordinates, organizes and guides agricultural research activities. However, its realization was challenged by many problems. Consequently, agricultural research was not able to solve the problems of the sector. Thus, it become necessary to lay an organizational structure that will guide, encourage, strengthen and coordinate research and development activities. The structure of agricultural research should be organized based on the country's political and economic directives that would enable the implementation of the national agricultural research policy. The country follows federal system of Government and a free market economy. Accordingly, the organization and structure of agricultural research system has three levels:

National agricultural Research Council

National Agricultural Research Institutions & Centres

Regional Agricultural Research Institutions & Centres

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2.4.2.1 National Agricultural Research Council

This Council is the highest Government body that coordinates and organizes agricultural research and advise the Government in any affairs of agricultural research.

Major objectives of the council

- Find means to raise the productivity, to improve the quality and nutritional value of plants (crops), wild and domestic animals, forest and fishery resources.
- Ensure that agricultural research is well organized, coordinated & efficient; and focuses on priority problems of the sector.

Duties and Responsibilities of the Council

The Council, to meet its objectives, shall have the following duties and responsibilities;

- Ensure the formulation of policies on agricultural research activities; consult and propose decisions to the Government; when approved, ensure its implementation through the secretariat office.
- Formulate guidelines which would support the Government's development plan; set agricultural R and D priorities based on the people's living conditions.
- Consult and facilitate ways of searching material, manpower and financial supports for agricultural research programs & projects; ensure that necessary efforts are made, and when secured ensure its appropriate realization through the secretariat office.
- Evaluate and approve research projects of various institutions with respect to the country's national agricultural research policy, strategy, priority and budget and propose for the Government decision.
- Advise the Government in all aspects of agricultural research
- Ensure that there is a strong functional linkage among research, extension and users for effective dissemination of research findings; follow its implementation through the secretariat office.
- Consult and support the development of agricultural education curriculum that would enable to produce qualified and capable researchers.
- Ensure the lay out of a system that would enable to document, organize and disseminate national agricultural research information.
- Create a system of awards to individuals/institutions for their outstanding R and D achievements; develop selection procedures; develop guidelines for capability building of Ethiopian researchers engaged in agricultural research; ensure the organization of professional meetings, seminars and conferences.
- Establish technical committees as and when necessary.
- Undertake any other appropriate activities which enable the development of R and D and utilization of research findings.

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Members of the council

The National Agricultural Research council consist of the following members from various disciplines, R and D institutions and agricultural science professionals from regional administrations. Others could also be included as and when necessary.

2.4.2.2 National agricultural research institutes and centres

Agricultural research institutes and centres administered by the Central Government shall be responsible for undertaking research to solve major problems of the sector at a national level. Research areas given major emphasis among others are;

- Improve and release hybrids of local land races (maize, sorghum, wheat, teff, coffee, etc.) which grow in most of the regions and have national importance.
- Focus on basic scientific studies that require high level of laboratory and skilled manpower (example: biology, genetics, physiology, entomology, soil science etc). In connection to this, strengthen research on new and emerging technologies and organize centres of excellence in some fields.
- Undertake research on major common agricultural problems (eg. drought, soil erosion, agricultural implements etc.) of various agro-ecological zones.
- Focus on export crops (coffee, sesame, spices etc) and potential export crops. Focus on crops that supply raw materials to big industries (coffee, sugarcane, fruits ,etc.)

2.4.2.3 Regional agricultural research centres and institutes

These research institutes and centres shall focus on solving major regional agricultural problems. In addition, shall have responsibilities to collaborate in research with other regions on common problems.

2.5 National Seed Industry Policy

2.5.1 Objective of the industry

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A sound national seed industry policy is instrumental in reinforcing plant genetic resources conservation and utilization, crop breeding research, and building a viable seed industry. The absence of a seed policy in Ethiopia has been a major drawback in the sub-sector. Lack of a policy to guide the national seed program has been a crucial deficiency which had negative impacts on the sustainable preservation and use of crop genetic resources, and the developments of crop breeding research and a healthy seed industry. To bridge the present gap in policy oversight of the Ethiopian seed industry, a national seed industry policy was formulated having the following objectives:

- Ensure that plant genetic resources of potential and current economic or social importance will be collected, preserved, evaluated, and used by the national research and development programs,
- Enhance germplasm development, variety evaluation, release, registration and maintenance activities in the country,
- Develop an effective system of producing and supplying high quality seeds of socially, economically, and environmentally important crops to satisfy the national seed requirements,
- Encourage the participation of farmers in germplasm conservation and in the seed production and supply system to share the economic benefits accrued as the result of the use of landraces,
- Create a functional and efficient organizational set up to facilitate cooperative linkage and coordination in the seed industry, and
- Regulate seed quality standards, import and export, seed trade, quarantine and other seed-related issues.

2.5.2 Organization of the seed industry

At present there is lack of an effective national guidance and functional inter-institutional linkage in the seed industry. To improve the coordination of the sub-sector, the establishment of the following organs will be essential.

National Seed Industry Council

A National Seed Industry Council will be created and will have a secretariat to execute its decisions and carry out day-to-day activities. The Council will in general have the following functions:

- Provide policy and national guidance, and advise the government in all matters pertaining to the seed industry,
- Review and monitor the overall development, and effective functioning of the seed industry, and
- Promote capacity building in research and development in the fields of genetic resources, crop breeding and seed technology.

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There will also be a Seed Technical Advisory Committee (STAC) to assist the Council in scientific and technical matters.

Seed Quality Control and Certification Authority

To date, there is no an independent body responsible for seed quality control and certification in the country. Therefore, a National Seed Quality Control and Certification Authority will be established to take the responsibility of handling seed quality control and certification of all commercial seeds produced and supplied by public and private seed enterprises.

National Variety Release Committee

An official National Variety Release Committee will be formed under the auspices of the NSIC. The NVRC will have its office at SQCCA. The functions and responsibilities of the NVRC will be drawn by the NSIC.

Seed Trade Licensing Agency

To protect the national interest and to maintain seed quality, seed enterprises will be licensed. The government will designate a national body that will be responsible for the issuance of seed business licenses to both public and private seed enterprises in consultation with concerned institutions and agencies.

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2.5.3 Components of the national seed industry

The various activities under the umbrella of the national seed industy are as follows:-

2.5.3.1 Plant genetic resources conservation and development

- The collection, conservation, development and rational use of plant genetic resources are areas of high national interest and priority.
- The national efforts on plant genetic resources need to be coordinated with other natural resources conservation and development programs in line with the overall national development policy and natural conservation legislation.
- Plant species that are in danger of extinction as a result of genetic erosion and those indigenous species of economic importance will be given high priorities in the conservation programs. The accelerated genetic erosion of local landraces as a result of aggressive promotions of improved exotic varieties will be minimized or checked through implementing balanced developments in the areas of plant genetic resources conservation, and seed production and supply.
- The protection of plant genetic resources from undue exploitation will be ensured

by developing and putting into effect appropriate germplasm exchange policies, laws and regulations.

- The government will issue directives to guide the licensing of foreign investors and joint ventures on endemic, semi-endemic and other economic or potentially economic plants to ensure the protection of these natural resources from genetic erosion, introduced diseases and pests, and undue exploitation.
- To minimize the introduction of diseases, pests and weeds threatening crop production; and control importation and testing of genetically modified organisms (GMOs) with potential hazards to human, animal, plant health, and the environment, introduction of plant material into the country would be exhaustively tested following appropriate quarantine procedures. The Ministry of Agriculture (MOA) in collaboration with Plan Genetic Resources Center/Ethiopia (PGRC/E), research and development institutions, establishments of higher learning and other relevant agencies will be responsible to implement quarantine regulations.
- The Ethiopian farmers have through generations conserved, improved and made available valuable genetic resources we are using today for the purpose of varietal improvement. This immense indigenous knowledge of farmers must be properly utilized in developing sustainable system of agriculture; and farmers should share the benefits accrued as a result of using indigenous germplasm they helped to preserve. The government will adopt appropriate policies to control and coordinate national and community level germplasm conservation, exportation, importation, distribution and utilization by governmental and non-governmental institutions through a central authority.
- The government will establish a National Board for Plant Genetic Resources (NBPGR) to coordinate plant genetic resources activities and streamline the national focus to address priority genetic resources problems. The NBPGR, composed of relevant governmental institutions and professionals, will be the policy making body that will advise the government in all matters pertaining to conservation, quarantine, exchange and utilization of plant genetic resources. The NBPGR will be chaired by the MOA. The PGRC/E will serve as the scientific secretariat of the NBPGR. The Center will be strengthened in organization, manpower, funding and facilities to enable it carry out its responsibilities effectively.

2.5.3.2 Crop variety development, testing and release

Crop Breeding

- A strong national research and development program on crop breeding is an essential component of a healthy national seed industry development. Therefore, the Government will strengthen the organization, and scientific capacity of the national plant breeding research system.

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- The national plant breeding system will be restructured to make the research and development work more purpose-oriented, efficient, creative and effective. National priority cereal, grain legume, oilseed, horticultural, fiber, forage, industrial and other crops will be identified to be given proper research thrusts by the National Agricultural Research System (NARS).
- The national crop breeding programs will, as much as possible, be based on the principle of using the indigenous crop genetic resources and the agricultural systems as the foundation of the crop improvement work; particularly, the traditional cereal-legume-livestock, and horticulture-livestock systems will be reinforced with modern research and technology.
- Though the government will encourage the development of the private sector in plant breeding and seed enterprises, in the short-and medium-term public breeding research will continue to play an important role.
- In accordance with the national research policy and strategy, the government may license private foreign seed firms to undertake crop research activities on only 'non-restricted' crops.
- The government will identify priority strategic crops for hybrid development to meet the national demand for hybrid seed on a sustainable basis.
- All seeds or planting materials imported into the country by public and private institutions, organizations or firms will be laboratory or field-tested under isolation at designated public research centers(s) under strict control and inspection by the public agency responsible. Private seed enterprises are allowed to import only elite materials.
- Research in conventional crop breeding will be supplemented with newly emerging technologies through the development of selected, strategic areas of plant biotechnology on priority crops.

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Variety testing

- Final stage variety testing and evaluation procedures will be developed for each commodity by the National Variety Release Committee (NVRC).
- The procedures set by the NVRC will be strictly followed by all private and public breeding and seed enterprises undertaking germplasm/variety/ hybrid evaluation or testing in the country.

Variety release and registration

- The NVRC, under the auspices of the National Seed Industry Council (NSIC), shall be the legal body responsible to officially evaluate, release and register plant varieties/hybrids for use.
- The NVRC will prepare and issue procedures for maintenance breeding for each crop.
- The NVRC, with its secretariat at the office of the National Seed Quality Control

and Certification Authority (SQCCA), shall be composed of relevant institutions and disciplines.

- The variety release and registration regulations and procedures developed for each crop by the NVRC will be approved by the NSIC and will be strictly followed by all individuals, institutions and enterprises.

- The Codes of Conduct set by the NVRC will also be applicable to imported seeds, not already released in the country, by private and public seed enterprises and other organizations.
- An annual Seed/Variety Register will be published by the NVRC listing varieties in production and those withdrawn from production.
- The current status of maintenance breeding will be improved by strengthening the same in all institutions responsible for developing varieties/hybrids.
- It is the responsibility of the breeder and the institution developing the variety/hybrid to maintain and make available sufficient quantity of breeder seed of a released variety/hybrid to officially designated basic seed producers in accordance with Plant Breeders' Rights.

2.5.3.3 Basic and certified seed production

- The NSIC will issue a list of priority crops for certified seed production and secondary seed multiplication to be used by both public and private seed enterprises.
- In the short-and medium-term of the seed industry development, the production and supply of high quality basic seed as much as possible will be the responsibility of the public sector. The production of basic seed may be done on agro-ecologically suitable government seed farms and on private farms under contract arrangements with close supervision by government seed specialists.
- To create an efficient, economic and viable certified seed production and supply system, seed production and supply will be decentralized based on major crop production zones with active involvement of both the private and public sectors. Public and private seed enterprises will be encouraged to operate at regional and sub-regional levels through functional relationship with the national seed system. The government will provide appropriate incentives to encourage the development of regional and sub-regional seed production and supply. Special seed supply system shall be developed to cater for environmentally vulnerable areas through smaller projects and strategic seed reserve programs.
- The informal seed production and supply system will be organized at community/village level using both local and improved cultivars so that low cost seed utilization is effected by using farmers own seed and secondary seed multiplication. The secondary seed multiplication scheme is an effort to help spread improved seeds to farmers.
- The public sector will also be responsible for the production and supply of seeds of crops which the private sector has less interest but important to the peasant sector and/or crops of specific adaptation having regional/local importance. Specifically, arrangements will be made for the production and supply of seed of nationally important crops currently not

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handled by the Ethiopian Seed Corporation (ESC).

- Recognizing the need for encouraging the development of the seed business in the country, the government shall promote domestic private seed enterprises.

2.5.3.4 Distribution and marketing

- Although seed supply activities are open to both the public and private sectors, seed distribution and marketing at central processing sites and regional levels in the short-term will be handled mainly by the public sector. At sub-regional or district level, however, seed distribution and marketing could also be handled by private firms or farmers' cooperatives.
- The government will take appropriate steps, by establishing strategic supply centers, to improve the national coverage of seed supply, quality standards, promotion and marketing.
- The price of seed will be determined by market forces (demand and supply). The government, however, may play roles by influencing the supply of seed through production plans and license control, and the demand by guaranteeing grain floor prices to farmers.

The participation of farmers in the seed industry and use of local cultivars

- At present the majority of Ethiopian farmers depend on their own seeds selected and saved from production fields planted with local cultivars well adapted to local environmental and farming conditions. Therefore, the active participation of farmers in the seed industry, and the sustainable use of local cultivars will be promoted.

Agricultural extension and inputs

- A national seed program can contribute towards the growth of the agricultural economy only if supported by a strong extension program and the supply of essential agricultural inputs. Hence, the agricultural extension program will be strengthened through the deployment of effective advisory system, qualified personnel, and facilities. Furthermore, the availability and efficient supply of inputs such as fertilizers, pesticides, farm implements, and credit will be improved.

2.5.3.5 Seed import and export

- The government shall issue from time to time a list of crops or plant species of which commercial seed importation into the country or exportation from the country is restricted, limited, made subject to conditions or prohibited following recommendations by the concerned authority(ies).

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- Seed or planting material for experimental purposes and commercial seeds shall be imported only after clearance by the seed import/export authorization agency.
- Issuance of seed/planting material import and export permit will be the responsibility of the NBPGR.
- The NBPGR will develop rules, regulations and procedures for germplasm exchange, seed import/export, and distribution in consultation with scientists and scientific institutions.
- These rules and regulations will be in line with the National Plant Varieties and Seeds Act and shall be approved by the NSIC before implementation.
- Quarantine regulations shall be strictly followed in the import and export of any seed or planting material.
- All imported seed or planting material will be subjected to variety/hybrid testing and release procedures and regulations set by the NVRC.

2.5.3.6 Reserve seed stock

- Unforeseen disasters during a growing season could result in seed shortage in the following season. The problem could be more acute in areas repeatedly suffering from droughts; farmers may be forced to consume their seed stocks thus accelerating genetic erosion. Therefore, a national seed reserve stock to supplement seed shortages arising as a result of unforeseen circumstances is essential. A national system for reserve seed stock will be developed for the different classes of seed. The government will allocate special funds to implement the scheme on sustained basis.

2.5.3.7 Public and private seed enterprise

Public seed enterprise

- The current contribution of private seed businesses in seed production and supply is negligible. Therefore, the public seed enterprise would continue to be the major producer and supplier of basic and certified seeds.

Private seed enterprise

- To ensure the productivity of and efficiency in the seed industry, domestic private seed enterprises will be encouraged to actively participate in the production and distribution of improved seeds.
- The government may issue licenses to foreign seed firms and domestic-foreign joint ventures only for the production and supply of seeds of NVRC-approved varieties/hybrids of non-restricted crops.
- The government will not permit private (domestic and foreign) seed enterprises to have a monopoly on the production and supply of seed of any one crop.

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2.5.3.8 Seeds act

- The government will prepare and promulgate a National Seeds Act to regulate seed trade, control seed quality standards, and protect users, Plant Breeders' Rights, and Farmers' Rights.

2.5.3.9 Quarantine regulations

- Most countries impose restrictions on the importation and movement of plant material in order to prevent the introduction and dissemination of dangerous diseases, pests and weeds.
- Ethiopia will effect external and internal quarantine measures through the use of standard regulatory and exclusionary procedures. The current quarantine legislation will be put into effect through the issuance of appropriate regulations and the creation and strengthening of implementing agencies and mechanisms.
- The national quarantine activities shall be made operational by making available reliable information system, trained personnel, effective inspection and detection procedures.

2.5.3.10 Seed data base

- A strong national seed information system will be created under the auspices of NSIC to serve as a clearinghouse for the national seed industry.

2.6 National fertilizer industry policy.

2.6.1 Objectives of the industry

Main objectives

The importance of fertilizer sub-sector in raising productivity per unit of land significantly contributing to the growth of a sustainable agricultural system needs no emphasis. This, of course, necessitates a wider and efficient use of organic and inorganic fertilizers which in turn requires a healthy development of the fertilizer sub-sector. The development of the fertilizer sub-sector along with other enabling environments will be instrumental to achieving the national goals of food security, the production of industrial and exportable crops.

The national goals of food security and food self-sufficiency can only be realized when carefully planned and designed agricultural development programs are implemented. This has to be supported by a clearly spelt out fertilizer policy which broadly aims at farmers' effective demand situation, supply of fertilizer, distribution and marketing, pricing and subsidies, credit, research and extension, quality control and environment and organizational set up to implement the policy. In order to achieve this goal a national fertilizer policy with the following sets of specific objectives is formulated.

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Specific objectives

To ensure that fertilizers are available to smallholders in the required quantity, product-mix at a time needed and at reasonable prices;

To develop the farmers effective demand through the interactions of biological/agronomic potential, supply of fertilizer, effective distribution and marketing system with appropriate incentive, better cropping pattern to increase agricultural production so that the objectives of food security, supply of raw materials and exportable crops could be achieved and sustained;

To provide the necessary support to the national research and extension systems to generate packages of technologies (improved seeds, irrigation, integrated pest management, farm implements, improved cultural practices, etc.) and disseminate them so that the rapid growth of fertilizer use would contribute to increased and sustained agricultural production and productivity;

To encourage judicious and efficient use of inorganic and organic fertilizers, and improve traditional soil management practices in order to increase and sustain agricultural productivity; to encourage small holders who know the benefit of fertilizers but constrained by unavailability of fertilizers and financial resources; and to educate non-users in remote areas to benefit from fertilizer technology.

To establish a streamlined, competitive and efficient fertilizer importation and marketing system to ensure the availability of fertilizer on sustainable bases;

To stimulate the exploration, evaluation and development of indigenous raw materials for local and domestic production of fertilizers (organic and inorganic) and soil amendment materials;

To encourage and promote the establishment of manufacturing plants for fertilizers (organic and inorganic) and soil amendment materials;

To establish environmentally safe and sound fertilizer use and develop and develop and strengthen programmes of quality control systems; and

To create a functional and efficient organizational set up to develop the fertilizer sub-sector and implement the national fertilizer policy.

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2.6.2 Organization of the national fertilizer industry

Lack of a national fertilizer policy coupled with the absence of a responsible governmental organization to guide and coordinate fertilizer activities have limited the growth and development of the sub-sector. Hence, an institutional arrangement under which all concerned organizations can coordinate their activities for the development of the sub-sector need to be in place. To this effect, a National Fertilizer Industry Board (NFIB) and National Fertilizer Industry Agency (NFIA) as its secretariat will be established.

2.6.3 Demand for fertilizers

Although fertilizer consumptions have been growing at annual rate of about 12 per cent, and seasonal and regional variations in consumptions are pronounced (85 per cent in main growing seasons and 80 per cent consumed in three regions), fertilizers consumption in Ethiopia is at a very low stage. In Ethiopia, fertilizer began at very low level (still very low by any standard) and grew gradually over time.

Demand estimation and sales forecast are key management functions for determining the right type and quantity of fertilizers to be supplied. Demand estimation has often been inaccurate and fraught with bureaucratic procedures leading to delays and consequential inventory costs as well as crop production losses. Hence, relevant institution or organization and a reliable mechanism for realistic national demand forecasts of annual, short, medium and long-term fertilizer requirements shall be established.

2.6.4 Supply of fertilizers

Fertilizer importation

Ethiopia imports, although not in sufficient quantity, all inorganic fertilizers for domestic use. The main constraints to importing fertilizers in sufficient quantity and timely delivery are: (a) shortage of foreign exchange; (b) inefficient procurement procedures (partly related to donors" procedures) which delay fertilizer shipment; (c) shortage of port facilities, clearing and handling at the port which has reduced offtake capacity; and (d) all fertilizer imports are handled in bags which has increased fertilizer costs. To reasonably deal with these constraints, the government will take the following measures:

Allocation of funds: The government shall allocate sufficient funds to ensure continuous and adequate importation of fertilizer to fulfill the growing requirement of the country. This means providing adequate foreign exchange for programmed and timely import of fertilizers. Furthermore, for the short-and medium-terms supply of fertilizer, the government will negotiate with donors (credit and grants) to make the funds available on time;

Port facilities and handling: The improvement and development of these facilities will become more critical with expected increase in volume of fertilizer to be imported in the coming years. Accordingly, the government will negotiate with concerned governments to ensure that the capacities and facilities of the ports will improve progressively through various arrangements.

Import of fertilizer in bulk: In the past as well as at present, fertilizers are imported in bags and the benefits of importing in bulk have been foregone. The benefits of bulk imports lie: (i) in avoiding the cost of bagging and loading bags into the ships in high labour cost supplier countries; (ii) in obtaining lower sea freight rate ; (iii) in avoiding the relatively high cost of stevedoring for unloading bags from the ship at destination ports; (iv) in achieving a higher rate of discharge which would save time and money; and (v) in creating local employment for bagging of fertilizer and allowing the use of locally produced bags.

To take advantage of bulk importing of fertilizer, the government will phase out imports in bags as rapidly as possible and encourage importers to import fertilizer in bulk. Accordingly, medium - and long term plans will be made to develop facilities to handle bulk imports at entry ports. In the mean time, measures will be taken to switch to bulk importing by making temporary arrangements, and encourage fertilizer importers (AISCO and privates) to use portable dockside bagging system.

Economies of scale in importation: Following the economic reforms pursued by the government in general, and the new fertilizer marketing strategy, competition in imports through inclusion of private importers is expected to improve timely arrivals and availabilities of fertilizer in the country. However, the advantage of economies of scale in importing in large quantity need

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not be overlooked and the government will ensure that such advantages be exploited to the possible maximum and shall encourage investment in warehouse and bulk handling facilities.

Phasing of fertilizer imports: In the past and currently phasing of fertilizer imports have been on ad hoc basis and this need to be synchronized with the main sales offtake period and imports to minimize inventories. Accordingly the government will encourage importers to develop schedules where the quantities to be imported would be tuned to the peak offtake season.

Emphasis will be given to the production of nitrogenous and phosphatic fertilizers from indigenous and available resources. The government will create enabling environment to encourage investment for the establishment of domestic fertilizer manufacturing plants.

Low cost organic fertilizers (bio fertilizers) can be used as supplements to the high cost inorganic fertilizers. The use of biogas slurry and other agricultural and agro-industrial wastes as fertilizer is very important. Some soil microorganisms are very cheap and useful biofertilizers which have to be used widely in the future. Therefore, the establishment of organic and biofertilizer production units based on agricultural and agro-industrial wastes,

Slaughter house by products, and town wastes will be encouraged for investment by the private and public sectors.

Fertilizer distribution and marketing

Supply of fertilizers (either imported or domestically produced), and intensive research and extension services to promote fertilizer and other inputs use will be a futile exercise without effective distributions and marketing system. The distribution system needs to ensure: (a) organized fertilizer distribution on a commercial basis so that users get the know how to use fertilizers and obtain optimum economic results (increase production and productivity per unit area) and improve living conditions; and (b) that fertilizer is available to smallholders in the required quantity, product mix, at the right time and at reasonable price. Accordingly, the process of developing competitive marketing system introduced in 1992 in the fertilizer sub-sector will continue. In the distribution and marketing system there will be three participants.

Participants

The private sector: In view of the growing fertilizer demand, the volume to be imported and distributed, the participation of the private sector will be crucial in reducing prices and delivering fertilizer to the smallholders on time. The government will encourage the private sector to fully participate in the importation, distribution, wholesale and retail trade of fertilizers in the country.

Service Cooperatives: The role of farmers' service cooperatives (SCs) in providing better services to their members is well known. Efforts shall be exerted to strengthen and encourage the participation of the service cooperatives in the fertilizer sub-sector to ensure the timely availability of the right fertilizer at reasonable prices to their members; in competition with other government and private sector traders.

Government role and participation: In the past importation, distribution and marketing of fertilizer has been carried out under the monopoly of Agricultural Input Supply Corporation. In view of the government's economic reforms and liberalization policies (the new fertilizer marketing strategy) AISCO will be restructured and streamlined to operate competitively in the

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free market with the private sector and cooperatives. It will be an autonomous organization and accountable to the board of directors, and the necessary regulations will be promulgated to that effect.

Transportation and Storage facilities: Transport and storage facilities have been the major bottlenecks in the distribution and marketing of fertilizers in the country. Since fertilizer is moved by roads from ports: (a) shortage of trucks have been critical to cope with the offtake of fertilizer from ships; (b) shortage of storage facilities at the ports and inland have caused unnecessary wastage and mishandling of fertilizers; and (c) lack and poor conditions of feeder and access roads delayed timely delivery of fertilizer to the marketing centers in the interior. To overcome these problems, the government shall invest to improve and expand physical infrastructure and other facilities as well as encourage and support the private sector to invest.

Fertilizer Reserve Stock: In the country where the road networks are not well developed, where fertilizer use is totally dependent on imports, where fertilizer usage is being developed, where fertilizer supply system can be constrained by world fertilizer demand/supply situations and international prices are volatile, etc., there will definitely be a need for minimum fertilizer reserve stocks. To this effect, the government shall take steps to maintain minimum fertilizer reserve stocks at strategic locations in the country and a guideline will be prepared on how such minimum reserve stock will be managed in a cost effective and efficient manner.

2.6 5 Pricing and subsidies of fertilizers

Fertilizer pricing: The main objective of fertilizer pricing is to provide incentive for efficient fertilizer use and to sustain a stable pricing environment to the farming community. In the past both fertilizer prices and grain prices (fixed grain prices and quota systems) were set by the government, and this had created dis-incentives to agricultural producers. The government believes that such pricing system would tend to distort the economic price structures of fertilizers, thus hindering effective competition in the fertilizer sub-sector. Nevertheless, the macroeconomic reforms (particularly foreign exchange adjustment) that is underway might continue to affect imported fertilizer prices. Accordingly the government will monitor the dynamic situation of the reforms on the import of fertilizers, growth of fertilizer consumption, the relative prices of agricultural output and fertilizer, and deregulation of the Pan-territorial pricing system in stages.

Fertilizer subsidy: Direct subsidy has not been practiced in the past because both agricultural product and fertilizer prices were administered by the government. However, the economic reforms and market liberalization policies of the government has changed the centrally administered pricing system into market-oriented system, which, it is hoped, will create competitive environment both for agricultural producers and suppliers of agricultural inputs. There are, however, cases where short- and medium term fertilizer subsidies are called upon and the reasons for such subsidies are; (a) that further exchange adjustment may dramatically increase the domestic prices of fertilizer which could be beyond the means of smallholders; (b) that international fertilizer prices are volatile and do fluctuate, and there could be a need for maintaining stable fertilizer prices domestically; (c) that fertilizer consumption in Ethiopia is extremely low and the need to increase its consumption is of paramount importance particularly

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during the period of early adaptation when the risks of farmers are high; and (d) in some cases it may be used to correct short term distortions in relative prices. It is therefore, essential to consider the question of subsidy in relation to promoting sustained fertilizer use for agricultural productivity and economic realities of the small holders in the short, medium and long terms.

The approach of the government shall be (a) to critically monitor and evaluate the policy of subsidy within the goals of the country's agricultural development strategy for increased and sustainable crop production, for food security, industrial raw materials and exports, and (b) to synchronize subsidy removal programmes with the prevailing conditions.

2.6.6 Fertilizer credit

Given the created enabling environment, aggressive participation of fertilizer importers, distributors, wholesalers and retailers are expected, and the government will encourage them to develop their capacity to operate within the banking institutions credit policies and operational guidelines.

Ensuring adequate credit facilities for smallholders and the mechanism through which the funds would be made available and recovered are important issues. Three constraints could be identified: (a) lack of appropriate financial institutions specifically dealing with smallhoders; (b) ineffective and inefficient rural institutions to administer and recover the fertilizer loans from farmers; and (c) a psychological problem where farmers feel that the government loans are grants, hence they do not plan for repayment. To minimize these problems, the credit programmes designed to help smallholders will consist of: (a) establishing rural financial institutions that will participate in expanding fertilizer credit to smallholders; (b) providing all the support in promoting, organizing and developing cooperatives, associations and groups and encourage them to participate at all levels of fertilizer activities; (c) ensure that proper management and discipline are followed in assessing the loan requirements and repayments on time.

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2.6.7 Fertilizer quality control and environmental protection

Inappropriate use of fertilizers can lead to adverse soil conditions and degradation of the environment. It is also possible that losses from agricultural fields and other areas can lead to environmental degradation, and contamination of ground and surface waters.

Quality control

Since fertilizer is an essential commodity and users are not highly informed and lack the tools to test the quality of the product, the government will have to lay down regulations to ensure quality control both at importation and within the distribution system. Quality control will include; (i) nutrient contents of the products; (ii) deterioration of physical quality; (iii) adulteration of the product at importation and distribution.

The government will protect farmers from using sub-standard fertilizers. To protect the interests of farmers the following measures will be taken:

Testing facilities are indispensable in verifying and ensuring the right types of fertilizers. To provide efficient and reliable services, efforts will be strengthened to increase the testing capacity in the field of quality assurance;

Ascertain the genuine supply of fertilizers, quality control system shall be strengthened at all levels through intensive inspection;

Farmers knowledge about the quality aspects of fertilizers will be raised to make them conscious of the deceptive finish of fertilizer products and encourage them to perform elementary quality control activities by themselves.

Legal action shall be taken to enforce the proper implementation of the existing standards of fertilizer control.

Environmental protection

The environment is adversely affected by improper use of fertilizer products and discharge of industrial effluent unless preventive measures are taken. To this effect, environmental standards for fertilizer products and industrial effluent of local fertilizer plants will be formulated and implemented. Accordingly:

Efforts will be made to introduce, develop and use efficient mechanisms that minimize losses of nutrients and other polluting elements into the environment;

Fertilizer materials that cause soil and environmental degradation will be carefully monitored, screened and restricted as required;

The impact of mining, processing and application of fertilizer raw materials and other agro-minerals on the environment will be investigated and monitored. In addition, reclamation and rehabilitation of mine spoils and degraded areas will be enforced;

Unwise and excessive use of fertilizers will in the long term lead to contamination of ground and surface waters; and the environment at large. Therefore, measures will be taken to monitor nutrient levels in water, food sources and the soils;

Fertilizer industry technology and plant location have considerable impact on the environment. Emphasis will, therefore, be given to the identification of environmentally safe technology and plant location;

It will be ensured that effluent and emissions from fertilizer plants shall be appropriately treated before being discharged;

Measures will be taken to establish monitoring and testing facilities for environmental protection in strategic locations;

Action will be taken for the compilation and maintenance of data base on the impact of fertilizers and other materials on environment; and

Ensure that types of fertilizer imported shall be based upon the recommendation of the National Agricultural Research System (NARS).

2.7 Related policies

2.7.1 Population policy

The consequences of rapid population growth for economic growth, economic development and welfare of the Ethiopian people are very negative. The number per se are dramatic as indicated in the situation analysis part of this report. As the population increases the

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question of food self-sufficiency will become more pressing. For example, if the population grows at 3 percent and per capita incomes grow between 1 and 2 percent, there will be an annual increase in food demand of about 4 percent (World Bank 1981). But in the last decade agriculture grew at less than half this rate (about 1.1 percent annually). Thus, unless there is a dramatic increase in agricultural production, more rather than less imported food will be needed in the coming decade.

As city population continue to expand it is almost certain that the majority of inhabitants will lack basic amenities such as water, sanitation and electricity. Other basic services will be very scarce: health care, waste disposal, street paving, communication, etc.

The government of Ethiopia in recognition to the consequences of high population growth it has adopted a population policy. The policy's major objectives are:

- closing the gap between population growth and low economic productivity through planned reduction of population growth and increasing economic returns;
- expanding economic and social development processes through holistic integrated development programmes designed to expedite the structural differentiation of the economy and employment;
- reducing the rate of rural to urban migration; and,
- maintaining/improving the carrying capacity of the environment by taking appropriate environmental protection/conservation measures;

The policy will be achieved through major areas of population activities such as:

- improving the quality and scope of service delivery;
- population research, data collection, analysis and dissemination;
- expanding and strengthening domestic capacity for training in population; and,
- expanding of education and social mobilization (population policy document)

2.7.2 Policy on women

Women in Ethiopia play a crucial role in agriculture both in terms of their labour input and decision making, such as, enterprises choice, labour exchange and disposal of production. Nevertheless, the economic status of the household, the women's age and her position in the family hierarchy and nature of the family (extended or small) and cultural factors affect the decision making role of women, and confine them to matters concerning their household chores and responsibilities.

In the urban areas where due to various social crisis as well as urban rural migration, about 35 percent of the urbanites are women. This huge workforce is forced to engage in low skill and low income due to lack of basic skills, education and inabilities to compete with their male counterparts. When one considers the labour force employed in modern sectors, not more than 21 percent are women. These are mostly in the service sectors with even fewer in administration and professional posts.

Although, the overall health status of the population is very low in Ethiopia, women suffer more due to their reproductive roles. Statistical records show that the maternal, child and child bearing mothers mortality rate is one of the highest in the world. In addition some of the various harmful traditional practices are among the factors affecting women's livelihood.

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The government of Ethiopia has issued a policy on women, in order to integrate women in the development process through the provision of equitable access to resources and opportunities created in the process of development to women on par with men. With the evolution of the policy women are expected to have equitable access to: modern awareness of employment opportunities and income, to education and training, to technology, to health facilities. In addition the policy also assures that women will equitably participate in the management and control of resources and freedom to control their own lives.

2.7.3. National policy on disaster prevention and management

Ethiopia is frequently threatened by disasters induced by drought and other factors. In the last forty years, disasters have, at varying degrees been occurring annually costing heavily both in terms of lives and resources. As concerted efforts are required to eliminate the root causes of disasters, a national disaster prevention and management policy has been developed so that relief assistance and other efforts contribute towards disaster prevention. The policy aims at a congruence of relief effort and planned development to strengthen the economic fabric of disaster prone areas so as to mitigate the suffering of affected population and enhance their capability to face the challenge of such disasters in the future. It also ensures that there is a close link between relief efforts and development programmes.

The objectives of the policy are:

- to ensure that no human life loss for want of assistance during time of disaster;
- to ensure adequate income to disaster affected households through relief programmes and to give them access to food and other basic necessities;
- to protect the quality of life of the people affected and to prevent adverse impacts;
- to reinforce the capability of affected areas by paying particular attention to relief efforts and to promote self-reliance; and,
- to eliminate the root causes of vulnerability to disasters.

The policy's basic principles are on:

- enrolment of community to play leading role in the planning, programming, implementation and evaluation of all relief projects; and,
- deployment of resources for the more urgent measures and priority in particular, where lives and livelihoods are more threatened.

Maximum benefit shall be derived from the application of scarce resources by identifying linkages between current relief and future capabilities and preparedness as a tool for reinforcing the disaster proofing content of relief measures. There shall also be integrated approach in the formulation and implementation of relief programmes and line departments will incorporate relief projects into their long term plans. As part of the long term development effort, appropriate prevention plans and programmes shall be designed for disaster prone areas in order to eliminate the root causes of their vulnerability. The extension of relief assistance to disaster victims shall be based on a relief plan to be prepared by the regions concerned. The preparation of the plan shall be bottom-up and shall ensure that measures designed to relieve current distress contribute to the build up of future capabilities to meet the challenges of disasters.

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Relief assistance to able bodied persons shall be through participation in employment generation schemes. This shall provide a means of distribution of income to deprived sections of society and build up the assets of communities so as to improve their resilience to disaster and create conditions and strengthen the infrastructures to help future development in the area.

It is intended to establish a national disaster prevention and preparedness fund for providing resources for the implementation of relief measures in disaster affected areas. It will be a separate autonomous corpus and will be built up by contribution from national budget and aid and donations from NGOs. Every region shall use its own local resources to finance relief measures and shortfalls shall be projected in relief plan for allocation from the national disaster prevention and preparedness fund.

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