Desertification in Ethiopian highlands

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ABSTRACT

Ethiopia is severely affected by recurring droughts and slowly advancing desertification processes. During the 1972/73, 80/81 and 84/85 drought and famine years, the social and the economic development of arid, semi-arid and dry sub-humid areas of the country were seriously affected. The 1984/85 drought claimed the lives of more than two hundred thousand people and millions of livestock.

Ethiopian land which falls within the UNEP's definition of desertification is estimated to cover 71.5% of the country's total land area. Overgrazing, deforestation, poor farming practices and using dung for fuel are the major causes of land degradation in Ethiopia. An estimated 70–75% of Ethiopia's livestock population is concentrated in the highlands. The recorded annual soil erosion (surface soil movement) in Ethiopia ranges from low of 16 tons/ha/yr to high of 300 tons/ha/yr depending mainly on the slope, land cover, and rainfall intensities. The total estimated annual soil loss (surface soil movement) from the cultivated, range and pasture lands (780,000 km^2) in Ethiopia is estimated to range from low of 1.3 to an average of 7.8 billion metric tons per year.

An Ethiopian highland reclamation study (FAO 1984) put the degraded area on the highlands at 27 million ha of which, 14 million hectares is very seriously eroded with 2 million ha of this having reached a point of no return. The Ethiopian government has carried out a massive soil and water conservation scheme through a "food for work" programme. But the magnitude of land degradation and the vastness of degraded land is so large that the impacts of conservation work seem comparatively small when viewed from a national perspective. The absence of ownership of land and other forms of benefit sharing and incentives, have been a major draw back. Conservation based sustainable development strategy guided by full grassroot participation is recommended. Resource ownership rights, appropriate land use plans at community level, intensification of production with the application of small scale irrigation integrated with local knowledge, and instituting proper population pressure releasing mechanisms are key areas to be considered.

Key words: Ethiopia, desertification, people participation, soil conservation, soil erosion.

INTRODUCTION

The dryland areas in Ethiopia which fall within the range of UNEP's definition of desertification cover 860,000 km^2, or 71.5% of the country's total land area. This zone is an important annual crop and livestock production zone. The drylands in Ethiopia occur from below sea level (Afar depression in the north-east) to 2700 m elevation. Examination and analysis of the climatic data from 250 stations throughout the country show that the drylands receive annual rainfall ranging from 28–1117 mm, have annual potential evapo-transpiration rates ranging from 1312–2832 mm and a ratio of RR/PET ranging from 0.05–0.65 (Figure 1, Table 1).

The dominant man induced causes of land degradation in the drylands of Ethiopia are poor farming practices, population pressure, overgrazing, soil erosion, deforestation, salinity and alkalinity problems, and the use of livestock manure and crop residue for fuel as energy resource of the rural households (Cesen 1986, World Bank 1984). More than twenty seven million people live in the dry sub-humid, semi-arid and arid areas, where the ratio of RR/PET is less than 0.65. The map on Figure 1 and the data on Table 1 show the extent and the coverage of the areas in Ethiopia which

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are susceptible and prone to desertification processes as defined by the UN: “land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities” (UN CCD 1994).

Table 1. Data on rainfall, evapo-transpiration, and aridity index for 250 stations in Ethiopia.

Zone	No. of stations (Total=250)	Elevation, m		Rainfall, mm/yr		Evapo-transpiration mm/yr		Aridity index		Land area $km^2 \times 1000$
		Range	Mean	Range	Mean	Range	Mean	Range	Mean	
Humid (moist)	138	425–3000	2205	910–2448	1679	1043–1681	1362	0.67–1,83	1.25	350
Dry sub-humid	37	1200–2700	2000	642–1117	900	1312–1790	1510	0.50–0.65	0.596	300
Semi-arid	50	625–2550	1639	411–897	656	1284–2138	1700	0.2–0.50	0.377	207
Arid	20	175–1000	510	83–406	266	1630–2950	2213	0.05–0.2	0.124	300
Hyper-arid	5	0–660	300	28–113	70	2830–2832	2831	<0.05	0.025	53

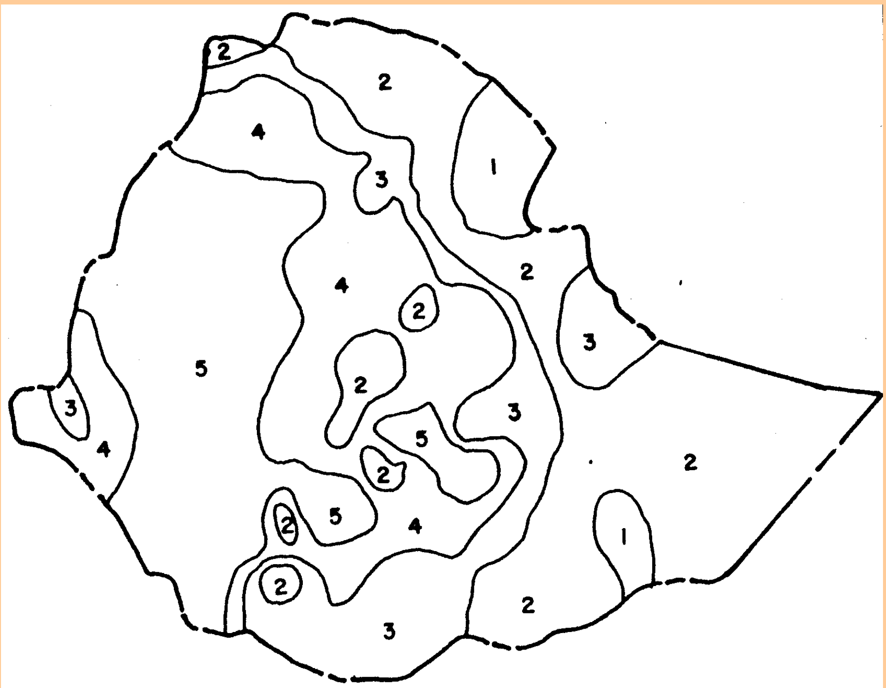

Figure 1. Dryland areas in Ethiopia delineated on the bases of RR/PET ratio. (Based on the information from NMSA, FAO and de Pauw).

Legend:			
	1	Hyper-arid	= RR/PET<0.02
	2	Arid	= 0.02≤RR/PET≤0.20
	3	Semi-arid	= 0.20≤RR/PET<0.50
	4	Dry sub-humid	= 0.5≤RR/PET<0.65
	5	Humid	= RR/PET>0.65

EXTENT OF LAND DEGRADATION IN ETHIOPIA

The Ethiopian highland studies revealed that the Ethiopian highlands, which cover 44% of the country’s total land area are seriously threatened by soil and biological degradation. Some 27 million ha representing approximately 50% of the highlands are already significantly degraded. Of this area 14 million ha are badly eroded and if the present trend of soil degradation continues, per capita in come in the highlands will fall by 30% in 20 years time (FAO 1984). Fifty four percent of the remaining highlands are highly susceptible to erosion.

FAO (1984) reported that on two million ha of cultivated land, the soil depth is so reduced that the land is no longer able to support any vegetative cover. The Hararghae highlands in Eastern Ethiopia, Tigrai, Wollo, and Semen Shoa highlands in the North and the Gamo-Gofa highlands and the Bila-te River basin, which starts in Eastern slopes of Gurage highlands and stretches through Eastern Hadiya and Kembatta highlands, are some of the seriously eroded land surfaces in Ethiopia. The highland areas in Ethiopia are defined and delineated to represent the land areas above 1500 m a.s.l. and the lowlands are defined as areas below 1500 m a.s.l. in altitude.

More than 90% of Ethiopia's population live in the highlands including about 93% of the cultivated land, around 75% of the country's livestock and accounts for over 90% of the country's economic activity. Land degradation is seriously threatening the economic and social development of the country as a whole. Due to degradation, increasing number of Ethiopians have become vulnerable to the effects of drought. The severity of the devastating droughts and the resulting famines in 1972/73 and 1984/85 can be attributed to an accelerating process of degradation combined with widespread general poverty of the population.

Measurements of land degradation usually focuses on the severity of soil erosion mainly caused by high-intensity rain storms on rugged geomorphic features, steep slopes, and barren land surfaces highly susceptible to soil erosion. The wide spread practices of burning dung, burning crop residues for fuel and for seed bed preparation under state farm conditions, burning of forests and range lands, deforestation for cultivation, fuel wood and construction materials, as well as poor farming practices particularly in the areas practicing cereal mono-culture farming system and cultivation of steep slopes, increase the susceptibility of the land resources to erosion in dry subhumid and semi-arid areas.

SOIL EROSION

Current rates of soil erosion documented in Ethiopia range from 16–300 tons/ha/year (Hurni 1988, Hawando 1989, 1995). The Ethiopian Highlands Reclamation Study (FAO 1984) suggested the average annual soil movement of 100 tons/ha/year for the Ethiopian highlands. The amount of annual soil movement (loss) by erosion is estimated to range from 1,248–23,400 million tons per year from 78 million ha of pasture and range lands and cultivated fields throughout Ethiopia (Table 2). When the average value of 100 tons/ha/year of soil erosion rate suggested by FAO (1984) is used, the average annual local movement of soil is estimated to be 7,800 million tons per year from the cultivated and grazing lands of Ethiopia.

Table 2. Annual soil movement (loss) documented in Ethiopia under various land use systems and topographic features (Hawando 1995).

Land use type	Land area million ha	Documented range of annual soil loss, ton/ha/year 16	50	100	200	300
		Annual soil movement, million tons				
1. Cultivated land	18	288	900	1800	3600	5400
2. Pasture & rangelands	60	960	3000	6000	12000	18000
Total	78	1248	3900	7800	15600	23400

In the dryland areas in Ethiopia, 30.9 million ha, consisting of twenty five major soil great groups, are shallower than 50 cm. Further erosion will cause severe damage if rehabilitation measures are not taken in time. Out of the 30.9 million ha, 20.2 million ha occur in areas with xeric SMR, 5.2 million ha in aridic SMR and 4.6 million ha occur in ustic SMR zones (Hawando 1995).

Soil conservation research project (SCRP; Hurni 1988) and National Conservation Secretariat (1992) claim that soil losses may have been severely over-estimated by FAO (1984). The figures for the soil loss by erosion from 6 SCRP sites range from 18–214.8 tons per ha per year (Table 3).

When the soil loss figures obtained from SCRP sites are used to calculate the magnitude of soil loss from cultivated fields, pasture and rangelands, the amount of annual local soil movement ranges from 1,248–23,400 million tons per year (Table 2).

Table 3. Soil erosion loss on 6 SCRP sites in various parts of Ethiopia (World Aragaye Berehe 1996).

Site	Soil loss (tons/ha/year)
South Wollo	36.5–53.8
Sidamo	41.2–49.5
Harar	25.5–27.8
North Showa	152.4–214.8
Gojam	40.2–199.2
Illubabur	18.0–135.3

It is reasonable to state that the soil movement figures reported by FAO (1984) were not over-estimated. Rather, the figures estimated by National Conservation Secretariate and the Soil Conservation Research Project can be considered to grossly under-estimate the magnitude of land degradation in Ethiopia mainly because of low land area figures used in their calculations. Study by Lund University Geography Group (Helden 1987) concluded that land cover is the most important factor controlling soil erosion, while precipitation characteristics and slope are also important. Therefore, for conservation and rehabilitation programme, we have to make sure that land cover is given the top priority.

LOSS OF PLANT NUTRIENTS

Associated with the soil movement is the loss of organic matter, nitrogen, phosphorus, potassium and other essential plant nutrients. Data in Table 4 shows that organic matter loss associated with the removal of surface soil ranges from 15–1000 kg/ha/year which amounts to 1.17–78 million tons of organic matter lost per year from 78 million ha of cultivated and grazing lands. The loss of soil nitrogen ranged from 0.39–5.07 million tons per year and that of phosphorus ranged from 1.17–11.7 million tons per year. Taking an average value of nitrogen loss of 30 kg/ha/year, organic matter loss of 200 kg/ha/year and phosphorus loss of 75 kg/ha/year the corresponding loss of the three plant nutrients amounts to 15.6, 2.16 and 5.85 million tons per year of organic matter, nitrogen and phosphorus respectively from 780,000 km^2 of land (Table 4).

The EHRS study (FAO 1984) estimated that about 10% of the soil crosses international boundary as a sediment load in rivers.

Table 4. Annual loss of organic matter, nitrogen and phosphorous associated with the loss of top soil under various land use systems (Hawando 1985).

Land use type	Land area million ha		Nutrient documented range of annual loss, kg/ha					
		OM	15	50	100	200	500	1000
		N	5	10	15	30	50	65
		P	15	30	50	75	100	150
			Amount of nutrient loss, million kgs					
1. Cultivated land	18	OM	270	900	1800	3600	9000	18000
		N	90	1800	270	360	900	1170
		P	270	360	900	1350	1800	2700
2. Pasture & rangelands	60	OM	900	3000	6000	12000	30000	60000
		N	300	600	900	1800	3000	3900
		P	900	1800	3000	4500	6000	9000
Total	78	OM	1170	3900	7800	15600	39000	78000
		N	90	780	1170	2160	3900	5070
		P	1170	2160	3900	5850	7800	11700

CLIMATE AS A NATURAL CAUSE OF DESERTIFICATION

Low and erratic rainfall and recurring droughts

Analysis of mean annual rainfall in Ethiopia showed that large areas in the highlands are characterized by more than 30% coefficient of variation (Degeffu and Haile 1990). The situation is further aggravated by the narrow intervals of drought occurrences. Analysis of the chronological events of Ethiopian drought and famine years revealed that there were over 305 drought years during the last 2310 years (NMSA 1990). The frequency of droughts in Ethiopia is variable but has been occurring in narrower intervals during the last 50 years, especially towards the end of 20th century. The most publicized drought and famine years were those of 1972/73 and 1984/85 when thousands of human lives were lost and millions of livestock died. The dry sub-humid, semi-arid and arid zones are the most affected areas during the years of low rainfall and droughts. The loss to grain production ranged from 500,000 tons during the normal years to 1,8 million tons in severely drought affected years. The figures estimated by the official government sources (RRC) on the loss of grain production ranged up to 1.4 million tons during the severe drought years.

Moisture regimes in Ethiopia – rainfall and evapo-transpiration

The analysis of rainfall and evapo-transpiration data from 250 stations throughout the country across topographic features and latitudinal zonation indicated that desertification threats are equally wide-spread in Ethiopian highlands and lowlands (Figure 1 and Table 1). The number of stations with ratio of RR/PET less than 0.65 which fall with in the range of areas classified as prone to desertification are 112. Of the 112 weather stations in dry areas, 68 are located in areas above 1500 m a.s.l. and 38 stations are located in areas below 1500 m elevation.

The arid and hyper-arid areas in Ethiopia range in altitude between 0 and 1000 m and get a range of annual rainfall from 28–406 mm. These two zones cover a land area of 353,000 km^2 and are used by nomadic pastoralist. Overgrazing, wind erosion, salinity and deforestation are the major man induced causes for land degradation in these zones. The semi-arid areas range in altitude between 625 and 2550 m a.s.l. and receive a range of annual rainfall from 411–897 mm with corresponding potential evapotranspiration ranging from 1284–2138 mm per year. The semi-arid areas in Ethiopia cover 207,000 km^2 and are used by semi-sedimentary agro-pastoralist and settled crop cultivators throughout the country. Poor farming practices, overgrazing, deforestation, water and wind erosion, and salinity are the major man induced causes for land degradation in this zone.

The dry sub-humid areas range in altitude between 1200 and 2700 m a.s.l. and receive a range of annual rainfall from 642–1117 mm with corresponding evapotranspiration from 1312–1790 mm per year. The dry sub-humid areas cover 300,000 km^2 and this zone is a major annual crop producing area where Oxen-plow cereal mono-culture is a dominant farming system.

There are fairly large areas in the Ethiopian highlands (above 1500 m a.s.l.) prone to desertification hazards and fall within UNEP's definition of desertification where RR/PET<0.65 (Figures 1 and 2; Table 1). The land degradation process in the dry sub-humid and semi-arid areas becomes very serious because it affects nearly 27 million people and 116,000 km^2 of cultivated land (64% of the country's total cultivated land area is located in this zone).

Soil moisture regime classification of Ethiopia

Soil moisture and temperature play major roles in controlling plant growth and development. Large areas in Ethiopia are subjected to recurring droughts, low and erratic rainfall, and frequent low available soil moisture. Reduced soil moisture increases soil temperature which causes reduction in plant cover and binding ability of soil particles and soil aggregates. This makes the soils susceptible to erosive forces.

The dryland areas in Ethiopia fall within ustic, xeric and aridic soil moisture regimes. The total land area covered by these three zones is 860,000 km^2 of which 106,000 km^2 is cultivated. This area supports a total population of 27.1 million (Figure 2 and Table 5). Areas in Ethiopia receiving 300 mm annual rainfall cover 26.4 million ha (22% of the total land area) and are classified in aridic soil moisture regime. There is no cultivation in this zone and the land is only used as nomadic rangeland. This zone is extremely sensitive to drought, salinity and alkalinity problems. Approximately 1.5 million nomadic people live in this zone. The major man induced causes for desertification are overgrazing and deforestation.

Table 5. Area coverage of various soil moisture regime classes in Ethiopia, potentials and constraints for development an environment rehabilitation.

Soil moisture regime classes	Annual rainfall & available water holding capacity	Land area in km², household in 1000 km² Total	Cultivated	Population million	Major uses	Major constraints leading to land degradation
Udic	1000–2800 (AWC=300–392)	361	64	29.5	Perennial & annual crops, forestry	Poor farming system, deforestation, overgrazing, population pressure
Ustic	700–1000 (AWC=196–342)	220	103	20.1	Annual crops dominate, perennial crops, grazing, forestry	Poor farming system, deforestation, overgrazing, population pressure, water & wind erosion, drought, salinity
Xeric	300–700 (AWC=50–196)	367	11	4.5	Rangelands, annual crops, irrigated farms	Deforestation, overgrazing, erosion, drought, low rainfall, salinity
Aridic	<300 (AWC<50)	270	2	2.5	Rangelands, farms, sporadic annual crops	Moisture deficit, wind erosion, drought, overgrazing, erratic and low rainfall, salinity
Total	1000–2800 (AWC=300–392)	1218	180	56.6		

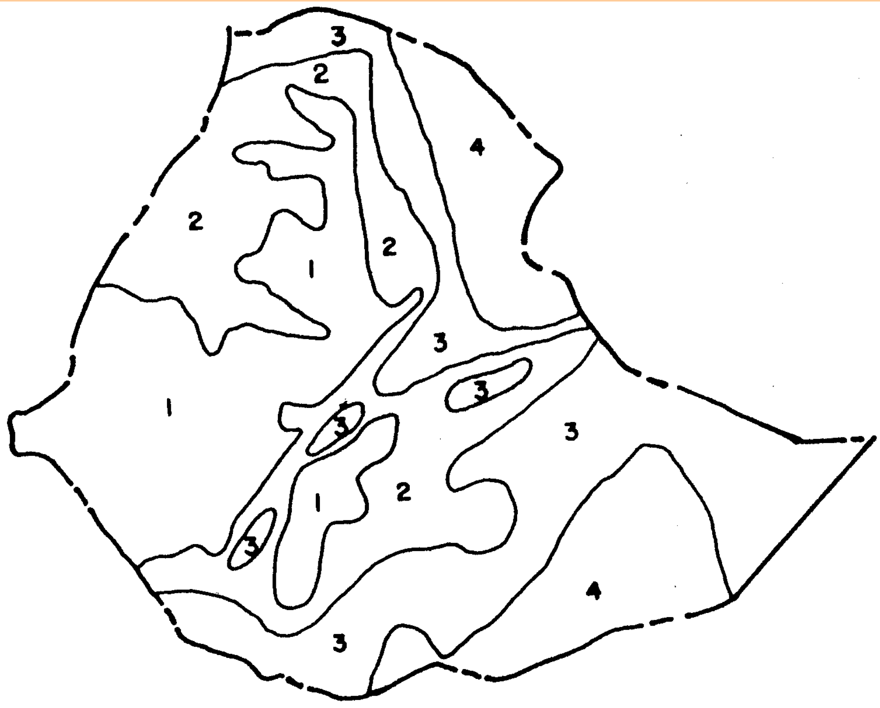

Figure 2. Soil moisture regime zones in Ethiopia (Hawando 1989).

Legend:

1	Udic SMR	= Ppt > 1000 mm,	AWC = 300–392 mm
2	Ustic SMR	= Ppt = 700–1000 mm,	AWC = 192–342 mm
3	Xeric SMR	= Ppt = 300–700 mm,	AWC = 50–198 mm
4	Aridic SMR	= Ppt < 300 mm,	AWC < 50 mm

SMR = Soil moisture regime.
AWC = Available water holding capacity.
Ppt = Precipitation.

Areas receiving 300–700 mm annual rainfall cover 36.7 million ha (30% of the total land area) and fall within the xeric soil moisture regime. The cultivated area in this zone is 1.1 million ha and it is a home for about 4.5 million nomadic and semi-nomadic pastoralists. This zone is also subjected to low and erratic rainfall, recurring droughts, soil moisture deficit and salinity problems. Overgrazing, poor soil management practices and deforestation are the major man induced causes of desertification in this zone. Areas getting 700–1000 mm of annual rainfall cover 22 million ha (18% of the total land area) and are classified in the ustic soil moisture regime. The land cultivated in this zone is 9.5 million ha and it is a home for 13.7 million people. The major problems in this zone are low soil moisture, re-curring droughts, overgrazing, deforestation, and poor farming practices. This zone is an important cereal producing area in Ethiopia (mainly dominated by ox-plough cereal mono-culture farming system). The effects of droughts, erratic and low rainfall in this zone are very detrimental, because most of Ethiopia's grain production is concentrated in this area.

HUMAN INDUCED CAUSES OF LAND DEGRADATION

Overgrazing

Ethiopia's livestock population is estimated to be 78 million and the poultry at 30 million by 1994 livestock census figures. From this 78 million livestock population, 75% (48.5 million) and nearly all the poultry population is located in the highland areas above 1500 m a.s.l. Therefore, the pasture and rangelands in the highlands are very severely overgrazed. Thus, overgrazing is much more severe in the highlands compared to the lowland areas. Recent studies carried out in Semen Omo zone in the southern Ethiopian Highlands, concluded that the forage bio-mass produced for livestock shows high stocking rates with concentration of animals of up to 23 TLU per ha whereas under normal and well managed pastures the stocking rates is recommended to be 2–5 TLU per ha. This means that there are far more animal units on the land than it can support in the Semen Omo zone in Southern Ethiopia, an area which represents one of the severely eroded land surfaces in Ethiopia (Tiku 1997).

Deforestation

The present estimates of Ethiopia's forest base vary according to the sources of report. FAO (1984) study reported 35 million ha while Cesen (1986) study documented 33 million ha and the State Forest Conservation and Development Department (SFCDD 1990) reported 27 million ha. This forest area includes an estimated 3.5–5.5 million ha of high forests in various parts of the country. The estimates of annual rate of deforestation vary from 150,000–200,000 ha. The state planted forests up to 1989 was reported to be 161,000 ha out of which *Eucalyptus* spp. accounts for more than 55% (EFAP 1994). Reports show that the country's forest resources covered 40% of the total land area some 100 years ago but now forests cover less than 5% of the country's land area.

From the information available, the rate of deforestation in Ethiopia is alarming and the rate of afforestation is very negligible in light of the very high rate of forest clearing for fuel, expanding agricultural land and construction purposes. Deforestation leaves the land surface barren and open to serious land degradation processes.

Population pressure on the land resources

The present population of Ethiopia is estimated at 62 million (Table 6) of which 88% live in the highlands. The highlands cover 44% of the country's land area and display very rugged geomorphic features, steep slopes with narrow inter-mountain valleys as common features of Ethiopian highlands.

The population has grown very fast on the limited land area in the highlands and every possible piece of land is put into cultivation to produce food. Means for relaxing this population pressure should be considered very seriously.

Table 6. Population estimates and projections (CSA 1988).

Year	Population million	Annual growth rate, %
1920	12.9	0.6
1950	19.2	1.7
1970	29.5	2.3
1985	43.3	2.9
1995	60.3	3.3
2000	71.5	3.4
2010	99.6	3.3

Use of dung and crop residues as energy

Studies in energy sector by World Bank (1984) and Cesen (1986) reported that 99% of the energy used in Ethiopian homes comes from bio-mass sources which include dung, crop residues, and woody bio-mass. These studies estimated that out of the 22.5 million tons of cattle manure annually produced, 38% is used as a fuel and out of the 21.2 million tons of crop residues produced annually, 24% is used as a fuel. The remaining 76% of crop residue is left on the ground and/or is used by livestock. Other studies in Ethiopia showed that a total of over 3 million tons equivalent of nitrogen, potassium and phosphorus are removed by livestock through grazing and crop residue consumption (NCS 1992, FAO 1984). The amount of nitrogen, phosphorus and potassium in the livestock manure produced annually in Ethiopia is estimated at 1.4 million tons in terms of N, P_2O_5 and K_2O (Hawando 1995).

Ox-plough, cereal mono-culture farming system

In the dry sub-humid and semi-arid highlands, the cereal mono-culture is the most dominant farming system. Crop rotation scheme, inter-cropping, mulching and using manure on the farm fields are not normally practiced by many farmers. In addition, dung and crop residues are used as fuel and livestock feed. The farmers plow their land up and down the slopes thus exposing the soil to rill and gully erosion. The Tigray, Wollo, Semen Shewa, parts of Gonder, Central and South-central Rift-Valley zones, Arsi and Bale highlands are good examples of cereal mono-culture farming system. With the exception of Bale and Arsi highlands, the other cereal mono-culture areas display severely degraded land surfaces.

Salinity and alkalinity problems

The semi-arid and arid lowlands and valleys in Ethiopia have major problems of salinity and alkalinity. Recent studies by Hawando (1989, 1995) have revealed that 44 million ha (36% of the country's total land area) are potentially susceptible to salinity problems. Out of the 44 million ha, 33 million ha have dominantly salinity problems, 8 million ha have combined salinity and alkalinity problems and 3 million ha have dominantly alkalinity problems. Out of the 170,000 ha under irrigation by state farms in Awash Valley and in Central Rift-Valley lake area, almost 10% (11,000 ha) are feared to have been salinized and have already gone out of production.

IMPACT ON PRODUCTION AND ENVIRONMENT REHABILITATION

The major impacts of dryland degradation on production and environment rehabilitation include:

- Soil loss caused by erosion reduces soil depth, consequently decreasing the amount of soil moisture and leading to the loss of plant nutrients. This contributes to the loss of grain production in the order of 80,000–180,000 tons per year (NCS 1992, FAO 1984). In addition, if the present soil erosion rates stay at their current levels, it is projected that land covered by soil less than 10 cm deep will increase from 20,000 km^2 in 1985 to 100,000 km^2 by 2010, contributing to large losses to crop production potential.
- The estimated soil movement ranges from 1,248 to an average value of 7,800 million tons per year causes a loss of organic matter of the order of 1.17–7.8 million tons, nitrogen from 0.39 to 1.17 million tons and phosphorus 1.17–3.9 million tons per year. The yearly loss of nitrogen and phosphorus from 780,000 km^2 of cultivated, pasture and rangelands in Ethiopia is estimated to be equivalent to 327–1064 million US dollars per year (Hawando 1995).
- The recurring droughts and low, erratic rainfall are responsible for the loss of thousands of human lives, millions of livestock and annual crop loss of up to 20% during severe drought years in-terms of grain produced (1,8 million tons per year).
- The present burning of animal dung and crop residues for fuel is estimated to represent a loss in crop production of 700,000 tons of grain (NCS 1992).
- The estimated annual loss of forests of between 150,00 and 200,000 ha is equivalent to about 6% of the remaining natural high forest. At this rate the natural forests will be gone in 15–20 years (EFAP 1994).

STEPS TAKEN TO COMBAT LAND DEGRADATION

- Soil and Water Conservation Programme. To combat the land degradation problem, the Ethiopian government launched a massive soil conservation programme in the middle of 1970's. The following physical and biological conservation measures were carried out between 1976 and 1992 (Hawando 1989, 1995, World Aragaye Berehe 1996, EFAP 1994).
  - 78,000 ha of soil and stone bunds.
  - 253,000 ha of hill side terraces and afforestation.
  - 15,400 km of clock dams in gullied lands.
  - 410,000 ha of closed areas of natural regeneration (area enclosure).
  - 465,000 ha of land planted with different tree species.
  - 580,000 ha of bench terraces.
- National conservation strategy has been completed and ratified.
- Action plan to combat desertification is under way.
- National population policy is adapted.

- Disaster prevention and preparedness programme has been approved and implemented.
- Ethiopian Forestry Action plan has been prepared.
- Environment Protection Agency has been established.
- Agricultural development and environment rehabilitation are given first priority in the Government of Ethiopia's Economic Development Policy.

RECOMMENDATIONS – FUTURE DIRECTION

Combating and reversing the desertification process requires comprehensive and cost effective programme. Environment rehabilitation is better attained and sustained at lower cost if:

- It is fully integrated into main stream agricultural and rural development programmes and activities starting right from the beginning.
- Bottom-up participatory planning, implementation and monitoring by the real stake holders at grassroots are practiced.
- Conservation practices increase sustainable farm productivity levels and the incentives for rural households to construct and maintain effective conservation structures are well established with clear right of ownership structures.
- Appropriate technologies are adopted and integrated with local/traditional practices that are known to be effective in conservation of the land resources, increase food and fodder production, and are cost effective.
- Proper land use, farming practices, and appropriate technologies are planned and integrated at grassroots for each specific agro-ecological zone.

The impact from such integrated agricultural and rural development programmes will be much greater than that can be achieved by bunding and re-afforestation alone – which are the core components of soil and water conservation programme presently implemented in Ethiopia.

The following actions are recommended:

- Conservation Based Sustainable Development (CBSD) Strategy appropriate for each agro-ecological zone with core components to sustain resources, increase yield, and conserve environment.
  - Appropriate technologies adopted and integrated with local practices to increase sustainable yield and rehabilitate the environment.
  - Increase productivity of the land resources and conserve the environment.
  - CBSD emphasizes increased vegetative cover on the land as the most important conservation component followed by bunds and terrace construction. Land cover has been found to be more important in controlling soil erosion under Ethiopian conditions than physical conservation measures.
- Land use policy and ownership right of land, physical constructions, trees and water wells/reservoirs with appropriate policy instruments should be established.
- Intensification of agricultural production with the integration of proven local practices and appropriate technologies should be pursued in dry sub-humid and

semi-arid areas where population density is high through use of small scale irrigation and yield increasing farm production inputs.

- Release population pressure through family planning, creating off farm employment, other income generating activities, and also through voluntary and well planned re-settlement programmes.

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