A Participatory Agroforestry Approach for Soil and Water Conservation in Ethiopia

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Abstract

The rates of soil erosion and land degradation in Ethiopia are frighteningly high. Crop production, livestock keeping and energy supply situations are at risk. The highlands are the most affected. Past rehabilitation efforts have been immense. Much labour, capital and trained staff have been mobilized to correct the situation, but the outcome has not been encouraging. There are a number of reasons for the failure. Methodical and technological problems are evident. Exclusion of farmers and their indigenous knowledge at all levels of planning and implementation, the use of uniform and 'foreign' soil conservation and reforestation technologies, mistrust between farmers and facilitators, farmers' bias to production over conservation, miss-use of *food-for-work* programmes in conservation works, lack of conducive land tenure and tree usufruct have all contributed.

Success in the effort calls for construction of an approach by which the traditional soil and water conservation and agroforestry knowledge of farmers can be studied, adapted and used. Therefore, farmers themselves were necessarily involved in the study, adaptation, implementation and evaluation of the rehabilitation work. The conceptual framework and the research questions were designed to reflect these issues and concerns.

The research has been farmer-participatory. It is an action research, which is conducted both at community/catchment-level and at a household/farm-level. Farmer-participatory trust building, socioeconomic diagnosis, environmental assessment, planning, implementation and evaluation methods are researched. The research is administered in a soft-system approach. The outcome of the research is a participatory agroforestry approach by which soil conservation is benefiting. It is composed of 'six sub-processes' that each are inter-linked in a logical order.

- The first sub-process deals with methods of approaching the farmer(s) and finding appropriate extension methods that can secure genuine trust and acceptance of development facilitators. Indigenous means of approaching farmers and trust building are devised.
- The second sub-process deals with a comprehensive social diagnostic approach. Appropriate methods of development extension, identification of production desires, social limitations and production potentials, indigenous land husbandry technologies are studied and identified.
- The third sub-process deals with methods of environmental assessment. The application of GIS output maps for synthesizing the information and enhancing the participatory research work on site diagnosis and relative land potential assessments is presented.
- The fourth sub-process focuses on methods of reconciling the findings in the human sector with the site factor. A methodology by which traditional soil and water conservation and reforestation skills, production desires and targets of farmers are understood and used in planning is devised. It involves preparing prescriptions for each of the planning units developed in the sub-process.

- The fifth sub-process focuses on adapting catchment level plans and prescriptions to farm and farmer-level situations, technology appropriations and implementations. A methodology by which these activities of the sub-process are conducted is devised.
- The six sub-process dwells on conducting tests on sustaining land quality, cost effectiveness and adoption ease of the implemented agroforestry development options at farm level. A methodology by which the participatory evaluation can be conducted is developed.

Each of the six sub-processes of the approach are constructed and tested under Tikurso catchment conditions. In the process, the researching steps that were initially conceptualized in their abstract form are transformed into more illustrated sub-processes. As a result, an agroforestry approach whose nested sub-processes are connected to form a multi-loop approach is evolved. The constructed approach assumes that circumstances change in either the social sector or the environmental setting or both through time. For generation and usage of this expectedly new information, the approach has three alternate avenues. Choice among the alternative avenues is made depending on the knowledge-gap identified during the evaluation and feedback sub-process of the approach. The results from land sustaining quality, cost-benefit analysis and adaptability tests confirm that the approach has significant benefits to soil and water conservation.

The evolved sub-processes indicate that the overall approach is nested in that the various discrete data and information generated in the sub-processes are hierarchical and built one in congruence with the other. The subsequent sub-processes make use of the conclusions and are guided by the information obtained in the preceding exercises. The approach is further characterized by an intimate bondage of the farmers' knowledge with the facilitator's knowledge.

In addition to its methodical aspect, construction of agroforestry and soil and water conservation intervention technologies for adoption by farmers is contained within the approach itself. It is further realized that locally understood land quality grading variables can be defined, adapted and used for determining agroforestry and soil and water conservation planning units in broad and detailed intervention categories. For the moist *Weyna-dega* agro-climatic zone situation, eleven agroforestry and soil and water conservation intervention categories are defined. Eight of them occur within the adapted cropping limit while the remaining three are devised for those lands that are out of the cropping limit. For each of the intervention categories, agroforestry and soil and water conservation components are defined and implementation issues are prescribed. Catchment level interventions and prescriptions serve as a guide to farm-level agroforestry and soil and water conservation planning and implementation undertakings. The development of the eleven interventions has resulted in realization of agroforestry as a land use option by which soil and water conservation measures are combined with woody perennials and non-woody components on the same piece of land simultaneously. In this regard, PAA is an approach that contributes to remedying the methodical and technological shortcomings of land rehabilitation in Ethiopia.

The conditions for its application on large-scale are studied by considering 38 peasant associations from four administrative sub-districts. Site reconnaissance, individual and group interviews with the farmers and the government authorities concerned as well as literature search were the methods of the study. The study shows that the conditions are partly non-conducive. The recommendations indicate the actions that need to be taken for improving applicability of the approach itself and the conditions for its application on large-scale.

Preface and Acknowledgments

I would like to express my sincere gratitude to Prof. Dr. Ir. Leo Stroosnijder and Prof. Ir. Adriaan van Maaren for their endurance, much-needed ceaseless support. Their invaluable scientific guidance, friendship and stimulating faith have made my education lively both at Wageningen Agricultural University (WAU) and the country of research, Ethiopia. In addition to their scientific guidance in the study, their advice and inventive comments in the structuring and restructuring of the thesis writing has been extremely helpful. Without their vivacious support, the work would not have had the quality that it has now. I highly appreciate the support given by Prof. Dr. Ir. Leo Stroosnijder and Mr. K. Freerk Wiersum in commenting on the research progress by coming to the research site in Ethiopia from their distant country, The Netherlands. At times, Mr. Wiersum became involved in untangling the domestic bureaucratic ruffle that I had been facing during my repeated travels to my University (WAU). A rewarding aspect of my study in Wageningen Agricultural University has been the warm contact and friendship I have had with a number of academicians in the department of Irrigation and Soil and Water Conservation. Many facilitated my studies and my special appreciation goes to Jan de Graaff, Leo Eppink, Geert Sterk, Wim Spaan, Fred de Klerk, Dirk Meindertsma, Henk Joschems and the secretaries.

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The concept of this study was born from the real problem that the (then) CFSCDD faced in rehabilitating degraded lands. Dr. Kebede Tato, called a meeting of the technical experts (both local and expatriate) of CFSCDD and made an apeal for an effort from every one of us (headquarters experts) to come up with proposals for speeded up reforestation and land rehabilitation efforts in the country. I have been thrilled by the problem and the plea made. This is how this search for "participatory agroforestry approach for soil and water conservation in Ethiopia" started. I am very much indebted to the encouragement of Dr. Kebede Tato.

At the same time, exhaustive studies indicate that the strategy and direction of successful reforestation and land rehabilitation in Ethiopia is recognizing agroforestry developments as one of the most appropriate options. In addition, farmers practise traditional agroforestry practices in many parts of Ethiopia. Regardless of all these insights and experiences, there is no tangible evidence for the recognition and implementation of agroforestry developments in the country. No institution seems to be mandated for using an agroforestry approach either. One of the bottlenecks is thought to be a shortage of a down-to-earth approach to be used by development facilitators so that adoption of land rehabilitation initiatives by farmers could be possible. This challenge has been an additional reason for the start of the search into this 'participatory agroforestry approach'.

Furthermore, the assignment of searching for workable directives in agroforestry know-how grew in me due to academic experience exchange I have had with the staff of academic and extension institutions, development consultants, field experts, forestry/agroforestry students and the farmers during the various years of my diversified work assignments. It is practically impossible to mention all who contributed here, but they all deserve my special thanks.

I can not conclude this note without thanking the influential community elders, social institution leaders and interested innovative farmers of Tikurso catchment who have been deeply involved in coordinating one another in mobilizing their labour, local knowledge and materials for the success of the study throughout the five years' period. Much of their scarce and valuable time was spent in coordinating fellow farmers and advising myself. I will, in years to come, remain indebted and appreciative of their friendship and hospitality. Without their cooperation, this thesis could not have been written.

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Lastly, I would like to say that the responsibility of any error or weakness of the study rests entirely with me while all the good outcomes are conferred to everyone with pleasure.

Abbreviations and Definitions of local (Amharic languge) terms

CFSCDD
Community Forests and Soil Conservation and Development Department

DA
Development Agent

DCDLU
Department of Catchment Development and Land Use.

Debir
Is a local term for a community defined by people going to a certain church for their religious worshipping

Debo
It is a local term for a system by which a farmers mobilizes labour by requesting help in labour for activities related to farming practices including harvest from his friends, relatives etc. free of charge. He or she prepares food and drink for the people who come to help. When the labour support is only for few hours in the early mornings, it is called ' *Giso*'.

DEM
Digital Elevation Model

Dinber
An earth embankment developed from an unploughed strip of land on a farm so that it can help in arresting sediment in run-off and be used for development of grasses for cattle feed.

DTM
Digital Terrain Model.

EOC
Ethiopian Orthodox Church

EPRDF
Ethiopian Peoples Revolutionary Democratic Front.

PAA
Participatory Agroforestry Approach

FHI-Gondar
Integrated rural development project of the Food for the Hungry International (NGO initiated and executed project)

FRC
Forest Research Center

GIS
Geographic Information Systems

GPS
Geographic Positioning System.

Golenta
A local term for an indigenous flood diversion channel that could substitute 'cut-off-drains'

Got
Community whose jurisdiction is bounded by the area belonging to people who worship a given church in the countryside.

ILWIS
Integrated Land and Water Information Systems

IRDP
Integrated Rural Development Project

Idir
A local term for local institution which is set up between close neighbours mainly for helping in labour and material during burial ceremonies.

Kab
A local term for an indigenous soil conservation structure constructed in a similar fashion to a stone terrace but necessarily built with doubly stone-faced, to arrest eroded soil and sediment in run-off so that a plot of land between two of these structures can develop into a more level condition.

Mahiber
A spiritual association which is most usually celebrated once in a month in the house of the timely entrusted member for preparing a feast. The entrusting shifts among each of the members on a monthly basis.

MoA
Ministry of Agriculture, Ethiopia

MoNRDEP
Ministry of Natural Resources Development and Environmental Protection

NGO
None Governmental Organizations.

OD
On-farm Discussion

ONCCP
Office of National Community for Central Planning

PA
Peasant Association

PRA
Participatory Rural Appraisal

QI
Written Questionnaire Interview

SCRP
Soil Conservation Research Project

SOS-WASP
Save Our Soil- Wollo Agricultural Support Project (NGO initiated)

Tella-Bet
a local term for a house where local drink (mainly *Tella*) is sold and people (mainly farmers) get together and discuss local issues while drinking the '*Tella*' (local beer).

WFP
World Food Programme

Wonfel
This is a local term for a method by which farmers mobilize labour in such a way that each member of the *Wonfel* contributes labour to each and every one on a turn-by-turn basis so that in a given day one will have all his Wonfel members working with him and for him

Woreda
An official and local term for an administrative jurisdiction area more or less similar to a sub-district

WVI
World Vision International

Yager- shimagile
A local term for community-respected and influential elderly who are recognized by the community for resolving issues that may occur between any two or more parties. They also help in being between the development professional and the target beneficiaries so that the necessary acceptance of oneself by the other will be more secured.

Zone
An official term for an administrative jurisdiction that includes a number of Woredas together.

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PART I

LAND DEGRADATION THREAT IN ETHIOPIA

a theoritical orientation of
problems and potentials

CHAPTER 1

INTRODUCTION

1.1 Background

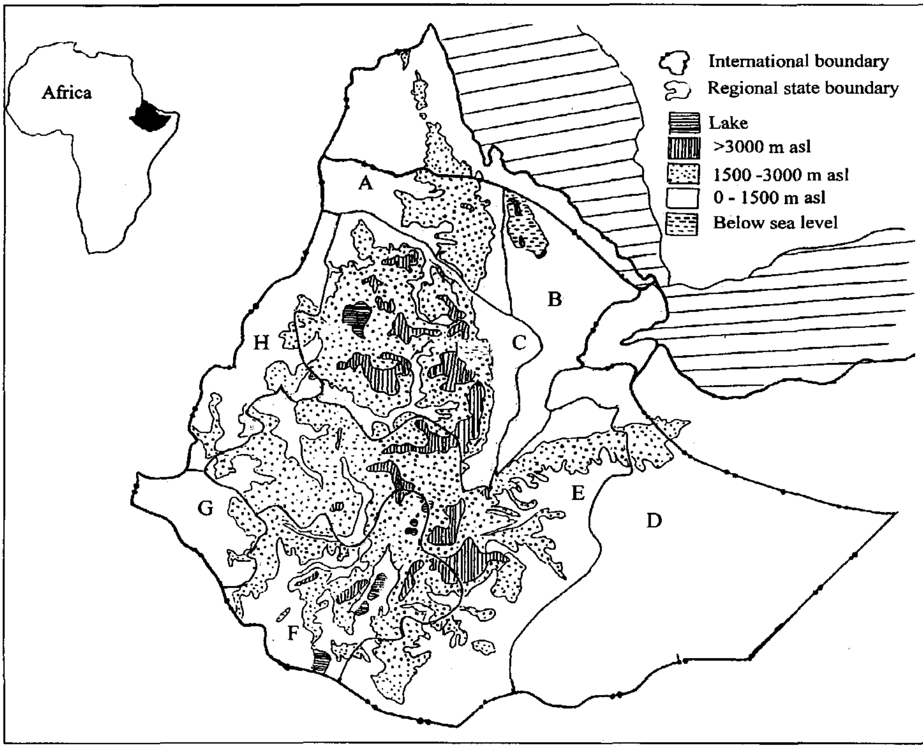
Ethiopia.

Ethiopia is situated in the eastern part of Africa North of the equator approximately between latitude 3.9° and 19.7° North and longitude 33.8° and 48.9° East. It shares boarders with Sudan in the West, Kenya in the South, Somalia in the East and South-East, Djibouti in the East and Eritrea in the North (Figure 1.1). The total land area is about 113 million hectares. According to NCS (1994a), the population of Ethiopia is estimated to be 53.6 million with a growth rate of 3.1% and is expected to double by the year 2010. According to NCS (1994b), Ethiopia ranks as one of the poorest countries in the world with a per capita GDP of about $120 a year. From a total of 17 million people who are assumed to be chronically poor, 13 million (~ 76 %) are subsistence farmers in rural Ethiopia. Agriculture is the backbone of the economy and the current pillar theme of development is "Agricultural Development- Led Industrialization" (NCS, 1994b).

Topography and agro-ecological zones

Ethiopia is a country of great geographic diversity. Erosion, volcanic eruptions, tectonic movements and subsidence have occurred and continue to occur. Its altitude ranges from the highest peak at Ras Degen, 4620 m above sea level down to the lowest Afar depression (Dalol) of 110 m below sea level. Much of the country consists of high plateaus and mountain ranges that are dissected by numerous streams that form huge river basins such as the Abay (the blue Nile), Awash, Baro-Akobo, Genale, Omo-Ghibe, Rift Valley, Tekeze and Wabe basins.

Rainfall in the country ranges between 2700 mm per year in the south-western highlands and less than 200 mm in the North and South-East with a further decrease of less than 100 mm per year in the North-East (NMSA, 1989; Haile, 1986 and Degefu, 1987).



Scale: Not to scale

Figure 1.1 *Physiographic map of Ethiopia with its administrative regions of A = Tigray (region 1), B = Afar (Region 2), C = Amahara (Region 3), D = Somali (Region 5), E = Oromiya (Region 4), F = Southern Ethiopia (Region 7, 8, 9, 10, & 11), G = Gambela (region 12) and H = Beni-shangul (Region 6) adapted from NCS, (1994a) and Bekele-Tesemma (1993)*

The southern, central, eastern and northern areas of the country have a bi-modal rainfall distribution while the southwestern and western areas are characterized by uni-modal rainfall. The country is broadly defined by five major agro-climatic zones (Figure 1.2) mainly based on altitude. The lowest is *Bereha* that has an altitude of less than 500 m above sea level.

Altitude > 3700 m above sea level	LEGEND A : Main crop C : Traditional conservation S : Soil on slopes T : Natural trees/shrubs	**HIGH WURCH** A: None (Frost limit) C: None S: Black soils, little T: *Hypericum quartinanum, Hypericum reoperianum*	
3700- 3200 m above sea level		**MOIST WURCH** A: Only Barley 2 crops per year C: Drainage rare S: Black soils, degraded T: *Erica arborea, Hypericum revolutum, dwarfed Croton macrostachys*	**WET *WURCH*** A: Only barley, 2 crops per year C: Widespread drainage itches S: Black soils, highly degraded. T: *Erica arborea, Hypericum reoperianum,* Hypericum revolutum
3200- 2300 m above sea level		**MOIST DEGA** A: Barley, Wheat and pulses C: Few traditional terracing S: Brown clay soils T: *Juniperus, excelsa Hagenia abyssinica, Podocarpus falcatus, Croton macrostachys, Rhamnus prenoides, Vernonia amygdalina*	**WET DEGA** A: Barley, Wheat, Nug, pulses, 2 crops/ year C: Wide spread drainage ditches S; dark brown clay soils T: *Juniperus excelsa, Hagenia abyssinica, Podocarpus falcatus, Arundinaria alpina, Rhamnus prenoides*
2300- 1500 m above sea level	**DRY WEYNA-DEGA** A: Wheat, *Eragrostis teff,* rarely *Zea maize* C: Terracing widespread S: Light brown yellow soils T: *Acacia saligna, Acacia tortilis, Acacia brevispica, Allophylus abyssinica, Arundo donax, Citrus medica, Combretum molle*	**MOIST WEYNA-DEGA** A: Zea maize, Sorghum vulgare, Eragrostis teff, Enset ventricosum (rare), Wheat, Nug, Dagussa, Barley. C: Traditional Terracing S: Red brown soils T: *Acacia nilotica, Cordia africana, Ficus vasta*	**WET WEYNA-DEGA** A: *Eragrostis teff, Zea maize,* Enset ventricosum (in W. parts), Nug, Barley C: Widespread drainage S: Red clay soils, deeply weathered, Gullies frequent T: *Acacia abyssinica, Cordia africana, Ehretia cymosa*
1500 - 500 m above sea level	**DRY KOLLA** A: Sorghum rarely, Eragrostis teff, C: Water retention terraces S: Yellow sandy soils T: *Balanites aegyptiaca, Boswellia papyrifera, Boswellia rivae, Citrus aurantifolia, Tamarix aphylla, Terminalia brownii, Ziziphus mauritania*	**MOIST KOLLA** A: Sorghum, rarely Eragrostis teff, Nug, Dagussa, C: Widespread terracing S: Yellow silty soils T: *Acacia senegal, Ziziphus pubesence, Erythreana abyssinica, Pliostigma thonningii,*	**WET KOLLA** A: Mangifera indica, Taro, Sugar cane, Maize, Coffee, Citrus. C: Ditches frequent S: Red clay soils, Highly oxidized. T: *Milicia excelsa, Cyathea maniana,*
< 500 m above sea level	**BEREHA** A: Possible only with irrigation C: Wind erosion frequent S: Aridosol, rigosols, silty and sandy. T: *Acacia bussei, Tamarix aphyla, Commiphora erythrea*		
Annual Rainfall	Less than 900 mm	900 - 1400 mm	More than 1400 mm

Figure 1.2 *The agro-climatic zones of Ethiopia (Bekele-Tesemma, 1993) adapted from Hurni (1986)*

The highest is *Wurch,* which is characterized by an altitude of greater than 3200 m above sea level. In between are *Kolla, Weyna-dega* and *Dega* that are defined by 500 - 1500 m, 1500 - - 2300 m and 2300 -- 3200 m above sea level respectively. Because of the favourable climate and absence of many tropical diseases, the highlands of Ethiopia are favored for settlement. The highlands above 1500 m constitute some 43 % of the country, which contains 88 % of the humans and over 65 % of the livestock population, 90 % of the cultivated land, and nearly 100 % of the industrial forests (CSO, 1984; EMA, 1988; EFAP, 1993).

Natural resources and the environment

Natural resources are the foundations for Ethiopia's economy. Small-holder peasant agriculture, in some areas including forestry, is the dominant sector accounting for about 45% of the GDP, 85% of the export and 80% of the total employment (NCS, 1994b). According to MoA/UNDP/FAO (1988), the coverage of non-arable land area of Ethiopia has grown to 49 %. If marginal lands of significant moisture limitation (only 60 - 90 days of dependable growing period in a year) and steep lands of > 30% slope are excluded from the arable land category, the non-arable land size increases to 72 %. Due to lack of employment opportunities in the non-agricultural sector, the great majority of the Ethiopian people are engaged in agriculture and as many as 80 % may be under-employed or even unemployed (NCS, 1994a).

Ethiopia has 22.7 million tropical Livestock Units (largest in Africa) and 20.6 million of this (75 %) are found in the highlands (Gamechu, 1988). Land, water, forests & trees and biodiversity, which meet the basic needs for food, water, clothing and shelter, have deteriorated to a low level of productivity. In many areas of the Highlands of Ethiopia, the present consumption of wood is in excess of production. The estimate of deforestation, which is mainly for expansion of rain-fed agriculture, vary between 80 000 and 200 000 hectares per year (EFAP, 1993).

The rural households account for about 93 % of the total energy consumption in the country and 99.5 % of their energy comes from biomass fuels such as fuelwood, twigs, leaves, charcoal, dung, and agricultural wastes (Bendz, 1988). The reality of this heavy dependence of the entire rural household on biomass fuel, even in future years, is inescapable (Plate 1.1)

Deforestation, cultivation of steep slopes, the use of crop residues and manure as fuel and long-term civil war conditions are main causes of soil degradation and accelerated erosion (Asrat et al., 1996 and NCS, 1994b). Ethiopia has shown an increase in land degradation and soil erosion over the last decades due to agricultural colonization of marginal lands. The negative consequences of the soil erosion are being manifested in all the production sectors of the farmers (cropping, livestock keeping and tree growing) via loss or decline in quality of soil.

Fuelwood has become extremely scarce (Karamachandani, 1989). For instance, the household energy contribution of dung cake and crop residue for cooking, lighting and heating in Mekdela sub-district (*Woreda*) is 81% (Bekele-Tesemma, 1996). The cumulative effect of land degradation in the country is immeasurable.

According to NCS (1994b), approximately 17 % of the potential agricultural GDP is being lost because of soil degradation. Soil fertility decline alone is causing a progressive annual loss in grain production of 40 000 tons. Cropland crisis is expected to occur by the year 2017 when all potential cropland will be utilized. Furthermore, land degradation is estimated to have resulted in annual loss of livestock production by 1.1 million Tropical Livestock Unit (TLU) and unless arrested the reduction would rise to 2 million by 2010 or 10 % of the national cattle herd (NCS, 1994b). Soil erosion is now in a vicious circle where fertility decline and soil erosion inhibit the growth of vegetation cover and the rural people are compelled to use their crop residue and dung for fuel instead of using it as fertilizer and soil quality improvement. The less fertile and unprotected soil facilitates the erosion process and causes further depletion of vegetation and massive usage of cow dung and crop residue for fuel.

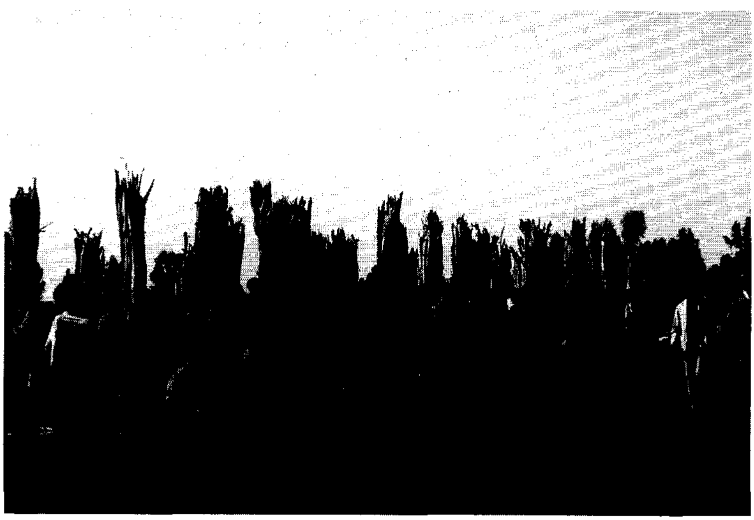


Plate 1.1
The flow of fuelwood to local markets (Eg. Bure town in Region 3) is enormous. Due to low yields harvested from cultivated crops, farmers are now getting involved more and more in selling fuelwood.

Long-term land and soil rehabilitation efforts have failed to stop this increase in erosion rates (NCS, 1994b; Atnafe, 1995 and Kruger et al., 1996). This is the result of the top-down approach under unpopular political regimes (NCS, 1994a). In addition, there is no conservation methodology that has been tested and proved to be viable in Ethiopia yet.

There is an urgent need for the development and testing of an alternative strategy for land rehabilitation and soil & water conservation .

1.2 Soil and water conservation in Ethiopia

In the Highlands of Ethiopia, people's major economic activities are largely confined to cropping, livestock farming and forest manipulation whose misuses are strongly connected to the degradation of the land resources. About 60 percent of the most serious soil erosion occurs in the highlands. Twenty eight percent of the highlands are in seriously eroded condition and a further 24 percent in moderate erosion condition (EFAP, 1993 and EHRS, 1986). The annual soil loss due to erosion is estimated at between 1.3 and 3 billion tons. Ten percent of it is carried away irretrievably by streams (Karamachandani, 1989). It is further projected that 2.4 to 3.8 million people will be affected by the year 2 000 and that land degradation at present rates could destroy the farmlands of 10 million highland farmers by the year 2010 (NCS, 1994b).

To grapple with the problem, massive reforestation and soil conservation schemes were launched in the country. Many generous international donors assisted the programme. The success rate has been minimal. For instance, WFP's assistance to Ethiopia's land rehabilitation efforts started in 1975 through WFP assisted project ETH 2488 "Rehabilitation of forests, grazing and agricultural lands" which had been the largest FFW project in Africa. However, despite its relatively long history, extensive areas affected and the considerable investments made by World Food Programme (WFP) and the government and people of Ethiopia, it is recognized that very little is noticeably achieved by the project, in terms of output, effects, impacts, and sustainability (Brown, 1989). Others such as Food and Agriculture Organization (FAO), Swedish International Development Authority (SIDA), European Union (EU), German Technical Cooperation (GTZ), Australian Aid and many others participated. Around US $ 20 million was disbursed annually during 1980s and 1990s. Farmers' labour involvement amounted to 30 million person-days in a year (Kruger et al., 1996, and Cheatle, 1993). However, due to lack of involvement of people in planning and implementation of the schemes, soil conservation measures were poorly executed and maintained (Scoons et al., 1996). Only 25 percent of the rehabilitation targets have been accomplished and most of the physical soil conservation measures and community forest plantations are destroyed (EHRS, 1986; Alemayehu, 1996 and Asrat et al., 1996). Food, fuelwood and feed remained to be more and more scarce. Faster than the degraded land recovers, more land becomes exhausted. The cycle continued for decades and has been accelerating to date due to the high population growth rate (3.1 %). A number of problem sources that are accountable to this failure could be cited.

Hillside emphasis

It is a fact that farmers can not afford to invest much time and energy in conservation activities aimed at improving natural resources management outside their immediate and direct interest. If they do, they are critical in the quality, quantity and duration of the returns to be obtained from such activities. But soil and water conservation and reforestation activities have been carried out mainly on hillsides, which have no defined owner. Farmers flirt with the quality of the hillside activities because they put more emphasis on the grain and oil that they get. 'Farmers' involvement' in labour has been impressive; but they remained skeptical about the benefit of the activities that they are doing.

Government offices claim that plantations and rehabilitation works on hillsides belong to communities and communities are paid grain and oil for the reforestation work; activities are guarded by site guards who are paid grain and oil from government offices. Moreover, there is no government office which can confirm community ownership of such developments on hillsides (say in official writing) because land tenure in Ethiopia is an unresolved issue (NCS, 1994b).

The focus on these lands of undefined owner, has calmed the farmers from raising outright oppositions against the soil conservation measures being propagated. This, in turn, has hidden the real internal feelings of farmers from development facilitators. Farmers have been interested only in getting the grain and oil whatever soil and water conservation measures were constructed (Alemayehu, 1996). Therefore, execution of soil conservation and reforestation activities in food for work programmes seemed to run effectively even when farmers do not support the activities. No one seemed to pose outright opposition against the planning, choice of species and conservation initiatives even when the initiatives are causing damage.

In addition, hillsides have been preferred by facilitators because they do have a large area extent to do conservation and reforestation activities uniformly and in greater quantities so that:

- the quantity-based food for work quota (target) could be achieved easily and
- few technicians who are guiding the job could easily accommodate a flock of people.

This high turnout of people for the *food-for-work* activities and absence of outright opposition of farmers against whatever is done on the hillsides obscured the true picture of the problem of participation from the development facilitators. Had it not been the case, the facilitators could have realized the failures and searched for farmer-appreciated and farm-level conservation measures and approaches. Lack of critics and feedback from the farmers kept the technologies continuously insensitive to farmer and farm realities. Professionals did not bother to correct them. For instance, the soil conservation guideline that defined soil conservation interventions by engineering parameters has been developed for soil conservation development agents in early 1986 (Hurni, 1986) but is not updated since. Farmers continued to shy away from adoption of the new innovations and intentionally obliterate them when they are constructed on their lands (Tato, 1989). Consequently, the success in soil conservation for increased productivity has remained as far back as the time the effort has been started in 1975 (Box 1.1 and Plate 1.2).

Box 1.1
Failure of soil conservation efforts on outside farm lands as explained in Tato (1989).

"According to the available information, in the past 12 years, areas outside farm land, which have been treated are:

hillside terraces =	612 000 hectares,	microbasins =	31.5 million,
planted seedlings =	713 million,	closed for natural regeneration =	334 000 hectares
checkdams constructed =	14 600 km.		

The total treated area appears to be impressive. However, one needs to look more closely into the effectiveness of these measures. Lands, which have been reclaimed through these interventions, did not reach the level of productivity required. To cite a few examples,

- Trees and shrubs which were planted have died in most cases and they have not been replaced by the farmers
- Hillside terraces have, in most cases, been obliterated by farmers and the labour that went into their construction can not be justified today
- Hillsides closed for natural regeneration have developed undesirable bushes, shrubs and unpalatable grasses with only little benefit to farmers

All these observations indicate the challenge ahead. An increase in the productivity so as to maintain the population in those areas remains as far away as when the work started."

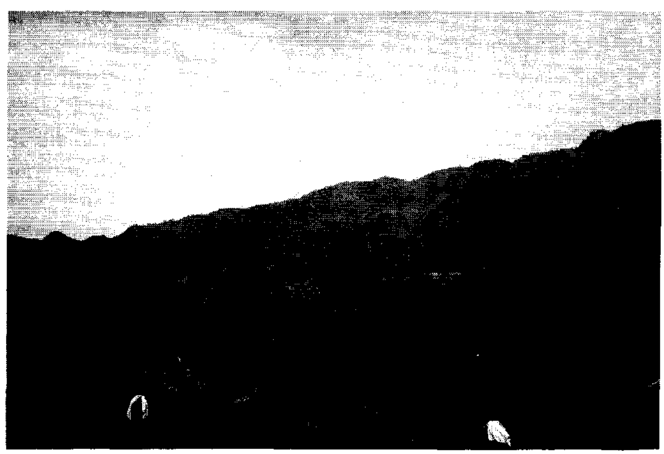


Plate 1.2
In northern and eastern parts of Ethiopia land degradation is still an issue of life. For instance, the over-flooding of this ephemeral river (Amedebeshir) of a desolate catchment has claimed 43 lives from Majete town (Antsokia-Gemza Woreda, Ethiopia) in just one overnight (August 1995). In sociopolitical terms, the event has caused the transfer of the Woreda capital from Majete to Mekoy.

Lack of conducive rural land and tree tenure

NCS (1994b) states that there are two opposing views on the ownership of the rural land. These are:

i) continuation under state ownership, or
ii) changing to private ownership with the right to sell and exchange.

Given the economic and political problems associated with it, the question was postponed for addressing it through a national referendum after a new constitution will be adopted. The constitution was adopted in early 1996 but the rural land tenure case is still not addressed. The Transitional Economic Policy confirms that there should be no reallocation of land except to the land-less and that there should be no further fragmentation of holdings (NCS, 1994a). However, the policy is contradicted by recent massive distribution and redistribution of land that occurs with no compensation for long lasting developments such as trees and terraces that were established by farmers on their land. The Amhara Regional State (Region 3) conducted such massive land reallocation and fragmentation work at the beginning of 1997. Under such tenure scenario, farmers have not been willing enough to plant trees that have long gestation periods for land rehabilitation purposes and to construct soil conservation measures provided that conservation is not planned and executed for increasing production within the immediate future.

Disincentive role of food for work

The disincentive role of grain and oil that has been used for mobilizing *food for work* labour in rehabilitation is an additional factor. Farmers developed a dependence on the grain and oil for almost every kind of development initiative. In many occasions, farmers uprooted seedlings and destroyed functional terraces in order to be paid grain and oil by doing them again. The short-term grain and oil gain killed their interest for implementing land care activities by themselves. Free will involvement of farmers in reforestation and soil conservation even on their own land vanished (Box 1.2). The very reason that farmers have been paid grain and oil for conducting conservation practices, before creating awareness and conviction among the farmers about the practices, limited the success.

The huge grain and oil flow and falsely perceived massive involvement of farmers in food-for-work also influenced prioritization of the 'food-for-work cultured' development institutions over those which work by free and willful extension (Box 1.2).

Brown (1989) reports that there has been an almost total dearth in integrated watershed management planning, including and in particular, lack of farmers' involvement in any planning. The rampant confusions and ambiguities regarding forest policy and tree ownership compounded the problem. Consequently, the positive impacts of the *food-for-work* project are limited and the prospects for long-term sustainability are poor.

Box 1.2

The disincentive role of inappropriate usage of 'food for work' in Ethiopia as explained in Karamachandani (1989).

The Forestry and Wildlife Conservation and Development Authority was established in 1979/80 and its overall objective was to promote awareness of the fast accelerating environmental degradation. Instruments used were mobilizing peasants through demonstration, training and extension for establishing new woodlots on Peasant Associations' lands through their own efforts for meeting their basic fuelwood and polewood requirements. From 1980 to 1983, the promotional and campaign approach awakened a number of peasants. Fifty thousand of them were trained in nursery establishment and tree planting techniques. Over 500 school and demonstration nurseries were established. Over 52 million seedlings were raised and 45 000 hectares were planted up. All this was without any incentive such as the Food For Work programme.

In mid 1994, at the reorganization of the Ministry of Agriculture, the Community Forest Department was merged with the Soil and Water Conservation Department. From this merger, the CFSCDD was formed. Then, the independent role and functioning of community forestry became totally diluted. The SWCD tree planting activity, which was part of food-for-work assisted soil conservation measures, substituted the earlier fuelwood resource creation effort that had been effected through free-will community initiatives. People's free involvement becomes secondary. The regrettable fallout of the merger was the acquiring of what may be termed the 'food for work culture' by the community forestry wing due to its association with soil conservation development department. This changed the very nature of extension and people's involvement in reforestation and soil and water conservation is considered to be secondary.

Exclusion of farmers in planning and implementation

Farmers have been considered ignorant of proper land use while they have lived in agriculture for millennia. Consequently, they have been excluded from planning and airing about strategies and technologies of implementation in soil conservation. Fones-Sundell (1989) indicates that African farmers find many donor remedies in soil conservation irrelevant, because soil erosion definitions and solution approaches have often been insensitive to farmer realities. Therefore, solutions proposed to soil erosion problems are unappealing or unacceptable to farmers. According to Alemayehu (1996), introduction of new soil and water conservation as well as reforestation activities in Ethiopia did not fulfill their planned objectives because the farmers did not participate fully at all levels of planning and implementation. The underlying socioeconomic reasons for the farmers to behave the way they do and even for their outright oppositions to the kind of land rehabilitation measures have been given less emphasis.

The issue has been ascertained by Shawel Consult International (SCI, 1989) who noted that the second most important problem in Ethiopia next to the soil erosion itself, is the low rate of adoption of soil and water conservation measures by the farmers. According to the same document, the problem is followed by weak soil and water conservation extension services which do not have farmer-based approaches. As indicated in Bedz (1988), development designs in Ethiopia have always been desk products cooked up at the headquarters. Often, the opinion of the headquarters' facilitators is substituted for the knowledge of the farmers and have been resulting in instituted design errors.

Disregarding indigenous soil and water conservation measures

According to Kruger et al. (1996), most facilitators are unaware of the range of indigenous soil and water conservation techniques that are available in Ethiopia. Knowledge, skills, survival strategies and risks of farmers have been ignored frequently by outsiders and facilitators resulting in introduction of innovations that are ill-adapted to existing systems. The introduced innovations require engineering skills and tools that are difficult to master by the farmers. Furthermore, the introduced soil conservation measures are biased to reduction of soil loss and control of run-off as opposed to indigenous conservation systems that also consider productivity improvement and appropriation of land for oxen-drawn cultivation. Hence, facilitators who instruct farmers to introduce 'their' soil conservation innovations could not earn acceptance from the farmers. Instead, farmers developed hatred for development facilitators who are instructing them on foreign technologies instead of advising them on modification of indigenous soil conservation and reforestation measures. The introduced conservation measures appeared to them foreign in layout, narrowly spaced and too much space consuming, self unproductive and in many areas unfit to site conditions (Bekele-Tesemma, 1995). Due to lack of farmer-considerate and effective soil conservation measures, farmers continued with their defective indigenous skills (Plate 1.3).

Lack of comprehension about soil erosion

One important factor in the failure of land rehabilitation and soil and water conservation is the abstract nature of the soil erosion process to farmers. At the same time, the approaches to farmers by conservation facilitators have been abstract. According to Hurni (1985), centuries of traditional land use systems have passed before the soils of Northern Ethiopia were completely degraded and the local people noticed the effects. Hurni (1985) further states that many of the Ethiopian farmers are unaware of the amount of soil they can prevent from eroding by applying a given farming practice, which is different from their traditional practices. The fact indicates that creation of awareness through application of farmer-level extension is essential.

Lack of understanding about farmers' farming systems and their way of life by development facilitators has inhibited the strength of the message they send to farmers for rehabilitation. According to Kahurananga et al. (1993), tree planting in land rehabilitation by local farmers in Ethiopia is poor with a low success rate of 5 - 10 % and the problem is more of the farmer's acceptance of proposed development initiatives rather than technical know-how. The same study suggests that this may be remedied by considering farmers' needs, perceptions and acceptance of tree planting with a better understanding of the farming system and how trees fit into the entire farm enterprise. According to Amanor et al. (1993), the failure of farmers to adopt technology does not result from their conservatism, but emanates from inappropriate design of the technology for the farmers' ecological and socioeconomic conditions.

Lack of farmer-endorsed rehabilitation technologies

There are impressive and effective traditional soil and water conservation measures being applied by farmers in Konso, North Shoa and Harrarghe. Still, what is learnt and recognized by facilitators is very minimal. The same applies to agroforestry developments. There are a lot of traditional agroforestry practices in Ethiopia. However, experience in the design and implementation of agroforestry interventions as viable land use options is very rare. For instance, in the effort of implementing externally sponsored agroforestry systems, farmers are advised to grow *Leuceana* species for fodder and mulch. At the same time farmers know and believe that they could be more successful if they grow *Ehretia cymosa* and many other local species for the same purpose. Conflicts between indigenous knowledge that the farmers have and the learned experiences that have been communicated to farmers widened instead of one strengthening the other.

Plate 1.3
Many of the indigenous soil conservation measures that farmers continue to use reflect on the problem of soil erosion but they lack continuity, appropriate alignment, gradient and strength.

1.3 (Agro) forestry in Ethiopia:

Ethiopia is rich in its flora. It is estimated to contain 6500 - 7000 species of higher plants of which about 125 are endemic (Tewolde, 1991). According to Brenan (1978), Ethiopia has the fifth largest flora in tropical Africa. The type of vegetation ranges from aridophyte species such as the *Adenium obesum* and *wet montane* species such as *Erica arborea.*

According to EVDSA (1996), the species compositions of even the disturbed natural forests of Ethiopia at Tiro-Botor-Becho, Belete-Gera, Ameya, Bulki-Mala-Koza, Bonga, Munesa-shashemene, Adaba-Dodola, Megada, Maji, Gibat, Wof-Washa, Chilimo-Gaji, Yogof state forest project areas are still rich in valuable timber species. Among the many of the timber tree species, *Anningeria adolfifredrechii, Anningeria altissima, Podocarpus falcatus, Juniperus excelsa, Olea wellwitschii, Prunus africanum, Cordia africana, Hagenia abyssinica, Allophylus abyssinsica, Croton macrostachys, Millettia ferruginea, Polyscias fulva* are common. Cash crop plants such *as Coffea robusta, Coffea arabica, Rhamnus prenoides, Rhamnus staddo* etc., also naturally growing in the forests. Medicinal plants such as *Embelia schimperi, Hagenia abyssinica, Eheretia cymosa,* and many others are also common. Farmers are collecting edible fruits from, *Mimosops kummel, Ximenia americana, Syzigium guneense*, etc. and important spice harvests from *Aframomum angustifolium, Zingiber offcinale*, etc., which are also growing in the wild. They use to supplement their income and diet from honey by placing local beehives in the forest.

Deforestation is accelerating as of the beginning of this century. According to Laike (1990), by the year 1960, closed natural forests covered only 4, 120 000 hectares or 3.4 % of the country. Currently, the forest cover has dwindled to almost 2.7 %. Production and use of lumber wood in Ethiopia is one of the lowest in the world (EFAP, 1993). However, this does not imply that wood is not much used in the country. It is rather a reflection of the fact that the bulk of the cutting comes from the bush and shrub woods, which are obtained from the agricultural landscapes.

Reforestation impact has not been commensurate with the deforestation rate. Poor implementations of plantations and even poorer subsequent care to the reforested areas have limited the success. According to Karamachandani (1989), community forest development has been based on the assumption that mass mobilization is the only possible way of achieving the target of self reliance in production and supply of wood and wood products. Targets are set in terms of number of seedlings to be planted by the various peasant associations with the assistance of local development facilitators. If the dung and the crop residue were to be diverted to agricultural use for soil management and animal fodder, the fuelwood consumption in excess of the current annual productive capacity would increase by 1.7 M m^3 every year from the already annual excess consumption of 21.6 M m^3 in 1984.

According to EHRS (1986), EFAP (1993), Karamachandani (1989) and NCS (1994c), the most appropriate strategy and direction to successful reforestation and land rehabilitation programme for Ethiopia, is agroforestry development. According to Raintree (1986), if multipurpose trees are appropriately selected, arranged and managed, they can offer micro-climatic benefits. Furthermore, Gathum (1978), indicates that under normal conditions, the mixed agricultural systems are well adapted to the prevailing environment in Ethiopia and are reflections of the physical land capabilities and social conditions.

Successful agroforestry technologies are not new to Ethiopian farmers and farming systems. Farmers in the southern regions of Ethiopia are successfully practising a highly complex agroforestry system (agri-silvi-horticulture subsystem). More than 18 cereal, horticultural and forest species are carefully and successfully combined and form a copy of the natural forest environment. Root crops such *as Junicus effusus, Colocassia antiquorum, Dioscorea abyssinica*, are grown for food. Cereal crop plants and fruit species such as *Persea americana*, peas, *Cucurbita maxima, Ricinus communis*, others such as *Brassica oleracea* are also grown for food. Selected tree species such as *Ehretia cymosa*, *Millettia ferruginea* and *Vernonia amygdalina* are grown for keeping the soil fertile. These are also used for mulching and provision of wood for cooking, heating and lighting. Drought resistant species such as *Enset ventricosum* that assure provision of food and livestock feed even during drought periods are added to the system. *Coffea arabica* that earns cash to the farmers and trees such as *Prunus africanum, Polyscias fulva, Eckbergia capensis* that are used for construction and farm implements are included.

Integration of scattered *Croton macrostachys* into farms by farmers at Finote-selam in West Gojam zone, *Faidherbia albida* in Debre-zeit, Nazereth, Meki, Alemaya and Fedis areas of Ethiopia is common. Integration of *Acacia nilotica*, *Ehretia cymosa*, *Cordia africana* and *Croton macrostachys* within agricultural land is common in North Shoa and South Wollo zones which all share the characteristic of *Weyna-dega* and *Dega* agro-climatic zone. Ethiopia is a land of mixed farming systems where a lot of improvement could be made. The vast indigenous and traditional agroforestry knowledge and potential can be refined, improved and developed to shoulder the chronic land husbandry problems of Ethiopia.

1.4 Extension approach in Ethiopia

Extension is an instrument of persuasion or a venue of support for free choice of individuals so that people could make well-considered choices among alternatives. It is an act of empowering. According to Garforth et al. (1988), extension entails education, advice, and training in specific skills and the provision of information. It involves veritable participation of development facilitators and the rural people as they try to solve constraints and realize potentials. Unfortunately, such real cooperation between development facilitators and farmers in the agriculture sector has not been strong.

Natural resources extension in Ethiopia started in 1952 by the joint effort of Ethiopia and the USA under a programme called 'Point Four'. Then there were only 4 extension staff in two regions and their role was to advise farmers in sheep keeping improvement and establishing Agricultural Youth Clubs. By 1968, the number of extension agents grew to 124 including 72 coffee specialists (Berehe et al., 1992).

Instituted forest development extension in Ethiopia started in 1943 when the Forest Development and Conservation Department was established to run nurseries and supply seedlings (FaWCDA, 1982). In the late 1950s, a Forest Division was created within the Ministry of Agriculture and functioned until 1971 (Karamachandani, 1989). Then, 75 % of the forests of Ethiopia were under private possession. During 1979/80 to mid 1984, the Forestry and Wildlife Conservation and Development Authority (FaWCDA) was made operational by Proclamation # 192/1980. This institution had been running extension by establishing task forces down to the peasant association levels. However, as of 1984/85, FaWCDA and its extension task forces were dissolved. The community forest development department was merged with the soil and water conservation department to form Community Forests and Soil Conservation and Development Department (CFSCDD). Food for work provision replaced the free will-based extension.

On the other hand, MoA, as of mid 1984, has been running a Train and Visit (T & V) extension system at a national scale (Berehe et al., 1992). The underlying assumption of this system is that the key to adoption of technology depends on timely relevant messages that should be efficiently communicated to farmers. Its distinctive characters are that:

- headquarters facilitators prepare and send timely agriculture messages to the subject matter specialists through regional and Zonal offices who in turn communicate the message to subject matter specialists. Subject matter specialists train development facilitators
- development facilitators make programmed and regular visits to contact farmers every 15 days
- the contact farmers are used at grass roots level to extend development packages to *'follow farmers'*

The organizational structure is hierarchical, single lined, command driven and strictly top-down. The system requires careful selection and training of innovative farmers for promoting them into contact farmer level. Regular and continuous training of farmers and development facilitators on holistic rehabilitation approach become equally required. The extension agents needed to be multipurpose development facilitators who provide timely advice on crop production, livestock development and land husbandry. Their major assignment has been in high cereal production potential areas in terms of cultivated crops. This has limited their role in the advancement of soil conservation and reforestation programmes on low potential cereal production potential areas.

According to NCS (1994b), motivating society itself to conserve itself releases a force that is compatible with the complexity of the issue and the difficulty of the mission. But, real motivation can only be done through a two-way communication. Participation is a sine qua non-condition for conservation and must be used as the core of any planning process in conservation (NCS, 1994c). However, in mobilized labour usage, instructions and decisions are passed only down. Farmers develop mistrust on the validity of technologies that the extension people take to them. Developing a functional bottom-up extension approach, which is not hierarchical but functions in a soft-system-based two-way communication, has become a real requirement.

1.5 Structure and outline

The study consists of four parts. Part I presents the land degradation threat and the potential of agroforestry in soil & water conservation. Part II provides the development and essence of the participatory agroforestry approach (PAA). Part III deals with Tikurso case study attestations. Part IV presents the reflection on the study conducted, the prevailing conditions for large-scale application of the devised approach and conclusive remarks and recommendations of the study. A detailed outline of the study is presented as follows.

PART I Land degradation threat in Ethiopia: theoretical orientation of problems and potentials.

After illustrating the scope and gravity of the land degradation problem, failures in the struggle to combat it, possibilities realized, structures and outlines of the research in this chapter, *Chapter* 2, deals with the research objectives and general methodology of the study. It presents the conceptual framework that puts the participatory development of farmer-based agroforestry approach in a logical perspective and order. The same chapter indicates research methodologies that are used for obtaining farmers' wills and trust, diagnosing site and social factors, generating the intervention plan, testing the effectiveness of the technologies whose feedback information is to be used for continual improvement of the approach. Chapter 2 further indicates that the researching method follows a soft-system approach where researching attributes and procedures are continually searched, adapted and used for the development of the approach in an action-research.

PART II Participatory agroforestry approach (PAA)

Part II includes deliberations of four chapters (Chapters. 3 - 6). It provides the basis of a newly developed participatory approach. The first chapter in Part II (*Chapter* 3) explains how participatory socioeconomic diagnosis can be conducted. It presents the lure, mechanisms and attributes of trust building. The comprehensive approaches and tools that are required in participatory learning and trust building as well as participatory socioeconomic diagnosis are presented in this chapter. Chapter 4 presents the environmental assessment techniques in farmer-based approach. It presents tools that are necessary for getting familiar with the site and for conducting farmer-understood land quality appraisal. It presents particulars of the participatory approach that are necessary for current land use and land potential assessments. The chapter concludes by indicating participatory learning and environmental diagnosis approach that exhibits participatory roles and additional roles of the facilitator in participatory environmental appraisal. Chapter 5 illustrates the approach, which is useful in the participatory learning and planning process. The chapter concludes the planning concern by illustrating the participatory learning and planning approach where participatory discussion roles and additional synthesis responsibilities of the facilitator in the planning process are shown. The last chapter in Part II (*Chapter 6*), presents the approach considered for implementation of the planned interventions and methods of evaluating the effects. It discusses indigenous technologies, adaptations of the technologies. It explains the technology implementation modalities and presents the participatory learning and implementation catalysis approach. The chapter also presents participatory effect evaluation and feedback mechanisms. It ends by exhibiting participatory learning and effect evaluation sub-process

PART III Tikurso case study

Part III deals with a case study where the applications of the approach are illustrated in four chapters (Chapters 7 - 10). It discusses the findings on the practical implementation of the participatory agroforestry approach at Tikurso catchment. In its Chapter 7, findings in building trust and socioeconomic diagnosis work are presented. Important issues and modalities that need to be considered in building trust are discussed. Farmers' development circumstances and production desires and priorities are presented. Indigenous land quality assessment variables and soil and water conservation skills of farmers are explained.

In Chapter 8, the case of participatory environmental assessment is presented. Among the major environmental appraisal issues, getting familiarized with the site, conditions of site limitations and potentials are attested at Tikurso catchment level. The mismatch between the current land use as compared to land potential and possibilities of compromise are presented.

In Chapter 9, participatory planning is discussed. The planning approach followed and the facts and issues identified at Tikurso catchment are presented. The participatory agroforestry intervention plan and prescriptions for implementation are discussed.

In Chapter 10, plan adaptations, implementation and evaluation issues at farm and farmer level are discussed. The agroforestry/soil conservation technologies and their attributes as referred to intervention categories are explained. Actual implementation issues are illustrated. The short-term production and long-term conservation effects of few of the implemented agroforestry/soil conservation interventions are presented.

PART IV Reflections on the study and actions for large-scale application

Part IV presents deliberations of the last four chapters (Chapters 11 - 14). Chapter 11 discusses the scenarios for large-scale application of the approach. It deals with evaluation of the existing conditions for large-scale application in the context of the Amhara region. It entertained:

- the scope and study coverage
- quality of existing institutions and facilitators
- the policy backing environments
- farmers' circumstances
- other instrumental circumstances

Chapter 12 presents the reflections made from the studies. It illustrates the limitations of the research findings and generalizations. The strength and weaknesses of the research in answering the research questions are discussed. In addition, time efficacy of the approach for using it on a large scale is discussed.

In Chapter 13, conclusions of the research work are presented. The nature of the approach as well as its sub-processes are discussed. The cyclic and inter-related nature of the sub-processes of the approach is presented. Usage concerns are indicated. The basic characters of the devised agroforestry interventions are illustrated. Competence of the approach in terms of land sustenance, economic viability and adaptability are discussed.

The recommendations, which are the necessary actions for large-scale application of the approach, are given in Chapter 14. The recommendations focus in the approach of application of the participatory agroforestry approach itself. In addition, actions that are required to be taken for the creation of an effective facilitator, conducive policy and incentive environments are recommended. Research issues that are pending and that need to be addressed are indicated.

CHAPTER 2

RESEARCH OBJECTIVE AND GENERAL METHODOLOGY

2.1 Research objective

Given the serious environmental problems and previous failures in rehabilitation efforts in Ethiopia, the objective of this research work has been to develop and test a productive, sustainable and adaptable agroforestry development approach for success in rehabilitation and soil conservation works in Ethiopia. It is to formulate a participatory agroforestry approach that consciously fosters short-term production needs of farmers and addresses long-term soil and water conservation requirements of the land simultaneously.

Farmers, especially those who lead a precarious life, can not subordinate their immediate production for long-term conservation benefits (EHRS, 1986 and Kruger et al., 1996). According to Kipe (1995), from an economic perspective, soil and water conservation is seldom the principal goal of farmers. Therefore, conservation will have to benefit from production role of agroforestry interventions. The growing pressure on both farming and grazing lands has increased the importance of mixed farming in Ethiopia (Asrat et al. 1996) and agroforestry in its mixed farming system context is an important avenue for addressing soil conservation issues if they are designed complimentary.

An equally important concern of the objective is substituting the top-down interventionist approach by the real participatory approach and remedying farmers' hesitance for working with development facilitators. Soil and water conservation programmes have to date proved unpopular among farmers because farmers have been excluded from decision making in the choice of technologies, planning of activities etc. (Kruger et al., 1996). Various literatures (Cornwall et al., 1994; Chambers, 1993; Rhoades and Booth, 1982; and Bunch, 1989) attest that the participatory approach gives farmers an array of choices and it allows them to suggest criteria for technological development. It further enables them to select elements of packages to adapt and adopt as well as to facilitate processes through which they can analyse their own problems and propose their own solutions.

The third important proposition of the objective is the use of indigenous technologies and experiences. According to Asrat et al. (1996), as agricultural productivity has fallen owing to changes in the local environment, traditional soil and water conservation methods that involve adaptive approaches to the dynamics of changing conditions have increased in importance. In addition, many of the introduced soil and water conservation innovations in Ethiopia have proved to be ill-adapted to existing systems and also resulted in removal of indigenous soil conservation measures (Kruger et al., 1996). Therefore, learning and taping the knowledge base accumulated by rural people could revolutionize the eagerly awaited soil and water conservation success in Ethiopia.

The fourth underlying issue is the level of application. Participatory socioeconomic assessment and environmental diagnosis that lead to participatory planning of interventions is envisaged to be treated at catchment level. However, the approach on the actual implementation necessitates adapting the general plan to individual farmer's sites at the consent of the individual farmer. It has been evident in that the final decision maker on whether to accept and apply or reject and damage soil conservation measures on privately owned lands are the individual farmers (Bekele-Tesemma, 1994).

The research in PAA construction is a special form of farmer participatory research (FPR) which is to be conducted under a soft system trial. Research under soft system approach does not follow static procedures. What is essential is farmers' participation where the facilitator and the farmers are continuously researching for effective means of conducting the research itself and developing the approach. Therefore, the approach is never static and researching methods and procedures can not be described for 100 % before the research is completed.

2.2 Conceptual framework

By considering the above-discussed objectives as a point of departure from the currently functional land rehabilitation techniques and approaches, a new conceptual framework is devised. The conceptual framework puts the development of farmer-based agroforestry technologies and development approaches in an integrated and meaningful perspective (Figure 2.1).

The theoretical framework is used as a guide for assembling the facts in this study, in a far better meaningful order. According to Kajambe (1994), without theoretical framework that binds facts together, knowledge is fragmented into collection of discrete segments of disconnected information. The conceptual framework enables to construct more and more inclusive generalizations.

The rationale of the six steps of the proposed study is related to the Diagnosis and Design (D & D) approach of the International Centre for Research in Agroforestry (ICRAF) explained in Raintree (1987). The conceptual framework further intends to use mutually supporting patterns of concepts, analytic methods and constituted sets of ideal practices that are praising effective marriage of farmers' knowledge with the scientific knowledge in resource management initiatives. Farmers' participation and usage of indigenous knowledge in soft system and action research are wedded into laboratory analysis and structured synthesis of information. According to Sikana (1994) and Matose and Mukamuri (1993), the dimensions of the rural farmers is vital because the local resource management decisions are made in the context of local political institutional structures, recognizing the dimension of rural farmers' knowledge. As recommended in Matose and Mukamuri (1993), an attempt is made to enter the peasants' world of concepts and representations, in order to establish a sound base for a partnership with this essential farmers' knowledge.

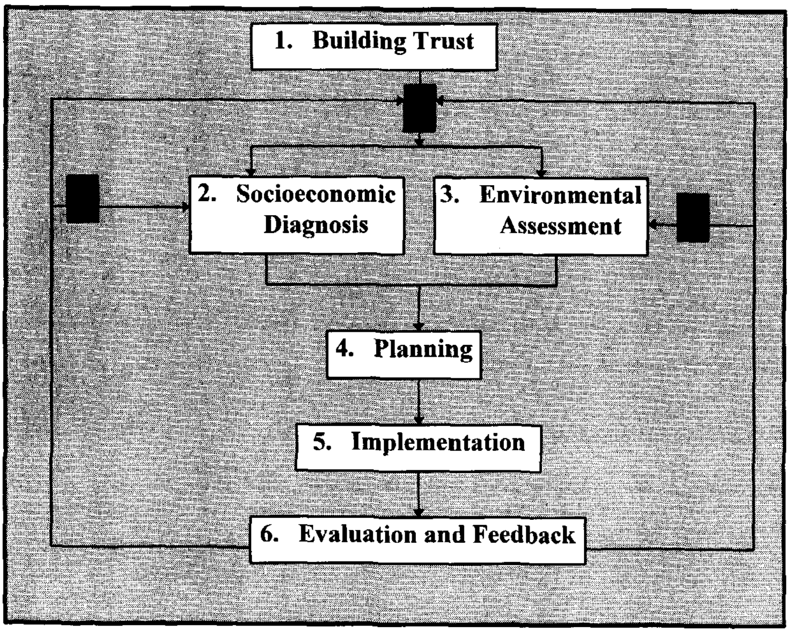


Figure 2.1 *Conceptual Framework for participatory agroforestry approach construction: A, B and C indicate revising entry possibilities.*

Consequently, due to the dynamic and strategic nature of farmers' knowledge, the conceptual framework does not intend to use pre-asserted and 100 % explainable researching methods as much as conventional science could have opted for. Instead, conceptual framework is envisaged at an abstraction level and the researching methods get the required shape and vigour through the process of the action-research itself. The general steps are indicated as follows.

Step 1 Building trust

The experience in Ethiopia teaches that no effective and efficient trust building mechanism exists (Alemayehu, 1996). Farmers and development facilitators still possess a different status quo. Farmers are excluded from deciding what land care practice is to be executed even on their own land. Farmers, on their part, continued to reject extension messages brought to them by facilitators even before they tried and proved their weaknesses only because they think facilitators are not theirs. This is why the first requirement in the objective set up of the study is *obtaining trust* within farmers for facilitators. The objective of trust building is getting farmers' will, closeness and confidence for working with the facilitator.

'Trust building within farmers' is considered to be a corner stone to generation and adoption of agroforestry technologies. It is understood as an ignition step to the creation of trust within the farmers about the facilitators being and reliability for whatever is consulted, proposed, done, and said between the farmers and facilitators. It is further envisaged that participatory social and site diagnosis can only be conducted in a truly participatory manner if such a trust is built first. Farmer-facilitator discussions are placed in the centre.

Step 2 Socioeconomic diagnosis

According to Oxford Advanced Learners Dictionary of Current English (Hornby, 1991), 'diagnosing' is finding out the nature of something (especially an illness) by observing its symptoms. Therefore, the study dwells on investigation of farmers' development constraints in line with their production desires. This section of the study deals with the assessment of indigenous technologies and associated problems as well as the reasons for renouncing soil conservation measures and integration of trees in farming systems by farmers.

It is set to find ailments and to develop an approach with the farmers themselves for analysing their problems and prescribing solutions. Therefore, the method makes the farmers participants of the research work. The main objectives of the socioeconomic diagnosis exercise is to know which are social diagnostic tools that would be perceived and be endorsed by farmers and that at the same time could enable facilitators to learn from the farmers and draw information upon which the approach could be built. During the trust building exercise, a clue on how farmers would like to be approached in social diagnosis is obtained. By using the hint, effective means of social diagnostic method is searched and used. The method of investigation focuses on identification of indigenous land quality assessment variables, land use appropriations, species preference factors, species choices and indigenous land constraint mitigation skills.

Step 3 Environmental assessment

Environmental assessment is conducted to identify land constraints, extent of the need for soil and water conservation measures and to rate the relative land potentials of development sites. As indicated in the objective set up, if the agroforestry interventions are to be developed with farmers and be seconded by farmers, the environmental assessment is required to be predominantly based on indigenous land quality assessment and rehabilitation skill of farmers. This is stressed in Dent et al. (1994), which emphasized that facilitators would have to focus in finding out what approaches to resource assessment and planning procedures communities already use, and determining what can be learnt from these and whether they can be transferred. Therefore, the environmental assessment work is also designed and executed with the research participant farmers.

Step 4 Planning

The objective of a farmer-seconded land use planning study is to produce a farmer-based agroforestry development intervention plan that could address short-term production requirement of the farmers and long-term protection requirement of the land. The planning process is performed in iterative discussions with the farmers who participate in the diagnosis work. Similar to the detailed social diagnosis, problems and potentials of the development site are identified. Taking into account the problems and potentials of the site, regions of various land potential categories are classified. Thereafter,

- production desires of farmers are known
- production potentials of their respective lands are studied
- farmers' constraints to introduction of trees into farms are identified
- the problems that farmers foresee in applying soil conservation measures on their own lands are studied
- their indigenous land constraint mitigation skills are examined and adapted

Farmer-based agroforestry technologies are developed through dialogue in discussion with farmers. Prescriptions for each of the planning units are made. The intervention plan fosters the desired and possible productions and conservation targets. The planning exercise considers and uses the outcomes of previously performed trust building, socioeconomic diagnosis and farmer-based environmental assessment findings. It makes use of accumulated knowledge from social and environmental diagnosis on:

- production desires of the farmers, species of interest, and problems that farmers foresee in applying soil conservation measures and integrating trees into farms,
- identified land constraints,
- indigenous land constraint mitigation skills and
- various land potential classes.

Step 5 Implementation

The plan prescriptions that are made for each of the planning units at catchment level are adapted to farm and farmer level conditions. The role of the facilitator in the implementation process is limited to facilitating adaptations of planning prescriptions as they are suited to farm and farmer situations, provision of inputs, technical backstopping, and guidance. The implementation focus is decided to be studied as a pilot scheme on real size holdings of innovative farmers. Implementation of the package, during the researching period, is limited to sections of lands within the cropping limit. However, interested farmers who intend to adapt and apply planned interventions to their own farm are encouraged as well.

Step 6 Evaluation and feedback

It is assumed that effectiveness monitory test follows implementation and precedes perfection of the interventions indicating that perfection of knowledge about participatory agroforestry approach is a continuous process. Monitoring is a pre-requisite for obtaining feedback on the implemented agroforestry interventions and extension approaches. The feedback is used for validating the currently implemented plans or modifying future plan and implementation attributes.

According to Raintree (1987), agroforestry technology viability is dependent on adaptability, productivity and sustainability. Hence, the objective of monitoring is to assess the effectiveness of the implemented agroforestry intervention in land sustenance, economic and social (adaptability) terms. The monitoring job aims at a search for weak and strong aspects of the interventions so that weak points can be corrected and strong points can be given emphasis in the creation of improved agroforestry intervention plans.

The set-up of the conceptual framework depicts that there are three avenues for perfecting the study. One is through a more detailed study of the socioeconomic sector ('A' in Figure 2.1). This avenue is used when the result obtained from the evaluation work indicate that the planned and implemented interventions are not perfectly matching with the existing social conditions. Such an entry of modification entails that the problem is not related to factors of the physical environment. The second avenue ('B' in Figure 2.1) suggests an entry for additional study of the environmental sector. The avenue is selected when the evaluation of the approach confirms that the approach is well fitted to the social settings but not with the environmental truth. The third avenue ('C' in Figure 2.1) is chosen when the evaluation results indicate problems in compatibility of the approach in the area of both social and site conditions. This happens when the trust between the facilitator and the farmers is not well developed and the information drawn from the diagnosis is not actually real and dependable. The third avenue is employed for adapting the approach to new areas.

The conceptual framework assumes that the participatory agroforestry interventions can be effectively useful when a conducive environment both from facilitators' side as well as from the farmers' sides exist. In addition, the existing policy and legal directives which are, most of the time, beyond the control of either the development facilitator or the farmer determine the success rate of development interventions. Hence, the conditions for large-scale application of the approach are investigated. Relevance of the study itself, the policy environment, socioeconomic conditions, the physical environment, facilitator backing and research feedback possibilities are studied.

2.3 Research questions

The study's focus is further concretized by six research questions. The search for the answer to each of these questions governs the emphasis of the study. The research questions are:

1. How is trust built between farmers and facilitators?
2. How can socioeconomic issues (such as issues related to the use of soil conservation measures and development priorities of farmers) be detected?
3. How is it that farmer-understood and-accepted environmental assessment could be conducted?
4. How could farmer-based agroforestry interventions be developed in discussion with farmers?
5. How could farmer's implementation wills be built? What incentives are still needed?
6. How can the effect of farmer-based agroforestry interventions be measured in a farmer-understood manner to be used as a feedback for further improvements?

2.4 General methodology for the six steps

The proposed farmer-participatory research focuses on addressing each step of the conceptual framework set in line with the research questions drawn. Throughout the development work, a nested approach is followed. The method for a step in the approach emanates from the findings of the preceding step. Participatory socioeconomic diagnosis makes use of the trust of farmers secured during the trust building phase. Farmer-based environmental assessment, in turn, makes use of indigenous land quality assessment factors that are identified during the previous participatory socioeconomic diagnosis exercise. This induction-based nested approach continues even after the effects of the approach are evaluated.

At the same time, multifaceted data collection approach is used. The approach facilitates the collection of both quantitative and qualitative data and information. The qualitative method helps to understand approaches that are relevant for obtaining free will and trust from farmers. It enables to learn traditional land characterization principles, social value judgements and indigenous technology evaluations. The quantitative method is important in rating significance of various approaches in free will and trust accumulation, contributions of components in land characterization, relative importance of technology components and alternatives. Both are applied independently and in an integrated fashion.

Various tools are used to generate these qualitative and quantitative data. One method is generating information through participant observation. Participant observation involves participating in community activities such as attending funerals, religious ceremonies, etc. It also involves attending and observing group activities such as weddings and other get-together festivals. Participant observation is used during occasions of household activities such as weeding, threshing and family visits. It is also used as a tool for visualizing the standard of living and problems that are pertinent on a household level. When appropriate, questions are raised and much time is allocated to listening. The process of participant observation helps the farmers to know the facilitator's wills and aspirations. It also helps the facilitator to regard and examine the research elements in their true social context and to make inferences and assumptions within the understood socioeconomic and cultural settings.

The other data collection method is surveying. Catchment configuration, land use, soil fertility, soil depth, slope, species preference, indigenous soil conservation technologies, institution preferences and agroforestry technology performances are surveyed. In addition to field reconnaissance, the method endorses group discussions, questionnaire interviews and farm to farm visits. Another quantitative information are the laboratory analysis data. The general methods as applied to each of the steps of the conceptual framework are indicated as follows.

Step 1 Building trust.

The method in building trust involves studying and using:

- local norms and customs
- effective local institutions and institution leaders
- traditional conflict-resolving and mediating mechanisms

In addition, the method applies audio-visual aided animation on:

- land degradation problems in the locality and its negative effects
- possibilities of arresting land degradation and its positive prospects
- purpose, modalities and benefits of the research work
- construction and use of A-frames in soil and water conservation and
- expected contributions from the farmers

After the required trust is built, a number of interested and innovative farmers are selected for conducting the farmer participatory research (Cornwall et al., 1994). The approach to be developed and tested in such a farmer participatory research considers these research participant farmers as collegiate farmers who have significant potential in experimenting (Gupta, 1989).

Step 2 Participatory socioeconomic diagnosis

Three complementary methods are used. These are:
- Participatory rural appraisal discussion method
- On-farm discussion method
- Questionnaire interview method

Participatory Rural Appraisal discussion method (PRA): This is a socioeconomic diagnostic method where people-based appraisal is made through participation of beneficiaries (Chambers, 1989). The local people in the study area are considered and treated as collegiate in which they collaborate with the facilitator to explore their own problems and solutions that impinge on their livelihoods (Biggs, 1989 and Cornwall et al., 1994). The farmers control information, map, model, analyse and develop options in collaboration with study conveyance (facilitator). The medium plays a catalytic role through listening and learning. The study vehicle, facilitates mutual goal setting and achievements through effective support in triangulating and disseminating the information delivered from generation long knowledge of the villagers on the one hand and school thought and experience of the moderator on the other hand. PRAD is conducted in a group of at least 2 members.

On-farm Discussion methods (OD): This is a dialogue forum between the farmer and the facilitator in a sufficiently equal standing. It involves constant feedback in order to find out if the farmer and the facilitator have understood the information they have exchanged and makes it possible to arrive at a complete mutual understanding and possible consensus (Dusseldorp et al., 1993). The facilitator prepares and studies structured issues of diagnosis well in advance. He (she) goes to the field with no pencil, paper or pen and meets the farmer at the farm, uses the expertise of building trust and opens discussions with the farmer while helping the farmer with the timely activities. Gradually, he (she) leads the discussions to the actual issues of either participatory socioeconomic diagnosis issues or farmer-based environmental assessment issues or both as appropriate. The facilitator obtains the necessary information for most of the queries by effectively probing the farmer.

The farm owner is kept relaxed, feeling free, master of the forum and on the same footing as the facilitator. He (She) is encouraged to share his experience, skill, knowledge, problems, solution approaches, potentials, land use appropriations, production wishes, aspirations etc. According to Dusseldorp et al. (1993), a sensible dialogue can only take place when effective knowledge networks link individual cultivators, allowing them to exchange experiences and information.

The facilitator explains the benefit of using the land according to its production potentials and the need for farm-level agroforestry development planning. He fixes appointments for future discussions and the development of a relative land potential plan with the farmer. He (she) assembles all the information that he got from the farmer back at home or office the same day and prepares a well-thought summary of constraints and potentials of the farm and the farm owner. The same facilitator once again goes to the farm with the farmer and produce a relative land potential map by considering farmer friendly parameters ... slope, soil fertility and soil depth. The mapping is farmer-driven and facilitator-guided in practice.

The facilitator goes back at home and prepares well-thought agroforestry alternatives (options) and mitigation technologies to be recommended for each of the production potential classes of the farm and presents these possibilities for the farmer in the subsequent meetings at the farm site. Finally the farm-level agroforestry intervention plan as a land use option is prepared for implementation. The plan will have all the implementation, management and monitory test prescriptions that are stipulated in a joint understanding.

Questionnaire Interview or formal survey method (QI): This is a formal survey method where an open-ended questionnaire is carefully prepared not to indicate preferred answers. The interview is conducted within the respondent's territory and in an interviewing atmosphere where interruptions or corrections by other members are none or minimal. The interview is conducted by an interviewer (researcher) who is careful enough not to look too official, is able to get the most out of the interview by probing the individual respondents with corollary questions such as who?, what?, where?, when?, why? etc.,. The interviewer tries to listen carefully, catches verbal clues, and does not repeat questions or ask vague, insensitive or leading questions. Furthermore, the interview is assumed to last for a maximum of one hour at any one time and the questions are open-ended (Appendix A).

Step 3 Environmental assessment

First, boundary of the site is identified and delineated from an aerial photograph of 1: 20 000 scale. Actual boundary delineation is made when the site reconnaissance is conducted with the farmers concerned. Topographic surveys and production of computer-aided topographic (contour) map, 3-Dimensional, aspect, shadow, slope and differential elevation maps follow the site reconnaissance. These environmental assessment maps are produced by using version 1.4 of the ILWIS-GIS software (ITC, 1993). After obtaining the introductory information on the physical environment, soils are sampled for laboratory analysis. Soil fertility assessment and production of computer-aided soil fertility and soil depth maps of the research site follow the laboratory analysis. By using the *gridding* option (from points) of the same ILWIS-GIS computer software, the maps are produced.

Only traditional land quality assessment variables (identified during social diagnosis) are used. A differential land potential map of the research area or farm is produced from the composite effect of these factors. The resultant land potential map is produced. Environmental assessment is finalized by identifying the potentials and limitations of the land.

Step 4 Planning

The method of planning includes:

a) deciding agroforestry intervention category limits and producing agroforestry intervention plan map by using ILWIS-GIS version 1.4 software (ITC, 1993).

b) identifying and associating agroforestry intervention prescriptions for each of the plans of defined intervention categories so that the prescriptions can possibly and mutually foster:
   - the farmer's production desires
   - species preference
   - problems foreseen in using soil conservation measures
   - negative and positive influences of integrating trees into farms
   - modified indigenous land constraint mitigation skills

Step 5 Implementation

The method of implementation includes:

a) adapting the catchment-level plan to farm and farmer-level situations
b) provision of tools such as crowbars, hammers, shovels,
c) provision of equipment such as graduated *A-frames* ,
d) limiting the provision of grain and oil incentive to only implementation of community-targeted activities and gradually breaking the habit of dependence on food aid in doing improved land use
e) provision of potted seedlings of preferred plant species,
f) encouraging the necessary labour input to be organized by the landowners,
g) providing technical backstopping such as demonstrations on the use of the A-Frame in making modified layout of gradients and levelling, construction of durable physical conservation measures and
h) providing technical backstopping on spacing, layout, mix and configuration of tree/shrub seedlings and seeding of forage grasses, etc. in line with prescriptions made for implementation at farm-level.

Step 6 Evaluation and feedback

The test methods include selecting and grouping 4 plot groups from randomly selected five farms. The first method is conducting ecological sustainability assessment by measuring:

a) slope gradient of plot groups before treatment and three years after treatment of and analysing the change in slope brought about by the interventions,

b) the soil movement by Pin method and realizing the amount of soil which is saved from eroding down the farms and
c) moisture conservation roles of the technologies indirectly via the assessments of growth and yield of the farm's produces.

The second evaluation concern is its economic viability. The economic benefit of the implemented interventions is measured by quantifying the cost incurred by the innovative farmers for the establishment of the agroforestry interventions and benefits obtained from such intervention on a per hectare per unit time basis. Price calculations are made in view of local market prices of the produce. Since the study is conducted on real size holding, cost-benefit advantages are assessed in comparison with what has been gained before the interventions were implemented. The third evaluation concern is its adaptability. Acceptance and replication possibility of the approach is tested by measuring the number of farmers who have copied the interventions either in part or in whole from those innovative farmers.

In addition to evaluation of the performance of the approach, effort is made to assess the possibility of using the approach at a larger scale in the same Amhara Regional State (Region 3) The method used in the assessment of conditions for large scale application include:

a) conducting field reconnaissance and observing
   - land husbandry problems,
   - status of implemented land rehabilitation measures
   - indigenous soil conservation and reforestation efforts and skills

b) holding discussions with
   - farmers in groups from Peasant Associations (PAs) of various agro-climatic zones (Appendix D)
   - authorities of the Regional Bureau of the MoA (Region 3) concerned, the respective Bureau of the Zonal Council and MoA of South Gondar, North Wollo, South Wollo, North Shoa, and *Woreda* Council and MoA of Simada, Meket, Mekdela and Antsokia-Gemza (Appendix C)
   - with the technical staff of selected NGOs that are operational in the *Woredas* indicated above

c) conducting individual farmer-level questionnaire surveys and

d) obtaining secondary information from
   - literature search and
   - elderly informants.

2.5 The Research Site: Tikurso

Location, geology, physiography and soils

Tikurso catchment (Figure 2.2) is located latitude 9° 50" N and longitude 39° 50" E, in North- East of Addis Ababa. In administration terms, the research site is situated in Mafud *Woreda* (sub-district) of the North Shoa zone of the Amhara Regional State. The research site is situated in *Weyna-dega* agro-climatic zone. The *Weyna-daga* agro-climatic zone is intentionally selected because of its behavioural complex interaction between the relatively highest agricultural potential and exhaustive resource usage that resulted in severe natural resource deterioration. It is the zone which is the most populated, cultivated, degraded, and comparatively having the best suitable rainfall, temperature and soil conditions in the country (EHRS, 1986 and EFAP, 1993).

In particular, Tikurso is selected on the basis of a manageable size catchment (~340 hectares) that covers one representative *Weyna-daga* agro-climatic zone fully. Moreover, the research site is selected due to similarity of the language and dialect of its inhabitants with that of the facilitator (researcher) which is a basic requirement in the development of such a heavily farmer-involving approach. An additional advantage of selecting the Tikurso catchment for such participatory research is the availability of office facilities of the Institute of Development Research (IDR) of the Addis Ababa University whose compound is fortunately located at a lookout position for viewing the entire catchment

The altitude of the research catchment ranges between 1600 and 2220 m above sea level and the mean annual rainfall is in the range of 1300--1400 mm. Tikurso catchment is reached after driving 200 km on the Addis Ababa-Dessie all weather tarmac highway. It is close to Armanya village and intersects three Peasant Associations namely: Armanya PA in its south and south-east, Asfachew & Chira-meda PA in its North-east and Weyra-amba PA in its west and north-west (Figure 2.2 'C'). In geologic terms, the study area is situated in the northeastern part of the central plateau of Ethiopia

The central Ethiopian plateau broadly consists of Tertiary Volcanic rocks, generally referred to as the Trap Series. These overlay Mesozoic mantle sediments and Precambrian basement complex. According to Fikru and Mesele (1988) the study area is located on Trap series of Ashangi groups that are Paleocene-Oligocene-Miocene in age. It can be generalised that there are two main lithologic units which form the ecological environment in the study area. These are:

i). doleritic sills and gabbro intrusive and

ii). tertiary basalt and trachite lava.

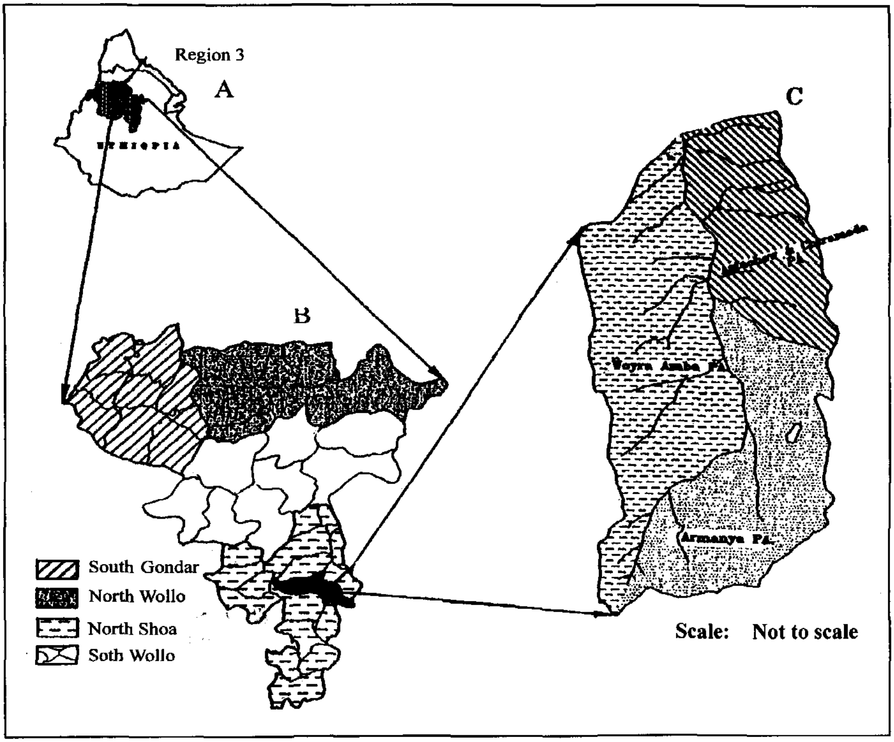


Figure 2.2 *Location map of the study areas. 'A' indicates the location of Region 3 in Ethiopia. 'B' indicates four selected administrative zones where conditions for application of the new approach are studied (Chapter 11) among those within Region 3. 'B' further indicates the location of Mafud Woreda where Tikurso catchment is situated. 'C' indicates the Tikurso catchment where the detailed study and construction of the approach has taken place.*

In Physiographic terms, the study area lies on the west of the major fault line that runs approximately NNE/SSW. This plateau landscape is subsequently subjected to a considerable degree of deforestation and desiccation the result of which is now a hilly landscape and valleys. In between these hills, ridges and fault escarpments are formed.

Its physiography is very rugged. Four different units make the above stated physiographic conditions. These are:

- *the valleys of the river channels:* These physiographic conditions of the research site could be visualized from the aspect map
- *foot slopes*: that consist of moderately steep and undulating slopes. They are mainly covered by colluvium.

- *terraces of the alluvial plain:* that are covered by both colluvium and alluvium deposits. These are mainly used for cultivated crops. They usually occur in the western half of the research catchment. Many of them show signs of drainage and mass wasting problems.
- *steep cliffs and ridges:* that transverse the different levels of the alluvial plains, In few places there are signs of mass wasting and land slide occurrences.

The soils are Cambisols but only with less developed diagnostic soil horizon. They show some shade of brown or reddish brown. They are permeable soils and they are easy to till. Black clay soils (vertisols) occur on the terraces of alluvial plains and gentle slopes. Along the drainage courses, they are highly oxidized and red. Most soils are slightly alkaline suggesting an accumulation of alkaline earth carbonates.

Climate

Regional climatic conditions have a significant influence on the amount and frequency of precipitation in a region. Therefore, a 20 years average climatic data of Shoa Robit is consulted. Shoa Robit is the closest town where a meteorological station is available and its altitude is 900 m below the peak of the research site. It is situated in *Kolla* agro-climatic zone (Figure 1.2) down in a valley which is about 15 km north of the research's closest boundary. At Shoa Robit, the average mean annual rainfall is 1468 mm while the mean annual evapotranspiration is 1517 mm. The mean minimum temperature for the year is 15.2 °C with a record minimum of 11.1 °C while the mean maximum temperature is 30.7 °C with a record maximum of 37.3 °C in June. Months when the precipitation exceeds the evapotranspiration are only February, April, June, July and August. The total length of humid periods is 161 days in a year (NMSA, 1989).

However, local precipitation characteristics strongly control the hydrologic framework within which the best land use suitability is to be analyzed (Bekele-Tesemma et al., 1986). Therefore, three rain gauges were set up within the research site for obtaining local precipitation data (Figure 2.3) so that the data can be used in reference to the data obtained from Shoa Robit. In specific terms, the study area is situated in moist *Weyna-daga* agro-climatic zone (cooler than *Kolla*) where average temperature spans approximately between 10 and 25 °C.

Based on the local information, the mean annual precipitation of the study area is approximately 1400 mm with a mean monthly precipitation of over a 100 mm and bi-modal distribution. The short rainfall season (*Belg* in the local languge) lasts for two months (March to May) with a peak monthly rainfall of about 200 mm in April. The mean monthly precipitation for the season is about 135 mm. The long rainfall season (*Kirmt* in the local languge) lasts for four months (June to September) with a peak mean monthly rainfall of approximately 330 mm in July. Mean monthly precipitation for the season is about 220 mm. Double cropping of rain-fed agriculture is possible during the two rainfall seasons i.e. from mid March to mid May and from mid June to mid September. Figure 2.3 depicts mean monthly rainfall distribution of the study area.

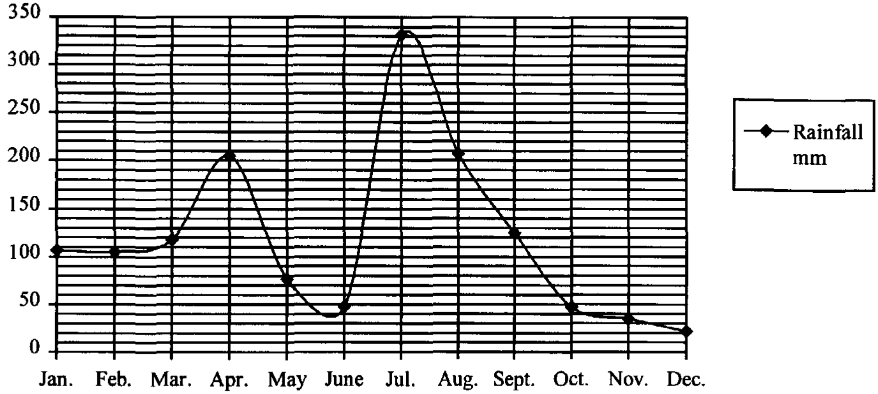


Figure 2.3 *Mean monthly rainfall distribution at Tikurso catchment*

Vegetation and Land Use

The vegetation consists of evergreen or semi-evergreen 2-3 m bushes, bigger bushes, small trees and occasionally larger trees. Deciduous trees are not frequent. Large trees are very scattered. The species that occur in the area include: *Celtis africana, Acacia bussei, Eckebergia capensis, Juniperus excelsa, Olea europaea, Croton macrostachys, Rhus natalensis, Premna schimperi, Allophylus abyssinicus, Carissa edulis, Rhus vulgaris, Rosa abyssinica, Phytolacca decocandra, Aloe calidophylla,* etc. There have been also few poorly managed *Eucalyptus camaldulensis and Eucalyptus globulus* plantations of 1984 -1988.

Socioeconomic features

Land titles are not given to any of the farmers of the study catchment. In addition, there are a number of farmers who contract land from the land owners by traditional arrangements without having any legal registration or agreements. Tracking and knowing who owns which land at any given time is very difficult. Therefore, it is difficult to confidently know the exact number of the households and the total population of Tikurso catchment beneficiaries. However, though it is not possible to know exactly who owns which land, at the time of the socioeconomic survey information, the average household land holding in the research catchment is known to be ~ 2.7 hectare. This implies that there are 125 households which own the 337 hectare catchment. Furthermore, 15 household leaders are known to have come from outside of the catchment area. To this end, it is possible to estimate that there are about 110 households who reside in the research catchment.

The average family size in a household is 5.5 persons making the total population at the catchment about 605. The work force (people above 13 years of age) per household on the average is 3.7. This confirms that 67% of the total population is available for work-force. The male population in Tikurso catchment is ~ 91 % of the female population or 48 % of the total population. Among the total population of the catchment, 33 % are below age 13. Ninety one percent of the male and 100 % of the female household leaders are not able to read and write.

Livestock production is the second important source of revenue and livestock population in the watershed is high. On the average, there are 5.32 heads of livestock per household making a total population of 585 in the catchment. These are 0.25 heads of equine (only 27 in total), 0.27 (30 in total) heads of sheep, 2.27 (250 in total) heads of goats and 2.53 (277 in total) heads of cattle per household.

Summary to Part 1

Chapter 1 has shown that soil erosion and land degradation problems of Ethiopia are serious. The highlands are the most affected. Crop production, livestock keeping and energy supply situations are at risk. The past rehabilitation effort has been immense. Much labour, capital and trained staff have been mobilized to correct the situation, but the outcome has not been encouraging. There are a number of reasons for the continued failure. The major reasons that are indicated in literature and/ or known from experience are:

- exclusion of farmers and their indigenous knowledge at all levels of planning and implementation
- the use of uniform and 'foreign' soil conservation and reforestation technologies
- mistrust between farmers and facilitators
- farmers' bias to production over conservation,
- miss-use of food-for-work programmes in conservation
- lack of conducive land tenure and tree usufruct

On the other hand, it is realised that there are a number of indigenous soil conservation measures. Likewise, successful agroforestry systems are traditionally practised by the Ethiopian farmers (Getahun, 1978). Given the potential role of agroforestry in controlling soil erosion (Lundgren and Nair, 1985) and the production possibility of diversified and short-term benefits to the farmers, an agroforestry approach appears to have potential in remedying the problem.

Continuing on problems and possible remedying directions that are indicated in *Chapter* 1, *Chapter* 2 has set the target of the study (objective to be accomplished). The conceptual framework and the research questions explain the core issues and directions of the study for accomplishing the objective set. The general methodology indicates that building trust, conducting socioeconomic diagnosis, environmental assessment, planning, implementation and effectiveness tests are vital components of the research work. The chapter shows that each would be addressed by farmer-driven parameters and through sincere participatory processes.

The chapter has indicated that the development of the agroforestry approach makes use of a nested approach in that the various discrete data and information generated are hierarchical and build one in congruence with the other. The exceeding information and data collection method makes use of the conclusion and is guided by the information obtained in the preceding research exercise. Therefore, details of the methodology for each step can not be explained by 100 % before the action research is completed. It is further underlined that each are inter-linked and a holistic study method is employed. In addition, it is indicated that the research methodology in developing the approach uses a combination of farmers' knowledge and scientific knowledge through soft system and action research. The same chapter indicates that a catchment is selected for the case study and the site is situated within the mid-altitude highlands where intensive resource usage and land tolerance are in distinct conflict and such conflicts are unabated. In addition to intensive studies such as participatory diagnosis of facts and issues of the farmers and the land in this study area, it is indicated that the study includes assessment of possibilities for large-scale usage of the approach.

PART II

PARTICIPATORY AGROFORESTRY APPROACH (PAA)

Plate 3.1
Farmers, including women and the community elders are necessarily involved in the socioeconomic diagnosis; environmental assessment; planning; indigenous technology enumeration, validation and adaptation; implementation and evaluation processes of the participatory agroforestry approach.

CHAPTER 3

BUILDING TRUST AND SOCIOECONOMIC DIAGNOSIS

Part I stressed that one of the reasons for the failure of land rehabilitation efforts is lack of genuine involvement of farmers in soil and water conservation and reforestation. This is mainly attributed to the top-down and supply-driven approach that has been in use. Consequently, the approach has troubled the trust between the farmers and the facilitators. Hence, the prior issue in the development of a new approach is the building up of trust between the farmers and the facilitators. Building trust and socioeconomic diagnosis are effected through participatory learning and application of soft system research techniques. Often, contrasting, verbal, pictorial and symbolic diagnostic tools are used more than written, numerical and absolute diagnostic techniques due to the fact that farmers at Tikurso catchment are illiterate. Details on the approach follow.

3.1 Building trust.

According to Scher (1991), it makes more sense to set priorities for the type of agroforestry research on the basis of questions identified through consultations and collaborations with users. They are already managing related agroforestry systems in the field and can benefit most from studies that indicate technology performance under specific, locally relevant site and management conditions. The technical and extension dimensions of such a participatory agroforestry research are stressed in Wiersum (1991). He states that farmer-involving research on the roles of agroforestry with respect to erosion may assess not only the rates and effects of erosion in existing or newly designed agroforestry systems, but also the willingness of farmers to accept these systems.

The experiences obtained from many scientific literature (Cornwall et al., 1994; Long and Villareal, 1994; Sikana, 1994b; Dusseldorp et al., 1993; Kruger et al., 1996) also teach that involvement of the farmers from problem identification to solution prescription is essential for effective land care and agricultural development. According to Hagmann and Kurwira (1996), traditional leaders are considered most important in the management of natural resources and the major condition for success with indigenous soil and water conservation is to work with local institutions and to strengthen them. Willful involvement of farmers with facilitators, in turn, requires use of effective extension methods by which the development facilitators present themselves for acceptance by these farmers. The premise is that it is when facilitators get trusted and accepted by the farmers and become able to obtain their wills that facilitators can learn and teach wisdom of land care. This is possible after facilitators built confidence and security within the possibly partner farmers. In order to narrow the wide conviction cleavage that exists and continues to widen between the farmers and the development facilitators in Ethiopia (Asrat et al., 1996; Kruger et al., 1996), applying various trust building methods is required.

Initially, in the construction of participatory agroforestry approach for soil and water conservation, local mediators and influential people are identified. Mediating mechanisms that are functional in the communities are studied. The need for establishing friendship and trust with the community is explained to the local mediators. Continuous plea is made for getting genuine and active involvement of the influential community elders (locally known as *Yager-shimagile*) in restoring the required trusteeship within the farmers in the community. At the same time, local norms and customs that have to be respected when making a plea for getting farmers' time are respected. The local watchful traditions in accompanying farmers and in conducting meetings are studied and used. Contacts are made by visiting every influential *Yager-shimagile* in his house. Visits are made early in mornings because local customs teach that mediators cooperate more seriously if the assistance seeker does so accordingly. Discussions are held with each and every one of the mediators first separately and later in groups. Gradually, effective and useful local institutions are identified. The level of recognition of farmers for these local institutions is studied and used.

Farmers' heart-felt approval for conducting the study in the area is obtained through these locally accepted mediators. The study catchment boundary is defined in consultation and agreement with the farmers. Site boundary reconnaissance is made with the local elders, local institution leaders and interested farmers. History of the previous land use, major area-specific problems and potentials, changes in land use patterns and the reasons attached to each, etc., are studied in a participatory approach.

Provocative speeches and animation are repeatedly made. Possibilities of arresting land degradation and its positive effects are discussed. Purpose, modalities and benefits of the study and what is expected from the farmers are stipulated. Film strips on alternative feed development undertakings, 16 mm films about natural resources depletion threats and possibilities of protecting them as well as the use of the A-frame are shown to the farmers.

Initiatives of the facilitator as a member of the group

The facilitator:

- identifies key-role players and introduces him (her)self to few influential community elders or local institution leaders or their combinations.
- Informs his facilitation roles and purpose of presence in the community

- Studies and exercises the local values and customs
- Identifies the development-committed influentials in the community (*Yager-shimagile*, religious leaders, other social institution leaders etc.)

- Introduces, in detail to the community influentials about the details of the development role to be played for the betterment of land husbandry in the area
- Learns the obvious problems of land productivity
- Learns preferred level of meetings (size of constituents)

- Organizes the necessary films, film strips, etc. that deal with consequences of soil erosion and deforestation and possibilities to combat them
- Encourages the influentials to organize discussion evenings

- Conduct film-supported discussion nights at preferred level of discussion forums repeatedly
- Cites the obvious production constraints of their land and similarities of the problems
- Stresses successes in the film shows and possibilities for repeating them in the community
- Selects volunteer farmers who could act as spearhead of the improved land husbandry work with the facilitator based on farmers' interest
- Organize site reconnaissance with the community influential and the interested farmers

- Is always apt to pursue every social obligation as a member of the community
- Behaves as a humble facilitator to the expectation of the community dwellers
- Organizes every input required for conducting detailed socioeconomic diagnosis and environmental assessment

Figure 3.1 *Methodical approach in the participatory learning and trust building sub-process*

A video film and slides about soil erosion and its danger, development alternatives of feed and wood; the benefits of improved land husbandry; the role of agroforestry in soil and water conservation etc., are shown at village-level by using a mobile audiovisual unit (car) on which such facilities are mounted. By living in the vicinity of the study community, active participation in the part of the facilitator, is made in religious and funeral ceremonies, get together occasions, weddings and other festivals.

Key leaders in the existing social institutions such as *Weyra-amba Iyisus* church, *Armanya* Junior Secondary School and students' parent committee and Armanya Idir are used in facilitating the trust building most often through individual contacts. In the film strip and video film shows and discussions, a total of 126 students, other children, and adult male and female inhabitants participated in two occasions. The viewers included people outside the catchment areas. Sixteen millimeters films are shown at village level at *Armanya*, *Chira-meda* and *Weyra-amba* villages on two occasions each. In each village and occasion, all social groups participated. Participation in each village ranged between 40 and 50 in each village and each occasion.

Finally, 12 interested and innovative farmers are selected on the basis of self interest and commitment for conducting farmer-participatory research because successful rural development depends on involvement of inventive, self-reliance and enabling farmers who could spear-head real farmer-participation (Richards, 1985). The learning and trust building process (Figure 3.1) indicates two major areas of involvement of the facilitator. As a member and catalyst of the participatory trust building process, the facilitator performs group activities within a group. On the other hand, the facilitator alone conducts a number of activities that further facilitate the subsequent group performances.

3.2 Participatory socioeconomic diagnosis

In the construction and application of the PAA, socioeconomic diagnosis is conducted with no interpreter. In addition, since many of the farmers are illiterate, diagnostic methods that involve symbols, perceivable objects, verbal communications and more of qualitative means are used whenever possible. First, the PRA exercise is tried in a pilot study. In the pilot study, two groups of five male and one female household leaders each participated. In this pilot study, farmers are requested to list and prioritize their problems and establish cause and effect relationships (problem-tree). Farmers listed many problem priorities such as health, water, road, school, flour mill etc., before they listed soil conservation or land rehabilitation issues. Agroforestry related issues such as soil erosion, livestock feed, fuelwood problems and yield reduction from farms were listed lastly. Hence, conducting social diagnosis by using PRA methodology proved to require immense resourcefulness and development objectives. It appeared necessary to have facilitators in all those fields such as health, education, flour mill and drinking water beyond land husbandry or land rehabilitation. The method pre-supposed the creation of projects and acquisition of capital that can make multifaceted projects functional.

According to Conway and McKracken (1988), PRA is a systematic yet semi-structured activity carried out in the field by a multi-discipline team and designed to acquire quickly new information on and new hypotheses for rural development. The solution appeared to be directing the diagnosis core issue to the subject area of interest. Of course, such kind of bias may be desired in order to dwell more on the focus issue (Thrupp et al., 1994). Since this study is a purpose-oriented undertaking, which is intentionally designed for developing participatory agroforestry approach for success in soil and water conservation, it is clear that these multifaceted project ideas are not its mandate. Therefore, targeting issues of diagnosis in the actual PRA exercise is used as a means of dwelling on issues that this study is intended to address.

The number of participants increased to two groups of 12 male household leaders each and a third group of 5 female household leaders. After learning the domination roles of the males over the females in the piloting exercise, the grouping in the actual PRA exercise is made gender specific. The maximum number of the PRA workshop participants in any one event is limited to 12. The participants constituted 24% of the total households in the catchment. It was proved true that farmers would identify agroforestry related development initiatives if the PRA workshop were targeted to identification of *causes to poverty* of farmers.

At the workshop, the facilitator served as moderator and supplier of information when available. It was realized that the people in the research site had been hit by famine during the 1984/85 famine period. Then, the farmers were instructed to leave the area and settle in the south western parts of the country. They resisted. Considering this instrumental situation, the site had been put under the *food-for-work* programme in which the farmers participated. However, developments were not successful. Terraces were damaged, plantations had been mishandled. Site guards were disliked by the community. The land got worse and people remained poor. Therefore, questioning what made them poor became a dazzling question and aroused effective participation of farmers in the PRA discussion. In the discussion, farmers are requested to visualize factors that caused poverty. In reply to the first question "What made you poor?" farmers gave causes and causes for the causes. The joint outcome of the PRA exercises forms the *problem tree* (Figure 7.1 on page 84) that shows cause and effect relationships that in turn, can guide the objectives of the solution approach. Cards of different colors and illustrative drawings helped in the construction of the problem tree. Many important ideas poured in and important findings are obtained.

The information obtained from the PRA discussion hinted a number of issues that would have to be concretized by additional social diagnostic measures such as the formal survey method. For instance, in the PRA workshop, one major problem of farmers is identified to be a lack of farmer-preferred seedlings. In order to provide farmer-preferred seedlings, factors of species preference of farmers were required with their significance score. In addition, the pool of species among which the most preferred are to be selected in accordance with their contribution preferential benefits of farmers are required. Such concretized information is generated from combined use of matrix ranking, questionnaire survey and on-farm discussion methods.

From the PRA discussions and various informant sources, a list of species-preference criteria for prioritizing a given species is obtained. For each of the preference criteria, representative drawings that are related to expected contribution of the species are made on white paper board by using a thick colored marker. Thereafter, 30 farmers are given 10 pebbles each and are requested to show their scale of preference by putting pebbles on the appropriate carton according to their preference and judgments. The number of pebbles accumulated on each of the paper boards that indicate a given selection criteria is counted. The comparative percentage score for each of the uses is calculated against the total score of all of the pebbles used for the rating.

In the survey of important tree/shrub species, 15 different species are nominated by the farmers in farmer-group interviews. In order to put the best species in priority rank, the species are graded for preference by weighing their importance against the above determined selection criteria. Grading has been conducted by 30 farmers in two groups. For each group, branches of all the nominated species are laid down separately on a field close to a house. Fifteen farmers are placed in a house where one does not see while the other is doing the grading. Each farmer is given 60 bean kernels each time the grading is conducted against each of the uses. Each farmer grades the 15 species ten times against the ten uses. During every grading, the appropriate paper board with a reminder drawing of the use is placed close to the species. Verbal explanation is given each time the need arises. Each farmer is informed to place none or 1 to 4 bean kernels available depending on the farmer's own judgment about the appropriateness of the species for each of the uses. Any leftover of the bean kernels is discarded. Theoretically, the total score for each of the species ranges between 60 (meaning that all the 15 species can give the use under consideration at best) and 0 (meaning that none of the 15 specified species can givethe use in consideation to any degree). The score is then calculated out of a maximum of four for each species against each use. The final weighted average grade in percentage is determined by multiplying each of these scores by the appropriate significance value of the selection criteria and dividing it by 4. Only 13 of the 15 species got a score of > 50 % (Table 7.7 on page 88).

From the problem tree construction exercise, social issues that need to be concretized by the use of questionnaire interview become apparent. In addition, the method exhibited weaknesses that emanate from socially diversified nature of the PRA participants. The people in the research area are highly diversified in social status. The wealthy and the poor, the male and the female, the young and the elders, etc., possess different status quo and do have different respects and obedience established by local customs. Hence, during the PRA exercise work, spokesmen get created and dominate the discussion. The opinions become those of the spokesmen only. Therefore, triangulating the findings by additional socioeconomic diagnostic tools such as formal questionnaire interview and on-farm discussion methods are used.

For using the questionnaire interview method, a written questionnaire (Appendix A) is prepared and used. Fifteen percent of the population above age 13 (60 individuals among whom 39 are household leaders) are involved in the questionnaire interview. Issues considered in the questionnaire are the following.

- family history
- choice of preferred local institutions where they feel free and relaxed in meetings when farmers participate in development discussions
- indigenous land rehabilitation measures that farmers know
- reasons that farmers have for not applying soil conservation measures on their lands,
- factors that farmers consider in selecting tree/shrub species of their interest
- list of best preferred tree/shrub species in order of priority as rated by the respondent
- prospective problems that farmers imagine to arise from integrating tree/shrub species into their farming systems
- major indigenous land quality assessment factors (variables)
- size of land, livestock and tree property that the respondent owns and income contribution of each to the household economy
- land use appropriations of the respondent
- list of production emphasis in order of priority
- major sources of income for the household and contributions of each

The questionnaire is used for conducting both farmer-group and individual farmer interviews. Major social and farming system constraints and potentials that determine the development of the agroforestry technologies for soil conservation are understood from the responses obtained by using the questionnaire interviews. The same is true to preferred local institutions for meetings, type of indigenous soil conservation measures, land quality rating factors, social limitations and production desires.

However, during the interviewing process, it is realized that the QI method is also weak. Genuine answers could not be obtained on the issues such as the size of land, livestock and tree properties, the number of children in the working force group, reasons for not applying soil conservation measures on their lands, and preferred local institutions etc. Observations at household level confirmed that certain answers are erroneous. It is found out that farmers are afraid of providing information that is to be recorded. The use of QI alone demonstrated that the information obtained on certain responses consist of eluding answers that are inaccurate. Practical experience and farmers' feedback implied that another supplementary diagnostic method is required. Therefore, the 'on-farm discussion method' (OD) is additionally used.

According to Stroosnijder et al. (1994), farmers, numerous and diverse, are inventive small entrepreneurs and difficult to catch in economic whole-farm projections unless studied and addressed in detail. Hence, farm to farm visit and discussion are applied. OD is such a detailed diagnostic tool by which the opinions of individual farmers are obtained in a free and relaxed environment while the diagnosing expert is equally engaged in the activity that the respondent is currently doing. In the process, acquaintance is restored and resentment is avoided.

- Under a friendly profile, local values and customs are studied, influential traditional leaders and social institutions are used for mediation, and the qualities of real facilitator are practiced.

- Trust is built and real participation of farmer is secured

By using participatory socioeconomic diagnostic tools and playing the roles of the facilitator,
- farmer's aspirations and development circumstances are studied as diverse as they are.
- diverse production inhibiting factors are understood.
- priority development targets are identified.
- species of preference and factors of species selection are known.
- major barriers to integration of trees into farming systems are understood,
- indigenous land constraint mitigation skills, their associated adaptive approaches and associated problems are learnt

- Examine findings in the light of observed experiences and scientific outlook
- Select controversial information for rectification through intensive critique in future dialog with farmers

Establish intensive dialog and
- study problems of production desires
- rectify important land quality grading variables
- learn problems of indigenous and introduced soil conservation measures with emphasis of detail as opposed to generalization
- subject and validate indigenous knowledge to test for conformity to justified reasoning through critique

- Concretize production attributes (trees and shrubs) through testing for use in planning (Chapter 5)
- Realize adaptation issues of soil conservation measures for use in planning (Chapter 5)
- Finalize adaptations of indigenous land quality grading factors for use in environmental appraisal (Chapter 4)
- Enumerate validated local technologies for use in the planning sub-process.

Figure 3.2 *Participatory learning and socioeconomic diagnosis sub-process*

On-farm discussions have been conducted by contacting the farmers on their own farm. Though having topics of the discussion in mind in advance is very crucial, no writingor recording of the discussion is done at the time of discussion. Every one is busily using his hands in the farm work. OD is exercised effectively in group-involving jobs such as weeding, threshing and construction of conservation measures that necessitate group work. The practice confirms that the family members including women interact effectively when they are approached on their farm where the family labour is deployed. OD starts by simple greeting and participating in the job that the respondent is doing. Almost always, helping the farmer in what activity he or she does creates a relaxed environment and makes the respondents impassioned on the discussion. What matters is the walking to every field, experience in how to do what farmers do and getting the genuine courage for getting involved in the timely job.

OD focused on the identification of information about farmers' production desires, land use appropriations, social limitations, local-level land quality assessment variables and indigenous land constraint mitigation skills. The on-farm discussion method is used to address all the issues covered in the PRA discussion and formal survey method. In each case the information obtained from OD helps to triangulate cases and examine responses for conformity. Since OD is done after QI and PRA are conducted, the reasons for the fallacy of farmers' responses are discussed in detail at this forum.

3.3 Conclusion

The approach starts at a low profile when the facilitator searches for possibilities for involvement of traditional leaders and social institutions in mediating the build-up of trust. It is shown that trust building between the facilitators and the farmers precedes genuine socioeconomic diagnosis. Socioeconomic diagnosis can again be effectively conducted by using complementary diagnostic tools such as formal survey methods, PRA and OD. Genuine and useful information can be generated when the facilitators and the farmers are at equal footing and when both parties obey to the same traditions, customs and use the same language and similar diction and idioms. Real socioeconomic assessment necessitates real participation of farmers in the realization of their own problems and this is not practical in a hasty situation. According to Mascarenhas (1993), participatory rural appraisal is a process of learning from and with rural people about their environment, their technologies, and their systems of management. Likewise, participatory socioeconomic diagnosis approach pre-empts edifying the minds of the development facilitators and the farmers under a painstaking process and lengthy time.

Socioeconomic diagnosis requires splitting things and digesting details so that generalization of facts and issues could be worked out clearly. Issues are studied in detail with the farmers in a discussion forum and the discussion may be held between groups of farmers and the facilitator and / or individual farmers and the facilitator. The facilitator serves as a moderator of the discussion while the farmers identify social issues and potentials as diverse as they are. The facilitator then studies the discussion outcomes in the light of common sense and learned experiences, selects controversial or conflicting issues and remaining queries for further refinement in discussion (Figure 3.2). In the following discussion, production desires of farmers and associated issues to each of the desires are investigated. Land quality grading variables in the context of their local situations are detailed. As indicated in Figure 3.2, the socioeconomic diagnosis sub-process involves a number of steps and tools. Learning, investigating, devising and again learning are the mechanisms of the diagnostic sub-process. By doing so, the indigenous knowledge is undergone through a test of peer critique for conformity to justified reasoning (Richards, 1994).

Problems of indigenous and introduced soil conservation measures as applied to various land and social situations are exhaustively discussed. Adaptation issues and skills are debated. Possibilities of integrating trees and perennial shrubs into their farming systems are discussed. Species type and factors to be considered in prioritization are learnt from the discussion. As indicated in Figure 3.2, the facilitator facilitates the discussion by attentively following and probing the discussion and pointing out conflicting views in contrast with valid experiences. The facilitator generalizes discussion outcomes of every session and presents the issues in the following discussion forum. At the end of the socioeconomic diagnosis, the production targets are identified. Traditional soil conservation skills are enumerated and the shortcomings for each of the skills are known. Traditional experiences in remedying each of the shortcomings of each of the indigenous skills are noted for use in planning Functional land quality grading variables are selectively identified for use in participatory environmental assessment (Chapter 4).

CHAPTER 4

ENVIRONMENTAL ASSESSMENT

The environmental assessment work is also a process executed in a farmer-participatory research environment. The assessment is implemented in three stages. At the start of the assessment, the following activities are conducted exclusively with the farmers. These are:

1. conducting site reconnaissance and boundary certification with influential community elders, local institution leaders and interested farmers. It enables getting well familiarized with the study area
2. in view of the site, certification of the site according to the land quality grading variables as identified during the socioeconomic diagnosis (Chapter 3),
3. conducting topographic surveys,
4. sampling soil depth and
5. collecting soil samples for soil fertility analysis.

At the second stage, the information obtained in the first stage of the environmental assessment phase is more systematized by the facilitator with the help of analytical facilities such as computer software and laboratory facilities. These activities include producing GIS-assisted maps of:

1 3-Dimensional and shadow maps that are used to understand the site situations from various productivity potential and limitation perspectives at office level,
2. differential elevations of the study catchment and realizing the potential sites for the different kinds of crops and tree/shrub species combinations,
3. the land configuration (slope) of area and accumulating the necessary information with regard to the slope gradient ranges of the site for use in the planning phase (Chapter 5),
4. a soil fertility map of the study area and visualizing the fertility standing of the study site from the results of the laboratory soil fertility analysis,
5. the aspect situation that can be used as guide in the orientation of shrub/tree lines of the agroforestry interventions when slope situations allow during adaptation of catchment-level plan to farm-level situations (Chapter 10),

6. a soil depth map by which soil depth potentials and limitation could be realized during the planning process (Chapter 5) and
7. the relative land potentials and limitations of the research area by using the composite effect of traditional land quality assessment variables (slope, soil depth and soil fertility) for which agroforestry intervention development is to be planned (Chapter 5).

At the final and third phase of the environmental assessment, the systematized data (mapped and numerical) is brought back to the farmers for acquiring a better understanding about the environmental situations among the farmers and the facilitator through intensive discussions. Finally, a common consensus is established. It is this consensus about the farming environment, which is used as an input in planning the agroforestry interventions. Details follow.

4.1 Getting familiar with the site

Being on a lookout place, a brief introduction is given for selected influential elders and social institution leaders about the boundary of the area of interest as delineated with the help of aerial photographs. The local influential persons are then requested to organize themselves and other interested farmers for field reconnaissance. The needs for certification of the boundary and usage of the occasion for getting to know the colleague farmers and the site are major objectives of the site reconnaissance work.

Later, by traversing the boundary of the research catchment, detailed and repeated field reconnaissance is conducted with the community elders, local institution leaders and other farmers who showed interest. While conducting the site reconnaissance, the boundary of the study catchment is determined. Final agreement for running the participatory agroforestry development research in a joint farmer-facilitator approach is established. Physical diversity and homogeneity factors of the area are visualized. Method of approaching the field study is established.

After detailed field reconnaissance, detailed topographic survey is made by using a Switzerland made D14L *Distomat*, which is fitted, on *WILD T2* apparatus. In the survey, the location of four anchoring points is first identified on a : 20 000 contour map. Their relative location on the research catchment is then identified. Their respective coordinates are read from the contour map. Their respective coordinates and altitudes are carefully checked by the readings from the GPS. By radiating from each of these four anchor points, the location of 175 soil sampling stations and 104 additional sub-stations are identified on the contour map. By radiating from these control stations, 30 -- 50 bearing (horizontal and vertical angle), and horizontal and vertical distance measurements are taken and recorded. In total, 9403 readings are taken from 283 control stations. The difference in height is computed for each of the reading points. After the computation is completed, the contour lines are produced by extrapolating the vertical distance between two adjacent points whose location is identified and height reading is recorded. The mapping is continued by forming polygons for each of the control stations from the crossed traverses. Finally a contour map of the study area is produced with a vertical interval of 5 meters and a scale of 1: 2500. The contour map indicates major features such as drainage systems, roads and location of villages. From the control stations, four are considered as anchor points for use in properly orienting the contour map during the future digitization process. The UTM position coordinate values of the four anchor points are marked on this 1: 2500 scale topographic map.

In order to process the survey information with the help of a computer, the contour map is digitized. Digitization is conducted by mounting the contour map on a digitizing board and first entering, the respective digital coordinate values of the four anchor points into the computer. Then after, these anchor points of known geometric position values (UTM) in the form of 'x' and 'y' coordinates, are used as tie points to orient and assign a position coordinate value for every point on the map touched by the digitizing cursor. The digitizing cursor, then, senses all the contour lines from this contour map of 1 : 2500 scale. The information that contained each contour line as a unique height is carefully encoded and kept in a digital format by using Integrated Land and Water Information System /Geographic Information System (ILWIS-GIS) software, version 1.4 (ITC, 1993).

The digital contour map is *rasterized* to get a raster digital contour (segment) map. The height code of each contour line is checked and confirmed. Nearly 150 000 pixels of a size of 5 m by 5 m are used. Being in '*Interpolation module*', from the attribute raster map that contained the *isolines*, an integer interpolated digital elevation model (*DEM*) is created as an output. After the *DEM* is obtained, the differential elevation map (Figure 8.3) is produced. After creation of the interpolated height map, in the *Visualization sub module* of the *Raster Module*, a *DTM* in *3D* perspective is displayed (Figure 4.1 on page 60).

In addition, by considering the integer file that contained the pixel values as an input file and using the '*Linear convolution filters*', the value of the central pixel is replaced by DFDX and DFDY. The "shadow map" of the research site is produced from artificial illumination (shadowing) by replacing the pixel values by the difference in x over difference in y. To create aspect and slope maps, the first derivatives in the 'x' and 'y' directions are calculated first. This is done using the standard filters *DFDX* and *DFDY*. The output maps are called *DFDX* and *DFDY* respectively. The programme used is *FILTERMAP* (Figure 4.1 on page 60).

The three dimensional view, the shadow map, and the space between the contour lines in the contour map are used to obtain a condensed information for the facilitator at office level. The maps give a preliminary view of physiographic conditions that are necessary for planning environmental assessment details. The aspect map produces useful information for future alignment of tree/shrub lines and configuration of shade demanding and shade tolerant species with reference to exposition to beforenoon and afternoon sunlight possibilities. Therefore, by obtaining information about the physical features of the research site at office, better familiarization about the site is made possible. Such a synthesized information is brought into a discussion forum held with farmers. Then the site diagnosis concerns are understood before the start of the actual land quality appraisal. Discussions are held in the open at a lookout place in order to facilitate viewing the various conditions of the study area and contrasting each of them with their respective fact indicated on the maps.

4.2 Farmer-based land quality appraisal

Indigenous and farmer-understood land quality assessment variables are identified and established in the preceding socioeconomic diagnosis phase (Chapter 3) of the study. Farmers are rating the quality of land by using slope, soil depth, soil fertility (quality), agro-climatic zone and water logging as factors. In order to simplify the participatory land quality assessment and agroforestry planning processes, limiting the study area to only one agro-climatic zone at a time is preferred. The issue of water logging in the highly erosion-threatened highlands of Ethiopia is not obvious (EHRS, 1986). Even when it occurs, it can be remedied by farm-level technology adaptation and prescription (Chapter 10). Therefore, this farmer-based environmental assessment sub-process uses the remaining three land quality grading variables. First, the situation of the land is examined in terms of each of the variables independently. The limitations and potentials of the site are studied in terms of spatial distribution of soil depth, spatial distribution of soil fertility categories and slope categories independently. Possible indigenous inowledge-based technologies that can be deployed for mitigating the specific constraints are analysed in accordance to each of the land quality indicators. Next, the quality of the land is appraised based on the composite effect of all the three farmer-understood slope, soil depth and soil fertility parameters (Figure 4.1 on page 60). The production potential of each of the microsite in line with the combined effect of land quality limiting variables is again examined.

Slope

According to FAO (1990), there are 10 different slope gradient classes with a recommendation for modification to suit local topography. In the Ethiopian highlands where soil erosion is devastating and soil conservation has to be addressed via the agroforestry approach, farmer-perceivable and broader classification is preferred. Therefore, the first four classes are merged into one class. This is especially necessary when conducting participatory land quality grading where farmers are required to clearly perceive differences in slope gradients. Detailed slope class differentiation can be made gradually after farmers are studied and are helped in making slope class distinctions. In total, five adjusted slope categories (Table 4.1) are considered. Ideas of locally-fit slope gradient class bounds are obtained from the previous field reconnaissance observation and topographic map readings.

A slope map is generated in three major steps. First, the input files DFDX and DFDY are processed by the *MapCalc* (map calculation) programme to obtain an unclassified slope map of the research catchment. Later, by using the input files that contain this unclassified slope data, the classified slop map is generated by using the class information in Table 4.1. Finally a five-class slope map is produced. The general ILWIS/GIS application procedure in generating the slope map is indicated in (Figure 4.1on page 60).

Table 4.1 *Slope range classes for Tikurso catchment*

Slope limit, %		**Associated slope status**		
Lower	**Upper**	**Class**	**Score**	**Description**
0	15	I	5	Very good
15	30	II	4	Good
30	45	III	3	Moderate
45	60	IV	2	Poor
>60		V	1	Very poor

Soil depth

Soil depth sampling stations are distributed across the slope of the catchment and radiate from the higher elevation (source) of the catchment towards the lowest elevation (outlet) of the catchment to effectively catch heterogeneous aspects of the site. There are 175 soil depth sampling stations in four major rows and are approximately 80 m apart in a row. The average distance between the rows is ~160 meters. From these sampling stations of known UTM position, soil depth measurements are taken. Soil samples are collected for soil fertility analysis in a soil laboratory. Dominant land use types of each sample point station (up to 25 m^2 area extent) are observed and recorded for land use assessment. The geographic position of each of the sampling stations is read from the *Garmin GPS* apparatus and the 1:2000 scale contour map. The regional coverage of these sampling stations is considered as a major input for all the subsequent generation of attribute *raster maps*. First, regional coverage of each sampling station of known UTM is produced. Next, the gridding option called '*FromPoints*' is used to perform gridding operations for the 175 sampling points whose position in the research site is stored in a point table in the form of 'X' and 'Y' and including the names of the respective points. Then after, a method option of '*Moving Average*' that gives the output map in the form of integers is used. Later, a *Byte map* is obtained from this *integer map* by using the regional coverage map in integer format.

Finally, the final regional-coverage raster map that has values that ranged from first to last sampling point is obtained. An unclassified soil depth map is generated by accessing the column where the soil depth data value of each sample station is listed and using the raster map that has defined regions of the sampling stations as inputs. The Map Calculation formula used is a branch of *Spatial Modeling* which is in turn, a branch of *Raster Module*.

The final classified map is generated by reclassifying the non-classified map into the required regions of soil depth groups. This is performed by using the non-classified soil depth map generated as an output earlier and the classification table (Table 4.2) where regions of soil depth categories are listed as inputs for the *MapCalc* (map calculation) sub-module of the ILWIS-GIS application.

FAO (1990) distinguishes five effective soil depth classes: Very Shallow (<30 cm), Shallow (30 -- 50 cm), Moderately Deep (50 -- 100 cm), Deep (100 -- 150 cm) and Very Deep (>150 cm). FAO (1990) further confirms that the estimation of effective soil depth is subject to individual interpretation. It is acknowledged that 'extremely shallow' (<10 cm) may also be considered. Therefore, a more site specific soil depth category is defined (Table 4.2) and is considered in relative land quality grading work. The soil depth map (Figure 8.5) of the research site is thus prepared by partitioning the site into these five soil depth categories.

Table 4.2 *Soil depth classes of Tikurso catchment*

Soil depth limit, cm		**Associated soil depth status**		
Lower limit	**Upper limit**	**Class**	**Score**	**Description**
0	10	I	1	Extremely shallow
10	30	II	2	Very shallow
30	50	III	3	Shallow
50	70	IV	4	Moderately deep
>70		V	5	Deep

The soil fertility map is produced by the application of a similar procedure. The data input, which is used in the calculation tables of soil fertility-related parameters, is generated from laboratory analysis results and is discussed below.

Soil fertility

Soil samples are collected from each of the soil depth sampling stations whose geographic positions are known. The samples are collected as mixed samples over a plough depth of 30 cm. Soil fertility status of the research site is determined from the composite contribution of Organic Carbon (C), total Nitrogen (N) and available Phosphorus (P) and Potassium (K). Soil fertility assessment in terms of these four macro nutrients and soil pH is conducted by soil chemists at the Soil Laboratory of the (then) Ministry of Natural Resources Development and Environmental Protection (MoNRDEP). The laboratory assessment result from each sample is indicated in Appendix B.

Farmers understand better when fewer variables are considered at a time. In addition, in Ethiopian conditions, soil fertilizers are provided only in the form of NPK and di-ammonium phosphate (DAP). Hence, in order not to complicate fertility issues for farmers' understanding and to be in congruence with the possible application provision of soil fertilizer, assessment of only these macro nutrients is considered. Moreover, though the farmers in the study area grade lands by their soil fertility status, it is realized that farmers do the grading only in very broad terms. They do not have any established soil fertility class boundaries or ranges. Hence, more broader classification from which differences can easily become discernible by farmers has been preferred. The soil fertility map is prepared with features that farmers can easily locate on a map of 1: 2500 scale. Farmers are helped in visualizing the soil fertility status of farms while standing at a lookout place where they can associate land situation on the ground with the fertility status of those sites on the map. Appropriation of the macro nutrient content of the study site for the environmental assessment sub-process is presented as follows.

Organic carbon (C): Organic carbon is determined as a measure of soil organic matter in the soil samples (Nelson and Sommers (1982). The soil organic matter in the soil sample is oxidized with Potassium dichromate in sulfuric acid condition. Excess of potassium dichromate is added to the soil to destroy all soil organic matter, and this excess is determined by titration with standard ferrous sulfate (MoNRDEP, 1990). The organic carbon values of each soil sample are then associated to each of the categories they belong to. Organic carbon values of each soil sample and its contribution to the total soil fertility rating are given in Appendix B and are classified into five groups (Table 4.3).

Table 4.3: *Organic carbon classes of Tikurso catchment*

Range of organic carbon, %		Associated soil fertility contribution status	
Lower limit	**Upper limit**	**Score**	**Description**
0.00	0.74	1	Extremely poor
0.74	1.48	2	Very poor
1.48	2.22	3	Poor
2.22	2.95	4	Moderate
2.95	3.69	5	Good

Available Potassium (K): In the assessment of available Potassium, ten grams of soil was added to a 50 ml extracting solution in a shaking bottle and shook for 30 minutes. The soil extract was then filtered into a 50 ml Erlenmeyer flask. The 'K' concentration is then measured by using the calibrated Flame photometer with K standards. The 'K' values are read from a standard curve and multiplied by the dilution factor (MoNRDEP, 1990). The values ranged between 0 and 3085 ppm and are grouped into 5 classes (Table 4.4)

Table 4.4 *Potassium distribution class of Tikurso*

Potassium distribution, ppm		Associated soil fertility contribution status	
Lower limit	Upper limit	Score	Description
0	500	1	Extremely poor
500	1000	2	Very poor
1000	1500	3	Poor
1500	2000	4	Moderate
2000	3085	5	Good

According to Steiner (1987), those areas which have less than 2000 ppm are low in their 'K' value and K fertilizer is likely to benefit.

Available Phosphorus (P): In the Phosphorus analysis, the Olsen method is used (Olsen and Sommers 1982 and MoNRDEP, 1990). After the analysis, the values of 'P' in ppm ranged between 0 (no soil) and 96.98 ppm. The 'P' status is categorized into 5 groups of distinct soil fertility contribution scores as indicated in Table 4.5.

Table 4.5 *Phosphorus class of Tikurso*

Range of Phosphorus, ppm		Associated soil fertility contribution status	
Lower limit	Upper limit	Score	Description
0	5	1	Extremely poor
5	10	2	Very poor
10	15	3	Poor
15	20	4	Moderate
20	96.98	5	Good

Total Nitrogen (N): The method used in this total Nitrogen analysis is the Kjeldahl method (MoNRDEP, 1990). The percentage values of total nitrogen range between 0 % (no soil) and 0.33 % for all the samples, and are grouped into five categories (Table 4.6).

Table 4.6 *Nitrogen classes of Tikurso catchment*

Range of Nitrogen, %		Associated fertility status	
Lower limit	Upper limit	Score	Description
0.00	0.07	1	Extremely poor
0.07	0.13	2	Very poor
0.13	0.20	3	Poor
0.20	0.27	4	Moderate
0.27	0.34	5	Good

Cumulative soil fertility is based on the contribution score of each of the macro nutrients to the general soil fertility by using the *overlay technique* in ILWIS/GIS (ITC, 1993). The total soil fertility index of each soil sample (i) taken from a known UTM position is calculated by using the formula:

$$\mathbf{Ft_i = Cs_i + Ns_i + Ps_i + Ks_i}$$

Where:

Ft_i = Total fertility score for sample 'i'
Cs_i = fertility contribution score organic Carbon of sample 'i'
Ns_i = fertility contribution score of total Nitrogen of sample 'i'
Ps_i = fertility contribution score of available Phosphorus of sample 'i'
Ks_i = fertility contribution score of available Potassium of sample i

In adding-up the soil nutrients for fertility status determination, independence of the four factors and one to one contribution possibilities are assumed only due to lack of other simple and cumulative soil fertility assessment methods. The cumulative score from the four soil nutrients ranged between 4 and 20 leading to the classes given in Table 4.7. With the cumulative fertility score of each of the samples of known UTM position a relative soil fertility class map is generated based on distinguished classes. The procedure of the map production was similar to the production of Soil Depth discussed earlier in this Chapter and is illustrated on Figure 4.1 on page 60.

Table 4.7 *Cumulative soil fertility status classification range for Tikurso catchment*

Cumulative score range		Associated cumulative soil fertility status
Lower limit	**Upper limit**	**Description**
4.0	7.2	Extremely poor
7.2	10.4	Very poor
10.4	13.6	Poor
13.6	16.8	Moderate
16.8	20.0	Good

4.3 Current land use versus land potential

Current land use

The numerical identification code of current land use are: 5 for cultivated land, 4 for forest land, 3 for bush and shrub land, 2 for grazing land and 1 for waste land. Every one of the 175 observatory locations of known UTM are associated the respective code in accordance with the land use it is under. This data file is accessed during computer-aided mapping of the land use. To facilitate computer rasterization from which a classified land use map is to be generated, the classification range of the land use categories (Table 4.8) is used in the application of ILWIS/GIS whose general procedures are depicted in Figure 4.1on page 60.

Table 4.8 *land use class ranges of associated codes of each land use of Tikurso*

Land use category	Class range of code values	
	Lower limit	Upper limit
Waste land	0.5	1.5
Grazing land	1.5	2.5
Bush and shrub land	2.5	3.5
Forest land	3.5	4.5
Cultivated land	4.5	5.5

Thereafter, the land use map of the research watershed is produced by using the corresponding land use code values of each sampling station of known UTM as grouped in accordance with Table 4.8. Here again, the procedure of the map production is similar to the production of Soil Depth discussed in Section 4.2 of this chapter.

Land Potential

Relative land potential classes of the research site are identified by considering the status of soil fertility, soil depth and slope for these are indigenous land quality assessment variables that are identified during the participatory socioeconomic appraisal period. The purpose of land potential classification and mapping on the basis of locally acknowledged land quality grading variables is to ease farmers' seconding of the limitations found. When farmers realize and approve the limitations of their land, they are assumed to become more engrossed by the outcome and to develop interest for getting involved in finding out solutions to the problems. They consider the problems as their own problems and get involved in land use adjustments as well as technology prescriptions in planning (Chapter 9). The same becomes true in implementation of land constraint mitigation undertakings (Chapter 10).

Farmers' involvement in realization of the problems of their land, land use and land husbandry becomes more certain when environmental assessment maps are produced in large scale and used to discuss findings on the map in line with actual situations on the ground. This is done when discussions are done on lookout places where comparing and contrasting the facts on the map with the actual site in view is possible simultaneously.

The benefits of site diagnosis culminate in the production of this relative land-potential class map which is used for establishing a common consensus about the land use determinant site limitations and possible land use potentials through discussions. Each region of the 175 sampling stations is assigned the sum of the respective score it obtained from the three attributes which are assumed to have an equal contribution. The following formula is used.

$$\mathbf{LP_{si} = SD_{si} + SF_{si} + SG_{si}}$$

Where:

LP_{si} = Relative land potential score of sample point 'i'
SD_{si} = Soil depth contribution score to land potential rating of sample point 'i'
SF_{si} = Soil fertility contribution score to land potential rating of sample point 'i'
SG_{si} = Slope gradient contribution score to the rating of relative land potential of sample point 'i'

The values ranged from 3 to 15 and are regrouped into five relative land potential classes shown on Table 4.9 as follows:

Table 4.9 *Classification range for relative land potential mapping of Tikurso catchment*

Land potential category	Range of code values	
	Lower limit	Upper limit
Extremely poor	3.0	5.4
Very poor	5.4	7.8
Poor	7.8	10.2
Moderate	10.2	12.6
Good	12.6	15.0

The regional coverage of these sampling stations is considered a major input for the subsequent generation of the land potential raster map. A gridding option called '*FromPoints*' is used to perform gridding operations for the 175 distributed sampling points stored in a point table in the form of 'X' and 'Y' against respective names of the points. Thereafter, a method option of '*Moving Average*' followed by '*no linear prediction*' is used. This gave the required output map in the form of integers where the value for each region is not a specific whole number. Later on, a *'byte map'* is produced from this Integer map. In the application of GIS in environmental assessment, two types of data are used; point data and line data. The general usage of GIS from these data sources is presented in a flow diagram in Figure 4.1.

Finally, a regional coverage raster map that has values of 1 - 175 is obtained. A non- classified land potential output map is produced by using this regional coverage raster map file which has defined regions of the sampling stations and associated land potential data. The non-classified map is then reclassified into the required regions of the 'classified land potential map' by using the non-classified land potential map and the classification table (Table 4.9). The relative land potential map to be used at the field is prepared in attractive and distinctive false colours and on a scale of 1 : 2500 with permanent features such as roads, foot paths and drainage systems in place so that the farmers can identify the location of a given site and the associated land potential classes. In the participatory land potential classification, farmers are requested to tell the limiting factor (either slope, soil fertility or soil depth) that determined the potential class of that given piece of land.

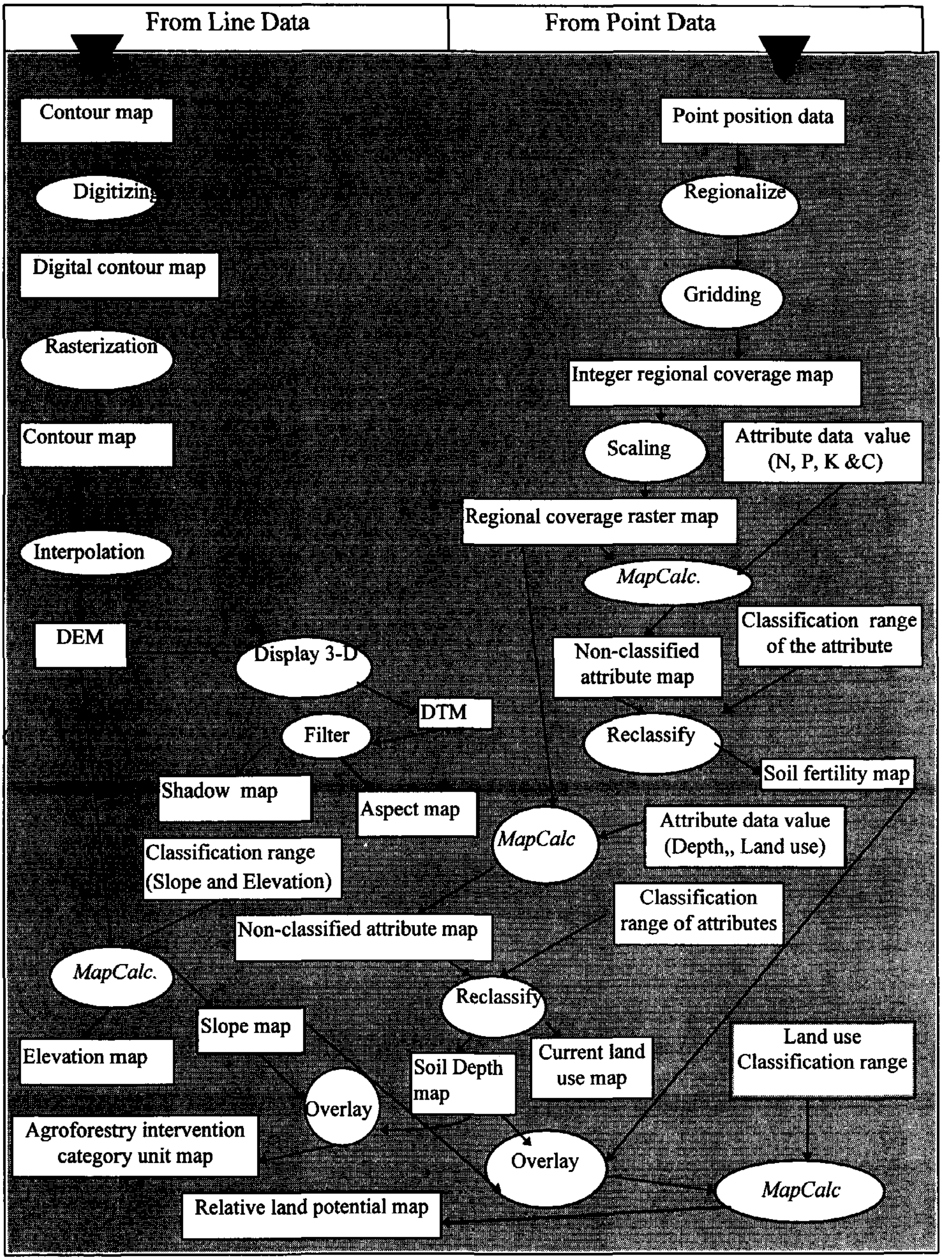


Figure 4.1 *Flow diagram for the application of ILWIS/GIS in environmental assessment*

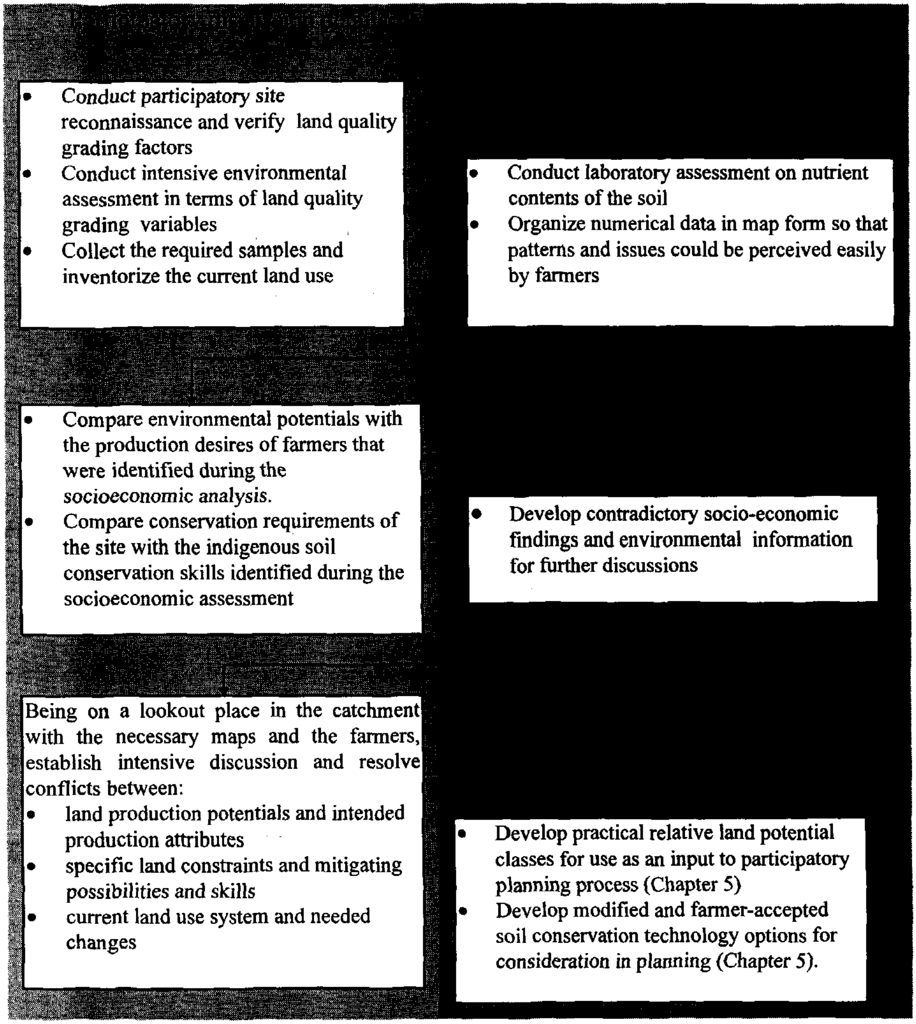


Figure 4.2 *Participatory learning and environmental diagnosis as a sub-process*

Similarly, the farmers are requested to comment on conformity of local technologies that are being implemented on the piece of land which is under consideration in the discussion. After establishment of a common understanding on the problems of the land and shortcomings of the land husbandry practices in the discussion, possible land-constraint mitigation technologies are discussed. Participatory environmental assessment is one of the sub-processes of the participatory agroforestry approach constructed. Since the process uses farmer-understood and locally appreciated land quality grading variables that are identified during the socioeconomic diagnosis period, it is logically conducted after many of the socioeconomic diagnosis concerns are identified.

Participatory environmental diagnosis approach of the PAA is a learning and diagnosing approach by which the facilitator initiates participation and discussion of farmers so that the exercise approaches more and more to the environmental realities by participatory learning among discussants. As indicated in Figure 4.2, the facilitator, as a member of the participatory environmental diagnosis process, airs his opinion and shares his experience and knowledge, which can be discussed among and with the farmers. As a facilitator, he (she) is responsible for catalyzing participatory initiatives such as organizing supplementary information (illustrations, laboratory information etc.), developing agenda items for further discussions, summarizing discussion outcomes and recapitulating previous agreements and decisions which have influence on the following participatory environmental diagnosis work.

The approach is a demanding exercise by which the facilitator is required to play two roles. On one hand, he acts as any one of the participant farmers in the community, airs his opinions to be discussed, obtains similar status and shares similar values and traditions. On the other hand, he moderates discussions and furnishes available information and guides the discussion forum according to the objectives set so that the flow of ideas and thoughts become properly articulated.

4.4 Conclusions

This chapter has shown that getting familiar with the site is as necessary as establishing trust between the farmers and the facilitator in the socioeconomic diagnosis. It shows that repeated field reconnaissance and surveying are stepping stones in the approach. Other factors such as aspect, shadow and 3-dimensional maps allow the facilitator to read and understand patterns and situations at manageable representations of the catchment information at office level. A more close look of the site is obtained from locally appreciated and used land quality grading variables.

In the case of Tikurso catchment, soil depth, soil fertility and slope gradients are investigated. The facts can be vividly observed by the help of computer-aided mapping. The chapter has presented the modalities of obtaining such kind of maps by application of ILWIS-GIS version 1.4 (ITC, 1993). It is realized that maps of 1: 2500 scale with permanent to semi-permanent features can be used for generating important discussions with farmers. The maps are taken and discussed at a lookout place to the site so that simultaneous observation of the actual site conditions and corresponding reality on the map is possible. It is also realized that farmers can easily appreciate and understand the soil depth and soil fertility conditions when they are presented in the form of coloured maps. In conclusion, the use of case studies in the development of a participatory environmental assessment approach is portrayed.

CHAPTER 5

PLANNING

5.1 Introduction

Planning in the application of the participatory agroforestry approach is conceiving the parts and processes of agroforestry and soil and water conservation innovations mentally and formulating thoughts in a meaningful manner for practical implementation of adapted, indigenous and comprehensive soil and water conservation practices by farmers. This planning in PAA is a catchment-level deliberation that is conducted with a planning team made up of community elders, social institution leaders and interested innovative farmers with the development facilitator. The planning involves outdoor exercise where land quality grading variables are discussed once again in line with categories of planning units.

The planning units are defined by ranges of soil depth, soil fertility and slope. First, planning units are defined by ranges of each of these three parameters. Slope constraint mitigation technologies, which are identified during the socioeconomic assessment (Chapter 3) and that need to be adapted to each of the planning units, are discussed. This is simplified by having the discussion on a lookout place. There, mapped information for each of the planning units, which is defined by a single attribute (either slope, soil depth, soil fertility or any other valid factor.), is contrasted with the actual land use and land care practices being exercised on the ground. For instance, land units of slope categories of 0 - 2, 2 - 5, 5 - 15, 15 - 30, 30 - 45, 45 - 60 and > 60 %, are classified into different slope classes indicating that there exist varied possibilities of land use appropriations (FAO, 1990). The land constraints and constraint mitigation skills of farmers vary accordingly. Participatory agroforestry intervention planning tries to maximize on such opportunities and possibilities. The same is done on other land quality grading factors.

Planning discussions that consider each of the variables are done in different sessions. During such planning sessions, possible land use and production emphasis are set. Suitability of the land under a given planning unit for the intended production is debated. Appropriate and validated constraint mitigation technologies that need to be adopted are discussed and decided. This effort of planning of possible production components and adjoining constraint mitigation technologies for each of the planning units that are defined by each of the different land quality determining variables allows to split facts and to examine planning issues deeply. Later, composite planning units are defined by the merged effects of the land quality determining variables that are valid for the specific site. For instance, in the case of Tikurso catchment (Chapter 9), the composite planning units are defined by the combined bounds of soil depth and slope (Figure 9.1) because the remaining third land quality attribute (soil fertility) happened to be uniformly very poor. The composite plan map that indicates the composite planning units is obtained by the application of *ILWIS-GIS*. The composite plan map that indicates the combined effect of land quality determining variables is again taken to the site by the planning team for discussion. For each of the newly defined units, the compatibility of previously suggested production targets and constraint mitigation technologies are discussed. Necessary modifications are made to the production targets and their combinations. Necessary modifications are made to the previously decided constraint mitigating technologies. Finally, the compromised plan and its attributes are carefully recorded by the facilitator for indoor discussion, critique and approval of the planning team.

As it is indicated in the process, the planning process in PAA follows a nested approach. It uses the findings of previous work and builds up a better understanding about the steps that follow. There is no pre-made assertion. The outcome always depends on the realities found in the preceding phase and the existing situations. The information generated in the participatory socioeconomic diagnosis phase is used as an input to the farmer-based environmental analysis job, which in turn, generates a lot of important information for the planning exercise.

The farmer-based environmental assessment approach (Chapter 4) has generated important information on the environmental status of the catchment. Directions of shadow casts, which are important in the alignment of the tree/shrub (component) lines in the agricultural plots, are known. The assessment further manifests the slope extent and orientation of the contour lines that would guide the orientation and spacing of physical soil conservation structures. The slope assessment information is used as a guide in selection of nominee agroforestry interventions in that whether a piece of land of a given slope is to be put under agroforestry intervention that involves cropping, tree farming etc., or not. The soil depth information is used to determine where to integrate deep-rooted and shallow-rooted crops (tree or shrub) in the planning exercise.

5.2 Facts and issues

Facts on major priority of productions of farmers such as food crop, cash crop, livestock feed shrubs, or trees of selected uses are inputs in directing the goals of the participatory planning. The major factor that inhibited realization or achievement of such prior production concerns of farmers are issues to be addressed in the planning.

In addition to production emphasis of farmers and their associated shortcomings that need to be tackled by the participatory agroforestry planning approach, the existing facts and issues that limit the introduction of trees into farmers' land use systems are discussed. Anticipated problems of farmers in using traditional and introduced soil conservation measures are once again discussed, debated, criticized, negotiated and compromised. The discussion outcomes are used in the development of the plan and the prescriptions. The socioeconomic facts and issues with regards to labour force available, material costs and availability are identified and discussed. Possibility of spreading labour and resource usage is accommodated in the planning.

When viewed from only site-condition diagnosis' point of view, lands that can be rated as moderate and good can be used for wood, feed and food crops. However, lack of such type of lands at satisfactory size can compel to include those lands rated as 'poor'. For instance, the coverage of land rated with moderate and good land potential category, in Tikurso catchment, is only 28 % while the land under current food production is already 41 % (Chapter 8). In such a case, only lands in 'very poor' (29%) and 'extremely poor' (17%) are excluded from crop production. The type of indigenous soil conservation skills that exist within the community and shortcomings that necessitate adaptations are thoroughly discussed. Solutions and compromises are made before the planning options are prepared.

5.3 The planning process

Participatory planning sub-process in PAA is a people-centered conception of agroforestry components for improvement and transformation of the existing ill-adapted soil and water conservation via the production potential of agroforestry interventions. According to Hoek (1992), planning is one of the three segments of the development approach that is succeeded by extension approach and project management (implementation) and preceded by monitoring. Strength of each segment determines the overall success. In participatory planning, the agroforestry intervention category defining variables such as slope, soil depth and soil fertility bounds are selected as appropriate. The bounds of each of these variables are determined in accordance with socioeconomic and agro-climatic realities. After the establishment of a common understanding on these issues, the facilitator organizes the agroforestry intervention category information in the form of a map with contrasting colors and at a scale that is perceivable by farmers. Such maps are used extensively in the planning discussions (Figure 9.2, Chapter 9).

In the second discussion the agroforestry intervention category map is illustrated and discussed. Farmer-endorsed agroforestry intervention components (specific trees and shrubs) and options are restated, elucidated and discussed in line with environmental conditions of the intervention categories. Possible adapted indigenous soil conservation skills and options that are obtained from the participatory socioeconomic diagnosis are restated, elucidated and discussed in line with each of the intervention categories. As an output to this discussion, farmer-based agroforestry intervention plan constituents (assemblage) are defined category by category for further discussion and refinement in a following discussion with farmers.

In the third discussion forum, prescription details on actual alignment and configuration of each and every component associated to each of the intervention category is discussed, debated, mediated and compromised. Detailed, farmer-approved and ready to be adapted to farm-level planing agroforestry options for soil and water conservation are organized. The extent of farmers' desire for increasing the size of the agricultural land by converting the remaining environmentally fragile bush/shrub land and grazing lands and its consequences are discussed. Options are devised and a compromise is made. Soil conservation technologies that could mitigate production constraints of the land or perennial crops that could guarantee annual production without deterring land sustaining potentials are screened out.

Though most agroforestry systems are intrinsically protecting the soil, it is noted, during planning, that some agroforestry systems are detrimental to the environment. From discussions with the farmers, it is also realized that farmers assume that integrating trees into farms is similar to having a lion and a leopard in the same enclosure and expecting serene conditions. It is an important admonishment that extreme care and knowledge are required for harmonizing the positive and healthy coexistence of the various agroforestry components. Selection of the components and their spatial arrangement are the key possibilities of harmonizing the coexistence of integrated perennial trees and shrubs with annual crops in such erosion-threatened environments. According to Wiersum (1985), it is not the trees but the spatial arrangement of the trees that protects the soil against erosion.

In the application of the participatory agroforestry approach for soil and water conservation, agroforestry is seen not only as a combination of woody perennials with herbaceous legumes and grasses but it also includes physical soil conservation measures such as *Kab, Dinber* and *Golenta.* Therefore, planning of agroforestry intervention in PAA involves optimal usage and arrangements of the biological components and the physical components of the production-focused conservation measures for improved and transformed land use. Therefore, agroforestry in PAA is a deliberate association of soil conservation measures in a forestry-agriculture integrated land use system by which short-term production concerns of farmers and long-term conservation requirement of the land are addressed simultaneously.

The planning process involves a lot of learning, amending, validating and systematizing what is known and rated useful. As indicated in Figure 5.1(next page), planning is a learning and acting process effected through extensive and repeated sessions of dialogue within the planning team.

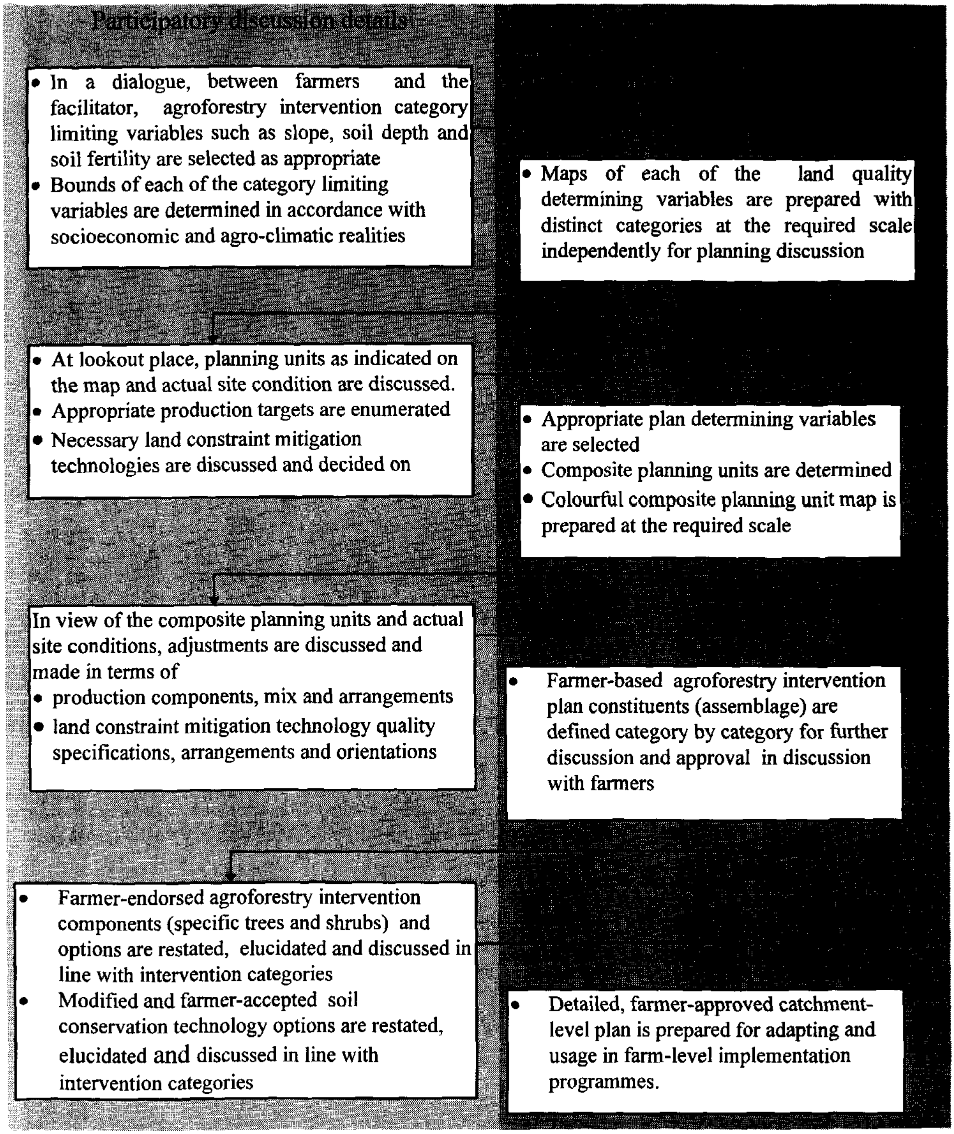


Figure 5.1 *General participatory learning and planning procedures of the participatory planning sub-process*

During such a learning and planning sub-process of the PAA,

- compromised planning units are defined
- land constraint mitigation technologies are enumerated, their weaknesses are discussed, criticized and corrected
- tested, amended and validated indigenous skills that are suited to each of the planning units are assembled
- production targets that are feasible in each of the planning units are set

Chapter 6

IMPLEMENTATION, EVALUATION AND FEEDBACK

6.1 Adapting catchment-level plans

Planning units at catchment-level are defined by broad ranges of land quality determining variables. They are important for establishing an understanding about catchment-level land use appropriations. They serve in framing land use and land rehabilitation technology options. In addition, *GIS*'s application in the planning exercise becomes more meaningful and economical when used at catchment-level than at farm-level. Furthermore, individual farmers are part of their communities that are traditionally mandated to function under their community values and customs. These linkages can not be discerned unless the farm and farmer-level situation studies are drawn from the catchment-level situations. However, within such framed land use and technology options that are studied at catchment-level studies, discrete specification and choices of land use and technology components are required at farm-level for practical implementation. Therefore, adapting the catchment-level plan and prescription to a farmer and farm-level plan is vital.

During adaptation, a farm is partitioned into various planning units by reconsidering each of the land quality grading variables. This is done by sketch mapping the farm on transparent papers so that overlaying is possible. Details of such a farm-level land quality assessment, adaptation of the plan and prescription for implementation as well as the implementation itself are presented through a case study in Chapter 10.

After identification of land quality classes that are defined first in terms of each of the land quality determining variables and later in terms of a composite contribution of all the three variables, adaptation of production targets to each of the planning units is discussed. Important production limitation issues of each of the planning units as defined by land quality determining variables singly and jointly are discussed. The required land constraint mitigation technologies are enumerated from those listed in the catchment-level planning.

The Catchment-level planning has addressed the production targets by planning units that in turn are defined by land quality determining variables. For each of the planning units, production components are defined in broad terms such as trees or shrubs. The same is true for land constraint mitigation technologies. Only the ranges of spacing and dimension are set. For instance, planning units of slope range 30 - 45 %, construction of *Golenta* in a spacing of 75 -100 m is planned (Chapter 10). The spacing of the *Golenta* in 30 % slope differs from that of a 45 % slope land.

At the same time, implementation pre-supposes knowledge and decision about a specific technology to be implemented with pre-determined specification on how to implement the technology. For instance, among the pool of trees identified, a certain farmer may be interested more in a certain tree than the other and his valuation of the tree may be different from that of the community average. Adapting the attributes of production, type of land constraint mitigation technologies, specification of the layout of the technologies and deciding on specifications of production attributes and arrangements precede actual implementation.

Adaptation is tried first in accordance with each of the production limiting factors. In order to mitigate slope constraints only slope correcting technologies are discussed. In cases where soil depth is limiting, technology designations differ in accordance with the extent of the limit. In such areas, the type of crop to be designated and conservation measure to be applied differs accordingly. In flood routing areas, technologies that are useful for trapping sediment in the flood water can be designated. In extremely shallow soil depth conditions, *in-situe* conservation may be the technology option. In deep soil conditions, agroforestry technologies that integrate commercial value tree production may be used while in shallow soil condition technologies that include fodder shrub productions may be more appropriate.

Another factor in technology designation is soil fertility. A number of indigenous soil fertility enhancement choices differ in accordance with what the specific farmer prefers and can afford to do. Depending on labour availability and will of farmers, time of intervention is spaced in accordance with different land uses. For instance, those lands of Tikurso catchment that are extremely shallow, steep and extremely poor in their soil fertility status are designated for ecological conservation (ecological farming). The agroforestry interventions and their prescriptions are different to those areas that qualify for cropping and so are the silvopastoral lands.

The source of the technologies is the finding of the appropriate indigenous technologies and skills (Chapter 3) and the basis of adaptation is the remedial outlook to the problems of each of the indigenous technologies that are identified earlier (Chapter 3). The procedures of adaptations of the catchment-level plan to farm-level planning are indicated in Figure 6.1 on page 71.

6.2 Implementation

Depending on the realities of the production potentials of the site and socioeconomic conditions of the farmer household, the proposed agroforestry intervention plan (Chapter 5) that holds for the identified land categories of the farmer are reviewed in a joint undertaking of the farmer and the facilitator. Components of agroforestry interventions to be implemented are discussed between the facilitator and the farmer.

Implications of the intended agroforestry intervention components and arrangements are more thoroughly analyzed from the point of view of the production desires of the farmer and conservation requirement of the land.. Conflicting issues of the discussion outcomes are enumerated by the facilitator and illustrated. Justifications are prepared for further discussion. Possible options are prepared for suggestions during a coming discussion session. In another round of discussions with the farmer, conflicting issues are discussed, debated and mediated in consideration of possible options and outcomes. Agroforestry species are nominated. Type, nature and dimensions of adapted physical soil and water conservation measures to be combined and strengthened by biological measures are discussed, enumerated validated and appropriated for the various intervention units they are fit for.

Advantages and disadvantages of the layout and arrangement of the species in line with assurance of positive cohabitation with the annual crops is discussed and decided on. Spacing and configuration of the shrubs, trees and adjoining crops in a farm plot are decided on.

The implementation phase equally involves a lot of learning from the individual farmers. It, at the same time, requires a lot of ingenuity from the facilitators in selling the more diversified and improved land use knowledge to these individual farmers. In the process a lot of area-specific knowledge is obtained. The method of using such combined knowledge for the betterment of the individual farmers and their lands is the most decisive and challenging task that needs to be played by the facilitator more effectively. The procedures and salient issues that are pertinent to adaptation and implementation this sub-process of the approach are presented as a flow diagram in Figure 6.1. In addition, spacing, and layout of physical soil conservation measures and their agreement with the layout of the tree and shrub components of the agroforestry intervention is discussed. Possibility of complementary and supportive arrangements are engineered. Labour, materials and other inputs that are required for the implementation of the agroforestry interventions are discussed and contributions of the farmer and facilitator are decided on.

Finally, the agreed implementation prescriptions are made for each of the agroforestry intervention categories of the specific farmer. Detailed implementation backstopping facilities are organized and implementation is continued by the farmer. In an on-farm discussion with the farmer, for each of the activities that are indicated to be implemented in each of the planning units, the necessary inputs that are required are discussed and estimated. Responsibilities for provision of such inputs are decided on. Implementation schedules are developed.

Details of the participatory discussion

In an on-farm discussion with the farmer

- farm-level land potential assessment and sketches are made and agroforestry intervention categories that hold for the land of the farmer are identified
- proposed agroforestry intervention plans that hold for the identified land categories are reviewed in accordance with farm and farmer household realities.
- components of agroforestry interventions to be implemented are discussed

- Implications of the intended agroforestry intervention components and arrangements are more thoroughly analyzed
- Conflicting issues of the discussion outcomes are enumerated and illustrated; justifications are prepared for further discussion
- Possible options are prepared for consideration in discussions

- In a dialogue with the farmer, conflicting issues are discussed, debated and mediated in consideration of possible options and outcomes
- Agroforestry species, layout and arrangement are decided on
- Soil conservation measures, spacing and layouts, inputs are discussed and decided on
- Materials and other inputs required for implementation are discussed and farmer's and facilitator's contributions are determined

- The agreed implementation prescriptions are made for each of the intervention categories
- Detailed implementation backstopping facilities are organized.
- Technical instruments are prepared for support in implementation

- Soil conservation fostering agroforestry plan is implemented by the farmer in accordance with the prescriptions made
- The required labour and materials are brought to the farm by the farm owner
- Tools and equipment that are required for the technical backstopping are brought and used at the farm

Figure 6.1 *General procedures in participatory adaptation of catchment-level plans and prescriptions to farm-level situations for implementation by individual farmers*

6.3 Evaluation

The participatory monitoring and evaluation sub-process (Figure 6.2) is a feedback mechanism for testing the efficacy (technical) and efficiency (economical) effectiveness of the approach and getting ready for correcting the shortcomings that might have occurred when implementing the approach. In participation with the farmers, farmer-discernible evaluation factors are discussed and used. The evaluation is both quantitative and qualitative. It includes examining the planning process in line with the fundamental objective of the participatory planning approach. It deals with the assessment of:

- the improvement of farmers' acceptance and will for cooperation with the development facilitator
- socioeconomic and environmental diagnostic processes if they have resulted in elucidating farmer-based and factual issues
- attractiveness of soil conservation technologies to farmers in their holistic nature

Sequential arrangement of the activities that are performed in this sub-process is presented in Figure 6.2. The end result is making use of indigenous soil conservation measures that gradually attain perfection through action-oriented participatory learning for attracting the will of farmers in keeping their lands productive on a sustainable basis. The impact assessment is conducted through a farmer-participatory action research at catchment and farm-levels.

Sustaining the land

Sustenance of the land under the agroforestry approach is conducted in terms of the soil erosion by the pin method (FAO, 1993). *Juniperus excelsa* (selected due to its resistance to termite attack) pegs of 5 cm diameter are driven into the soil. According to Mutchler et al. (1988), support practices such as terracing contour ploughing and strip cropping that affect soil erosion are evaluated better as a simple terrace interval unit. Hence, soil movement assessment measurements by the pin method are determined to be conducted in farm plots whose boundaries are defined by two adjacent *Kab*s. Land sustenance at farm-level is determined from the cumulative average of farm-plot level average assessments.

Soil conservation potential of the approach, in terms of the amount of soil arrested by the implemented agroforestry interventions, is the major concern in measuring the land sustaining quality. In addition, the assessment is conducted in participatory approach with the farmers who applied the interventions. Therefore, farmer-discernible soil conservation assessment method is used. Plot groups of various slope categories are identified as PG1, PG2, PG3 etc. from randomly selected farms. The assessment is conducted by pegging termite resistant circular wooden pins (FAO, 1993) prepared from *Juniperus excelsa* at a distance of 1.0 meter above and below the *Kab*. The distance between any two adjacent pins that are pinned along the width of the plot is 2 meters. The pins at the outer edges that transverse the farm are at least 10 meters inside of the farm boundary to avoid border effects

(Figure 6.3). Initial height of the pins above the soil surface is recorded immediately after the agroforestry interventions are in place. Regular soil erosion and depositions are monitored by measuring the height difference of the pins above the soil surface at the end of each of the two cropping seasons after the crops are harvested and the land is settled.

The annual average depth of the soil eroded from the upper side of each of the plots in the four farm plots groups is calculated from the three years record. The same is done to the annual average depth of soil arrested in the lower section of each of the plots in the four plot groups. Later, the annual average depth of soil arrested and eroded is computed from the two annual averages. It is this average depth of soil which is used to calculate the amount of soil eroded and arrested on a per hectare per year. A detailed case study calculation is presented in Chapter 10.

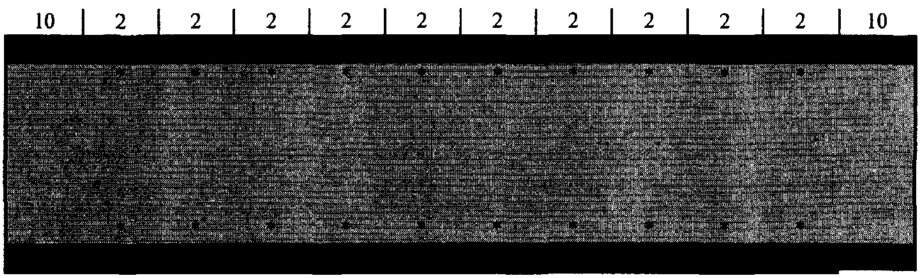


Figure 6.3 *Model layout of pins in a farm plot*

Key: '2' indicates distance between any two adjacent pins in a farm plot
'10' indicates outer edge of a farm plot buffering the boundary effect for the pins
'*' pin location
Kab location

Note The plot width between any two adjacent *Kab*s varies according to intervention category

The objective of land sustaining quality assessment of the interventions in PAA is to evaluate conservation measures and to verify prescriptions of the agroforestry interventions. The feedback is used to improve the approach. The basic data on the amount of soil eroded and arrested in such real size holding levels are used as justifications for establishing confidence in among the facilitator. In addition, the same information is used to demonstrate efficiencies of conservation measures for the farmers and conservation facilitator. According to Mutchler et al. (1988), the advantage of farm-level (large scale) assessment is the willingness of farmers to believe assessment results of larger-scale experimentation. In addition to measurement of the soil movement, leveling (change in slope) effect of the interventions is judged from initial and final slope measurements. A Clinometer is used for measuring average slopes of farm plots.

Productivity

One important measure of land productivity is the growth measurement for the tree species and butt diameter and biomass measurement for the fodder and cash value shrubs as well as trees. Growth assessment measurements are made every year after one year of the planting of trees and shrubs that are used in the agroforestry intervention. The measurements include height and diameter increment of tree and shrub species under agroforestry interventions.

Productivity is measured by considering actual harvests of cereal crops and shrubs as compared to initial (base year) production harvests. Production increments are computed and recorded. Financial value of the harvests is calculated by considering unit prices of similar commodities for the corresponding years at local markets. Price estimates of standing crops of trees and shrubs is estimated by requesting owners to estimate the farm gate price for the equivalent size. This is done only at the final data collection period. Taking the above mentioned problems and possibilities of estimating gross productivity of the implemented agroforestry intervention, the total production gain of the farmers known. In addition to quantitative figures, the farmers' feeling about productivity of the interventions implemented is considered useful and used for judging the success of the implemented interventions.

Cost Effectiveness

Cost effectiveness of the agroforestry interventions is judged by comparing the input costs (cost of implementation and tending of the implemented interventions) and the increased financial gain as compared to the base year obtained by farmers due to adoption of these technologies. Normally, in cost-benefit calculations, the *effective life* expresses in either physical or economic life (whichever is short) is considered (Graaff, 1996). However, in reality, farmers decide either to conduct a conservation measure or not, only by visualizing the labour and material input and benefits that may be obtained in a short duration of time. The practice of discounting of the high costs of soil conservation measures, which normally produce late benefits, is much debated.

According to Price (1993), we can not predict whether and how we will experience expected benefits of such soil and water conservation measures for they have long gestation periods. In this regard, long-term follow-up and assessment is necessary. However, discounting over the long effective life is further constrained by the fact that farmers do not risk applying conservation measures on the basis of long-term benefits especially under the conditions where there is no constitution that secure land tenure (such as in Ethiopia). To this effect, the cost-benefit comparison is decided to be the farmers' costing time scale.

Adaptability

Adaptability of the technologies is to be assessed by conducting a survey of the farmers who have copied the technologies. The adaptability survey is conducted only within the catchment but it is felt that outside farmers who happen to see the developments may also try to copy them. However, as it would be very difficult to ascertain the area of influence and whether it is really due to the influence of the research outcomes of planned agroforestry work, the assessment is intentionally limited to the catchment-area farmers.

The test result enables us to judge if farmers are replicating the exercised intervention or rejecting it. *Since it is conducted in participation with the farmers, the facilitator gets a first* hand opinion of the adopter and views on how to continue correcting the deficiencies of the approach. Participatory monitoring is an effective extension tool for easing farmer participation in the improvement of the interventions. The individual farmer needs to understand the monitoring processes and this can be helped by participatory learning. Figure 6.2 presents such a learning and evaluating sub-process.

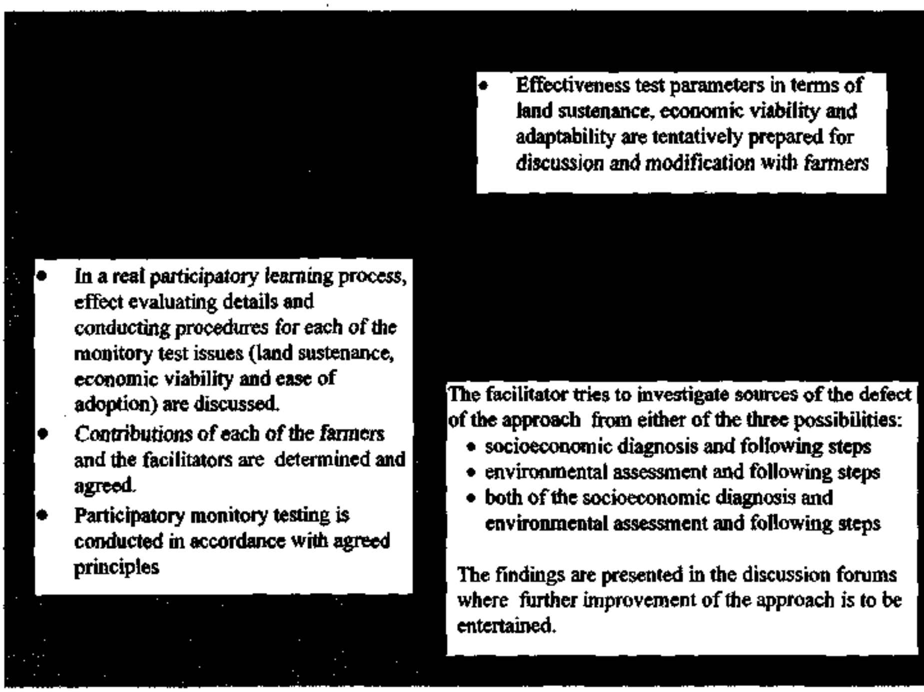


Figure 6.2 *Participatory learning, evaluation and feedback generation sub-process of the PAA.*

6.4 Feedback

The participatory monitoring process (Figure 6.2) is a feedback mechanism for testing the effectiveness of the approach. Depending on the feedback obtained from the monitoring, the avenue of correcting the mistakes that might have occurred during the diagnosis, planning and or implementation period is determined. In obtaining the feedback, farmer-discernible evaluation methods are discussed and used. Evaluation may be qualitative and or quantitative. The literacy rate amongst the farmers will have a significant impact in determining evaluation attributes and methods to be used. The feedback enables us to know whether farmers are implementing the soil and water conservation via the agroforestry approach or not. It further portrays whether the applied interventions are addressing the land sustenance problem effectively or not and whether it is economically attractive to the farmers or not (efficiency).

Summary to part II

The challenge for sustainable land use management in the nineties is to initiate a people-centered development process which creates opportunities for local people to make their own choices about which development strategy to follow (Hoek, 1992). This is of special concern to the contemporary Ethiopia that embarks on a rural-centered and agricultural development-led industrialization development policy (NCS, 1994a). The participatory agroforestry approach tries to address methodical and technical problems of soil and water conservation and reforestation schemes that are required for the betterment of the farmers and their lands in the agricultural landscapes of Ethiopia. The core intent is addressing soil and water conservation problems via agroforestry developments.

The approach involves six distinct steps. The first and pillar of the approach is building trust for a facilitator within the farmers. Without getting full-hearted acceptance, the approach assumes that it would be practically impossible to fulfill the mission of the approach. After willful acceptance of the farmers is obtained, participatory socioeconomic assessment (step 2 of the approach) may be effectively conducted. Process details are summarized in Chapter 3. Schematic presentation of Figure 3.1 gives an important illustration.

Chapter 4 details with the process of participatory environmental assessment (step 3 of the approach). As illustrated in Figure 4.2, the facilitator fulfills two roles. In participatory discussions, he serves as a moderator. In his off-discussion time, he synthesizes debatable (contradictory) information or resource information in a farmer-discernible manner for further discussion. Production of large scale colored maps, laboratory analysis and supply of soil nutrient information are few of the examples in this field.

Chapter 5 addresses the participatory planning process or step 4 of the approach. The planning makes use of the findings of Chapters 3 and 4 but revitalizes the information in a planning discussion. Necessary changes and adaptations as well as designation of technologies to their best-fit conditions are addressed here. The mechanism is illustrated in Figure 5.1. The last chapter in Part II (Chapter 6) discusses the implementation (step 5 of the approach) and effect evaluation and feedback assessment (step 6) issues of the approach. As envisaged by the approach, the end result of the feedback may lead to revising the approach through either of the three possible routs indicated as 'A', 'B' and 'C' in Figure 2.1 of Part I. Therefore, the final premise of the approach is that perfection of the participatory agroforestry approach for success in soil and water conservation gets more improved as our knowledge in each of the above stated steps grow.

PART III

TIKURSO CASE STUDY

A

B

Plate 7.1
Tikurso catchment depicts a scenario where there exists an environmental challenge in that: the topography is rugged, the land is misused and exhausted (A above) and the farming system involves continued cultivation of steep slopes with no proper care for the land (B above).

CHAPTER 7

BUILDING TRUST AND SOCIOECONOMIC DIAGNOSIS

7.1 Building trust

The first step in the case study test on the constructed agroforestry approach for soil and water conservation focuses on creation of trust within the farmers of Tikurso catchment. The approach as described in Chapter 3 is used. From the study, useful information about traditional beliefs, norms and customs is obtained. Familiarization with the local community is facilitated by local influential elders. The study on traditional norms and customs indicates that a number of venues could effectively be used for building trust between the development facilitator and the farmers. At the same time, as understood from preference analysis of farmers' interviews, each of the venues are rated differently. Based on the 88 interview participants, 41 % of them prefer *Yager-shimagile* while the other 36 % favor religious leaders. *Idir* leaders and PA leaders shared the remaining 17 % and 8% respectively (Table 7.1). However, 100 % of the respondents indicated that the combined role of such social institution leaders is more effective than any of the single avenues.

Table 7.1 *Effectiveness of local authorities in catalyzing developments at community level*

Influential authorities	**Favoring respondents, %**	**Rank**
Local elders (*Yager-shimagile*)	40	1st
Religious leaders	35	2nd
Idir leaders	15	3rd
Peasant Association executive committee	10	4th
Total	100	

The success in development discussions that are coordinated by the support of such social institution leaders is found to be affected by the size of the constituency of the discussion forum. Farmers stressed that they either overhear discussion issues and messages or have difficulty of passing their ideas through meetings of large constituencies. Feeling a stranger and fears hold back their free airing of their opinions in large crowds. Opinion survey indicates that different meeting whereabouts have different preference scores (Table 7.2). In most cases, the smaller the size of the jurisdiction of the discussants, the better preferred and effective it is. In addition, the purpose of the institution for which it is basically established, appears to matter. For instance, *Idir* is the smallest in size of its constituencies but is less favoured (3rd level in Table 7.2) for use in development meetings due to the fact that it is mainly established for coordination of relatives and people from neighbourhoods in funeral issues.

Table 7.2 *Preferred meeting levels for participatory discussions*

Meeting Whereabouts	Percentage of preference	Importance priority ranking
Village	55	1st
Got	20	2nd
Idir	15	3rd
Peasant Association	10	4th
Total	100	

More than 50 % of the respondents in the questionnaire survey indicate that success in obtaining trust by the use of influential local institutions, authorities and meetings of preferred levels need to be substantiated by respect and use of the following local norms and customs. These are:

- being loyal, trustworthy and reserved from infamous doings
- respecting people by their age and locally acknowledged fortitude
- greeting every person met in the community
- standing when answering questions and making speeches in a gathering
- attending funerals and proper condoling
- respecting invitations

In addition, on-farm discussions and local experience teach that the following qualities of the facilitator are helpful for obtaining trust and effectively communicating with farmers. These are:

- presenting ideas through the local elders or obtaining approval by them
- presenting appeals for assistance to the local elders or other mediators by visiting them in their house early in mornings
- getting approval of the development agenda by the local elders, religious leaders, peasant association authorities and respected farmers

- showing courage, demonstrating continuous and inflamed efforts and intellect on the development subject
- selecting the development site with such locally accepted and respected mediators
- conducting development site boundary delineation officially with the elders and other influential farmers
- being very careful about technologies that are not endorsed by the farmers or doubted for effectiveness
- conducting audiovisual-aided and continuous swaying training and animation

During the trust building period, 12 innovative farmers got committed to conduct the farmer participatory research and detailed participatory research work commenced.

7.2 Socioeconomic diagnosis

Based on the results obtained from the socioeconomic studies (Chapter 3), the population characteristic of the people in the study area are given in Table 7.3. The study indicates that there are 605 inhabitants in the watershed. The population density is 180 persons km^{-2}. The female population is only slightly greater (52 %) than the male population. Twenty four percent of the male and 25 % of the female are literate while only 4 % of the female and 6 % of the male have completed high school. By the community standard, age 13 is the minimum age limit for legitimizing any one as a working force in agriculture. Considering this community standard, the work force in the population is 67 %. The average agricultural production from their land for the base year (1992) is 1300 Birr (~ US $ 200).

Table 7.3 *Population characteristics of Tikurso catchment*

	Population category		**population density**		**labour force in the population %**
			Per household	**Catchment**	
1	Labour force	Above age 13	3.7	407	67
		Below age 13	1.8	198	0
	Total		5.5	605	67
	Gender	Female	2.9	319	35
		Male	2.6	286	32
	Total		5.5	605	67
2	Education status		Catchment Population percentage		
			Illiterate	Read and write	High school complete
	Total population	Male	76	18	6
		Female	75	21	4
	Household	Male	91	9	0
	leaders	Female	100	0	0

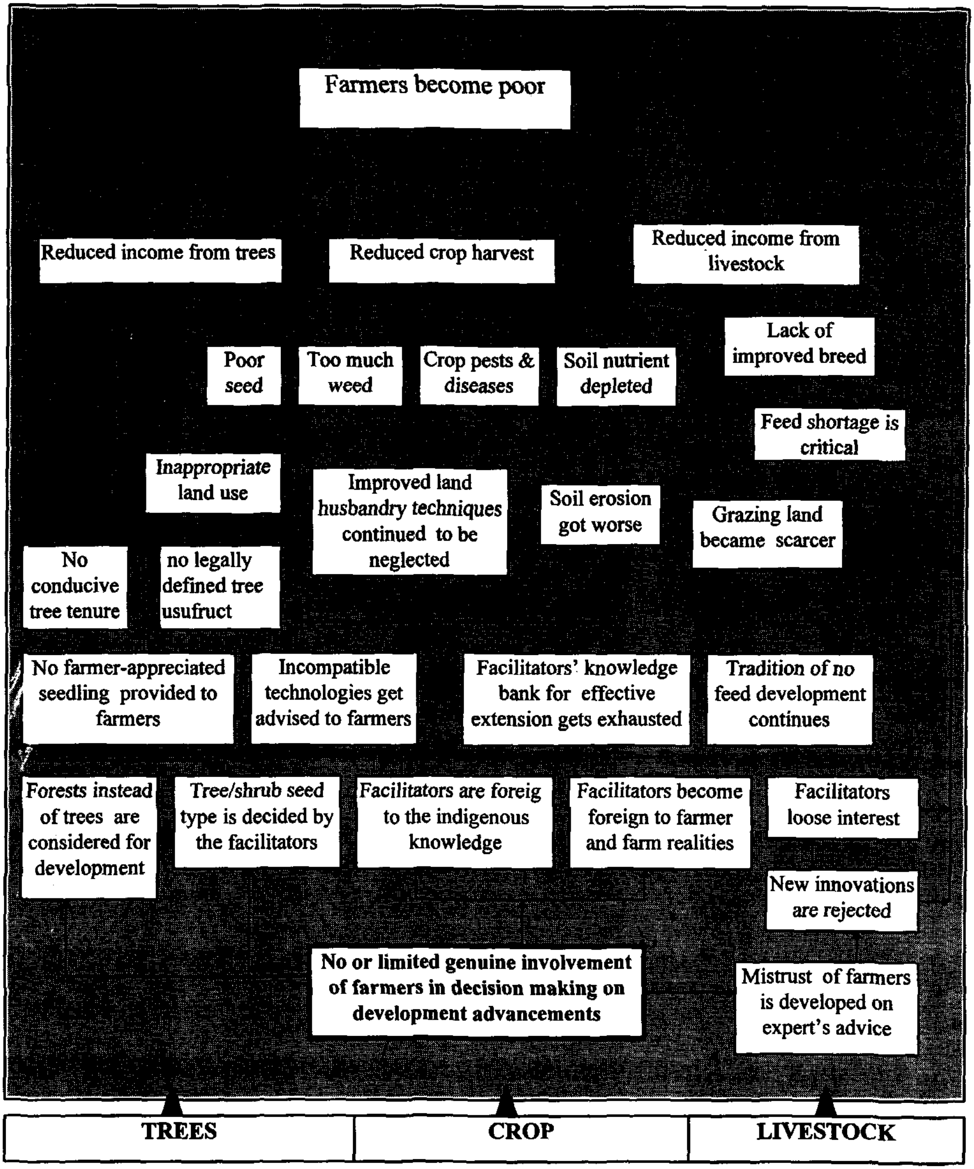


Figure 7.1 *The problem tree of farmers of Tikurso catchment*

After having gained insight in the population characteristics (Table 7.3), farmers' problems have been studied in line with their production sources. The *problem tree* (Figure 7.1) that indicates the cause and effect relationship of the problems of the study area is developed in a socioeconomic diagnosis exercise. The *problem* depicts the prevailing development circumstances and community development trends in the study area. The finding is substantiated by the information obtained from the questionnaire interview (OD). It is equally true to on-farm discussion (OD) methods. In the PRA workshop, farmers indicated that there are three sources of income on which they aspire to increase production. These are:

1. cropping,
2. livestock keeping and
3. tree/shrub development.

Crop production

Crop production is found to be the number one priority that accounts for 68 % of the family income. Such a strong dependence on cereal crop production has put even the non-cultivable lands under agriculture and worsened the erosion problem. Nearly 60 % of the farmers interviewed about the rate of annual productivity decrement indicated that agricultural land productivity declines by 5 - 10 % every year progressively. Farmers estimated that their agricultural land productivity has decreased by over 60 % from the time their parents used it. In the questionnaire interview, farmers listed seven causes for the decline. The significance percentage for each of the factors to the decline (Table 7.4) is calculated based on the number of farmers who listed each factor as compared to the total score obtained

Table 7.4 *Causes of crop production decline*

Causes of crop production decline	Contribution significance, %
Crop pests and disease	16
Low soil fertility	25
Poor seed	7
Shortage of rain	9
Untimely excess (erosive) rain	18
Weed	19
Wild animals	6
Total	**100**

As indicated in the problem-tree, there are a number of crop production issues that need development of either technological or extension and input supply. In addition to the above stated problems in crop production, farmers are only interested in selected types of crops that are appreciated for food consumption and cash earning (Table 7.5).

Table 7.5 *Priority food and cash crops of farmers of Tikurso catchment*

Food crops	Significance, %	Cash crops	Significance, %
Barley	9	Coffee	17
Maize	6	Maize	7
Millet	3	Onion	10
Others	7	Others	12
Sorghum	31	Red pepper	10
Teff	41	Sorghum	18
Wheat	3	Teff	26
Total	100	Total	100

Among the many of these crop production issues that are indicated in the problem tree, only those that have direct linkage with soil erosion are considered in the detailed socioeconomic assessment.

Livestock production

On the average, there are 5.4 heads of livestock (Table 7.6). Cattle and goats account for 90 %. Livestock production accounts for 17 % of the family income and serves as bank for depositing the family's surplus cash. Livestock keeping is traditional. The major constraints that are identified are scarcity of grazing land, feed development know-how and poor livestock breed. According to the *problem tree,* the problem emanated from limited involvement of farmers in decision making on development advancements. Farmers have mistrust on the facilitators' advice for they do not believe that they are for farmers' betterment.

Table 7.6 *Livestock holding at Tikurso and feed shortage priorities*

Livestock Type	Per household	Total in catchment	Priority rank in feed development
Cattle	2.5	275	First
Equine	0.3	33	Fourth
Goats	2.3	253	Second
Sheep	0.3	33	Third
Total	5.4	594	

The facilitators appeared to continuously loose interest for working hard for the farmers who discredit their contributions. By tradition, man is not expected to grow livestock feed except by looking for supplement feed such as scum of local brewing and crop residue only for plough oxen and lactating cows in dry months. Therefore, farmers' neglect of advice on new innovations resulted in persistence of this '*no feed development*' tradition.

Compounded by the shortage of grazing land, livestock feed becomes in short supply and income from livestock continues to deteriorate.

Tree/shrub development

Income from tree/shrubs account for nearly 9 % of the family income. The remaining 6% of farmers' total income is due to *Rhamnus prenoides* which makes the total income contribution of trees and shrubs 15 %. The desire and potential for tree/shrub production, as indicated by farmers, are at least three times more than actually produced.

Similar to crop production, the tree/shrub development problem stems from limited involvement of the farmers in decision making for development advancements. Farmers cite that facilitators are more in support of communal plantations as opposed to individual tree developments around agricultural fields. Trees and shrub seeds are chosen by facilitators without the consent of the farmers and seedlings are distributed to farmers if they are in excess of those needed for project plantations or if the type of seedlings are undesirable for project plantations. Limited farmer-appreciated seedlings are raised and distributed to farmers. Compounded by unappealing land and tree tenure as well as tree usufruct, farmers have planted less trees than they could have planted. The economic potential of tree development remained untapped and misappropriation of tree production areas for agriculture continue to contribute to land degradation.

In the PAA the above indicated method of species selection is substituted by veritable involvement of farmers. The species selection criteria come from the farmers and their rate of importance is determined by them. The ten most prevalent factors, on farmers' preference, and their contribution in selection of species are presented in (Table 7.7).

By using the identified selection criteria during matrix ranking exercise, 13 important tree/shrub species, whose selection score is over 50 % compared to the total list of nominated species, are identified (Table 7.7). Six of these farmer-preferred species are raised for use in the implementation of the agroforestry interventions in crop lands while two others are raised and planted in silvopastoral lands of the study area. Due to time limitations of the study, no effort has been made to identify the type of nurseries (farmer-group, village, etc.) to be established and administered by the farmers of Tikurso catchment.

The tree and shrub species that ranked as 9th and 10th are planted by the individual farmers who have their land in the research fields while those ranking 1st, 5th and 6th are not planted. This indicates that community-level species prioritization can be different from individual level preference and rankings and justifies that adapting catchment-level prescription to farm-level situations is essential. The list of species and their associated preference rank is used as a general indicator of facts on the species. However, species selection of individual farmers for the implementation is conducted during adaptation of plans and prescriptions for implementation (Chapter 10). Then, farmers are encouraged to make their own preference and use every species they themselves approve of suitability. They discuss about the merits of prioritizing the preferred species in discussion with the help of the facilitator regardless of the rank the species decided during the catchment-level species ranking.

Table 7.7 *Factors of species choice by farmers of Tikurso catchment.*

Use categories and their respective use significance in %		**Use value of each species (out of a maximum of four) graded against 10 use categories of different use significance**												
		An	Ce	Ca	Cm	Ec	Eg	Es	Gr	Mf	Oe	Rp	Rc	Va
Cash earning quality	14	0	2	3	2	3	3	2	3	4	3	4	0	2
Positive cohabitation	13	4	4	3	3	0	0	4	3	4	3	4	4	4
Construction use	12	1	3	4	3	4	4	3	3	4	4	2	0	2
Resistance to harsh climatic condition	11	4	2	2	2	3	3	4	3	3	4	4	3	4
Fuelwood use	10	4	4	3	3	4	4	3	3	3	4	4	2	3
Fodder quality	9	3	0	2	0	0	0	4	2	4	4	3	0	4
Soil improvement use	9	4	4	3	3	0	0	3	2	4	2	4	4	3
Farm implement	8	2	2	2	3	3	3	4	2	4	4	2	0	4
Mulch use	8	2	2	4	4	0	0	4	3	4	2	3	4	4
Home use	6	2	2	4	4	3	3	4	2	4	4	4	4	3
Weighted total score in %	100	65	65	75	66	51	51	85	67	95	87	86	50	81
Priority rank		9	9	6	8	10	10	4	7	1	2	3	11	5
Planted in research fields			xx		xx	xxx	xxx	xx	xx		xx	xx		

Key:

An	*Acacia nilotica*	Gr	*Grevillea robusta*
Ce	*Casuarina equisetifolia*	Mf	*Millettia ferruginea*
Ca	*Cordia africana*	Oe	*Olea europea*
Cm	*Croton macrostachys*	Rp	*Rhamnus prenoides*
Es	*Ehretia cymosa*	Rc	*Ricinus communis*
Eg	*Eucalyptus globulus*	Va	*Vernonia amygdalina*
Ec	*Eucalyptus camaldulensis*		
xx	integrated into crop fields		
xxx	planted in homesteads, and non-agricultural lands		

The use of PAA for success in soil and water conservation is a means by which farmers are attracted via the production roles of the agroforestry developments. Soil conservation is benefiting from the spin-off of conservation potentials of agroforestry interventions. In addition, application of PAA envisages the use of agroforestry components (trees and shrubs) for strengthening physical soil conservation measures whose weaknesses are realized to be 'frequently-collapsing'. In this regard, agroforestry development interventions are mere integration of physical soil conservation measures with perennial crops on farms. This, in turn, necessitates studying the dilemmas of farmers for not integrating trees and shrubs into their farms (Table 7.8).

Table 7.8 *Barrier to integration of trees into farms and respective significance in %*

Barrier	**Significance, %**
Shortage of potted seedlings	14
Lack of seedlings of own preference	13
Land tenure	13
Conflict with other crops	12
Land shortage	11
Tree tenure	11
Protection from livestock	7
Gestation period of perennial species	7
Government tax	6
Labour shortage	6
Total	100

In addition to the fear that farmers have on integrating trees into farms, studying why farmers are not adopting and maintaining the introduced soil conservation measures gives the basis for updating the physical soil conservation measures to their liking. Therefore, the basic reasons why the farmers of Tikurso catchment do not use soil and water conservation measures on their fields and why they have obliterated them instead are studied. The ten most obvious reasons are presented in Table 7.9.

Table 7.9 *Reasons for not using introduced soil conservation measures on farms*

Major barriers	**Significance, %**
Occasional collapse of conservation structures	14
Poor quality of the conservation structures	13
Land tenure	13
Obstruction in farming operation	11
Space consumption	11
No appreciated benefit	10
Lack of know-how	8
Labour problem	8
Shortage of material inputs	7
Harboring rodents	6
Total	100

On the other hand, farmers are observed struggling with indigenous soil conservation structures whose outcomes are not satisfactory in the farmer's own judgments. It is believed that their efficiencies could be improved through share of knowledge between farmers and the facilitators. Hence, a study on indigenous soil conservation skills of farmers and their shortcomings is conducted. The findings are exhibited and are discussed under Section 7.3.

7.3 Indigenous soil and water conservation skills

The study on indigenous soil conservation skills of farmers revealed that there are a great number of technologies. A brief account of each of the indigenous technologies, in order of importance, is presented in the following paragraphs and an overview given in Table 7.10.

Kab is a local term for traditionally built physical structure from a pile of stones on a farm. Its purpose is to let a plot develop into bench by arresting the sediment in run-off so that the slope of the plot is reduced and soil and moisture are conserved better. It is a stone wall of 50 - 100 cm width and its height depends on the slope gradient of the land. Traditionally constructed *Kabs* are as tall as 1.7 meters. *Kab* is used on gentle to very steep sloping lands. The steeper the land the taller its height would be. Traditionally constructed *Kab*s are widely spaced but tall in height. It has problem of alignment along the gradient. It is not continuous and has no uniform spacing. It collapses frequently and is tiresome to repair.

Dinber is a local terminology for a farm-level ridge in the form of a strip that is developed from an unploughed piece of land for obstructing sediment movement. Though it has significant potential for arresting soil erosion on flat to gentle sloping lands, its potential is not effectively tapped. The way traditionally used, *Dinber* has problems of alignment and continuity. Its discontinuity obviously results in accumulation and channeling of flooding water in the middles of farm plots. Traditionally constructed *Dinber* is frequently collapsing and non-uniform in size. It is usually covered with runner- and stoloniferous grasses. Such grasses become troublesome weeds to farmers.

*Golenta*s are traditional cut-off-drains that are locally used to divert excessive runoff from uphill sources, e.g., from lands owned by a number of farmers or from uncultivated bare land. Their route used to be decided on by the local elders whose advisory decisions have been respected by the community members. Their construction was made possible by human labour, which was mobilized by the community elders. Their construction involved huge and more than necessary excavation. Farmers recall that the major problems were collapsing and their development into huge gullies and flood channels. This is due to excessive gradients used at the time of construction. The other problem is their occasional collapse. The latest *Golenta* construction is 30 - 35 years old. Young farmers have abandoned constructing them due to absence of agreement on their route by neighbouring farmers. This is again due to lesser recognition of local elders in extension work by the current extension staff. *Golenta* is a catchment-level soil conservation technology of which the benefits are realized by the farmers who could easily observe the amount of flood it diverts towards a waterway during peak rainfall periods. The technology could effectively revive if elders are involved in the extension process. Additional actions to be taken are on its technical perfection.

Boi is a local terminology for a traditional drainage furrow that is used to drain excess water from farm plots during peak rainfall periods. Each indicate boundaries in broadcast sawing. In addition to their draining purposes, farmers use them to determine the boarder lines of the weeding and harvesting strip that would be accomplished at any one go. Almost all farmers use the technologies on their cultivated fields. The problem associated to this technology is the gradient. Almost always, it is constructed perpendicular to the contour lines and ends up in having a smaller catchment area for draining.

Fereka is another indigenous means for decelerating soil fertility deterioration by which farmers try to use different soil profiles at different seasons by seeding their crop fields with crops of different rooting depths. Normally in the study area, *Sorghum vulgare* is alternated with *Eragrostis teff* and the same crop is not grown more than twice in consecutive seasons on the same field. The major problems of the practice are that high value crops could not be grown continuously. On the other hand, even when the practice is required, agreement for growing similar crops between neighbouring farmers is required. Else, protection of crops such as *Sorghum vulgare* against pray such as birds, becomes very difficult.

Fig is a local terminology for all livestock excrement. It could be decomposed or not. Farmers knew for generations that animal excrement could serve as fertilizer. They pile such excrement at their backyard and transport it to fields after decomposition. Farmers do not know that organic biomass such as weeds and other leafy vegetation could be used in preparing organic fertilizer. Hence, there is no much to take to fields. Secondly, backyards are far from the cultivated fields and transporting manure used to be problematic. Therefore, only homesteads used to be treated with manure.

Maker is a local terminology for an indigenous soil conservation measure by which soil fertility replenishing leguminous crops such as peas, beans, chickpeas, lentils etc. are grown when farmers realize soil fertility of the land has terribly declined. The problem in *Maker* is a seasonal conflict with the major crop and protection from wild animals and the humans who are eating them in the field.

Ribrabo is local terminology for an indigenous soil conservation measure by mulching with branches of trees/shrubs. Mulching is a traditional moisture retention and soil fertility enhancing measure in the area. Traditionally, it is the piling of leafy and readily-decomposing branches on land's surface. The most preferred species used in mulching are *Croton macrostachys*, *Millettia ferruginea* and *Justicia schimperiana*.

Gorf-metlefia are literally known as flood traps. They consist of branches of vegetation plugged into side outlets of streams, gullies and rills in order to trap and sieve off the sediment that is coming with the flood. It is used to stop eating away of land by gullies, rills and streams. Successful farmers use the sediment traps to reclaim lands that were once devoid of their good soil cover by erosion. First, vegetation branches are scattered all over the depressions on which the flood is to cross over and the sediment is to be trapped. When the flood comes in, the sediment gets intercepted. The water drains through the vegetation mat leaving the sediment behind. Gradually, the vegetation becomes buried underneath the trapped sediment. The success depended on the resistance of the trap against the flood force. Only few farmers used to succeed in it. Summary of the associated benefits and problems of each of these indigenous land-constraint mitigation technologies is presented in Table 7.10.

Table 7.10 *Indigenous soil conservation measures, benefits and problems, Tikurso, Ethiopia*

Local technology of indigenous soil conservation measures	Benefits	Problems
Kab	• Obstructing transportation of sediment and eroded soils	• No continuity • Improper alignment • Frequent collapse due to steep slopes and plow interference • Harbouring rodents • Being weed source
Dinber	• Obstructing eroded soils and transportation of sediment.	• Non-continuity • Improper alignment • Frequent collapse due to plow interference • Poor quality • Being weed source
Golenta	• Diverting excess water from flood source areas	• Lack of mediator for negotiating between farmers for getting proper route, • Irregular and excessively steep gradient • Frequent collapse
Boi	• Draining without causing soil erosion	• Gradient • Alignment
Fereka	• Improving soil fertility	• Obstruction of growing the same high valued crop season after season
Fig or manure	• Improving Soil Fertility	• Decomposition • Far distances between site of origin (backyard) and site of application (farms)
Maker	• Improving soil fertility	• Lack of seed and interference with major cropping
Ribrabo or Mulch	• Retaining moisture and increasing soil fertility	• Decomposition • lack of mulching material
Gorf-metlefia or ***Flood trap***	• Trapping sediment from floods	• Fixation and size estimate

7.4 Conclusions

The socioeconomic assessment reveals a great deal of important information that serves as an input to environmental assessment and planning. According to the findings, there are basically three sectors of development which are concerns of the farmers in Tikurso. Therefore, agroforestry innovations require to address these three sectors of development. Among these three development sectors, crop development is the one that is given the highest priority in planning agroforestry development. Many of the factors that inhibit productivity are related to extension which is difficult to be addressed by improved designs alone. However, the soil fertility problem that has a land potential grading contribution of 25 % (Table 7.4) can be tackled, to a certain extent, by the agroforestry interventions to be planned.

The emphasis on feed development also indicates that cattle and goat feed (grass and browse feed) maximization deserves attention in the planning (Table 7.6). The tree and shrub component of the agroforestry system can also benefit substantially from the socioeconomic findings. The species domain is fixed (Table 7.7). The problem of tree integration into farms (Table 7.8) can be remedied by playing a true facilitator role. At the same time, the findings demonstrate that the success in tree development on farms is dependent on policy-related environments that are beyond the control of the facilitator and the farmers. Conducive land and tree tenure as well as tree usufruct and government taxation can be created by policy makers only. For suggested solutions, refer to policy recommendations in Chapter 14.

The findings on the soil and water conservation measures (Table 7.9) delivers important clues to many of the questions related to previous failures in the rehabilitation efforts. It also presents various possibilities of approaching the problem in the use of agroforestry for soil conservation. Avoiding collapsing of conservation structures, improving the quality of the conservation measures, avoiding serious obstruction problems of the structures in the design of the measures, etc., are all that can be addressed in good design. All these are input to the planning and implementation sub-process of the PAA (Chapters 9 and 10).

The socioeconomic assessment has also indicated that land qualities can be graded by slope, soil depth and soil fertility parameters that are acknowledged by the farmers in Tikurso. Such a finding is an input to the participatory environmental assessment (Chapter 8). At the same time, the assessment has indicated that there are a number of indigenous land constraint mitigation technologies, which can be used in mitigating land constraints. Such shortcomings can be improved by combining the farmers' knowledge with the facilitators' knowledge during the planning phase (Chapter 9).

CHAPTER 8

ENVIRONMENTAL ASSESSMENT

During the socioeconomic assessment, it has become evident that farmers practise an environmental assessment and land quality grading. This is substantiated by the existence of native terminology for each of the land quality grading factors.

1. Farmers say *Ye-kola* land (lowland), *Ye Weyna-dega* land (mid altitude highland) or *Ye-Dega* land (highland), etc. for classifying lands by agro-climatic zones. Such zoning is highly determined by differences in altitude (Figure 1.2). This is mainly in view of the possibility of growing certain crops or trees.
2. They classify land qualities by water logging conditions too. Farmers distinguish lands as *Yechekeye* (damp), *Arenqoa* (soggy), *Naniga* (swampy) and *Eregreg* (water logged).
3. They say a land is *Kulkulet* (steep), *Gedel* (very steep), *Zebata* (gentle) and *Meda* (flat). The farmers consider a given land as only fit for hoe-cultivation and perennial crops while the other may be fit for oxen-drawn all in line with their slope gradients..
4. The same is true to soil depth. According to the local terminology of the farmers, *Yegechere* means shallow, *Dilb* means deep soil. They value land qualities in terms of soil depth and associate crops of different root length accordingly. Even among cereal crops, in very shallow soils, farmers grow chickpeas and lentils and *Eragrostis teff* instead of sorghum or corn that root relatively deeper.
5. They also rate the quality of a given land by its fertility status. By using their own terminology, they grade a land as *Wojed* (fertile), *Chorenke* (infertile), and *Boda* (very infertile). They allocate different agricultural crops based on their local land capability ratings. They even attach different price tags for lands which possess different combinations of such land quality attributes.

The difficulty in each of the above parameters is that the class boundaries are not distinct. Farmers do not have a systematized method of assessment either. Still, the very existence of the local terminology itself indicates that farmers perceive such kinds of land characteristics. The fact indicates that farmers could easily discern environmental assessment and land potential grading if the environmental assessment is measured by factors that farmers have already been using in their land quality grading. Such an environmental diagnosis facilitates farmers' agreement in appropriation of agroforestry interventions in accordance with the productivity potential of their land. Having such local knowledge-based environmental assessment commitment in mind, four key environmental assessment issues are considered. These are:

1. getting familiarized with the site
2. discerning the site limitation / potential situations in terms of indigenous land quality assessment characteristics.
3. realizing the relative land potentials of the site and precautions that are necessary for considerations in allocating it for a certain use and
4. comparing the current land use in accordance with the existing land potential and differentiating issues for consideration in better land use appropriations.

8.1 Getting familiarized with the site

The environmental assessment job started by getting familiarized with the history of the site as witnessed by the farmers themselves. It started by conducting a field reconnaissance and boundary certification of the research site with the community elders and other adjoining farmers. Oral information (Box 8.1) from the local elders indicates that the research area has lost most of its previous vegetation type and quality, major wildlife and productivity. Soil conservation efforts had been there but are disliked by the farmers.

Box 8.1
Historical description of [illegible] catchment

In the youth time of a 80 years old elderly informant, the study area was covered with varied natural forest species. The upper part was covered with species of *Juniperus excelsa, Hagenia abyssinica, Ekebergia capensis, Mimusops kummel, [illegible], Syzygium guineense, Podocarpus falcatus, Acacia abyssinica, [illegible], Olea europea* and many other valuable species that are not available at this time. In fact one of PA community "*Woyra-amba*" meaning the area of Olea, got its name after the (then) abundant Olea europea species. This was uniformly the same to neighbouring [illegible] ... [illegible] hardly see them this date.

According to the informant further, the lower area down to Shoa Robit was covered with *[illegible], Croton macrostachyus, Terminalia brownii, Strychnos innocua, Maytenus arbutifolia, Dodonaea angustifolia, [illegible], Rhus natalensis, Rhus vulgaris, Carissa edulis, Acacia tortilis, [illegible]* etc. They used to harbour a number of wild animals. Thus, no one could walk alone and without a weapon in the area in fear of these wild animals especially such as the cheetah, leopard and the lion. In the valleys, even the elephants used to come periodically. Presently, only the baboons remain. In those years, the informant further indicated that agricultural lands gave very good yields, [illegible] got fed very easily. But the informant admits that he did not notice when all these [illegible]. Currently, farmers in the study area [illegible] tell that what they have now is nothing [illegible]. Every piece of land is being cultivated but no satisfactory yield is [illegible].

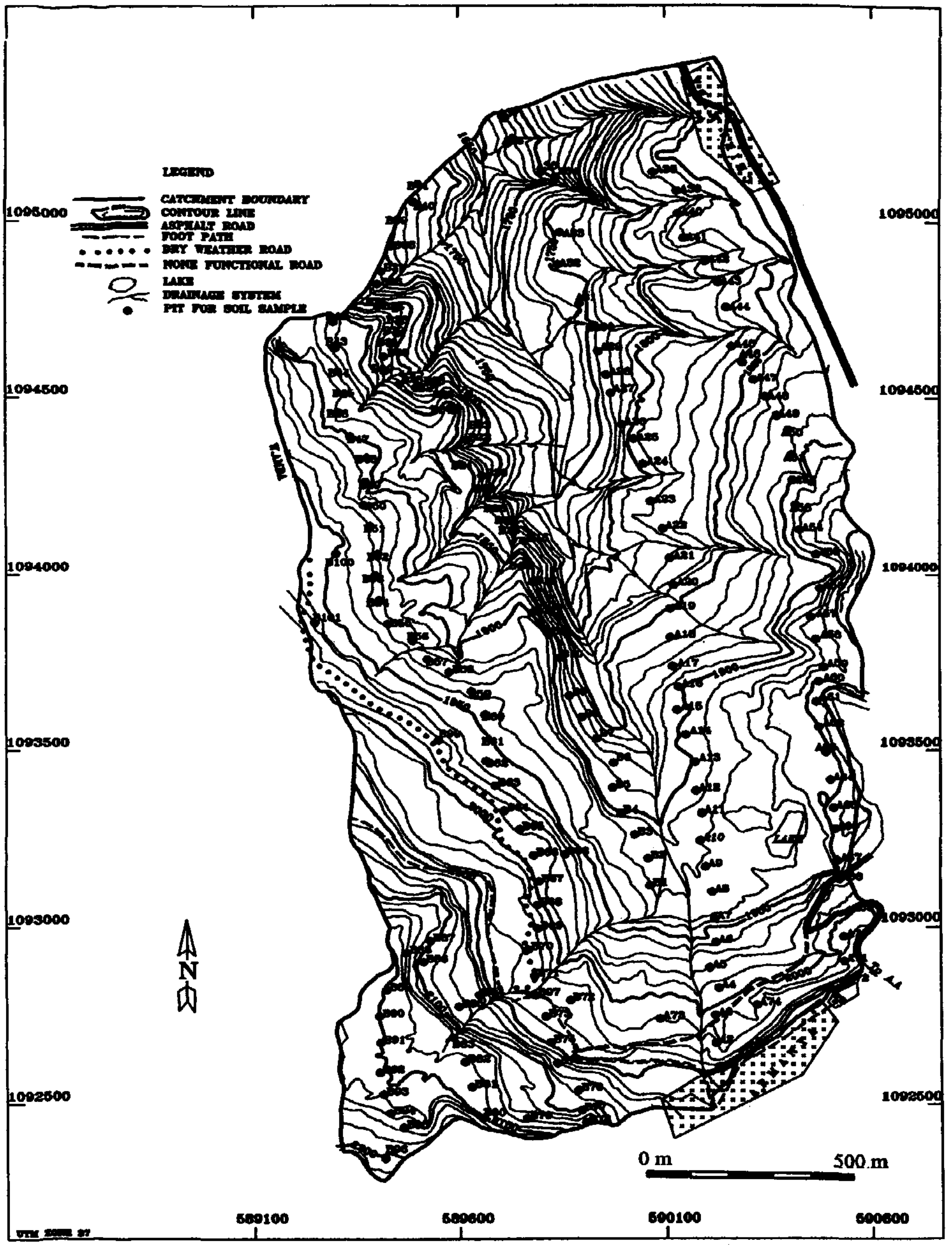


Figure 8.1 *Topographic (contour) map of Tikurso catchment. The dots indicate sampling locations.*

A preliminary understanding of the physiographic conditions (Figure 8.1) and aspect situations (Figure 8.2) is established during the site reconnaissance. As experienced at Tikurso catchment, the introduced soil conservation structures and plantings are obliterated by farmers because they do not believe in the technology due to a number of barriers that were discussed in detail earlier (Chapter 7).

During the subsequent site reconnaissance period, a topography survey has been conducted and soil samples were taken for laboratory assessments. Figure 8.1 is the result of such a topographic survey. The map indicates the location of the 175 soil sample collection, soil depth measurement and land use sampling spots. Following the field reconnaissance and surveying, an in-depth familiarization with the site is established with the help of 3-dimensional view and the shadow map. The maps are used for getting a general picture of the site at office level and they save efforts to try to physically visit every micro site.

The computer-processed aspect map (Figure 8.2) indicates the general picture of the area which is most exposed to before noon, afternoon and mid-day sunshine. Hence, the 1 : 2 500 scale aspect map helps in recommending proper orientations of the tree/hedgerow lines that do not cast much shading by the trees/shrubs in much of the day to the adjoining crops. The same information is used to know the most appropriate location of shade-demanding and shade-tolerant species as compared to expectedly tall growing trees/shrubs.

The Topographic, 3-dimensional view and shadow maps hint that the topography is ragged and soil erosion threat is severe. The aspect map indicates that very few areas are flat and almost all of the site faces east and west. In general, the finding indicates that the shadowing effect of north to south aligned tall growing components of the agroforestry intervention alleys can cast serious shadow on the adjoining crops and care is required.

8.2 Site limitation versus potential

The limitations and potentials of the site as rated by indigenous land quality grading variables are key factors that are used to illustrate production possibilities and soil erosion threats to farmers. Therefore, examining the agro-climatic zone, soil depth, soil fertility, slope and water logging conditions (land quality rating factors that farmers perceive easily) of a given site becomes vital. The assessment on each of these factors unravels important information on the quality of the physical environment.

Elevation

Information on altitude helps to advise on aggregates of tree/shrub, agronomic and fodder crops. Crops and trees that grow in *Kolla* do not grow effectively in *Dega* or *Wurch* zones of various altitude ranges. But, the study area is limited to the *Weyna-dega* agro-climatic zone and variations of crops are not substantial. However, in few instances, making distinctions by altitude is still essential. For instance, *Eucalyptus camaldulensis* that would effectively grow in the lowest altitude zone of *Weyna-dega* zone (1500 -1800 m a s l) does not effectively grow the upper region of the same zone (2000 - 2300 m a s l). The opposite is true to *Eucalyptus globulus*. In the lower altitude section of the catchment, barley does not grow. *Juniperus excelsa* is not frequent. The types of fodder grasses are not identical to those that grow in above 2000 m altitude. In order to perceive the possibility of allocation of the different plants of farmer and farm-preferences in space, an elevation class map of the study area (Figure 8.3) is produced. This map is used for framing crop and tree/shrub choices for a given farm in accordance with the range of altitude it belongs to. This is especially essential in developing adapted farm-level plans for implementation (Chapter 10). More than 62 % of the research sub-catchment is situated in the mid-altitude highlands. About 20 % of the land (towards the southern part) is situated above 2000 m altitude. Less than 18 % of the land (towards the north) is found below 1800 m altitude (Table 8.1).

Table 8.1 *Land size distribution of the research site by elevation classes*

Altitude in meters above sea level	Land size	
	Hectare	%
> 2000	67	20
1800 - 2000	210	62
< 1800	60	18
Total	337	100

The assessment result on elevation indicates that the whole of the study catchment is suited for *Rhamnus prenoides, Cordia africana, Eucalyptus grandis, Croton macrostachys, Grevillea robusta, Milletia ferruginea, Olea europaea, Ricinus communis*, and *Vernonia amygdalina* of the species that are appreciated by the farmers (Table 7.6). The lower and mid sections of the catchment are additionally fit for *Ehretia cymosa* and *Eucalyptus citriodora.* The lower section is additionally fit for *Acacia nilotica, Eucalyptus camaldulensis* while the uppermost section is additionally fit for *Eucalyptus globulus.*

Slope

The contour map (Figure 8.1) which is produced with contours at 5 m verticals and on a 1 : 2 500 scale is digitized to build a digital terrain model (DTM). The DTM is then used as a basis for the production of the *Slope map* (Figure 8.4). The result of slope analysis (Table 8.2) indicates that only 1 % of the development land is within a slope range of 0-2 % or is *flat to very gently sloping* (FAO, 1990).

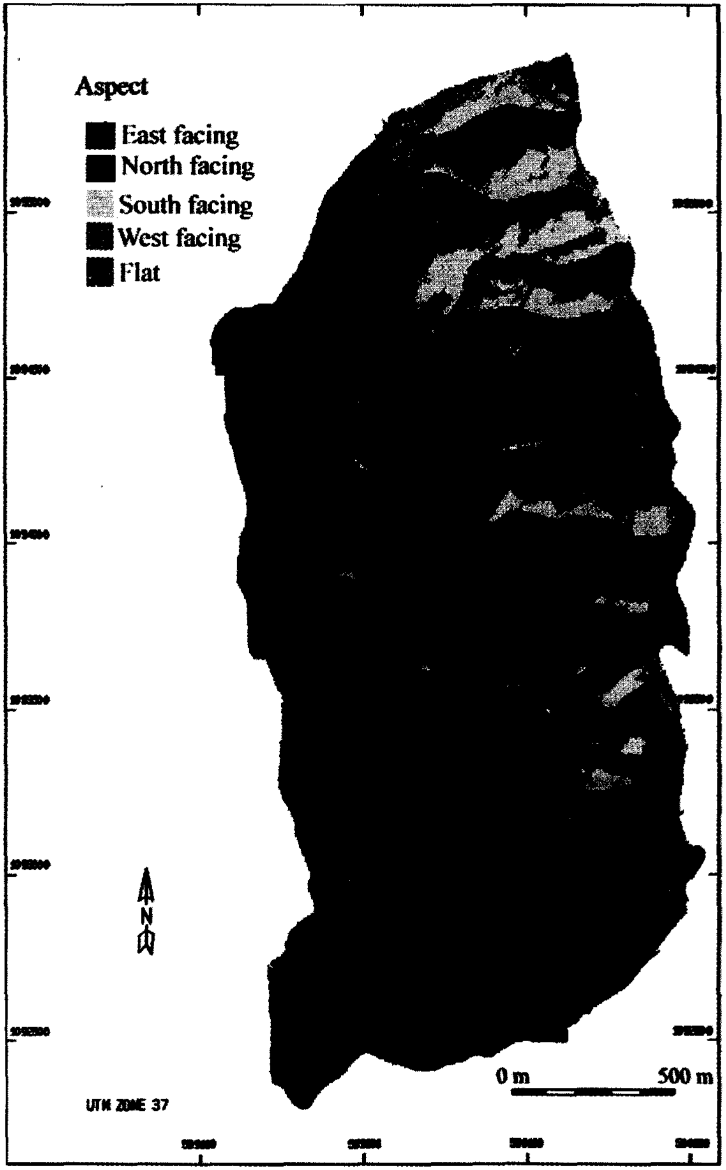


Figure 8.2 *Aspect map of Tikurso catchment*

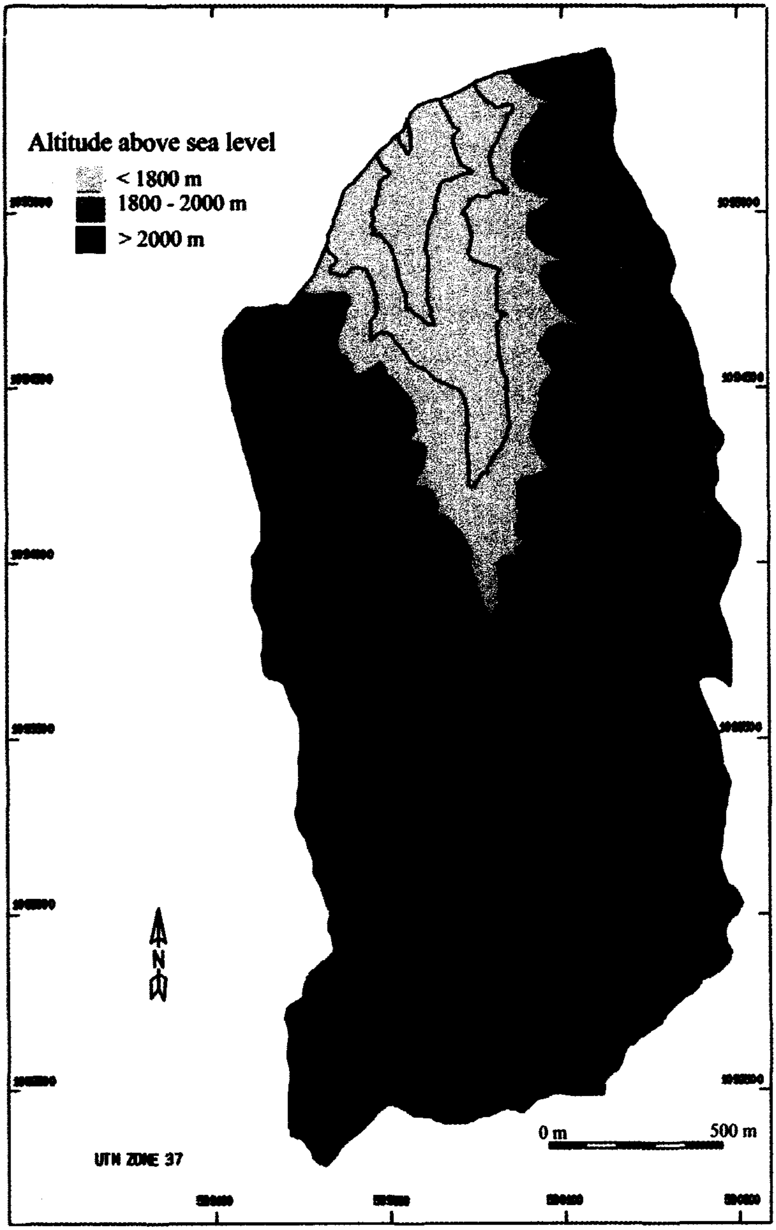


Figure 8.3 *Elevation map of Tikurso catchment*

Lands that are rated as gently sloping (2 - 5%) are less than 2 % of the study site. Hence, the size of land where biological soil conservation measure alone can be effective (< 5 % slope) is less than 3 %. In addition, the size of land which is rated very steep (> 60 %) comprises 19 % of the study area and is undoubtedly out of cultivation. Hence, nearly 97 % of the study area requires intensive soil conservation care.

Table 8.2 Land size distribution of Tikurso catchment by slope range category

Slope range , %	Area coverage		Associated discription
	Hectare	%	
0 -2	3	1	Very good
2 - 5	7	2	
5 - 15	57	17	
15 - 30	105	31	Good
30 - 45	67	20	Moderate
45 - 60	34	10	Poor
> 60	64	19	Very poor
Total	337	100	

The slope assessment indicates that production is heavily constrained by slope. If slope alone is considered as a sole decisive factor in determining land use, only 50 % of the study site or the land with slopes < 30 % can be allocated for agriculture (FAO, 1990). However, it has been evident in the study site that farmers cultivate (hoe cultivation) lands even in excess of 60 % slope. Survey results further indicate that more and more marginal lands are becoming agricultural lands. Therefore, extending the land to be allocated for cultivated crops up to 45 % slope and using more intense and effective soil conservation measures is preferred. Slope map (Figure 8.4) is produced in a scale of 1 : 2500 so that field discussions with farmers become more discernible.

Soil depth

The soil depth at the research site attests that soil erosion has been serious. The area of land rated as extremely shallow in FAO soil depth classification (< 10 cm) is nearly 15 % (Table 8.3). If very shallow depth (20 -- 30 cm) and shallow (30 -- 50 cm depth) lands are to be excluded from cultivation, only about 30 % of the area qualifies for cultivation (FAO, 1990). However, in practice, farmers in the study area are cultivating lands as shallow as 10 cm soil depth. There is no law and order that prohibits farmers from using such very shallow lands either. The endurable solution is using lands as shallow as 20 cm for agriculture and forestry and intensifying the soil conservation measures as appropriate. This is made possible through discussion, mediation and compromises.

Table 8.3 *Soil depth status of the Tikurso catchment*

Soil depth		Area		Associated
Cm	**Description**	**%**	**Hectare**	**land quality rating**
< 10	Extremely shallow	15	51	Extremely poor
10 -- 20	Very shallow	11	37	
20 -- 30	Very shallow	12	40	Very poor
30 -- 50	Shallow	31	105	Poor
50 -- 70	Moderately deep	11	37	Moderate
> 70	Moderately deep to deep	20	67	Good
Total		100	337	

The result on soil depth diagnosis further indicates that only less than 20 % of the catchment area has soils deeper than 70 centimeters. Considering only soil depth as a determinant factor, the size of land which is not useful for agriculture and forestry (< 20 cm soil depth) accounts for 26 % of the catchment. If lands of 30 -50 cm soil depth are to be allocated for agricultural production, extra ordinarily intensive soil management and conservation measures would have to be deployed. The soil depth diagnosis also indicates that using deep rooted perennial crops would be possible in only 20 % of the catchment area whose soil depth is at least 70 cm. The soil depth map (Figure 8.5) is produced in scale of 1: 2500 so that field discussions with farmers becomes more discernible.

Soil fertility

At Tikurso catchment, the availability of total Nitrogen (N) ranges between 0 % (no soil) to 0.33%. The land that accounts for a total nitrogen content of > 0.2 % is only 10 % or 34 hectare. More than 75 % of the land contains less than 0.13 % total nitrogen in the soil. The area of the catchment that accounts for 0.13 -- 0.2 % of total Nitrogen accounts for 15 %. When rated in terms of the judgment presented in Sterner (1987), only 10 % of the research sub-catchment meets the medium nitrogen fertility requirement (0.2 -- 0.33 %) indicating that Nitrogen deficiency is uniformly a serious constraint in the catchment (Table 8.4).

Available Phosphorus (P) content of the soil ranges between 0 (no soil) and 97 ppm (parts per million). However, 99 % of the research watershed contains land with an available Phosphorus content of less than 20 ppm. More than 70 % of the catchment area consists of available Phosphorus of less than 5 ppm. Based on the rating presented in Steiner (1987), 96 % or nearly 324 hectare of the research sub-catchment is poor in Phosphorous indicating that almost all the catchment area is deficient in Phosphorous content.

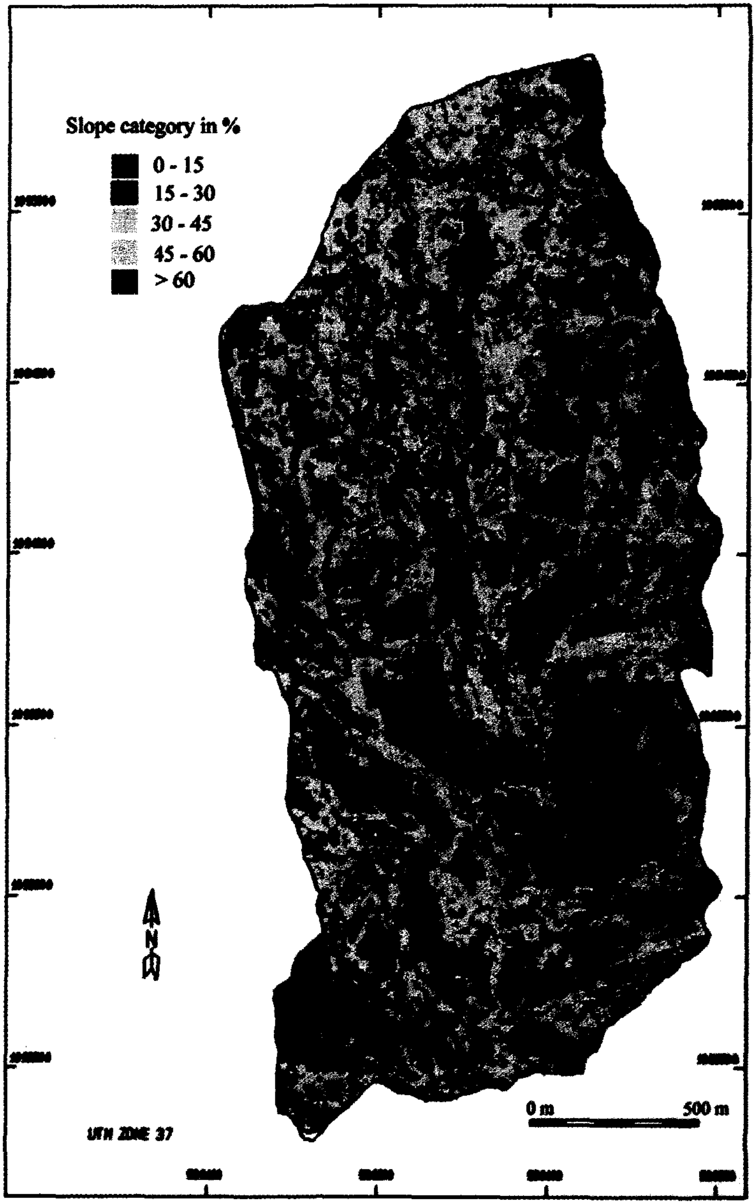


Figure 8.4 *Slope map of Tikurso catchment*

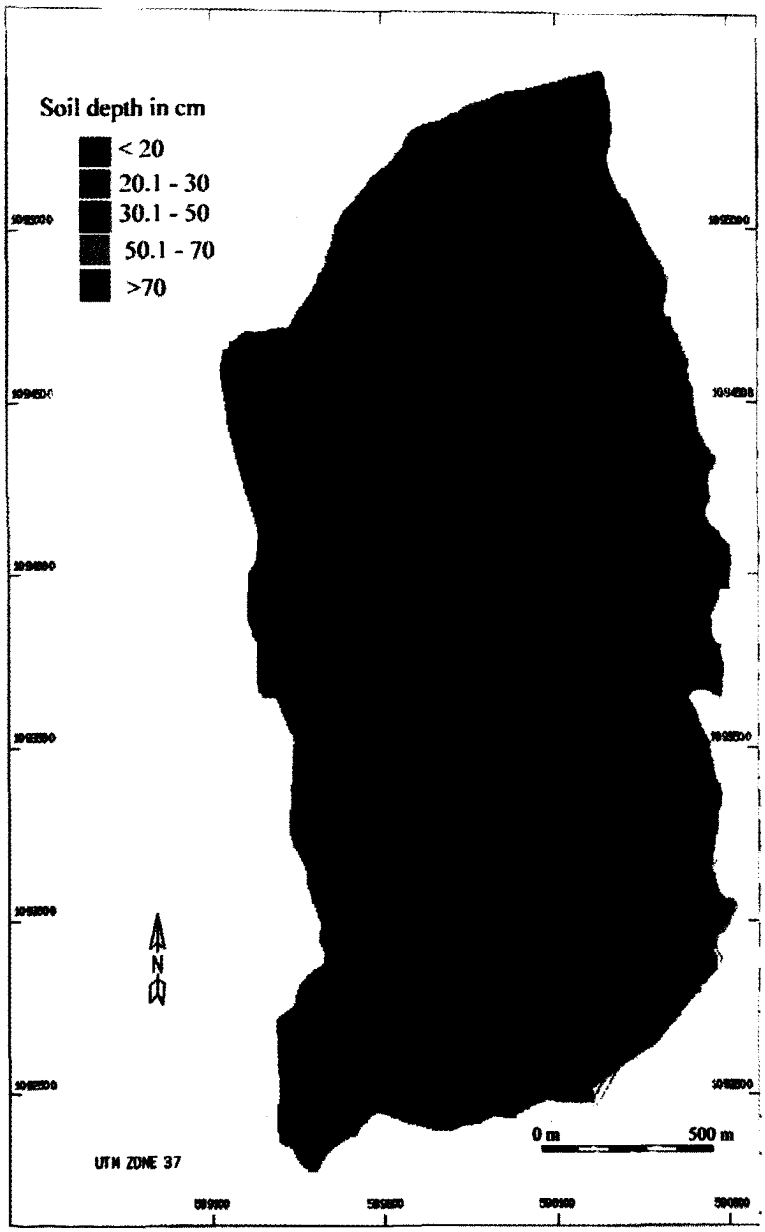


Figure 8.5 *Soil depth map of Tikurso catchment*

Table 8.4 *NPK content of soils in Tikurso catchment*

Nitrogen (N) content and area coverage			Phosphorus (P)			Potassium (K)		
Content, %	Coverage, %	Hectare	ppm	%	Hectare	ppm	%	Hectare
0.00 - 0.07	27	91	0 - 5	73	244	0 - 250	54	182
0.07 - 0.13	48	162	5 - 10	15	51	250 - 500	14	47
0.13 - 0.20	15	51	10 - 15	8	28	500 - 1000	27	91
0.20 - 0.27	7	24	15 - 20	3	11	1000 - 2000	1	4
0.27 - 0.33	3	9	> 20	1	3	> 2000	4	13
Total	100	337		100	337		100	337

The available Potassium (K) content of the soil in Tikurso catchment ranges between 0 (no soil) and 3085 ppm. Though few sites exhibit the higher values of K, more than half of the research watershed contain less than 250 ppm. The total area of land that contains less than 1000 ppm available K is more than 95 % or 320 hectares. Chemical reaction and microbial activities in the soil are largely governed by the soil's acidity which is best reflected in its pH value. Hence, soil samples collected from 175 sample stations of the research watershed were analyzed for pH values. The result ranges from pH 6.8 to 7.9 (Appendix B) indicating that the soils in the watershed are slightly alkaline. More than 76 % of the area is in the range of 6.7 to 7.0 indicating the possibility of poor drainage (had the slope been conducive) and suggesting the possibility of accumulation of alkaline earth carbonates as constraints.

Table 8.5 *Organic Carbon, pH and cumulative soil fertility status of Tikurso catchment*

OC			pH			Fertility		
Availability in soil , %	Distribution in catchment, %	Hectare	Range	%	Hectare	Quality	%	Hectare
0.00 - 0.74	21.5	72.6	6.78 - 7.00	76	257	Ext. Poor	25	83
0.74 - 1.48	46.3	155.8	7.00 - 7.23	15	54	V. poor	29	98
1.48 - 2.22	19.4	65.5	7.23 - 7.45	6	19	Poor	24	82
2.22 - 2.95	8.5	28.5	7.45 - 7.68	1	3	Moderate	18	60
2.95 - 3.69	4.3	14.6	7.68 - 7.90	2	6	Good	4	14
Total	100	337		100	337		100	337

In general, it can be concluded that the catchment is extremely poor in its soil fertility status. The cumulative result from the fertility diagnosis shows that nearly 78 % of the research area is poor to extremely poor in fertility status. Lands which are said to be fairly fertile (relatively good) are only 4 % (Table 8.5). If there is anything to be done in alleviating such a chronic fertility problem, all the areas require it. Therefore, soil fertility could not be used to sub-divide the catchment area into agroforestry intervention planning units that require soil fertility enhancement action at varying intensities. The soil fertility map (Figure 8.6 on page 108) is produced only to initiate discussion with the farmers and illustrate how the fertility issue is critical throughout the catchment area.

8.3 Current land use versus land potential

According to the socioeconomic assessment and field survey results on current land use, (Table 8.6), 40 - 48 % of the site is already under cultivation. Still, more cultivable land is in great demand indicating that the cropping limit in future planning needs to be pushed beyond the normal 30 % slope limit. The land use assessment by QI method indicates that, on the average, farmers allocate 48 % of their land for cropping, 30% for grazing, 6% for forestry and 3% for home-garden. The estimate for land that is excluded from agriculture, forestry or grazing use is 14 %. According to this diagnosis's result, the total catchment area is 374 hectares. Please realize that that the difference in the total area estimates (337 and 374 hectares in Table 8.6) is the result of an error that occurred due to farmers' area judgments and gross conversion of local area measurements into hectares. According to findings from the ground survey (Figure 8.7 on page 109), the land allocated for cropping is 41 % while the land allocated for grazing is 25%. Land area allocated for forestry/plantation is 12%.

The percentage of badly eroded bush and shrub land as well as the waste land constitutes 17% and 5% of the total catchment area respectively (Table 8.6). To this end, the catchment is being used extensively exempting only the 5 % of the catchment which is covered by exposed rocks and / or is extremely steep cliff.

Table 8.6 *Current land use / land cover/ of Tikurso catchment*

Land use type	Topography survey		QI survey	
	%	Hectare	%	Hectare
Cropping land	41	138	48	180
Bush and shrub land	17	40	--	--
Forestry/plantation	12	17	6	23
Grazing land	25	84	29	108
Out of use	5	58	14	52
Home-garden	--	---	3	11
Total	100	337	100	374

Ninety five percent of the catchment is in use in one form or another. Except those lands that are indicated as 'waste lands' that do not have soil at all, all the other lands are being used either to graze livestock, collect fuelwood and or grow food crops. Cultivation is conducted without consideration of land quality determining variables. If there is any soil that can support the growth of crops even on temporarily basis, the natural vegetation is cut and burnt. The land is cultivated and the crops are grown on it. In few years time the soils are washed down. The forest/plantation sites are those planted by *food-for-work* program. For most of the case, relatively good lands that could have been allocated for cultivated crops are used.

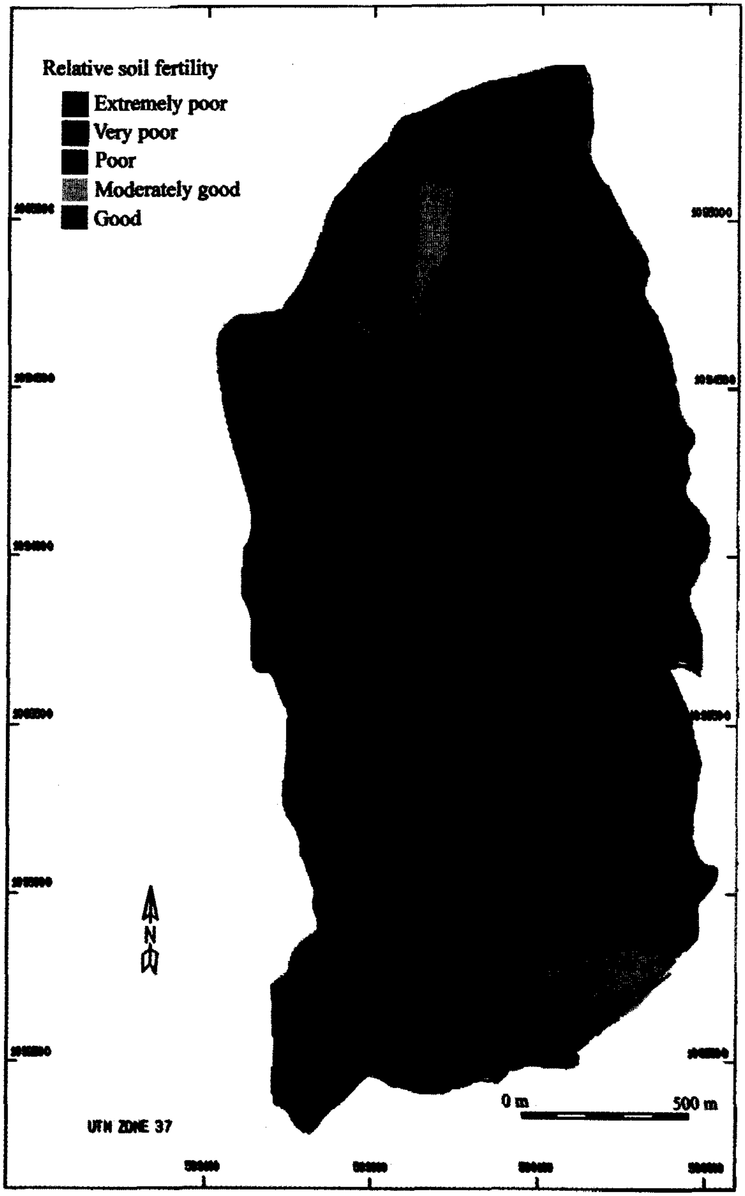


Figure 8.6 *Spatial distribution of soil fertility status of Tikurso catchment.*

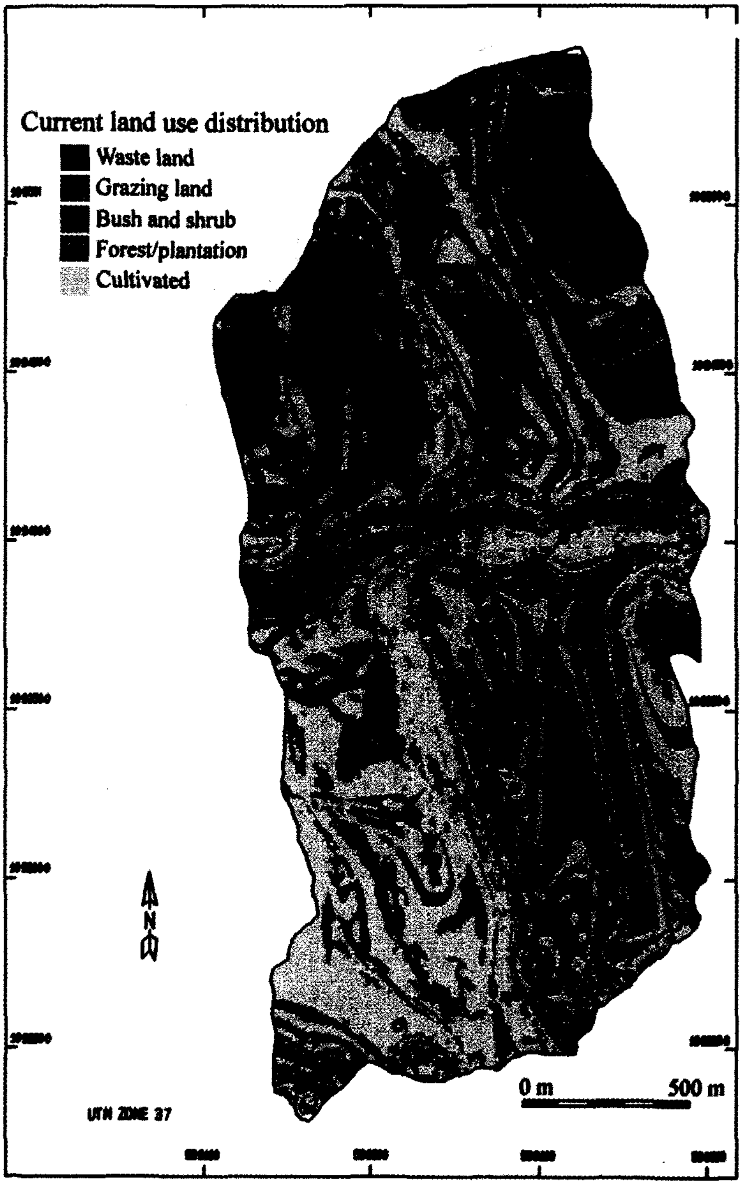


Figure. 8.7 *Current land use(land cover) map of Tikurso catchment*

The peasant association (locally perceived only as executive committee members of the PA) own the plantations. Therefore, the plantations are miss-handled by the people at large. They are cut and destroyed at nights.

The bush and shrub lands are the major sources of fuelwood for the community. They are common access lands and are mainly situated in very steep slopes. Not quality or well grown tree occurs in these bush and shrub lands mainly because they are repeatedly cut and used by the almost every one in the community. Only those patches which are by the boundary of the cultivable lands are owned by the farm owners and are better cared. The grazing land are no different in treatment. They are grazing lands only for the cattle to stay on. They do not have any feed crop except for few weeks after every rainy season. Only those patches which are by the boundaries of the cultivable lands are owned and protected by the farm owners mainly when there is crop on the cultivated lands. If the crops are harvested, post-harvest grazing is allowed on every body's land.

In contrast, from the cumulative effect of soil fertility, soil depth and slope conditions of the catchment areas, the land potential assessment has resulted in that only those lands with land quality rating of good and moderate (Table 8.7) are cultivable. Therefore, the total cultivable land size in the catchment is only 28 %. These are the lands that are within slope range of less than 30 % and soil depth of at least 50 cm. The relative land potential assessment is made by the application of *ILWIS-GIS* software and the general application procedure indicated in Figure 4.1 on page 60. The spatial distribution of the lands of various potential classes of the Tikurso catchment is presented in Figure 8.8 on page 111.

Table 8.7 *Relative land potential status of the study area*

Land quality rating	Land size in catchment	
	%	Hectare
Good	2	7
Moderate	26	88
Poor	26	88
Very poor	29	98
Extremely poor	17	56
Total	100	337

From the comparison of the existing land use and land potential situations, it is evident that the problem lies in the mismatch between the currently cultivated (41 %) and what is cultivable area (28 %) of the total catchment (Table 8.7). The same is true for the total land being used and the total land that can tolerate any use. Even when only soil depth is considered as a limiting factor (excluding < 20 cm soil depth lands from any use), the amount of usable land becomes only 74 % (Table 8.3). This is significantly opposed to the current land usage of 95 % (Table 8.6). However, the reality compels to make a compromise between the current land use and the available land potential. The case is acknowledged to be confronted in the planning sub-process of the approach (Chapter 9).

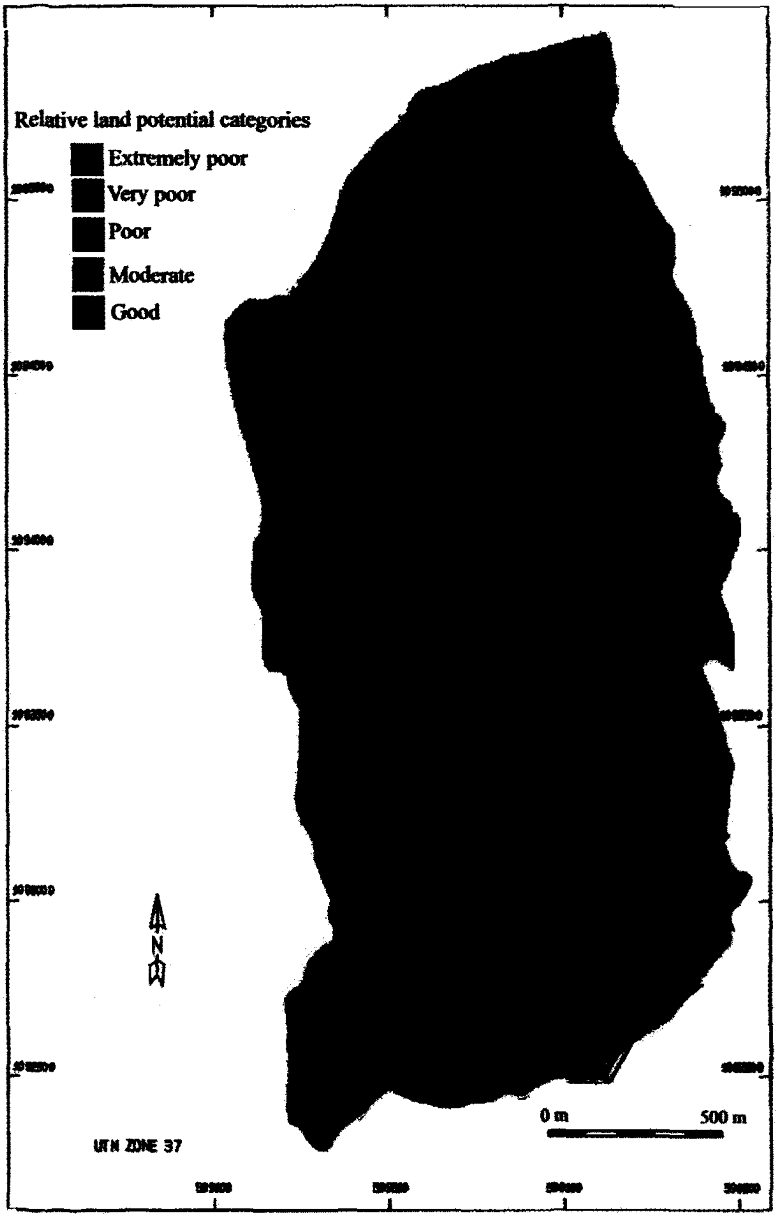


Figure. 8.8 *Land potential class map of Tikurso catchment*

8.4 Lessons learned

The environmental assessment indicates that the study area has a number of limitations and constraints. Throughout the catchment, soil fertility is uniformly limiting. This indicates that many planning units (for Tikurso case) can not be defined by soil fertility ranges. At the same time, the assessment results indicate that all the agroforestry interventions need to aim at maximizing soil fertility.

The slope condition assessment indicates that slope heavily constrains land use in the catchment. At the same time the catchment area is sparsely distributed over the lowest to the highest slope ranges. Hence, various planning units can be defined on the basis of the ranges of the slope gradients.

When coupled with the unavoidable cultivation of steep slopes by farmers in the catchment (Chapter 7), the environmental assessment finding implies that durable soil conservation measures that do not collapse easily under such steep slope conditions are critical issues in future technology prescriptions (Chapter 9). When this fact is viewed in line with the problem of frequent collapsing of soil conservation structures which is identified by farmers as a barrier to use of soil conservation measures by farmers (Table 7.9), the fact strongly recommends that establishing well strengthened soil conservation structures is a formidable priority. The spread of cultivation in steeper slopes further indicates that narrowly spaced soil conservation structures are required. But this contradicts with farmers' interest in widely spaced structures where obstruction in plowing is reduced. Therefore establishment of structures which are widely spaced and at the same time tall in height become necessary. The tall height of soil conservation structures in such steep slopes further fixes the focus on strengthening the structures. Prescriptions on soil conservation structure strengthening attributes are topics of Chapter 9.

Another area of interest in the environmental assessment work is soil depth. The overall soil depth condition of the catchment area is poor. Loosing more soil is not affordable. When compounded with the grave soil fertility problem, the finding implies that effective soil conservation is crucially essential. Though the range is limited, the existence of noticeable soil depth difference entails that there can be few planning units that can be defined by soil depth parameters. Soil depth differentiation is especially important in agroforestry interventions which involve integration of annual crops, trees and shrubs whose rooting depth is variable.

The overall environmental assessment result reveals that the physical environment is challenging. Therefore, thoughtful, far-reaching and accommodating technology aggregate, design and implementation of agroforestry interventions need to be prescribed for correcting such tenacious land productivity limiting factors. Hence, the benefits of environmental assessment culminate at the production of an indicative land-potential class map (Figure 8.8) that evinces the degree of limitation of each factor. The result serves as an input to planning and technology prescriptions treated in Chapter 9.

CHAPTER 9

PLANNING AGROFORESTRY INTERVENTIONS

9.1 Orientation to circumstances

Planning is conducted at catchment-level in discussions with a group of farmers who have been continuously involved in socioeconomic diagnosis and environmental assessment. In the discussion forums, 12 of the innovative farmers, 2 community elders, 1 *Idir* leader and 1 church leader are involved. Other farmers who happen to be interested in the planning discussions are also allowed to participate. However, planning is conduced in continuous rounds of discussions that are held when at least 50 % of the members in the discussion forum are present. One of the innovative farmers is also a PA secretary who could as well represent the executive committee of the local PA.

The plan started by establishing a firm orientation about the existing development circumstances of the catchment among the planning team members. In this orientation discussion, the objectives of the agroforestry planning are presented to the discussants by the facilitator. The socioeconomic issues and facts are reiterated in that farmers of the Tikurso catchment crave for maximizing yields from their land. Their desires include increased cattle feed and wood development for domestic consumption. Each of the production desires has associated problems. By combining the farmers' knowledge with the scientific knowledge, recommendations for mitigating technologies are prepared by the facilitator for discussion and approval (Table 9.1).

It is further understood that the farmers at the catchment area are poor who have an average annual income of only 1300 Birr (US $ 200). From the social diagnosis it is further realized that only selected trees and shrubs are of farmers' interest and their values differ by land use. For instance, the appreciation for *Eucalyptus camaldulensis* differs when it is envisaged to be integrated in crops from when it is to be planted in woodlot development sites.

The possibility of growing food crops appears to be limited within the moderate to good production potential lands that cover about 95 hectares or 28 % of the total area. Furthermore, except the almost negligible (2 %) of the area that falls under relatively good potential, all the remaining areas which are assumed to be capable of crop production require intensive conservation measures. In addition, the current crop land usage (41 % in Table 8.3) includes those lands poor in soil fertility.

In the orientation discussion, it is further realized that farmers would like to increase the size of the agricultural land by converting the remaining environmentally fragile bush/shrub land and grazing lands into agricultural land. Their production desire is growing short duration crops on those lands. Prohibiting them from doing it can not be successful. Instead, technologies that could mitigate production constraints of the land would have to be planned and implemented. Therefore, the interventions to be recommended require to take into account the reasons of farmers for not applying soil conservation measures on their lands too.

To approach reality, a number of compromises are made. The uniformly limiting land quality grading variable is excluded and land use appropriation is decided to be determined only by soil depth and slope bounds (Figure 9.1 and 9.2). In addition, all lands of greater than 20 cm soil depth and less than 45 % slope are considered for cultivation. After such compromises are made, the total cropping land becomes 59 %.

In the planning discussion, the planning team has also realized that inclusion of marginal lands of slope 30 - 45 % and soil depth of 20 -50 cm requires subdividing such lands into different intervention planning units and subjecting them to different conservation and production intensities. Therefore, studying possibilities of production with their associated problems and problem mitigation possibilities become essential (Table 9.1).

In contrast with the benefits of integrating trees/shrubs with food crops, farmers' fear about the negative influence of trees on the adjoining annual crop (Table 7.8) is discussed. It is realized that careful consideration of selected tree and shrub species based on farmers' species preference and consideration of the solutions that could maximize positive cohabitation between tree/shrub and annual crops are needed. The fact that farmers are not interested in controlling soil erosion if the ultimate outcome is not an immediate increase in productivity is given due consideration. Thus, the general belief in the use of agroforestry for conservation is to let conservation benefit from the spin-off of the production potential of the agroforestry practice.

The information about the mismatch between the current land use and land potential in the catchment is discerned. The common socioeconomic and site potential facts under which circumstances the plan is to function and the issues that the planned agroforestry interventions are intended to address, are presented and discussed at this orientation forum. The discussants are additionally informed about the fact that 96 % of the catchment is deficient in soil fertility. Few of the facts and issues pertaining to the planning of the catchment are common to all of the intervention categories while others are specific to selected intervention categories. The general facts and issues that apply to the entire site and the farmers of the study area suggest the following.

- Developments need to target at maximization of short-term and diversified income
- Food crop production is the outstanding priority of farmers
- Production of wood for own energy supply and fodder for livestock are in the second most priority
- Positive cohabitation between the species of the agroforestry components is required
- Soil fertility is severely limiting production

From the potential side, it is realized that 67 % of the total population can be included in the work force (Table 7.3). Possibilities of appropriating the local technologies for effectively mitigating productivity constraints are discussed. Important adaptations are made to each of the technologies in this participatory discussion form (Table 9.2),

Table 9.1 *Development issues of farmers', associated problems and mediated solutions*

Production desires	Associated problems	Problem mitigation possibilities
1. Maximizing agricultural land	• Slope limitation • Soil depth limitation	• Application of indigenous knowledge-based slope mitigating technologies. • Making slope extremes slightly relaxed • Making soil depth boundaries slightly relaxed • Applying effective soil conservation measures
1. Maximizing short-term income	• Long gestation period of perennial plants • Feed shortage for livestock keeping • Lack of initial capital	• Introducing cash value shrubs which could be harvested in short rotations • Enhancing feed development such as grass covered bunds and fodder shrub lines • Various kinds of incentives that contribute to availability of initial capital (see Recommendations)
2. Increased yield from farms	• Soil depth limitations • Soil fertility limitations • Continued nutrient erosion	• Using moisture maximizing agroforestry interventions such as mulching, composting and strengthened *Kab*. • Using strengthened *Golenta* and *Kab*as well as cash value perennial shrubs that are good for conservation
3. Commercial tree production	• Cohabitation problem with adjoining crops • Unsecured tree tenure	• Using phenologically selected tree species which are known for positive cohabitation • Issuing conducive land tenure and tree usufruct policies
4. Enhanced feed development	• Lack of know-how in feed development, • Shortage of appropriate seed for feed crops • Grazing land shortage	• Audio-visual aided feed development demonstration on methods and possibilities of improved feed development • Using feed value tree and shrub species appreciated locally

After a detailed discussion on each of the issues, consensus is established for establishing planning units that are defined by slope and soil depth parameters. In addition to the slope and soil depth characteristics that are pertinent to each of the intervention categories, the production objectives of each of the intervention areas are defined by the socioeconomic and environmental facts and issues. Each of the developed interventions take into account specific environmental and socioeconomic issues that are identified in the participatory environmental assessment and participatory socioeconomic diagnosis work respectively. Each of the intervention categories has its own environmental and socioeconomic issues.

9.2 The plan

The actual planning started by reviewing the site in terms of slope and soil depth conditions. Discussions are held at the compound of the Institute of Development Research (IDR)-center which is fortunately located at an observatory position for the research site. First, the 1 : 2500 scale slope map (Figure 8.4) is taken to such a lookout place of the catchment. Considering the lands in each slope class, as a planning unit, production, targets, limitations, limitation-mitigation experiences and possible interventions are discussed. The same is done by using the soil depth map (Figure 8.5) in a 1: 2500 scale in a subsequent session. Among the three farmer-understood and used land quality determining variables, soil fertility is not used in defining planning units because, in the case of the Tikurso catchment, nearly 96 % of the catchment is uniformly and severely poor in soil fertility. Therefore, based on discussion outcomes and the benefits foreseen, only soil depth and slope planning unit bounds have been readjusted for a composite planning unit definition.

Intervention bounds / **Area**	**Intervention components**						
	No physical measure		***Kab*+ Biological**	***Golenta* & *Kab*+ Biological**		***Golenta* + Biological**	
Coverage	**1 %**	**2%**	**17 %**	**31%**	**20 %**	**10 %**	**19 %**
Slope	**0-2%**	**2 – 5%**	**5 – 15 %**	**15 – 30 %**	**30 – 45%**	**45 – 60 %**	**>60%**
Soil Depth	**Intervention categories and their respective area coverage, %**						
>50 cm (31%)							
20–50 cm (43%)	Not valid for this catchment						
0 – 20 cm (26%)							

Figure 9.1 *Schematic presentation of intervention categories of Tikurso catchment*

By considering such new attribute bounds in the GIS application, an agroforestry intervention category map is produced to be used in planning interventions and prescribing intervention particulars. The sizes of each of these intervention categories is presented in an illustrative figure (Figure 9.1). Planning units that do not require physical soil conservation measures and those that require *Dinber*, *Golenta*, *Kab* and their combinations are discussed.

Table 9.2 **Indigenous land constraint mitigation skills, problems and introduced adaptations**

Technology	Associated problems	Introduced modifications (adaptations)
Kab	• Non-continuity • Improper alignment • Frequent collapse due to plough interference, lack of good foundation, poor material usage, etc. • Being weed source • Lack of construction material	• Training farmers in proper alignment of *Kab*s and providing graduated A-frames for maintaining contour alignments and continuity • Introducing excavation for the floors of the *Kab* foundations, and lining of the excavated floor with thorny and spiny coarse branches of vegetation (plate 9.2 On page 123) • Making gradation for the stones used in *Kab* building • Planting the under side of the *Dinber*s with fodder shrub or cash-value trees as appropriate • Planting single or double rows of cash-value shrubs as appropriate along the upper side of the *Kab* at one meter distance from the upper side of the *Kab*. • Substituting boulder size stones by *Aloe calidophyla (plate 9.3 on page 123)*
Dinber	• None continuity • Improper alignment • plough interference • Being weed source	• Training farmers in proper alignment of *Dinber*s and providing graduated A-frames for maintaining contour alignments • Planting the under side of the *Dinber*s with fodder shrub and establishing a 1 meter wide strips of non -runner and non-stoloniferous grass such as *Phalaris aquatica* and Gamba grass
Golenta	• Lack of mediator for negotiating between farmers for getting proper routes, • Irregular and excessively steep gradient • Frequent collapse	• Involving community elders in extension work that included mediating for proper routes • Training farmers and providing graduated A-frames for slope gradient adjustments • Having proper floor excavations, and constructing lower embankments with coarse vegetation which is laid over excavated foundations • Planting the under side of the *Golenta* with shrub or tree as the site quality allows
Boi	• Gradient	• Training farmers in proper alignment of drainage furrows with the help of the A-Frames
Fig	• Decomposition	• Demonstrating compost preparation to farmers • Mediation and strengthened social institution
Fereka	• Protection • Need for cooperation	• Mediation and strengthened farmer-cooperation
Flood trap	• Fixation and size estimate	• Introducing selective use of vegetation such as *Carissa edulis, Rhus natalensis* and other Acacia species that can maximize fixation of the physical structures to the ground • Pegging lower sides of the treatment areas to back up the pile of shrubs.
Maker	• Produce may not be competitively marketable	• Using byproducts for compost production and livestock feed to maximize income • Introducing leguminous crops in mixed farming instead of in 'maker'
Ribrabo or Mulch	• Decomposition	• Advising farmers about proper timing of mulching and additional species to be used.

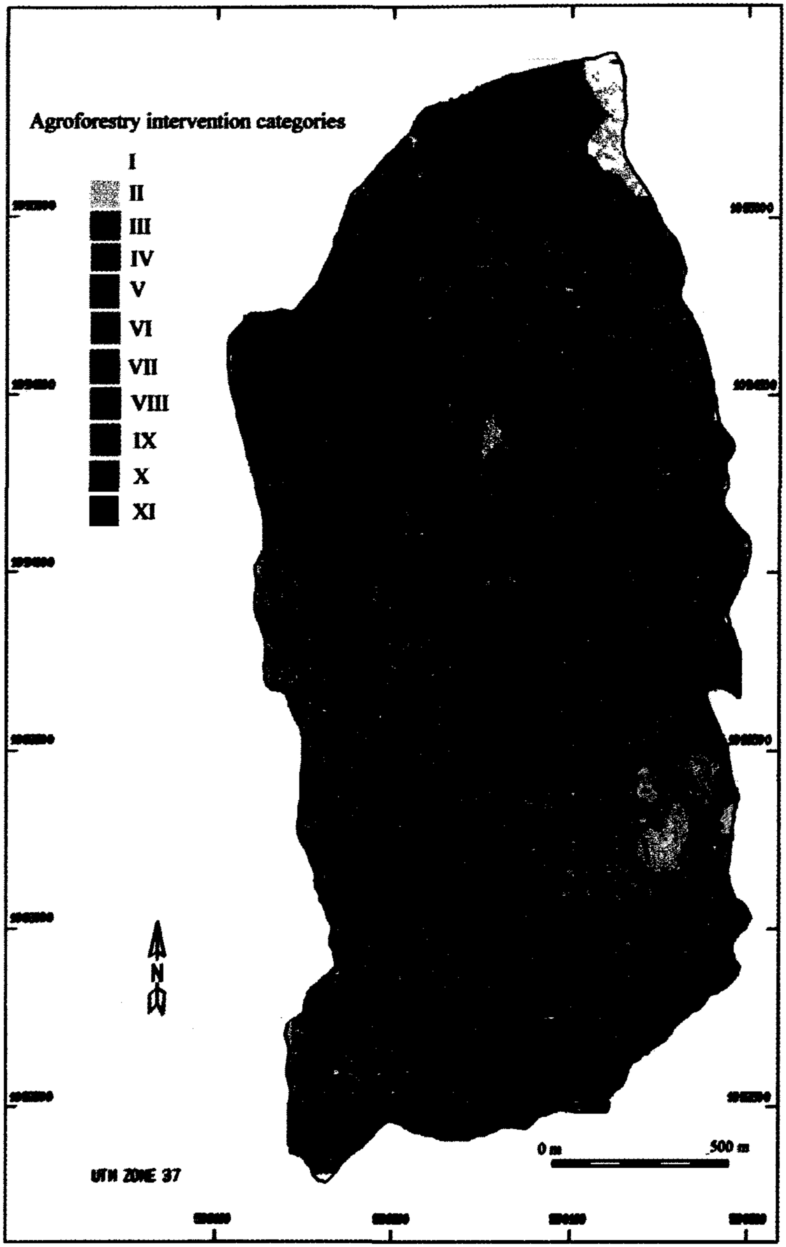


Figure 9.2 *Spatial distribution of agroforestry intervention categories defined for the Tikurso catchment*

The comprehensive planning units of the catchment as categorized by slope and soil depth cum physical soil and water conservation measures are developed (Figure 9.1) and their spatial distribution is indicated in Figure 9.2 on page 118.

At the following discussion forum, the agroforestry intervention category map (Figure 9.2) of the catchment which is also in 1 : 2500 scale is presented and explained by the facilitator. The map is used to illustrate spatial distribution of pieces of land of the various slope and soil depth categories. Discussant farmers associate each of the intervention category units on the map with the actual land situation at the ground. Production possibilities in each of the planning units are discussed in line with the general and specific facts and issues. Possibilities of using the indigenous site constraint mitigation skills of farmers are considered. The discussion forum has produced a set of negotiated prescriptions which are meant to address the issues that pertain to each of the intervention categories defined in Figure 9.1.

9.3 Plan prescriptions

In the plan prescription discussion forum, development aspirations of farmers, associated problems and meditated solutions are discussed. Indigenous soil and water conservation technologies and their problems are discussed (Table 9.1). The indigenous soil and water conservation technologies are adapted and modified for improved mitigation of site potential constraining facts. Such adaptation and modification discussions are conducted on facilitator-suggested possibilities and locally discerned innovations as applied to each of the technologies.

During the next discussion forum, facts and issues that are generally applicable and those that are specific to each of the planning units are concretized. Cropping limits and other land use possibilities as applied to each of the planning units are discussed. A prescription of modified technologies and combination of agroforestry components for each of the planning units is worked out. Such planning units of certain soil and water conservation technologies and prescribed agroforestry intervention components are identified as prescriptions of Agroforestry Intervention Categories (Table 9.3--9.6).

The components of each of the envisaged agroforestry development interventions, their arrangements and patterns of the mix between the components is exhaustively discussed and explained. Detailed attributes of the plan for each of the intervention categories are decided to be included as implementation guides (prescription). Prescriptions that are made for each of the agroforestry intervention categories (Table 9.3 - 9.6) are designed to address the general as well as the specific facts and issues that pertain to the appropriate intervention category. In addition the recommended technologies need to make the indigenous soil conservation skills their basis. The prescriptions indicated in Table 9.3 do not generally involve integration of built-up structures with trees and shrubs. However, in intervention category II, the trapping of sediment by a grass strip which is strengthened by a line of shrub planting would encourage the formation of an earth embankment locally called *Dinber* in the long run. The fact that trees are scattered minimizes farming operation obstruction that the farmers fear. As the components indicate, the prescription takes care of production of construction wood, fuel wood and feed along with production of food crops.

Table 9.3 *Prescriptions for agroforestry intervention categories that do not involve man made structural soil and water conservation measures*

Facts and Issues	Prescriptions
Scattered-tree integrated (I)	
• Shade and dry-season fodder are liked • Production of wood for own energy • Soil depth is not limiting	• Scattered-tree-based agroforestry intervention is prescribed. About 50-100 trees/hectare are planted. *Casuarina equisetifolia, Acacia nilotica, Grevillea robusta* are planted to guaranty positive cohabitation of the trees with cereal crops. Trees are pruned and pollarded during the peak growing season of the adjoining cereal crops. Soil fertility is enhanced by mulching at the start of the onset of rain and cultivation. Compost usage is encouraged.
Dinber **-based tree and shrub integrated (II)**	
• *Dinbers* collapse occasionally, have layout problems and are weed sources • Drainage furrows have layout problems • soil depth is not limiting • Sheet erosion occurs	• The agroforestry intervention is fodder-shrub cum cereal crop combination. *Dinber* is the indigenous soil conservation measure nominated for controlling sheet erosion. It is stabilized by seeding or sodding quality grass species that are not runners or stoloniferous. The alignment is adjusted to the contour lines by the help of A-frame instead of line levels that require more than one man that many farmers can not afford. Perennial grasses of good culm and palatability such as *Phalaris aquatica* and *Pennisetum clandestinum* are required to address the feed problem and conservation requirement. At their lower sides, all *Dinbers* are strengthened by fuelwood and fodder-value shrub/tree plantings. All *Dinbers are to be over*-topped by 75 - 100 cm wide grass strips. The *Dinber* are laid along the contour at 15 -- 20 m spacing. and are continuous in a farm. Trees/shrubs are planted at 50 cm spacing along the lower side of the *Dinber* continuously from edge to edge of the farm along its contour. Timely mulching and composting are stressed before the sheet erosion occurs during heavy rain showers especially in July, August and April.

Table 9.4 *Prescriptions of agroforestry intervention categories that involve only Kabas a structural soil conservation measure with accompanying biological measures*

Facts and issues	Prescriptions
Kab**-based shrubs and trees integrated (III)**	
• *Kabs* are acknowledged but collapse occasionally having layout and spacing problems • Excessively graded drainage furrows are widely used • Soil depth allows planting of deep-rooted crops such as trees • Sheet and rill erosion occurs during Big and Little rainfall	• Cash generating *Rhamnus prenoides* cum cereal combined form of agroforestry is recommended. Improved form of locally appreciated Boi and *Kab*are practiced. The gradient problem of drainage furrows is handled by slope adjustments. Kabs of 60 - 75 cm width are constructed in 10 - 20 m spacing and made durable by planting *Rhamnus prenoides* in a single row in about 50-100 cm distance along the upper side of the *Kab*and at 30-50 cm distance between plants in a row. In addition, cash value, construction -and fuelwood and mulch quality trees such as *Grevillea robusta, Croton macrostachys, Cordia Africana, Casuarina equisetifolia* are planned for planting in the lower

seasons	sides of the improved *Kab*s to strengthen them and remedy their collapsing problem. The *Kab* and its complementary tree and *Rhamnus prenoides* rows are continuous in a farm with their ends along the contour with slightly uphill curving ends.
***Kab*-based shrubs integrated (IV)**	
• *Kabs* are acknowledged but collapse occasionally having layout and spacing problems • Soil depth restricts planting of deep-rooted crops such as trees • Soil erosion occurs during the big rainy season • Land is highly sensitive to intensive cultivation	• *Kabs are made durable* by planting cash value *Rhamnus prenoides* in a single row in about 50-100 cm distance along the upper side of the *Kab*. In addition, the *Kab* is supported from the lower side by planting a row of fodder, fuelwood, mulch and farm implement value shrubs such as *Ehretia cymosa* at about 30 cm distance in a row along the lower side of the *Kab*. Mulching is conducted before the onset of big rainy season (*Kiremt*). The *Kab* are laid along the contour in 10 -- 20 m spacing. They are continuous from edge to edge of the farm along the contour with reparable crossings for the plough oxen.

Table 9.5 *Prescription of agroforestry intervention categories that involve Golenta and Kab with accompanying biological conservation measures (Eg. plate 9.1 and 9.2)*

Facts and Issues	Prescriptions
***Golenta* and *Kab*-based trees and shrubs integrated (V)**	
• Soil depth allows planting of deep-rooted crops such as trees • Its 15 - 30 % slope is encouraging erosion and shattering of physical measures • Soil erosion occurs during the big rainy season • Land is highly sensitive to intensive cultivation	The rows of the cash-value shrub to be planted along the upper side of the *Kab* are double and in a staggered fashion so that the barring effect of the shru*b* is maximized. The lower side of the *Kab*is planted with high quality tree species for providing support to the *Kab*and producing construction wood, fuelwood, farm implements and soil replenishment resources. The *Ka b*are laid along the contour at 20 - 10 m spacing. They are continuous in a farm. At 75--100 meter spacing, *Golenta* are constructed. The lower side of each *Golenta* is planted with trees. Their gradient are adjusted with the help of A-frames.
***Golenta* and *Kab*-based shrubs integrated (VI)**	
• Soil depth restricts planting deep-rooted crops such as trees • Slope is encouraging precedence of erosion and shattering of physical measures • Soil erosion occurs during big and little rainy seasons • Land is highly sensitive to intensive cultivation	Kabs are constructed along the contour, level in gradient, and at a spacing of 20 - 10 m. The steeper the parcel of the land the narrower the spacing becomes. In the upper side of the *Kab*, cash-value shrub is planted similar to Category V. In the lower side of the *Kab*, a row of fodder, fuelwood, mulch and farm implement value shrub species such as *Ehretia cymosa* are planted in about 30 - 50 cm distance along the lower side of the *Kab*. Mulching is applied during the rainy periods. In 75--100 meter spacing, *Golenta* are constructed. The lower side of each *Golenta* is planted with shrubs
Half plot cash-value shrub in *Kab*+ *Golenta* -based tree integration (VII)	
• Farmers still opt to use the land for cultivation • Soil depth does not restrict tree planting • Slope is encouraging erosion and shattering of physical measures. land slide occurs • Soil erosion occurs during big and little rainfall seasons • Land is highly sensitive to intensive cultivation	The strengthened physical conservation measures to be constructed are graded *Golenta* every 75 - 100 meters that are inter-spaced by strengthened *Kab*. Soil erosion is handled by *Rhamnus prenoides* except in that the lower side of the *Kab* planting is done with quality tree species instead of shrub species. When conditions allow, Agri-silvi-horticulture form of agroforestry combination is considered • Trees are planted along the lower side of each *Kab*. Along the upper side, 50 - 100 cm distance from the *Kab*, half of the plot is planted with rows of *Rhamnus prenoides*. The *Kabs* are laid along the contour in 6 - 10 m spacing. They are continuous on a farm, curved uphill at their ends.

Half plot cash-value shrub in *Kab+ Golenta* -based fodder shrub integration (VIII)	
• Farmers still opt to use the land for cultivation • Soil depth restricts planting deep-rooted crops such as trees • Slope is encouraging precedence of erosion and shattering of physical measures • Down movement of soil is substantial and land slide could occur • Soil erosion occurs during big and little rainfall seasons • Land is highly sensitive to intensive cultivation	• Occasional collapse of the *Kab*is avoided by strengthening it with *Rhamnus prenoides* along its upper side and useful fodder and farm implement value shrub such as this *Ehretia cymosa* planted along its lower side. Soil erosion threat is severe at this slope gradient and is mitigated by construction of strengthened *Golenta* at a spacing of 75 - 100 meters They are inter-spaced by strengthened and level *Kab*is practiced. The *Kab*are laid along the contour at 6 -- 10 m spacing. Furthermore, partitioning the plot between any two adjacent *Kabs* into cereal crop and *Rhamnus prenoides* farm is recommended. The *Rhamnus prenoides* planting is in a staggered fashion and always along the upper side . The lower side of the *Kab* is planted with quality shrub species but at a more closer spacing (25 - 50 cm). Shrubs are planted along the lower side of each *Kab*.

Plate 9.1
The arrengement of cash-value shrub (Eg. Rhamnus prenoides) above the Kab and fodder value shrub (Eg. Ehretia cymosa) below the Kab and /or Golenta is one major configuration when soil depth is limiting.

Plate 9.2
The arrangement of cash value shrub (Eg. Rhamnus prenoides) above the Kab and cash value trees (eg. Grevillea robusta) below the Kab and /or Golenta is another configuration tried at Tikurso.

Plate 9.3
In places where boulder size stones are not available for Kab construction, a line of Aloe calidophyla is substituted. Trees and shrubs are used to strengthen the the closely spaced Aloe in a similar fashion to the stone-built Kab.

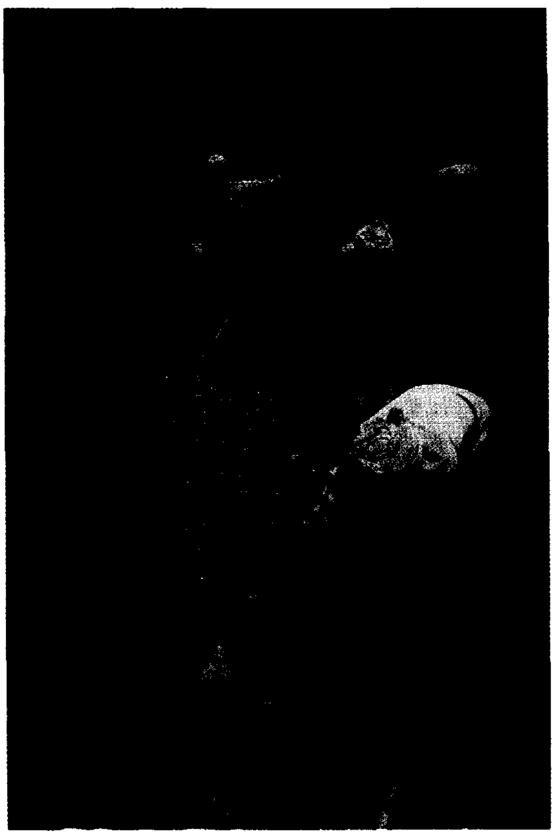


Plate 9.4
In order to give a firm foundation to the Kab, thorny and spiny shrubs (Eg. Caris edulis) are laid down in the excavated floor. The boulders are carefully built on the shrub. Rodent harbouring problems and slippage of the Kab are reduced.

Table 9.6 *Prescriptions of agroforestry intervention categories that involve Golenta alone as a physical soil conservation measures with accompanying biological measures*

Facts and Issues	Prescriptions
***Golenta -based* tree and shrub integrated Silvipasture (IX)**	
• Short-term and diversified production is appreciated. • Slope is encouraging occurrence of erosion and shattering of physical measures • Down-movement of soil is substantial and landslide can occur • Soil erosion occurs during big and little rainy seasons • Land is highly sensitive to use interference	• The site of intervention is distinguished by slope gradients of 45 - 60 % and soil depth of > 50 cm. The combination includes deep rooting quality tree species. Here too, a silvopastoral form of agroforestry sub-system is a nominee. • *Golenta s are* constructed at 75 - 100 m spacing. The lower side of the *Golenta* is supported by a line of trees that are spaced at 0.5-1.0 m distance between one another. In between the *Golenta* , trees are planted in approximately 1.5 meter by 1.5 meter spacing which is narrower than the MoA standards of 2.5 m by 2.5 m. Spot planting by only pitting is exercised. Native grass re-growth is encouraged. Only selective-cut utilization method is to be applied
***Golenta* -based shrub integrated Silvipasture (X)**	
• Either soil depth restricts planting deep-rooted crops such as trees or shrubs or slope are causing severe erosion and shattering of physical measures • In only slope constrained sites, down movement of soil is substantial and land slide can occur • Soil erosion occurs during big and little rainfall seasons • Land is highly sensitive to use interference	• Due to the considerable slope limitation, the intervention involves only perennial crops such as perennial grasses, fodder legumes as well as fodder, fuelwood and farm implement quality shrub species. Instead of terraces plot after plot, only construction of graded and strengthened *Golenta* , at a spacing of 75 - 100 m is required. The lower side of the *Golenta* is supported by a line of shrubs that are spaced at 0.5 meter distance between one another. In between the *Golenta*, fodder and fuelwood quality shrubs are planted in 3 meter by 3 meter spacing. Spot planting by only pitting is exercised. Matured and hardened-off seedlings are planted from those listed in Table 7.7. Native grass re-growth is encouraged. Fodder legumes and herb are introduced in spots. Selective-cut utilization method is applied to the shrubs while cut and feed system is applied to fodder legumes, herb and grasses.
Ecosystem-conservation intervention (XI)	
• *Golenta s are* acknowledged but are extremely unstable and collapse occasionally, have layout and gradient problems • Either soil depth or slope restrict use interference by human and livestock • Slope is encouraging occurrence of severe erosion and shattering of physical measures • The ecology is assumed to be fragile. • Down-movement of soil is substantial and land slide could occur • Soil erosion is severe during big and little rainfall seasons	• Only ecosystem conservation form of agroforestry intervention is intended. The form of development is encouraging minimum disturbance to the site even when development aids are carried out. Hence, in situ conservation is prescribed. The sites can be used as sources of 'home use' (medicinal, scenting, etc.,) plants because the local people in the area value such uses of plants significantly. A form of agroforestry that aims at genetic conservation becomes of a significant value here. • *Golenta is* constructed in 50 - 100 m spacing. A line of shrubs and trees supports the lower side of the Golenta as the soil depth allows. The trees and shrubs are spaced at 0.5 meter distance between one another. In between the *Golenta*, in-situ conservation is encouraged. Refining the natural growth by species refinement is exercised. Spot planting of only improved grass, shrubs and trees is tried. Fodder legumes and herb are introduced in spots. Only utilization of feed grasses and herb at the end of the rainy seasons, in a cut-and-carry system is advised.

In all of the intervention categories, shrub/tree growing is a common denominator. In agroforestry intervention categories I -- VIII the major agricultural production is meant to be cereal crops from those indicated in Table 7.5. In intervention categories IX -- XI, productions are targeted to come only from perennial tree/shrub and grass species.

Interventions that involve integration of *Kab* and *Golenta* with the perennial shrubs and trees are included in Table 9.5. Among such intervention categories, VII and VIII are excessively constrained by slope but are designated for cultivated crops. Therefore, the lower half plot is to be planted by *Rhamnus prenoides*. In all of the intervention categories I--VIII where a natural spring is available, valuable medicinal and spice plants such as *Ocimum basilicum* (*Beso-bla*) and *Ruta halepensis (Tena-adam*) and cash value fruit plants such as *Musa x paradisiaca* and *Coffea arabica* are acknowledged.

The environmental assessment has indicated that soil fertility is limiting the production throughout the study area. The farmers are also convinced that their soils are poor in nutrients. Hence, the identified indigenous soil fertility enhancement technologies (*Fig, Maker, Ribrabo* and *Fereka*) will be improved and applied as necessary. Soil erosion in the study area is severe during July to September (big rainy season locally called *Kiremt*) where the mean monthly precipitation exceeds 200 mm and March and April (little rainy season locally called *Belg*). As of the onset of these months, the prescriptions include maximization of cover crop and mulching.

The prescriptions indicated in Table 9.6 are distinct in that they involve only *Golenta* in integration of tree/shrub with physical measures. The intervention categories are beyond the cropping limit either in soil depth or slope gradient. Where appropriate, tree growing and fodder development from shrubs, leguminous herb and grasses is encouraged.

9.4 Conclusions

The participatory planning has been conducted in discussion with farmers by using the learning and planning processes indicated in Figure 5.1. Important findings are generated. In the planning process, it is realized that farmers have a number of production desires which exceed the production potential of their land. In the case of Tikurso, five production desires are identified. From the miss-match between the land production potential of the farmers' land in the catchment and the production desires of the farmers, a number of associated problems are identified. However, for every problem identified, mitigation possibilities are identified. During these identifications of miss-matches between production desires of farmers and limitations of their production areas, problems of the miss-match and possibilities of mitigation of each of the problems, an important knowledge combination is made. Details of the attributes are indicated in Table 9.1

The possibilities of overcoming the identified problems necessitated studying and using indigenous land constraint mitigation skills. Such skills and their associated problems are studied. Nine indigenous land constraint mitigation skills of farmers are identified.

Their associated problems are studied. Their associated problems and weaknesses are corrected by the use of combined knowledge of the facilitator (researcher) and the farmers. The details of the results of this exercise are presented in Table 9.2.

After realization of development desires, production constraints (problems) of the land and strategies of overcoming the problems and improvement of the indigenous soil and water as well as reforestation skills of the farmers, the development intervention areas are defined by their potential and constraint. Four groups of agroforestry cum soil and water conservation interventions are devised. The first group (Table 9.4) is composed of those two interventions which do not involve any structural soil and water conservation measure. The second group (Table 9.5) also involves two interventions but are distinct in that they commonly involve only *Kab* as a distinctive structural soil and water conservation measure. The third group (Table 9.6) consists of four interventions which commonly involve *Golenta* and *Kab* jointly. All the interventions of these three groups are intended to be practised within the cropping limit. In the case of Tikurso, they are applicable in the 59 % of the catchment. The fourth and last group (Table 9.7) consists of three interventions which commonly involve only *Golenta* as a structural soil and water conservation measure. These are intended for those areas of beyond the adapted cropping limit. In the case of Tikurso catchment, these three interventions are intended for the 41 % of the area. However, 33 % of the total catchment area qualifies for only one of the three interventions of the group (Ecosystem Conservation).

In total, eleven intervention categories are defined. The prescription details are devised in such a way that they can address the socioeconomic facts that are identified in Chapter 7 (mainly Figure 7.1, Table 7.3, 7.7, 7.8 and 7.9) and the environmental facts and issues that are identified in Chapter 8 (Table 8.2, 8.3, 8.4, 8.5 and 8.7). The intervention categories discussed in this Chapter are constructed from socioeconomic diagnosis (Chapter 7) and environmental assessment (Chapter 8). The final outcome of this planning is creation of an input guide plan for farm-level adaptive planning and implementation (Chapter 10). The inter-relationship between the issues in these four chapters explains that the approach is highly inter-twined and cyclic and its derivative indicates that the knowledge about the approach is a continuous process.

CHAPTER 10

IMPLEMENTATION, EVALUATION AND FEEDBACK

10.1 Adapting catchment-level plans to farm-level conditions

Broad ranges of land quality determining variables define planning units in the catchment-level planning. They are very important for establishing an understanding about catchment-level land use appropriations. They also serve in framing land use and technology options. However, agroforestry intervention implementations necessitate discrete specifications of agroforestry components and indigenous technologies within each of the framed land use categories. Therefore, adapting the catchment-level plan to farm and farmer-level plan becomes vital. Adaptation is performed by considering the same land quality assessment variables whose general fact was established during the catchment-level planning. This is done with the help of sketch mapping on transparent papers where manual overlaying is possible.

For the case of Tikurso catchment, the two farmer-understood land quality assessment factors (slope and soil depth) are considered. In slope class map production, the development facilitator measures the slope percentages of the various sections of the farm. After repeated measurements, the farmer and the facilitator become able to guess the slope percentage of any given section of the farm with ocular estimates. A typical example is presented here.

Being with the farm owner, the boundary of each section of land, which is defined by the slope categories that are used to define catchment-level intervention units, is mapped on a transparent paper. From experience, sketches in the scale of 1: 500 proved to be useful and practical. Figure 10.1 indicates the slope map of one of the innovative farmers drawn by the facilitator and the farmer in the field. In view of the mapping output, discussion about the kind of soil conservation measures to be in place, dimension of each of the measures and spacing distances, strengthening particulars etc. are discussed. In the discussion, the farmer and the facilitator discuss constraints and potentials of each of the sections of the farm defined by these slope categories. As shown in Figure 10.1, this farmer has no land with slope categories of 0 - 2 %, 45 - 60 % and > 60 %. Therefore the slope map of the farmer depicts slopes of only 2 -5 %, 5 - 15 %, 15 - 30 % and 30 - 45 %.

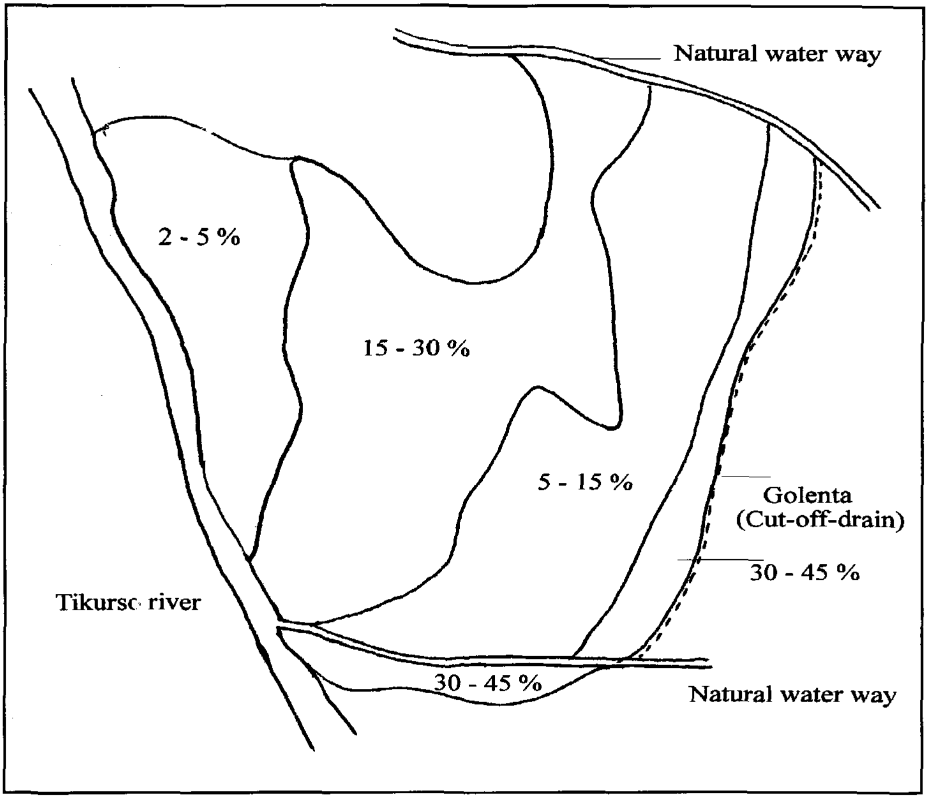


Figure 10.1 *Slope category sketch map of an individual farmer's land*

The farmer understands that the portion of his land in slope category of 2 - 5 % is not constrained by slope while the one in 5 - 15 % is moderately constrained. On the other hand, lands of 15 - 30 % are well constrained by slope and need intensive slope correction measures. The situations in sections that are within slope class range of 30 - 45 % are worse. Therefore, intensive soil conservation measures need to be in place. In the discussion with the individual farmer, decision is also made on what kind of physical soil conservation measures to be used in each of the slope categories and at what definite spacing. Moreover, the type of crop to be grown, moisture retention capacity and susceptibility to soil erosion are mainly dependent on soil depth. In addition, soil depth is a land-quality grading variable of farmers. Therefore, mapping the different sections of the farm in terms of soil depth becomes essential. The facilitator demonstrates what a 20 cm and 50 cm measure is like in magnitude by preparing equivalent measuring sticks for the farmer.

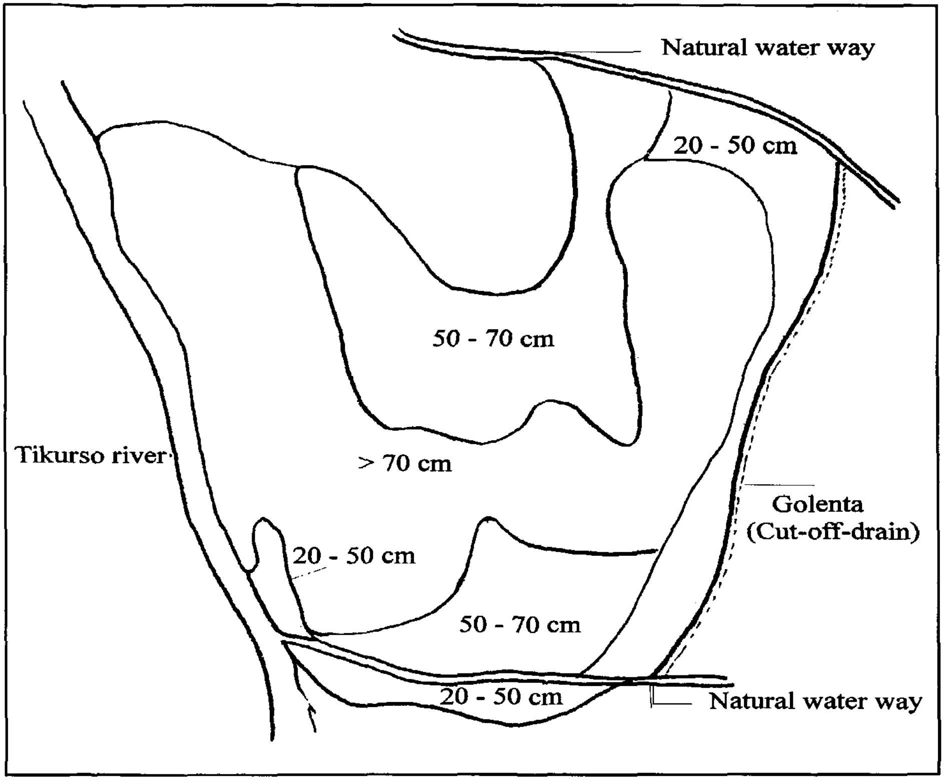


Figure 10.2 *Soil depth category sketch map of one of the innovative farmers of Tikurso*

The farmer, who is the most familiar about his land, easily visualizes portions of his land which have soil depth measures of less than 20 cm, 20 - 50 cm and > 50 cm if they occur on his land. In some cases, one or more soil depth groups may be missing at a single farm-level. For instance, the land of the farmer whose soil depth situation is depicted in Figure 10.2 has not a soil depth category of < 20 cm. The farmer and the facilitator identify the sections of the farm with either of the necessary soil depth, soil fertility and slope bounds and map the situation for either of the existing variables at a time on a transparent paper. It is always good to have the same scale with identical outside boundaries.

The slope category sketch map (Figure 10.1), soil depth sketch map (Figure 10.2) and the agroforestry intervention implementation plan map (Figure 10.3) illustrate the fact. Had land units of less than 20 cm soil depth been occurring on the farmer's land, closure and conservation could have been discussed. Therefore, the sections of his farm with the two defined soil depth categories are mapped.

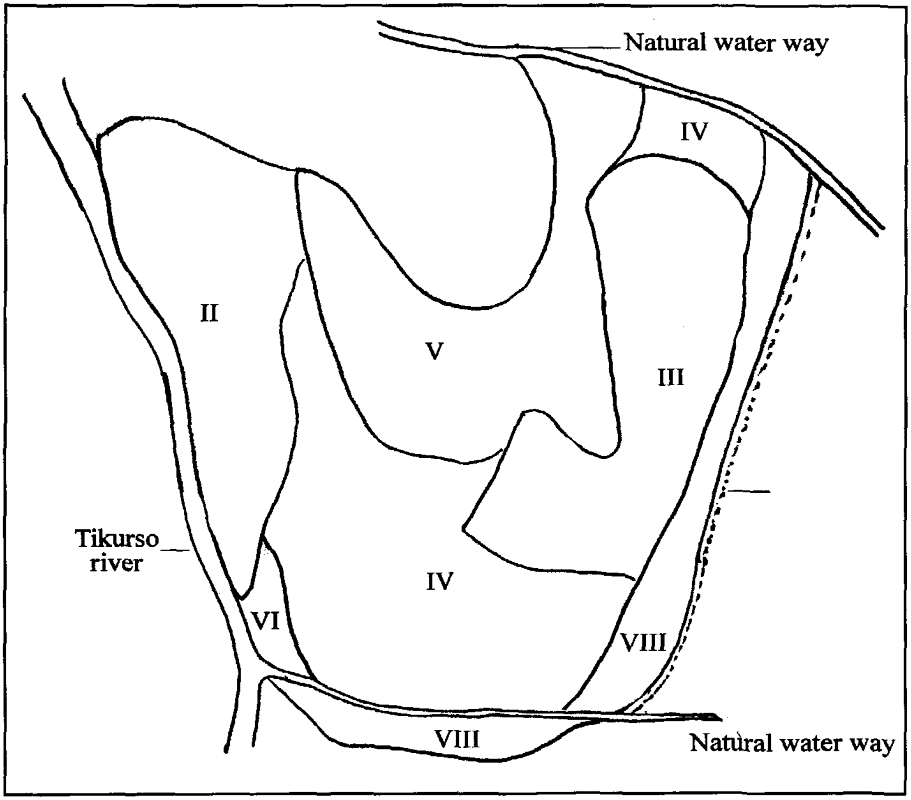


Figure 10.3 *Sketch map of adapted agroforestry intervention planning units of one of the innovative farmers at Tikurso catchment*

The constraints and potentials of each of the land categories are discussed separately. Those sections of the farm with 20 - 50 cm (shallow) soil depth and which constrain growth of crops whose roots need to grow deeper are identified separately. The sections of the farm with > 50 cm soil depth are relatively good provided that the necessary soil conservation measures are practised. The soil depth map of the farm is prepared together with the farmer.

By overlaying the soil depth map (Figure 10.2) on the slope-category map (Figure 10.1), the facilitator illustrates the composite characters of the newly defined planning units.

This composite map (Figure 10.3) is used as a basis for adapting prescriptions of the intended agroforestry technologies that combine conservation practices. Within each of the identified plan adaptation units, the farmer further selects the actual tree and shrub species to be planted, the actual dimension and spacing of physical soil and water conservation measures. All these decisions are made and in participatory learning, discussion and negotiation between the farmer and the facilitator.

Interventions / Slope / Soil depth	Intervention components			
	No structural measure	Strengthened *Kab*	*Golenta* + Strengthened *Kab*	
	2 - 5	5 - 15	15 - 30	30 - 45
20 -50 cm	Not applicable for this farm			
>50 cm				Not applicable for this farm

Figure 10.4 *Agroforestry intervention categories for the land of one of the innovative farmers defined by the same catchment-level intervention category definitions.*

After identification of the intervention categories, the respective agroforestry prescriptions are consulted in a joint discussion with the farmer. Specifics such as actual spacing of structural soil and water conservation measures, shrub species, tree species and their configuration and spacing dimensions are discussed. The length of structures to be constructed, the labour required, number of seedlings to be prepared and planted are computed. Responsibilities are shared.

Within the study period, providing sod of quality grass species by the facilitator (researcher) proved to be impossible for there is no grass seed multiplication nursery within the zone of the study area. Therefore, the prescription developed for intervention category II is not implemented. For all the remaining intervention categories, the farmer has tried to do his best and is proud of doing it. Other farmers have done similar undertakings.

10.2 Adapting prescriptions

The catchment-level intervention planning has defined the production targets by planning units in broad terms such as trees and / or shrubs or range of spacing for allocation of land constraint mitigation technologies. However, implementation pre-supposes knowledge and decision about specific dimension of the technologies to be implemented and pre-determined specifications about how to implement the technologies. For instance, deciding on the use of specific species from those identified in Table 7.7 is the issue of adaptation to farm and farmer level conditions. In adapting such species, in line with preference of the farmer, matching the altitude requirement of the species in accordance to the specific location of the farm in the catchment is required. In such a case, the location of the farm is viewed in contrast to the elevation map of the catchment to which the farm belongs (Figure 8.3) and the altitude niche of each of the species that are intended to be developed. In addition to adaptation of species of trees, shrubs, herbaceous legumes and grasses that are of interest to specific farmers, adaptation of land constraint mitigation technologies is required.

Depending on similarities of the slope and soil depth dimensions that are identified with the farmer in adapting the plan, an appropriate agroforestry intervention is chosen from those prescriptions listed in Tables 9.3 - 9.6. However, necessary adjustments are done to the actual spacing of physical soil and water conservation measures as well as below and above the *Kab* or *Dinber* plantings. For each of the physical measures, the required width, minimum height and the required gradual height increment as well as the maximum height are decided on.

10.3 Implementation

As a preparatory step, planning units are adapted to farm-level conditions. Matching prescriptions are identified. The necessary agroforestry intervention attributes are selected and adjusted to the farm and farmer level situations. Based on slope and soil depth characteristics of the farm-level planning units, the required physical soil conservation measures are selected for construction. Labour is organized by the farm owners. The facilitator provides a graduated A-frame and other necessary on-farm technical backstopping. Implementations have continued in accordance with specific technical specifications. Adjustments to the technical specifications are made based on an on-farm discussion outcome with the farm owners. School thoughts, practical experiences and results of trials and errors are used.

Implementation of agroforestry interventions involves construction of *Golenta* and *Kab* that are strengthened by lines of trees and shrubs. During the implementation of the chosen agroforestry intervention, more focus is given to improving the stability of *Kab* and *Golenta* . From farmers' experiences, foundations of *Kab*s are made rough by laying vegetation underneath the *Kab*s so that connection of the *Kab* to the ground is made more firm by maximizing friction at their surface of contact (Plate 9.4). This is well founded experience of farmers in North Shoa. An important note is that, as much as the unification of the singly brittle threads effectively chains a lion, it is the coordinated force of the physical structures, the soil and the vegetation that can strengthen the structures and successfully arrest sediment in run-off. Therefore, the foundations are excavated and their excavated floors are covered with branches of thorny or spiny shrubs such as *Carisa edulis*, *Acacia* species, *Nuxia* species, *Ruhus natalensis* etc. as available to a depth of 5 -- 10 cm. Except on the farm of one of the 12 innovative farmers where *Aloe calidophyla* has been used with gravel due to lack of larger size stone (boulders) from nearby areas (Plate 9.3), *Kabs* are constructed from gravel and boulders. The constructed *Kabs* have had agreed spacing in accordance with farmers so that it will not interfere with their farming operations. The effectiveness of these widely spaced *Kabs* is helped by increasing their heights.

The bottom floor of all *Golenta s* is made 50 -- 70 cm wide while the corresponding width, measured at the top of the lower side is 70 - 100 cm. Along their lower side, a single riser stone faced embankment is made. The lower side of each *Golenta* is further supported by a line of tree or shrub planting (based on soil depth of the micro site). All *Golenta* s are graded and connected to natural water-ways while all the Kabs are level. The routing of the cut-off-drains to the water-way is discussed and negotiated with only the concerned farmers in an on-farm discussion.

In addition to the setup of specifications for construction and use of physical conservation measures, specifications are made for planting and use of trees and shrubs in general and *Rhamnus prenoides* in particular. Potted tree/shrub seedlings are planted in a pit of 25 - 30 cm depth and 30 -- 40 cm width. The seedlings were well hardened-off in nurseries to resist the harsh climatic conditions awaiting them at the planting site.

10.4 Feedback/Effects

The basic theme of the agroforestry approach is innovating a means by which

- farmers' acceptance and will for working with the development facilitator could be improved
- socioeconomic and environmental assessment becomes more farmer-based and factual
- soil conservation technologies become indigenous knowledge-based and attractive to farmers to do them by their own will

The end result is enabling farmers to have indigenous soil conservation measures that gradually attain perfection in attracting the will of the farmers and keeping their lands productive on a sustainable basis. Therefore, the test involves assessment of the impact of the participatory agroforestry work in terms of productivity, adoption ease, economic viability, and sustaining the land. The impact assessment has been limited to farm -level only.

Rhamnus prenoides is a famous cash-value shrub (Plate 10.1) that can be coppiced and marketed repeatedly. Since it is always planted in a cultivated field, 1 meter above the *Kab*, potted seedlings are planted directly by preparing planting holes by farmer's hands at the time of planting. Care is taken not to cover the leaves with mud as they are found to be sensitive to it and survival will be affected significantly. The *Rhamnus prenoides* seedlings are planted in a spacing of 50 cm between plants themselves. After they are established, multiplication is possible by layering. During layering, the underside bark of the branch is split longitudinally 2 - 3 cm by a sharp blade and it is buried in the ground. The buried part of the branch is usually 10 - 15 cm long.

After development of the agroforestry intervention plans, defining specifications of components and agitation of farmers about treatment of the land in accordance to the plan is continued. The necessary A-frames are prepared and given to village leaders for use by interested farmers. Technical assistance is given to those farmers who have requested for it. It is believed that reliably sustainable reforestation programmes need to enable farmers to have their own nurseries and raise their own seedlings. However, due to researching time limitations, in the study of the development of PAA, an effort has not been made to let farmers establish their own nurseries and raise their own seedlings. Therefore, all the potted seedlings of 8 species were raised by the facilitator and distributed to farmers free of charge.

Plate 10.1
Rhamus prenoides is a marketable perennial shrub that can earn farmers cash in every 6^{th} month after an establishment time of a single year. In every local market of the the Amhara regional state, and Addis Ababa (the nation's capital), it is a domestic stock in trade. It can grow effectively in many of the Kolla, Weyna-dega and Dega agro-climatic conditions and is of special interest to women.

Plate 10.2
The farmers at Tikurso are after strengthened conservation measures, short-term income and production of fodder shrubs that are addressed by the implementation of this type of agroforestry interventions

Six of the species are planted on those lands designated as intervention categories of III -- VIII as appropriate. The other two (*Eucalyptus camaldulensis* and *Eucalyptus globulus*) are used for lands of intervention categories IX and X.

Sustaining the land

After the agroforestry interventions are introduced in an agroforestry approach, the slopes are modified (Table 10.1). Every farm of the innovative farmers is found to have many (not all) of the agroforestry intervention category units. At the same time, farmers give different priorities and set different time schedules for implementing different interventions. Therefore, four farm plot groups that are identified as PG1, PG2, PG3 and PG4 are considered from five randomly selected farms for the assessment. The number of plots in PG3, is only 2 that are interspersed by three adjacent *Kab*s while in the other farms, there are 4 plots that are interspersed by five longitudinally lined *Kabs* each. The plots are grouped by their similarity in slope range, average plot length and intervention category they belong to. The total number of plots is 14. In PG3, there are 20 pins per plot while there are 19 pins per plot in all of the remaining 12 plots. In plot groups of PG1, PG2 and PG4, there are 72 pins per plot group while in PG3 there are 40 pins. The total number of pins is 256.

The amount of soil eroded and arrested is calculated by using the equation 10.1. For instance, the amount of soil loss eroded and arrested from plot groups of PG1 is calculated from the following information. The average soil depth eroded and measured by the pins in three years time is 5 cm. The average depth of soil arrested is 5.5 cm. The cumulative annual average of the soil eroded and arrested in three years time is 5 cm (when considered to the nearest 0.5 cm). Therefore, the annual depth (H) of soil eroded and arrested under PG1 conditions becomes 0.05 m. Effective length of the plot from where soil is eroded (0.5L in Figure 10.3) is ~ 6 m. The plot width (W in Figure 10.5) which is covered by a row of pins in the plot is 18 m because there are 9 pins in the plot group PG1 which have 2 m spacing in between every adjacent pin in a raw. Average bulk density of soils range between 1.3 and 1.6 (Hillel, 1982).

$$T = [1/2\,(1/2L \times H) \times W \times D] / a \qquad \text{.......} \quad 10.1$$

where:

T	=	Tons of soil /hectare per year
H	=	average height of the triangles in meters which represents the average depth of soil eroded and arrested in a year
W	=	Width of the plot covered by the spacing of the pins in meters
D	=	bulk density of the soil (~ 1.3)
1/2	=	constant in the formula for calculating area of a triangle
L	=	Plot length (spacing between two adjacent Kabs) in meters
a	=	plot size in hectare [(L x W) / 10 000)

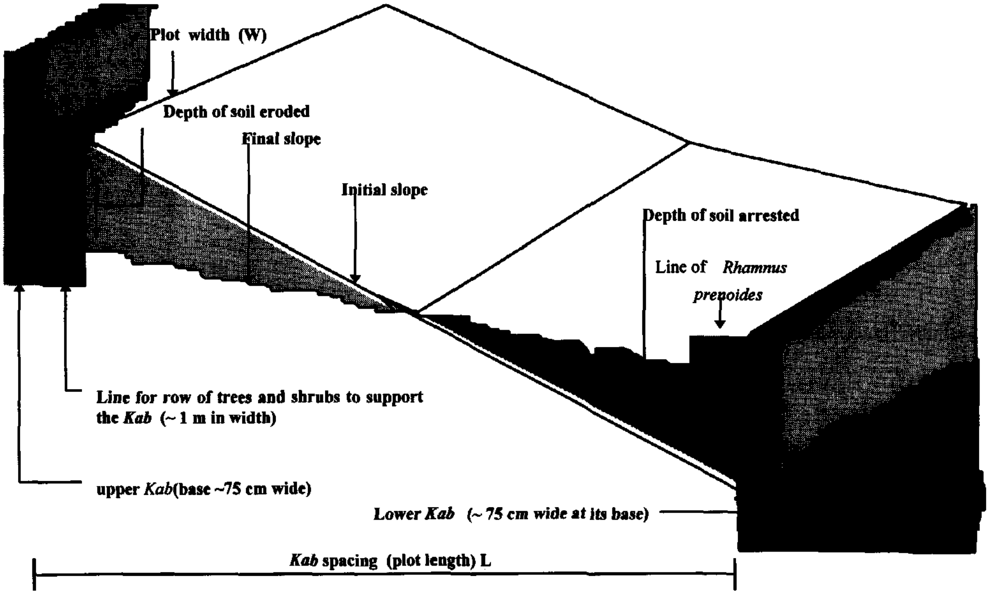


Figure 10.5 *Schematic presentation of soil movement assessment plots*

Table 10.1 *Soil movement and slope correction effect of agroforestry interventions after three years of continuous measurement*

Attributes	PG1		PG2		PG3		PG4	
	3-years' cumulative average soil depth measurements in cm							
	Eroded	Arrested	Eroded	Arrested	Eroded	Arrested	Eroded	Arrested
Plot 1	4.5	5.0	3.0	3.0	6.0	7.0	7.5	8.0
Plot 2	5.0	5.5	4.5	5.0	6.5	7.5	7.5	8.0
Plot 3	5.0	5.5	4.0	4.0	No plot	No plot	8.0	8.0
Plot 4	5.5	6.0	5.0	5.5	No plot	No plot	8.0	8.5
Annual plot group 's average	5.0	5.5	4.0	4.0	6.0	7.0	8.0	8.0
Average soil movement	5.0		4.0		6.5			
Soil eroded & arrested in tons/hectare/year	163		130		211		243	
Average plot length	12 m		16 m		9 m		8 m	
Intervention category	V		VI		VIII		VII	
Average plot width in m	18		18		20		18	
Initial slope %	25		17		32		38	
Slope reduction ~ %	8		5		14		18	

However, the bulk density for the medium textured (Cambisol), non-consolidated and cultivated soil of the study area is assumed to be 1.3. By substituting the above indicated values in Formula 10.1 above, the amount of soil eroded and arrested under the condition of PG1 amounts to 163 tons per hectare per year. The same procedure is used for calculating the amount under PG2, PG3 and PG4 and the result is presented in Table 10.1.

The total soil eroded from the uphill peg area in a plot is always found to be less than the total soil deposited in the lower peg area of the same plot. This might be due to the movement and deposition of soils that are eroded from the area above the plot and /or due to possibly more air volume and lesser bulk density than the soil cut from the upper section in the same plot. Due to this soil movement, the slope change brought about by the implementation of the interventions is found to be significant. The average slope of the farms is found to be modified to 17 %, 12 %, 18% and 20 % resulting in a net decrease of 8, 5, 14 and 18 % slope respectively in three years time.

The result obtained indicates that *Kab*s constructed on steeper slopes, provided the necessary strengthening measures are taken could result in a more net decrease of slope gradients than those constructed on less steep ones. Please compare the net decrease in slope (18 %) for PG4 that had an average slope gradient of 38 % as compared to the net decrease in slope (only 5 %) for PG2, which had a slope gradient of only 17 %. Furthermore, if the amount of soil deposited in the lower pin area is greater or as much as the soil removed from the uphill peg area, farmers realize that the land is getting leveled and the technologies are competent in sustaining the land.

Measurement of soil movement by the pin method is realized to be simple, educational and demonstrative to farmers. In plots where the deposited soil measurement is found to be less than the soil removed, farmers easily understand that the soil is transported down below the farm plot. Under such circumstances, farmers are quick in suggesting height increment of the *Kab* and strengthening and widening of the *Golenta* as immediate solutions.

The second method of land sustenance assessment is the growth measurement of the tree and shrub species. It is believed that growth parameters indicate the conditions of availability of moisture, which is a function of soil and water conservation. Measurements include height and collar (stump) diameter measurement for the fodder and cash value shrubs as well as trees (Table 10.2). The measurements are taken every year and start after the plantings are a year old.

Table 10.2 *Mean annual height and diameter increment of tree and shrub species under agroforestry interventions*

Species name	Height, meter	Butt diameter, cm
Casuarina equisetifolia	0.9	1.3
Croton macrostachys	1.3	2.8
Ehretia cymosa	1.1	1.7
Grevillea robusta	1.6	2.4
Olea europea	0.6	1.1
Rhamnus prenoides	2.6	1.3

In the case of *Rhamnus prenoides*, after it has become a year old, the farmers harvest it by cutting the whole crown of the shrub twice in a year. Therefore, the annual height increment is the annual cumulative height of the two cuts. In the case of *Ehretia cymosa*, farmers cut and feed the growth frequently. At the same time, it has been very difficult to protect it from livestock as it is very much liked by cattle. Therefore, the height measurements indicated in Table 10.2 under-estimates its growth. It has been very difficult to get any published comparative data on growth increments of the above indigenous tree and shrub species under similar situations in Ethiopia. However, farmers' judgments indicate that the growth of the species is at least twice higher than the usual growth that can be obtained under food-for-work rehabilitation plantations of the supposedly fast growing Eucalyptus species in the area.

The third land sustaining quality measure is qualitative. It is the visual assessment of farmers on the implemented interventions. It is rated in terms of good, high and very high (Table 10.3). The visual assessment conducted by farmers during farm visits is found to be more convincing to *follow-farmers*. Farmers are found to be experienced in judging the land sustaining ability of the effort from the field performance of the crop be it perennial or annual.

The qualitative assessment on land sustenance and productivity, is proved to be a successful undertaking for extending farmer-appreciated, productive, conservation-efficient and multi-benefit innovations. As indicated in Plate 10.2, *Kab*s that are strengthened by lines of cash-value *Rhamnus prenoides* in their upper sides and lines of fodder value *Ehretia cymosa* have inter-spaced the staple food crop *Eragrostis teff* farm. In the lower plot the same farm, the soil is deeper and cash-value *Grevillea robusta* is substituted for the *Ehretia cymosa*. By doing so, impressive harvests of *Rhamnus prenoides* and *Eragrostis teff* are obtained (Plate 10.3). This visually impressive intervention scene has been one of the methods that played a significant role in the farmer-to-farmer extension.

Productivity

Productivity measurements taken from seasonal harvests of cereal crops, and *Rhamnus prenoides* shrub harvests are easily quantified from actual harvests. Their market values are easily available too. Fodder harvests from *Ehretia cymosa*, mulch harvests from *Ehretia cymosa* and *Croton macrostachys* and the like are difficult to quantify and to calculate the financial gain from their produces. Productivity from the tree component, though not harvested yet, is estimated by requesting owners to estimate the market price for the equivalent size. Taking the above mentioned problems and possibilities of estimating gross productivity of the implemented agroforestry intervention, the total production gain of twelve farmers is presented (Table 10.3 and 10.4). In addition to quantitative figures, the farmers' feeling about productivity increment is qualitatively analyzed and presented in Table 10.3.

Plate 10.3
Farmers consider healthy coexistence of the woody perennials and non-wood crops (such as this Eragrostis teff, staple food crop of Ethiopians) as a major decisive factor in the application of agroforestry interventions for soil and water conservation.

Table 10.3 *Estimated annual financial gains in US $ from implementation of the planned agroforestry interventions on a per hectare basis.*

	From					Farmers' opinion
Farmer's ID	**Cereal crop**	***Rhamnus* harvest**	**Standing trees/shrub**	**Fodder species**	**Total**	**visual assessment and productivity**
001	185	0.00	20	0.00	205	High
004	160	0.00	35	0.00	195	Good
005	200	5	20	5	230	Very high
008	110	15	25	10	160	High
011	280	15	0.00	0.00	295	"
012	170	10	45	15	240	Very High
014	190	5	25	0.00	220	"
015	150	15	30	0.00	195	High
016	270	5	45	5	225	Very High
017	60	5	30	5	100	High
024	120	10	35	5	170	"
046	120	5	30	5	160	"
Average					**200**	

The productivity value estimated and indicated on Table 10.3 does not include the soil conservation benefit that sustains the productivity of the land for many years to come. It is also believed that the benefit increment from the *Rhamnus prenoides* would be growing faster after its vegetative reproduction increases its stocking density in a line of planting. Growth of the trees and their corresponding value is also expected to increase faster during their active growth period in the years to come.

Cost effectiveness

Cost effectiveness of the agroforestry interventions is judged by comparing the cost of implementation of the technologies and the increased financial gain obtained by farmers due to adoption of these technologies. In practice, the farmers do not hire labour. Either they use the family labour or create a team in the form of *Wonfel.* Only one of the farmers has used hired labour in cash and is only for the construction of Kab. Therefore, the implementation cost is calculated by estimating the labour cost of the family labour or labour contributed from the *Wonfel.* One person-day labour is estimated at four Ethiopian Birr or US $ 0.6. In addition, because the farmers have been implementing the interventions continuously in three consecutive years, the annual average implementation cost is calculated by considering annual average from the total cost. Therefore, the cost that indicated in Table 10.4 below is the annual average cost. It includes all the costs incurred on a hectare basis but does not mean that the hectare is treated completely. Completion of activities by farmers is gradual.

Table 10.4 *Annual cost/ benefit analysis information on a per hectare basis*

Farmer's ID	Cost incurred for various interventions					Total gain	Profit
	Kab construction	*Golenta* construction	Planting	Tending operation	Total cost		
001	20	0.00	5	5	30	205	175
004	135	50	10	10	205	195	-10
005	105	30	5	10	150	230	80
008	30	40	5	5	80	160	80
011	55	0.00	5	5	65	295	230
012	55	0.00	5	5	65	240	175
014	50	15	5	5	75	220	145
015	50	0.00	5	5	60	195	135
016	115	35	10	10	170	225	55
017	20	0.00	5	5	30	100	70
024	35	0.00	5	5	45	170	125
046	40	0.00	5	5	50	160	110
Average					85	200	115

Many of the activities are seasonal. Much labour requiring activities such as *Kab* construction are normally conducted in December, January and February when the crop is harvested and the farmers are not busy in agricultural activities such as cultivating, seeding, weeding and harvesting. Then, the labour cost is cheaper. Other less labour demanding activities such as planting of the trees/shrubs are conducted when the farmers are busy and labour is expensive. However, these are conducted by the household labor. In the calculation of the cost the most probable average is considered.

The average income gain of US $ 115 indicates that farmers' income is increased by ~ 57 % of the initial year. However, this has to be noted that most of the increase may be accountable to the growing surface area increment for the crops due to removal of the stones from the fields for the construction of *Golenta* and Kabs. Therefore, after all the stones are used, continued increment of financial gain, most probably will not continue at the rate indicated here. The farmers at Tikurso are observed to plan and conduct long-lived agroforestry and soil and water conservation on incremental basis. They add up to them gradually and make them complete gradually. For instance, the number of *Kab*s constructed in a farm or the height of the same *Kab* is never completed in a single year. This distributes the labor demand, other input costs and the risk factor of their interventions.

From experience of various countries, in many of the conservation efforts that have down-stream or other public benefits, the concept of *price sharing* is applied and price is shared between government and farmers. Under such circumstances, the farmers *receive* subsidies according to their own contributions (Graaff, 1996). Costs are shared between identified beneficiaries who contribute labour. In practice, this is often difficult. In the case of the *Golenta* constructed on Farmer 004's land (Table 10.4), all the labour is organized and effected by the farmer in the form of *Debo*. The farmers who contributed the labour are not those who would be benefiting from the down-stream effects of the *Golenta* . The farmer will pay back the labour contributed by the farmers but may be in various forms of 'farmer-to-farmer relations' that are difficult to imagine the cost. It is not certain whether he pays back all the labour to those who participated at the *Debo* either. Therefore, the labour spent in person-day is converted into financial cost by using the average person-day cost for the area.

The downstream farmers do not rate the importance of the *Golenta* equally. Therefore, though the long-term benefit of the *Golenta* for the down-stream farmers is perceivable, the cost of the *Golenta* is accounted as a cost incurred by Farmer 004 (Table 10.4) alone. In such a case, the net gain of individual farmers, most obviously in the short-term, is not attractive. Still, this particular farmer has appreciated its benefit by weighing its cost against the very existence of his land below it.

Adaptability

Adaptability of the soil conservation practices via the participatory agroforestry approach is measured by conducting a survey of the farmers who have copied the components of the interventions. The adaptability survey is conducted only within the catchment but it is felt that have also copied them. However, as it would be very difficult to ascertain the area of influence and whether it is really due to the influence of the approach, the assessment is intentionally limited to within the catchment area only. Within Tikurso catchment, the number of farmers who have implemented interventions within the last two years has increased between 5 and 32 depending on the kinds of practice adapted (Table 10.5).

Table 10.5 *Assessment record on adaptability*

Intervention components	Number of farmers who copied practices of the innovative farmers			Total
	1st	2nd	3rd	In 3 years
• Strengthened *Golenta* construction	9	12	0	21
• Strengthened *Kab* construction	0	14	17	31
• *Rhamnus prenoides* planting	0	10	17	27
• Shrub planting	0	11	14	25
• Tree planting	0	14	18	32
• Improvement of *Boi* gradient by A-Frame	0	2	3	5
• Fencing farms and prohibition of on-farm post harvest grazing	0	7	15	22

Summary of Part III

Chapter 7 indicates effective trust building and *socioeconomic* assessment results. In the same chapter, it is indicated that farmers consider short-term and diversified income production as first priority regardless of their land capabilities. Their choices of crops, trees and shrubs as well as their grading factors and talents are illustrated. The chapter further illustrates possibilities of increasing the land capability. Traditionally used land quality assessment factors are identified. Indigenous soil and water conservation measures and associated problems of the study area farmers are treated here.

Chapter 8 presents participatory land quality grading by the use of traditionally used land quality assessment factors identified in Chapter 7. It is realized that the land capability is severely constrained by soil fertility. Its potential to accommodate farmers' production desires is limited.

Chapter 9 illustrates participatory planning outcomes by which the poor land capability and extended production desires of farmers are debated, mediated and negotiated for an output of a compromised agroforestry intervention plan. Adjustments (adaptations) are made to production desires and their associated problems. Local land constraint technologies and their problems as well as intervention designs are discussed here. Chapter 9 further indicates that planning units may be defined in accordance with existing realities. For each of the planning units, certain intervention packages are prescribed.

Chapter 10, which is the last chapter, in Part III, deals with technologies and detailed attributes of the identified technologies in the implementation processes. The Chapter also deals with participatory effect evaluation. It shows that the participatory agroforestry approach is one of the options by which soil and water conservation can be conducted by farmers effectively. According to deliberations in Part III, the Tikurso case study demonstrates that the approach can be practised, is soft-system and action-oriented with ample room for modification by using its own in-built feedback mechanism.

PART IV

REFLECTION ON THE STUDY AND ACTIONS FOR LARGE SCALE APPLICATION

CHAPTER 11

SCENARIOS FOR LARGE-SCALE APPLICATION

After the construction and application of PAA at Tikurso catchment level, the immediate concern became to know the likely scenarios for its applications on a wider scale. Therefore, an assessment of the conditions for large scale application of the approach has been conducted. The assessment has been focused on:

1. commitment and quality of facilitator and institution in the development sector
2. policy framework,
3. the farmers
4. other instrumental circumstances

The study has been limited to Region 3 (Amhara Regional State) where Tikurso catchment is situated. The objective of the study on large scale application of the devised agroforestry approach has been getting a general opinion on the above-indicated four conditions. Four administrative zones of Region 3 (North Shoa, South Wollo, North Wollo, and South Gondar) are considered (Figure 2.1). From each of the zones one sub-district (*Woreda*) has been selected. The *Woreda* involved are Antsokia-Gemza in North Shoa, Mekdela in South Wollo, Meket in North Wollo and Simada in South Gondar. Within each *Woreda*, individual farmers, farmer groups, the head of MoA and technical staff concerned, the head of the administrative council or his representative and the coordinator and concerned technical staff of major functional non-governmental organizations (NGO's) are contacted.

Choice of these study areas has been made on the basis of proximity of the administrative zones to the case study area as well as the availability of development NGOs. The latter indicates the severity of the land degradation and inferior social conditions in the study areas. An additional factor for the choice was the possibility of getting services for the researcher through which he could get the necessary logistics for the study. Among the

NGO's, the following are considered.

- Food for the Hungry International (FHI) which is operating in South Gondar Zone,
- Save Our Soil (SOS-Sahel) operating in Meket *Woreda* of North Wollo Zone,
- Ethiopian Orthodox Church (EOC) which has conducted a study for operating in Mekdela *Woreda* of South Wollo Zone
- World Vision International (WVI) which has been operating in Antsokia-Gemza *Woreda* of North Shoa Zone

From these four *Woredas*, 38 peasant associations (Appendix D) were used during the study of the conditions on large scale applications. Due to differences in objectives of the client NGOs, which have offered the positions for the consulting services, the magnitude and methods of the assessment were not identical. However, the study methods included site reconnaissance, farmer-group and individual farmer interviews, on-farm discussions with individual farmers, discussion with staff of the MoA concerned, respective NGO and heads of the Council of Administration and a literature search (Appendix C).

Details of the assessment are documented in the consultant reports of Bekele-Tesemma (1995 and 1996a & b). From the field reconnaissance, the physical environment in line with the need for soil and water conservation is observed. The status and extent of soil and water conservation measures have been realized. The socioeconomic conditions of the people and major agricultural produces are observed during market days. After getting introduced with site and socioeconomic conditions, farmer-group interviews and on-farm discussions have been held.

After building up a general opinion about the problems that may have an influence on the rate of success in the application of PAA at farmer and farm level, necessary questionnaire (Appendix C) have been drawn and referred to the involved MoA, NGO and Council of Administration Office for discussion. For issues that required more authoritative information, the Zonal MoA offices (North Wollo and South Gondar, North Shoa and South Wello) were contacted. Finally, the regulatory department of the Regional office (Amhara region) has been contacted. A number of important issues from which implications for the application of PAA at a large scale can be made have evolved.

11.1 Institutions and facilitators

At the national level, there is no institution solely mandated to execute agroforestry development programmes. Agroforestry and soil and water conservation tasks are currently assumed to be executed by MoA that could not handle them coequal to its more pressing mandates such as epidemics of livestock disease or infestation of crop pests. Agroforestry research in Ethiopia is in its infant stage (Debela, 1989) and if any thing is done it is mainly on species screening trials.

In addition, merger, divorce and or disintegration of forestry and soil and water conservation institutions, either in whole or in part, occurs repeatedly. For instance, even during the life time of the PAA development research, forestry and soil and water conservation institutions at the national level, have been restructured three times. At the national level, the public forestry wing (which used to be called community forests development department) is totally dissolved. Though the reasons are not clearly understood, forestry and soil and water conservation institutions appear to be considered as a laboratory for "institution formulation engineering".

The situation in Region 3 is not different from the national level situations. Agroforestry and soil and water conservation activities are delegated to the Regulatory Department of the Regional MoA. Lack of a stable and solely mandated institution will make the implementation of participatory agroforestry approach at large scale very difficult (if not impossible).

From the study at Tikurso, the use of local institutions for application of the PAA at a larger scale is proven to be essential. According to Ogolla and Mugabe (1996), control over natural resources needs to be devoted to local communities and appropriate local level institutional and normative regimes should be encouraged to look after sustainable resource management. Unless the information upon which policies, technologies, interventions or institutions is constructed is drawn from local experience, soil and water conservation and reforestation approaches and technologies are unlikely to reflect the needs of the local farmers. When this happens, the farmers are likely to cease investing in soil and water conservation, tree planting, genetic resource conservation etc. And, this is what is happening to the land rehabilitation efforts in Ethiopia. Experience has demonstrated that the local social institutions are not strengthened and channeled into the rehabilitation effort. There are difficulties for using individuals and local institutions without obtaining permission from the office of the *Woreda* Council that can notify the 'go ahead" to the peasant association which the lowest administrative cell linked to the government body. Therefore, large scale trust building processes may prove to be difficult on a large scale unless the conditions of the current highly politically sensitized system of governance and local institution-negligent rehabilitation traditions are changed.

From the discussions with the farmers and the MoA professionals concerned, it has also been understood that the effectiveness of reforestation and soil and water conservation facilitators is affected by the non-stability of the relevant institutions. A facilitator will not get a chance of learning from patterns of failures and successes due to the lack of coherence and continuity of data. In addition, most facilitators have not been trained to seek knowledge, analyze situations, understand facts and solve problems that are related to implementation of reforestation and soil and water conservation in the realm of societal involvement. Regarding the size of available man-power, each *Woreda* is composed of three to five college level graduates and nearly the same number of technicians who could be deployed for reforestation and soil and water conservation programmes. In each of the *Woredas* studied, there are at least an equal number of facilitators in the NGO sector who could be deployed for the same purpose.

However, college graduates are stationed at *Woreda* office level. They are expected to supervise activities through out their respective *Woredas* uniformly and these are very wide to cover in any one programme. Finally, their efforts remain diluted with no noticeable development impact. For instance, the Mekdela *Woreda* is about 1400 km^2 divided into 25 PA jurisdictions while Meket *Woreda* is about 2200 km^2. In addition, there is still a tendency for development facilitator institutions to do many reforestation and soil and water conservation support activities on their own without farmers' involvement. During adoption of introduced technologies that are rejected by farmers, the facilitators thaught they could achieve their ambitious plans by their own efforts. The act of playing such a reactant role is so ingrained in the existing extension system and dislodging both institutions and the facilitators from their overbearing method of extension requires comprehensive effort.

11.2 Policy

General

The policy vacuum originates from the lack of a ministerial level institutional set up for the forestry and soil and water conservation sectors of the country except for nearly 3 years in the early nineties. Lack of such an able and spearheading institution has affected the issuance of land use, soil and water conservation and reforestation policies. For instance, during the existence of the Ministry of Natural Resources Development and Environmental Protection, basic studies that lead to formulation of effective policies have been launched. The Ethiopian Forestry Action Programme (EFAP) is an example. After the dissolution of the ministry in 1995, the study is completed but its recommendations are forgotten. Denial of the creation of an agroforestry institution, which was recommended in the EFAP (1993) study, is one example.

Misappropriated implementation of legal directives and policies also happen due to lack of mandated institution. For instance, according to Article 13 (1a) of the Proclamation No. 94/1994, utilization or harvest of *Hagenia abyssinica, Podocarpus falcatus, Cordia africana* and *Juniperus excelsa* from state or regional forests is prohibited. Each of these species are of farmers' interest (Bekele-Tesemma, 1993). At the Tikurso catchment, *Cordia african*a is the sixth most important species considered by farmers (Table 7.7). However, because there is no solely mandated institution, distinction between the trees harvested from individual land, state or regional forest land could not be made and followed. Instead, all lumber, poles and manufactured goods that are of these species got confiscated regardless of the origin of the trees. From what has happened, farmers realized that growing or maintaining tree species that are considered 'important' by the government is not worth while. As a result, many of the *Cordia africana* trees of the farmers in Region 3 have been cut, pit sawn and hurriedly used and destroyed immediately after the issuance of this proclamation. Such instances will have negative repercussion on future integration of trees into farms.

In general, there is no conducive national policy on natural resources conservation and farmer-level land husbandry initiatives in Ethiopia yet. As compared to its indispensability, the action is much delayed. No doubt in that a preliminary effort was done towards the development of this important policy sector. Various national conservation strategy documents for the preparation of national policy on the conservation of natural resources and the environment have been produced. The promise on the future enabling environment, as understood from these documents (NCS, 1994a-e) is impressive. The documents indicate immediate priorities, medium-term priorities, the basic guiding principles and strategies that the policy would address. The topics covered in the strategy formulation for the production of national policies include:

a) Land use-related issues such as:

- issuing policies on rural land and natural resources tenure and access rights
- developing, promoting and training extension and development workers in appropriate research, planning and development of improved land husbandry technologies
- integrated and multi-purpose land use
- integrated land use and on-farm soil management
- on-farm water management

b) Reforestation issues such as:

- production of tree and forage planting material particularly of indigenous trees
- introduction of suitable indigenous and exotic multipurpose fodder species, especially trees coupled with technical advice on livestock feeding techniques
- compiling the knowledge and experience of rural people on native trees and make up the deficiency in scientific silvicultural knowledge
- expanding the current programmes of farmer-based multi-purpose tree seed production and distribution

c) Soil and water conservation issues such as:

- optimum use of rain water and soil moisture for crop and biomass production.
- developing action plans on how individual crop land holdings can be gradually enclosed (fenced) for:
    - bund and terrace maintenance
    - increased manure application
    - increased forage production on harvested lands (e.g. under sown legumes, forage planting on strips, bunds and terraces).

d) Promoting and training extension and development workers on:

- appropriate approaches to local level, participatory problem diagnosis
- use of adapted technologies useful for organic matter and soil nutrient enhancement
- physical and biological methods of soil protection and water conservation
- improved methods of harvesting and conserving rainwater and soil moisture

If the promise is fulfilled and the envisaged policy is issued, successful application of PAA does not require more than practicality of the issues covered in 'a-d' above. The problem is only when the issues remain in the document form as many used to be .

As indicated in the socioeconomic diagnosis phase, the first order cause, given by the farmers of Tikurso catchment for reduction of crop yield, is soil nutrient depletion brought about by inappropriate land use due to lack of guarantee for long term ownership of the land (land tenure). The same is true for the reduced income from trees. Here too, the first order problem for reduced income from trees is land tenure, which is reflected by the tree tenure and usufruct. According to Swaminathan (1987), agroforestry is a long-term practice so it will not be surprising if tenant farmers fail to adopt it. The problem is also reflected in reduction of income from livestock due to critical feed shortage. The long-term feed shortage could be intensified due to lack of long-term secured ownership of land on which the feed development can take place.

Lack of secured land and tree tenure by various farmer groups is a serious threat to a speeded up and extended application of PAA. Peasants who are disadvantaged in terms of access to land are:

- youngsters who are married over the past one decade,
- individuals who have settled in a community after the land has been distributed to all peasants,
- households which lack the necessary labour, oxen, seed etc. to cultivate their land share,
- households which failed to pay taxes,
- ex-soldiers and returnees from settlement programme areas due to ethnic conflicts and
- those who become adults after land is distributed to all peasants.

In Region 3, the disadvantaged farmers maintain access to land through locally established produce-sharing agreements (tenancy). The commonest produce sharing agreements are:

- *Gemis* or *Yequl* (the annual harvest is divided half in half between the lands owner and the tenant)
- *Siso* (one third of the annual harvest accrues to the land owner and two third to the tenant) or
- *Erbo* (one fourth of the annual harvest accrues to the land owner and three fourths to the tenant).

In addition, secured access to a given plot of land for ploughing it for longer periods always depends on the ability of the tenant in producing higher crop yield (not trees or fodder shrubs). Therefore, every new tenant tries to get the most of the land even at the expense of its future destruction. Under such land ownership and land use situations, speeded up and large scale adoption of PAA becomes despairing. According to EFAP (1993), one of the problems in tree growing on farms is the lack of conducive land and tree tenure policy. Over the last years, frequent redistribution of land has created perception of the high risks of future dispossession and made tree growing unattractive to individual farmers.

Due to the inability of getting land to till by farmers who become adults after the land is distributed, a new social order that cripples the labour force on the farm has started emerging. Unlike the previous years where the husband and the wife are in the labour force, young land-less males are now getting married to old landowner widows for the sake of getting land. Likewise, old men who already possess land are getting married to unmatched young wives. Hence, many young farmers who are still in queue do not contribute their potential labour, which is required during the implementation phase of the PAA.

In the use of PAA, perennial plants of long gestation period will have to be integrated with long-lasting but highly labour-intensive physical structures. According to the study conducted on the possible actions to be taken for the adoption of agroforestry interventions for successful land care and rehabilitation works by farmers, it is understood that assurance of the long lasting efforts would have a significant impact.

On the other hand, from discussions held with the respective authorities of the Bureaus of the *Woreda* Council and MoA, Offices of Simada, Meket, Mekdela and Antsokia-Gemza, the benefit of assurance of compensation for willful land care efforts are understood and considered as a strategy in the manifesto of the current Amhara People's Democratic Organization (APDO) which is the dominant government political organization in Region 3. However, according to farmers who were interviewed in all of the 4 *Wordas*, the possibility of compensation intent was not communicated by the authorities concerned to the farmers.

Appropriation and improvement of conducive policy depends on availability of autonomous and mandated institution that is staffed by quality personnel. When such is the case, the staff could produce policy directives with convincing justifications. According to Maaren (1986), if the existing forest policy is to be improved, foresters have to initiate an action by putting foreword a comprehensive conception about the sector. In view of the current forestry and soil and water conservation institutional arrangement, such chances in Ethiopia are far from reality because staff and institutions of the sectors are not well organized.

One additional factor that is likely to have influence on the rate of adoption of the approach is the ability of farmers for transferring and marketing their forest produces. In this regard, farmers in the four study sub-districts confirm that they are discouraged from transferring and selling their tree products in markets of another *Woreda.* For selling inside their *Woreda*, they first need to have a permit for harvesting and thereafter, they have to pay 40% of their cash gain as royalty fee to the government. If they can not sell it for local consumption in the *Woreda*, they have to sell it to licensed merchants whose number is very limited. For instance, the number of licensed merchants in Gaynt zone who would buy forest produces from farmers of any given *Woreda* is not more than two. This highly reduced number of licensed merchants has compelled the farmers to accept the monopoly price set by the merchants for there are not many merchants who would compete for purchasing. Therefore, from the land tenure, tree usufruct and transfer right of forest produces' points of view, the possibility of large scale adoption of PAA is bleak.

Individual-focused developments.

The major targets of the participatory agroforestry approach are individual farmers. Therefore, investigating the support to an individual farmer's developments in the region is essential for the realization of the large scale application of the approach. The study, shows that land rehabilitation efforts on communal lands are given preference over individually owned lands by MoA and the NGOs. On the other hand, especially because the Ethiopian farmers have been victims of the communal approach in the socialistic era, farmers (excluding members of the PA council) are adamantly anti-communal initiatives. As a result, communal plantations have remained guarded by food-for-work paid guards who themselves abuse the plantations when possible.

In the contrary, farmers who are members of the executive committee of the PA council appreciate communal titles for at least two basic advantages. In the one hand, the executive committee establishes cases against those farmers who cut wood or let their cattle into the plantations, passes judgments and collects fines in cash and that is used under the expenditure title of daily allowance. Secondly, if there is any produce of the plantation to be sold and used, the executive committee decides for what the revenue is to be allocated. Therefore, large scale application of the new approach (PAA) that focuses mainly on individual farmer's initiatives may face difficulties from the development facilitator institutions and executive committee members of the PA council who prefer a communal approach.

11.3 Farmers' circumstances

In many peasant associations of the studied *Woreda*s, food-for-work has been used as a prime incentive for farmers to be involved in soil and water conservation and hillside reforestation. As a result, the land husbandry spirit and working enthusiasm of the farmers in the *food-for-work* areas appeared to be affected by the supply of the grain and oil. For instance, in Antsokia-Gemza *Woreda*, the percentage of farmers who showed willingness for conserving their land without external assistance in the food-for-work areas is only 54 % while in the non food-for-work (control) areas it is 79 %. In the same *Woreda*, only 19 % believe that they have benefited from the soil conservation measures (Bekele-Tesemma, 1996a).

Majority of the rural farmers contacted are constrained by capital and products from their farming practices. Their possession is limited almost in everything. They are limited in possession of farming tools, plow oxen, commercial fertilizer and income resources such as livestock products, tree resource and marketable farm products. Though the household leaders appear to be exposed to education during the illiteracy campaign of the previous regime, this is almost discontinued. Most children do not go to school for they are busy in collecting fuelwood for home consumption and feed for livestock.

So far, extension has been given through the PA apparatus. Farmers in almost all contacted PAs have expressed that such a situation has compelled them to remain in the shadow of the idea of other farmers that they do not know their background. In such a big crowd, farmers do not know one another and approve an idea forwarded by a farmer without discussing it thoroughly only because they are in fear of objecting that farmer whose political background or social status is not known. The farmers contacted expressed that acceptance of motions passed by the farmers in a big crowd does not guaranty trust and will for support of the motion. Such development decisions have no definite chance of being implemented. Farmers consider resolutions of such meetings "*Alubalta*" (deceptive and perfunctory) and confess that this has crippled the extension as well as the actual soil and water conservation work.

Farmers suggest that such a problem can be remedied by considering many of the local community cells such as the village, *Got* and *Idir* where the discussion constituencies become small enough to a level that all farmers know one another. In such a small meeting, every farmer knows the political background and scale of genuineness of each and every farmer so that they can have every basis for supporting or rejecting the point presented by any farmer before approving it for implementation. When discussing such a case with the authorities of the *Bureaus* of the *Woreda* Council and MoA at Simada, Meket, Antsokia-Gemza and Mekdela, they seem to realize the benefits. However, they are equally in doubt if scaling down the extension to a village or *Got*-level without the consent of the PA apparatus is going to be endorsed by higher authorities.

11.4 Other instrumental circumstances

The physical environment

The need for an approach that helps in willful implementation of soil conservation thereby maximizing multiple production is found very essential in the studied *Woredas* indicating that large scale application of the PAA is essential. Their soils are eroded very badly. Obliteration of soil conservation measures that have been constructed by *food-for-work* initiatives is widely observed. It is realized that an approach by which farmers' will can be developed on large scale is needed. Many farmers have stressed that the severe nutrient erosion has affected their production most. Even farms of good soil depth produce low yields. Gravel and boulders cover a substantial proportion of the agricultural lands in all *Woreda* considered for the study. The proportion of wasted land is worse than in Tikurso catchment. For instance, according to the information obtained from the *Woreda* MoA office, the size of cultivable land in Mekdela *Woreda* is as low as 29 % while the waste land is 42 %. The coverage of reforested land in the same *Woreda* is only 2 % (Bekele-Tesemma, 1996b). In all the four *Woredas* studied, soil moisture management is the problem instead of its cumulative shortage.

The socioeconomic situation of the people confirms the inferior quality of the agro-economic situations of Meket, Simada and Mekdela *Woreda*. People are extremely poor who at the current level of farming practice, could not support themselves (Bekele-Tesemma 1995, 1996a-b). For instance, in Mekdela *Woreda*, the percentage of households who can afford to produce at most half of their food requirements are only 30 %. Farmers' clothing situation and in-house belongings justify this fact. The case is justified more by their abandonment of their *Mahiber* (celebration of saints' day festivals) which had been deeply implanted in the religious commitment of these ardent believers of the Orthodox Christianity.

The farming system is not complex. Cereal farming is dominant. However, in few places, complex home gardening such as Rhamnus-Coffee vegetable mixes can be observed. In addition, trees, mainly *Eucalyptus globulus* and *Eucalyptus camaldulensis*, are observed in the plateaus of *Weyna-dega* and *Dega* agro-climatic zones of the *Woreda*s studied. Feed development is in great demand. The conservation practice that farmers use is mainly drainage furrow for draining excess water from their fields during rains. Soil conservation structures are continually obliterated. The causes to their destruction are not different from those indicated in Table 7.9. Other soil conservation practices such as manuring by distributing decomposed livestock manure, though known, is constrained by significant consumption of the manure for fuel. In Mekdela *Woreda* alone, dung cake and crop residue account for 57 % of the household heating and cooking energy demand. In the same sub-district, for 98 % of the households, the land area allocated for tree growing is less than 2 %. In view of the above indicated physical environments prevailing in Region 3, the benefits of application of the PAA at large scale are justified.

Indigenous knowledge

The farming practices observed and results of discussions held with farmers confirm that the farmers possess similar farming practice, land management and livestock feeding knowledge to those studied at Tikurso. From the difference in naming, configuration, species preference and application of flood control and routing, tree planting, fertility enhancement and moisture management between the *Woredas* studied, it is realized that many of the farmers have important knowledge to offer in PAA application. At the same time, the combination of the indigenous knowledge within the introduced reforestation and soil and water conservation is in its infancy. For instance, for trees whose end product is not intended to be large poles or lumber, farmers' stocking density is as high as 10 000 - 40 000 per hectare while the facilitators still insist a spacing of 2-2.5 m by 2-2.5 m or 1600-2500 trees per hectare. Facilitators do not seem to bother finding why the farmers are doing the way they do and how compromising solutions could be promoted. On the other hand, farmers do not seem to bother about the improved technologies facilitators preach. For instance, the number of farmers who used agricultural practices such as soil conservation, growing of livestock feed, usage of fertilizer, contour plowing, preparation and application of compost etc., in Antsokia-Gemza *Woreda* is not more than 30 %.

CHAPTER 12

REFLECTION

This chapter reflects on some of the limitations of the study, strength of the participatory agroforestry approach and likely conditions of large scale applicability of the approach in line with the preceding discussion in Chapter 11.

12.1 Limitations

Site representation

The study on the construction of PAA has been conducted in the moist *Weyna-dega* agro-climatic zone, which is only one of the 11 agro-climatic zones of Ethiopia. Though it is the largest agro-climatic zone in the country, in its coverage, it can not be claimed that it represents all the agro-climatic zones in the country. In addition, the study has been conducted in an Amhara society, which has an extensive and established social tradition, belief, culture and farming heritage, which may not be reflected equally even throughout the moist *Weyna-dega* agro-climatic conditions of the country. Furthermore, the study on the possibilities of large scale application of the approach has been conducted with reference to Region 3. However, there may be variations in resource management policies, farmers' circumstances and indigenous skills. Therefore, though the approach's large scale applicability is justified, its application needs to be treated with a strong adaptation component.

Always under construction

The devised participatory agroforestry approach is never complete. First of all, the application of the approach is not in its final stage. Collection and assessment of feedback information necessitates implementation and follow-up of the interventions for a longer time than allocated for this study. Therefore, the evaluation conducted at the study level in Tikurso does not represent all the conditions that may occur in the many years to come. In addition, the approach involves integration of knowledge and practices that continue to be discovered through time. Our knowledge about social diagnosis and environmental assessment grows continuously. The same is true for the planning, adaptation, implementation and evaluation steps of the approach. This very truth of continued gain and -synthesis of knowledge is inherent in the cyclic nature of the approach and implies that the approach is never complete.

In addition, the components of the approach change in accordance with changes in geopolitical situations. For instance, at Tikurso, intervention categories are defined by only two of the three locally acknowledged land quality grading variables due to the fact that soil fertility is uniformly deficient. In other situations, the number of variables may increase or may change type. Always, application of the approach appreciates readiness for investigation of new knowledge and experience by which its construction approaches perfection. Furthermore, the study has dwelled more on learning and discovering knowledge from indigenous practices, which are also influenced by local norms and customs. Because the local customs and traditions may mask the true nature of the information, it is likely that much more lore remains undiscovered. Therefore, the study should be treated as preliminary and more studies need to be done.

A lot of the details of the trust building attributes are still in their abstract form and can not be equated in an equation of definite and easily applicable variables. The same is true for the execution modalities of the on-farm discussion method. The success reality in trust building still depends on the rate of understanding of the abstractions and corresponding abilities of facilitators in convening illustrated versions of these abstractions. At the same time, the impact of the strength of the social institutions, education standard, the effect of the wealth-status and age or clan of the local elders and social institution leaders require further study.

Adherence to "soft" system approach

The construction of the participatory agroforestry approach has been engineered by a farmer participatory research (FPR). It involved farmers in various processes of the research in order to build trust, conduct social diagnosis and environmental assessment, plan, adapt, implement, test and evaluate indigenous knowledge-based agroforestry and soil and water conservation interventions which are appropriated to the needs of individual farmers. Thus, unlike more customary research approaches that are devoted to pre-established and more analytical researching methods and procedures, this FPR has followed a soft-system researching methodology. The objectives of the research that are deeply seated on maximization of farmers' participation in the implementation of agroforestry and soil and water conservation practices did not allow to follow the systematic and externally defined ("hard") system approach. Except at abstraction level, the conceptual framework of the research in PAA has not been organized in a methodical context either. Therefore, PAA construction has been fully envisaged to be engineered by a "soft" system approach.

As applied in this study, soft-system researching approach is a style of investigation that considers knowledge development to be a multi-dimensional and interactive process that involves learning, validating and applying adapted knowledge for further investigation into the human/nature interaction by doing. The researching tools and methods give consideration for and build upon new findings and circumstances. The researching tools and methods become more developed and best orientated towards the fact within the research in action. The system is composed of continued interactive learning through dialogue and reflex that occurs between the facilitator (researcher) and the farmers in doing. As indicated in Scoons and Thompson (1994), under such a "soft" system approach, the boundaries between the researcher, the extension facilitator and the farmer are broken down. The researcher is no longer considered to be a detached, invisible investigator but acts as a catalyst, a facilitator and provider of the research occasions.

At the same time, endorsement and usage of the "soft" system approach in the construction of PAA does not imply rejection of scientific knowledge but it implies that the investigative approach needs to involve the farmers and address their perceptions, aspirations, knowledge and constraints. It is then, that, the agroforestry and soil and water conservation science can accommodate situation specifics of knowledge and create a common ground for ease of its applications. However, as rightly indicated in Scoons and Thompson (1994), a lot remains to be done on the nature of the farmer-researcher (facilitator) roles and relationships. A more detailed and quantified presentation on the application of the soft system approach, as applied in the development of PAA, has been beyond the scope of this research and a lot remains to be done. Therefore, in addition to a search for optimization of the integration of the components of the agroforestry systems with the soil and water conservation measures, combining the farmers' knowledge with the facilitator's knowledge in right proportions needs to be explored in a greater detail in future studies.

Lack of data

There are two major areas where this study suffered from lack of reference data.

1. Due to the 'soft' system nature of the research, there has not been a pre-sorted and asserted methodology. In addition, the plan adaptation and implementation as well as the evaluation phases of the research have been conducted on real size holdings where there is no possibility of establishing control plots. Instead, base year data have been used as reference. Obviously, the base year data from the farmers are not retrieved from document sources. Data have to be salvaged from farmers past memories. Therefore, even those limited data need to be treated with caution.

2. The tree and shrub species used in the study are mainly indigenous species which have not been concerns of classical professionals. Therefore, country and agro-climatic-specific documented data on growth performance of these species could not be found. Even for the exotic species, finding documented source on growth performance under moist *Weyna-dega* agro-climatic zone proved to be impossible. Except rating the growth performance in qualitative terms, farmers could not estimate growth increment of either of these species under similar conditions to that of the study area. Therefore, the comparative growth performance of the tree and shrub species is rated only in qualitative terms.

12.2 Strengths and weaknesses of the study

There are a number of strengths and weaknesses in the study. They are discussed in line with the research questions posed in Chapter 2.

Trust building

The first research quest has been getting an answer to the research question ' how is trust built between the farmers and the facilitator?' As indicated in a number of literatures such as those in Schoons and Thompson (1994) and Chambers et al. (1989), real participation of farmers is a prerequisite for success in rural development. Therefore, a methodology by which this trust, solidarity and friendship between the farmers and the facilitator can be established is searched. A participatory learning and trust building process is constructed (Figure 3.1). By using the trust building process which is discussed in Chapter 3.1, a tested methodology on how to network with local institutions and authorities for facilitating trust building is devised and discussed in Chapter 7.1. Where and with whom trust can be effectively established are identified. The duties and responsibilities of a genuine facilitator are indicated. The comparative strength of local institutional leaders and authorities as well as various levels of discussion forums through which trust is built are given. A mechanism by which learning the societal facts, traditional values and local customs and applying what is learnt from building the trust in a participatory process is developed and presented. In realization of its applicability, it is possible to infer that the trust building method can be applied on a large scale with the necessary changes and adaptations. However, large scale application necessitates premise for respect of truly bottom-up and non-hierarchical facilitation and significant consideration of indigenous knowledge. Such conditions need to be created anew.

Socioeconomic diagnosis

Next to trust building, the second research question has been finding an answer to the question 'How can socioeconomic issues (such as those that are related to the use of soil and water conservation measures and development priorities of farmers) be detected?' The question is addressed by constructing a participatory learning and socioeconomic diagnosis methodology that indicates the processes of the diagnosis (Figure 3.2). The elements of this socioeconomic methodology are elucidated under a case study condition in 7.2. In general, the approach follows the diagnosis and design (D & D) methodology (Raintree, 1987). The distinction is that the socioeconomic diagnosis process in PAA is entirely farmer-driven and facilitator-guided by which the farmers are the core role players in diagnosing facts and issues by themselves as well as planning and implementing for themselves. To facilitate farmers' participation in the diagnosis, the tools of socioeconomic diagnosis are intentionally decided to be locally known, farmer-discernible and applicable within the existing socioeconomic setting. PRA workshops and matrix ranking techniques, questionnaire interviews with individuals and farmer-groups and on-farm discussion method (OD) are used.

A participatory learning and socioeconomic diagnostic approach is devised. However, in the realization of the strength of the socioeconomic diagnostic tools (PRA, QI and OD) for addressing the purpose that they are intended for, both strengths and weaknesses are witnessed. A detailed reflection is made on the applicability and strength of these socioeconomic diagnostic tools as follows.

Participatory rural appraisal (PRA): In using the Participatory Rural Appraisal, the community come together in groups and appraise the community development plan in a participatory approach. They discuss, develop problem trees, rank and prioritize problems and options etc. Unfortunately, the people in the community, like any other area in the region are socially diversified by wealth, age, education standard, gender, clan, etc. and almost always it appeared that there are few spokesmen emerging from the group. At the same time, it is felt that there are disadvantaged groups whose opinions are masked by presumably superior farmers. Even when the number of discussants is reduced to few (4 or 5), it is found out that they differ by age, clan, esteem, etc. and the opinion is swayed to a certain direction. When the number of participants increases, the discussion become highly dominated by those socially acclaimed spokesmen. Even under tempting discussion situations, the disadvantaged group are observed in facing difficulties for approving or rejecting ideas by their own merit. Therefore, planning development plans at farm level on the basis of the findings of such a PRA-discussion alone becomes, to a certain extent, erroneous. However, for obtaining macro-level information which may have universal acceptance and truth, PRA proves to be the best diagnostic tool (Figures 12.1 and 12.2 on page 164 and 165 respectively). It portrays the truth on community-level issues and possibilities that are governed by community influential.

Formal Questionnaire Interview (QI): The usage of guided individual interviews (Beebe, 1985) also shows weaknesses and strengths. QI is an important method for obtaining data that can easily be assembled and statistically explained. This is more so for those issues that the respondent is confident and free to deliver information. Unfortunately, in many of the socioeconomic issues of farmers in Ethiopia, such freedom and confidence has been eroded. Consequently, in quite a number of issues, the interviewee farmers from Tikurso catchment are observed in deflecting facts that are related to their personal properties, income, family size, etc. Their reasons are:

- fear of accountability to what they inform due to political implications that the outsiders use to give
- fear of getting undermined for smaller quantities or inferior qualities they report
- fear of high tax and contributions that government institutions attach if the high quantities are reported
- cultural beliefs in that their wealth posterity can dwindle by jealousy of evil sprits if the relatively big magnitude of their wealth or greater number of their children is reported and recorded

For instance, when comparing the number of cattle they reported in QI with what is actually observed in a house to house visits in OD, it appeared that farmers have a greater number of cattle than they actually reported in the QI. In a few other instances, they have reported more than they actually possess. For instance, when they are asked for the type of grain they often eat in the family, they have reported the 'superior' staple crop (*Eragrostis teff*) while actually they are using *Sorghum vulgare* or a mix of the two.

In addition, it is very difficult to interview farmers in a very good interviewing atmosphere. Getting the respondent alone is very difficult for the required period of time. Whenever the interviewer comes to the place of interviewee, people crowd around and try to adjust responses of the interviewee to their opinions. It proved difficult or culturally unpleasant to avoid these assistant respondents. At the same time, interviewees do not appreciate the presence of these people.

On-farm discussion method (OD): After PRA and QI usage, the on-farm discussion method is employed for rectification of facts in the socioeconomic diagnosis work and adaptation of catchment-level plans to farm and farmer-level. If the necessary trust is build-up in advance, on-farm discussion (OD) is the preferred tool for investigating farmer and farm realities that are more genuinely related to likely conditions during the implementation. Since it is a down-to-earth approach, farm-level findings can be obtained from farmers who also share common boundaries in farming. It enables us to obtain refined information in the light of not only social but also site conditions at the same time. However, OD has its own weaknesses for ease of application. It strongly requires creation of trust between the facilitator and the farmer in advance which has not been the case in Ethiopia in the past due to the ingrained top-down extension approach and repressive roles of facilitators. There is no structured format in its application yet. It is entirely dependent on the mood of the discussant and timely activity of the farmer. It is more tiresome than the other methods because it requires actual participation of the professional in field activities. It entails that facilitators in soil and water conservation as well as agroforestry need to have rural extension knowledge in consideration of the technical knowledge that the farmers possess.

Facilitators need to raise local custom-conscious relevant questions for discussion as appropriate. They need to have excellent memories for recording queries to be asked and responses obtained. They need to record the answers mentally for later retrieval and documentation. Moreover, since there are community-influenced and directed activities that every community member as a member must comply with and PRA is more suited to diagnose, OD requires to be supplemented by PRA.

In general, each of the three diagnostic tools of social diagnosis shows strong and weak points. One is found more suited to diagnose a certain social concern than the other. Farmers expressed different feelings for each of the diagnostic tools when they participated in each. Hence, evaluation of the three diagnostic measures against selected issues has been tried. Based on the experience obtained from using these social diagnostic tools, 20 different issues (Appendix E) are prepared in the form of a written questionnaire. The questionnaires are then given to:

a) Local headquarters (HQ) staff and expatriate technical advisors whose duties dwell in preparing policies and technical directives in the sectors,
b) development facilitators who are involved in interpretation of policies and technical directives as well as supervision of their implementation by farmers, and
c) farmers who are the final decision makers on whether to adopt or reject development initiatives that are extended to them via PRA, QI and OD jointly or separately.

The questionnaire (Appendix E) includes community-level, individual farmer-level and farm-related issues that are required for getting information for participatory planning and implementation of agroforestry interventions for soil and water conservation. A few of the questions are intentionally repeated with slightly different wording for building a firm opinion on the subject.

According to the result obtained from the evaluation of the social diagnostic methods (PRA, QI and OD), there is a general agreement that PRA is more appropriate for issues coded Q1-Q10 with an exception of Q7 and Q9 (Figure 12.1A). Likewise, for socioeconomic issues coded Q11 - Q20, the on-farm discussion method is favored (Figure 12.1C). In addition, though with distinct magnitude differences between the ratings of the various respondent groups, the QI shares the high score for issues coded Q4 - Q8 with PRA (Figure 12.1B).

However, the score for Q7 (that asks for singling out the non-preferred method that farmers appreciate not to participate in) is generally high for QI indicating that it is the method where farmers would prefer not to participate in at all. The HQ staff favor PRA for issues such as Q2, Q3 and Q4. The same opinion is reflected by the technical guide and policy interpreter experts (Figure 12.2A &B). However, farmers feel that OD is also substantially favored next to PRA (Figure 12.2C). The rating for Q7 also demonstrates the

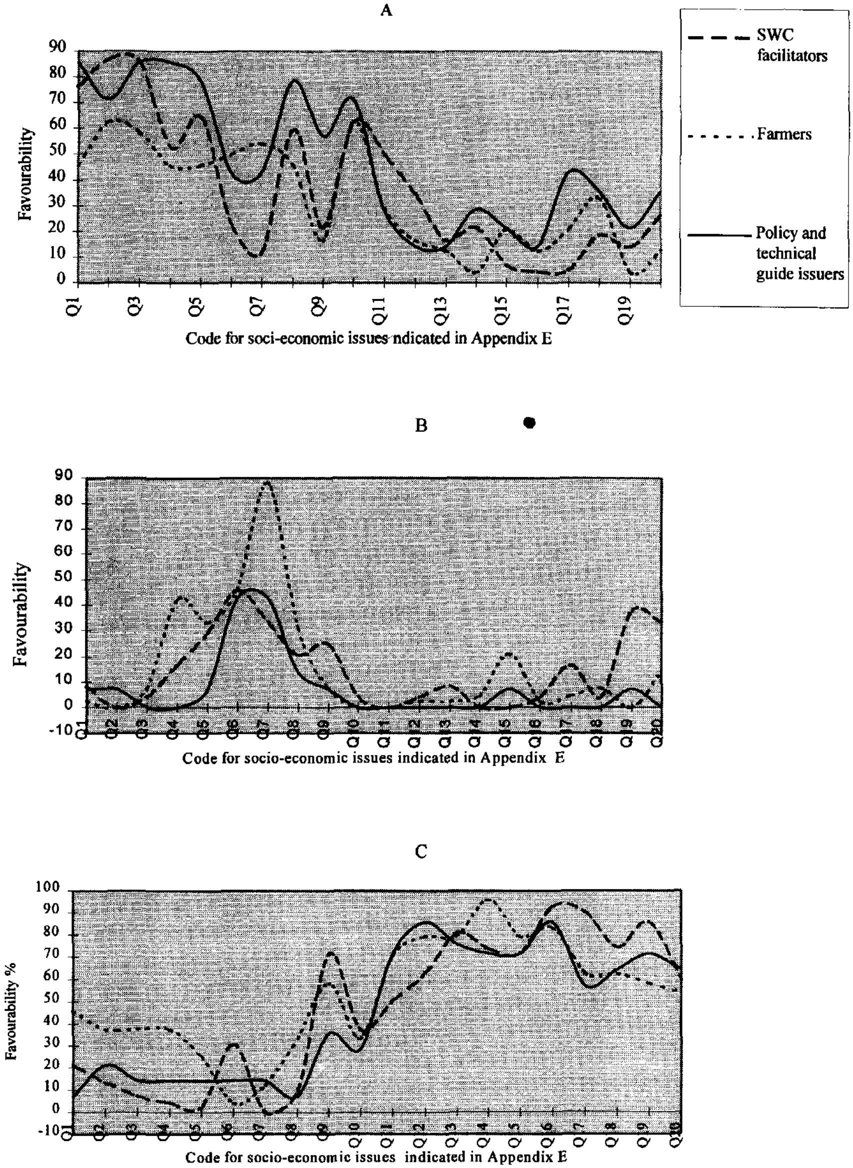


Figure 12.1 *Comparative favourability of PRA (A), QI (B) and OD (C) for diagnosing various socio-economic issues indicated in Appendix E as rated by soil and water conservation facilitators, Policy and technical guide issuers and the farmers.*

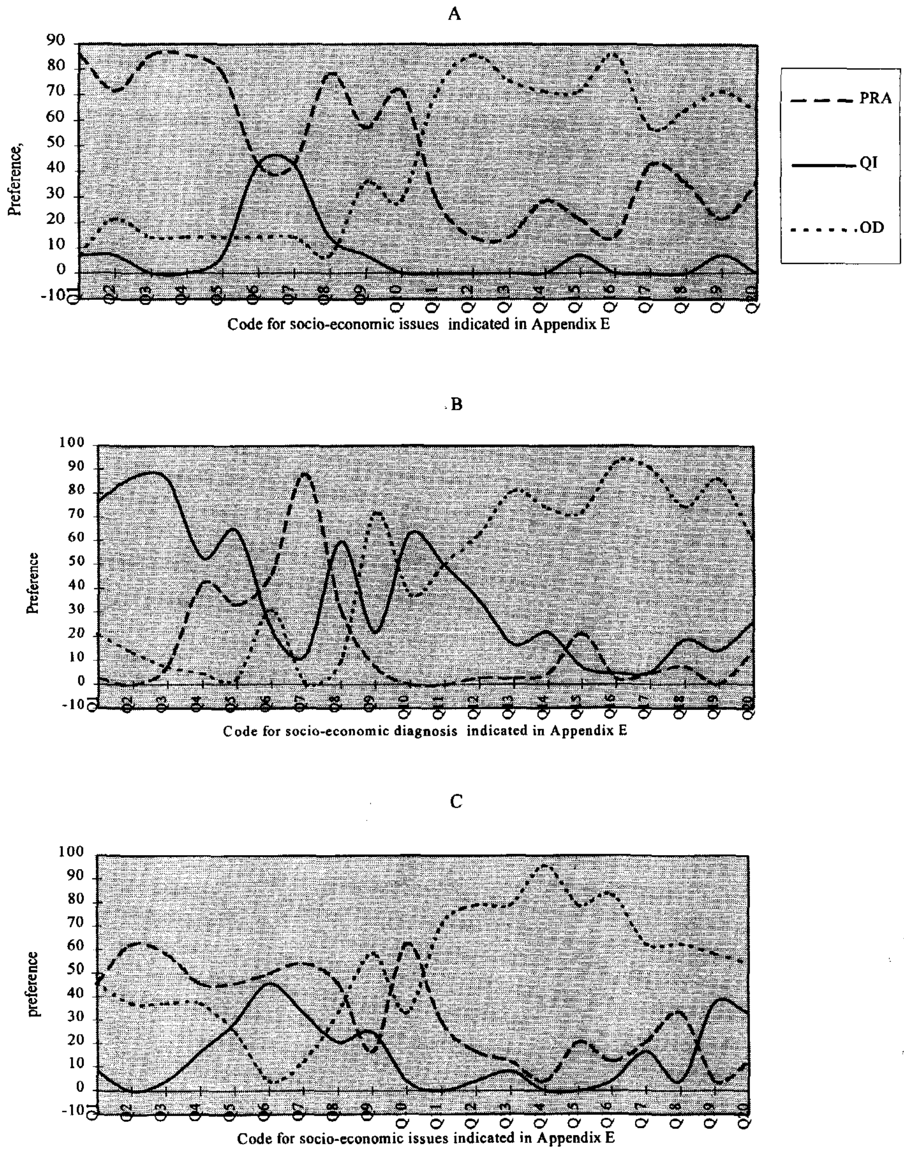


Figure 12.2 *Comparative preference of community forest and soil and water conservation policy and technical guide issuers (A),soil and water conservation facilitators (B) and farmers (C) among the three socio-economic diagnosis tools (PRA, QI and OD) for diagnosing various socio-economic issues indicated in Appendix E*

difference in valuation of the different socioeconomic diagnostic tools between the development catalysts and the farmers. The head quarter staff (Figure 12.2A) and their subordinate experts (12.2B) believe that farmers would appreciate not to participate in QI while farmers (12.2C) would appreciate not to participate in PRA more than in QI.

The evaluation indicates that there is a general agreement by all the three groups that OD and PRA are more appropriate diagnostic tools (Figure 12.1A-C). Both the farmers and the HQ staff believed that PRA is the most appropriate tool for diagnosing community-centered issues while OD is the most appropriate tool for diagnosing potentials and constraints of individuals. However, farmers, unlike HQ staff, also believed that OD could significantly be useful in understanding development potentials and constraints of the community as a whole (Q1-Q4 in Figure 12.1C). On the other hand, farmers confirmed that they would appreciate not to participate in PRA (Q17 in Figure 12.1C). Farmers, unlike development facilitators, also indicated that PRA and OD methods would allow socially and politically superior persons to undermine or cover up their opinions. Here, they preferred the QI method (Q6 in Figure 12.1C). Development facilitators thought this would be so in PRA and QI instead. The HQ staff believed that PRA would be the best tool for diagnosing issues related to neighbouring farmers and farms while farmers believed that it is OD (Q9 in Figure 12.1C).

Environmental assessment

The third research question has been "how can a farmer-understood and accepted environmental assessment be conducted?" Initially, a methodology by which indigenous land quality assessment variables are identified in the socioeconomic diagnosis phase. After this identification, a methodology by which participatory site familiarization and land surveying can be conducted is constructed and used. Spatial distribution of land constraints is illustrated by GIS-processed mapping. Environmental facts and issues that are inputs to the planning phase of the approach are enumerated. The procedural learning and environmental assessment processes are assembled (Figure 4.2). The method by which GIS applications can be appropriated for generating environmental assessment as a side information (in a form of map) is presented (Figure 4.1).

Devising agroforestry interventions

The fourth research question asks for a methodology on "how farmer-based agroforestry interventions could be devised in discussion with farmers". In this sector of the approach a methodology by which the agroforestry interventions can be devised is constructed. The method involves, socioeconomic facts and issues (identified by the socioeconomic diagnosis methodology), environmental facts and issues (diagnosed by the environmental assessment methodology) and relative land potential bounds of the site (identified by the environmental assessment methodology). The modality of learning and intervention planning in the implementation of this methodological approach is developed (Figure 5.1). Planning has been effected through review of potentials and constraints of the catchment and production desires of farming communities under the existing indigenous knowledge and technology adaptation possibilities. Each of the matters are thoroughly discussed repeatedly with planning farmer groups. A methodology is devised. By the application of the method, possibilities of producing short-term and diversified income under conservation-conscious agroforestry development can be debated and consolidated in the planning process. The participatory learning and planning process enables one to make a compromise about conflicting views of planning topics. The method enables one to make gradual improvements in viewing realities. The developed planning method enables one to tap indigenous land rehabilitation skills of farmers. Planning is exercised in considerations of procedures that lead to negotiated agroforestry intervention plans. Defining planning units in association with site conditions is simple due to the fact that it is based on physical factors. In the case of Tikurso catchment, only slope and soil depth determine it. In other situations, more factors may be included.

Will and incentive

The fifth research question craves for a methodology on "how farmers' implementation will can be build and what incentives (if any) are still required." The methodology by which farmers' will can be raised is multi-faceted. Creating the required trust and solidarity between the farmers and the facilitator is a prerequisite. In PAA, the methodology by which the trust is build is addressed. It includes being considerate to farmer's problems, production desires and available inputs such as labour. Encouraging the farmer to adapt catchment-level plans and prescriptions best fitted to the farmer's and farm's realities helped too. Implementation is preceded by adapting the catchment-level plan and prescriptions to a farm and a farmer level conditions by which the special interest of individual farmers is entertained. The method by which such issues are addressed effectively is devised. The components and the method by which the planning and prescriptions are adapted to the farm with the respective farmer are the possibilities by which farmers' interest for implementation of the planned interventions is increased. The results from the exercise has support the case.

The study on conditions for large scale applications show that many of the farmers in Region 3 are victims of top-down extension approach, poverty and food-for-work subsidies. In a few other occasions, the land husbandry practice becomes more of a community-level undertaking that a committed single household is not able to fulfill. The top-down approach is effectively replaced by the PAA. However, motivation of farmers for willful involvement in land husbandry (mainly at community level) can also be speeded up through the use of adjoining and effective means of incentives.

Farmer-understood evaluation

The last and sixth research question in the PAA development exercise has been the development of farmer-based agroforestry evaluation methods by which the farmers can realize the shortcomings and successes of their own doings to be used as a feedback for further improvements. The application of the participatory learning and evaluation methodology, which is developed in the study of PAA (Figure 6.2), has shown that farmers can perceive the evaluation process. The evaluation on land sustaining quality of the interventions involved the pin method. It showed the size of soil movement, in simple and attractive means to farmers. Comparison of growth and yield in successive years is also found useful.

More than any of the measurements that farmers were subjected to, observation of the crop performance in the field is found impressive and convincing in the validity testing efforts. The participatory learning reveals that field crop performance assessment during the growing period is necessary especially due to the fact that the final crop harvest may be misleading. This is mainly due to occurrence of crop damage by locusts, unexpected rain at the time of harvest especially for *Eragrostis teff*, or fire that are all not related to the land husbandry. In addition to what are considered as performance evaluation factors, durability of the technologies is found to be a measure of appreciation of the approach.

Another measure of validity assessment considered to be very useful by the farmers is the healthy coexistence of the recommended trees and shrubs in the agroforestry interventions that are implemented.

Indigenous knowledge

One distinguishing strength of PAA is its apparent usage of validated indigenous knowledge in combination with the scientific knowledge. In the combination of the indigenous knowledge with the scientific knowledge in PAA, the premise is that indigenous knowledge is an equally relevant information whose benefit is improved by giving it scientific dimensions (validating) and creating order out of the disordered knowledge. This is achieved through a process of learning by doing, initiating critique, devising practicable planning and doing all of it in a dynamic, adaptive and negotiated research. Hagmann and Kurwira (1996) indicate that synthesis of traditional techniques and new methods for soil and water conservation could be adapted to specific sites, situations and farmer needs. Likewise, in the synthesis of farmers' knowledge with the scientific knowledge by PAA, the facilitator has been facilitating, initiating, catalyzing and providing occasions for the fusion and synthesis of the knowledge systems.

The fusion has been effected in an action research that uses local methods. The venue of combining the indigenous knowledge with the scientific knowledge has been collaborative work of the farmers and the facilitator through dialogue, farmers' and facilitator's critique, negotiation and mediation. The importance of such local technology screening and validating process is stressed in Richards (1994) when he said "for local knowledge to be valuable for development, there must be some way to judge its quality and the quality of inferences drawn therefrom".

Throughout the construction of PAA, knowledge is produced by splitting facts and issues and learning from patterns in similarities and incongruous ideas for synthesis of knowledge through debates, discussions and compromises. The general theme has been "splitting facts preempts clarity on facts and facilitates systematization". It is after exhaustive study of the diversified indigenous knowledge that systematization is exercised. Farmers' knowledge is used as an endless source in mediating and resolving conflicts, socioeconomic and environmental valuations, planning farming systems and evaluating failures and successes. Farmers' active involvement in the generation of knowledge has made the development of the PAA for soil and water conservation comprehensive, factual and rich. In PAA, fusion of the indigenous knowledge with the scientific knowledge is a common denominator and has been used throughout the construction process of the approach itself. The same is applied in the preparation of the prescriptions for the agroforestry interventions.

12.3 The Role of the facilitator

Studying the role of the facilitators is beyond the scope of this research. Therefore, the subject is not treated as much as it deserves to be treated. However, the subject is realized to be a key factor in determining the success in the application of the participatory agroforestry approach. Therefore, based on the experience gained in the study of 'conditions for large scale applications' and the various literature which addressed the subject, reflections on the role of the facilitators of agroforestry and soil and water conservation interventions are given. Kruger et al (1996) comments that the facilitators used to undermine indigenous knowledge of farmers and most experts are largely unaware of indigenous soil and water conservation skills in Ethiopia. Survival strategies of farmers, risks faced when they are operating with low levels of external input, phasing strategies of construction of conservation measures by farmers and flexibility of traditional approaches of farmers have been frequently ignored. The facilitators have been more of instructors instead of providers of occasions, managers of soil and water conservation and reforestation developments instead of catalyzing farmers' developments.

On the other hand, participatory agroforestry approach is an approach that demands superior quality from a facilitator. The core activities of the approach are:

- initiating new innovations,
- learning from indigenous knowledge and experiences,
- splitting facts analyzing trends, correcting and adapting weak segments of local knowledge,
- compromising on divergent issues,

- moderating in farmer participatory discussions, blending in with societies,
- catalyzing farmers' active participation and doings, appreciating traditional knowledge and experiences.

In addition, the approach involves both technical expertise in diversified fields (forestry, soil conservation, crop science, range science and planning) with extension. A real facilitator that integrates the technical subject within the existing problems and potentials of societal realm is required. From the experience in this study, it is realized that no approach is appreciably good to the farmers unless it embraces technologies that contribute to their production increment. In this regard, what is expected of the new facilitator is significantly greater than what is currently available.

12.4 Transformation of the conceptual framework

At the start of the study, the conceptual framework has been developed (Chapter 2). It is recalled that even the core parts (steps) of the framework have been perceived at an abstract level. After five years of farmer-participatory action research work, those abstractions are made clear. The six steps of the conceptual framework are developed into six sub-processes of a comprehensive participatory agroforestry approach. Each sub-process is having a number of steps (Chapter 13) whose details are logically arranged in six learning and acting flow diagrams (Chapters 3 and 4). In this logical arrangement of the parts, it is realized that the approach is made up of several interdependent, closely connected and nested sub-process loops that continue to develop and become more comprehensive. In fact, due to this in-built characteristic of fluidity, cyclic and nested nature of the parts of the evolved approach, even creating an academic split and writing the thesis in a systematic format proved to be difficult. The transformation of the conceptual framework into this more comprehensive participatory agroforestry approach has shown that its development involves a great deal of zeal, expertise, patience and above all appreciation of local circumstances. Its application will undoubtedly require such qualities at a greater depth and intensity.

12.5 Time efficacy

Participatory agroforestry approach works against promptitude. It involves developing the consciousness and will of farmers so that they can be self-committed for investing their labour and other resources. At the same time, it requires significant blending ability of the development facilitator within the community by studying and demonstrating local norms and customs. Moreover, indigenous knowledge-based rehabilitation techniques and land use appropriations would have to evolve. All these attributes require sufficient time. In this regard, it may be right to question the validity of the approach for the desperate land rehabilitation requirements of Ethiopia. However, without undermining the urgency of the solution to the land degradation problems of Ethiopia, it is felt that this approach can be one of the quickest possible land rehabilitation options.

It has been indicated that a lot of resources have been deployed in soil and water conservation and reforestation programmes in the country for more than two decades. It is sad that there is not a single peasant association or even village where soil erosion is halted and useful conservation is effectively practised by farmers' committed involvement. Had it been possible for one facilitator to effectively convince one farmer in a year (slower than the PAA pace), the existing 3000 development facilitators of the MoA could have had more than 60000 farms effectively rehabilitated within the last 20 years. This is of course without considering the farmer-to-farmer extension effect which could have had resulted in unprecedented success.

In the creation and application of PAA at Tikurso catchment, it has been attested that it is possible to convince and involve a dozen of innovative farmers in land rehabilitation in just a year time. When the rate of adoption of the interventions is judged, even at the researching pace, it appears that at on the average, a facilitator can have more than 10 new farmers committed for the improved land usage every year. The multiplication effect of the outcome of the approach could have been increased had the facilitator (the researcher) not been involved in research attributes in addition to the extension work. In addition, if the land tenure issue, which is identified as one of the first three barriers of integration of trees into farming systems and using of introduced soil conservation measures on farms (Table 7.9 and 7.10), is made conducive, the success can be improved significantly and the time efficacy of the approach becomes excellent.

CHAPTER 13

CONCLUSIONS

13.1 The approach

Participatory agrofrestry approach is a process by which soil and water conservation techniques are integrated with agroforestry components to form soil and water conservation-conscious agroforestry interventions through a committed farmer-participatory interaction. The interventions are deliberate associations of physical soil and water conservation measures with useful tree/shrub species and grasses for production of food, wood and feed by individual farmers while conserving the resource base. PAA's goal is production of compromised agroforestry interventions and willful implementation of the interventions that foster land rehabilitation issues of the land and production desires of farmers.

The approach is made up of 6 inter-linked sub-processes (Figure 13.1). Each of these are composed of various activities that involve different tools and are accomplished in various steps. Each of the sub-processes involve and integrate a great deal of techniques blended with farmer-participatory action approaches. The activities addressed at the various steps of each of the sub-processes are put into participatory learning and acting flow diagrams (Chapters 3, 4, 5 and 6). Due to this inherent inter-linkages of the various sections of the approach, making an academic split and writing the methodology and nature of the approach, without using the information obtained from the case study, proved to be very difficult.

The first sub-process deals with staying within the vicinity of the community and building trust among farmers. It has four important components. These are:

- studying and applying local norms and customs
- using local elders
- using local institutions
- applying audiovisual-aided animation.

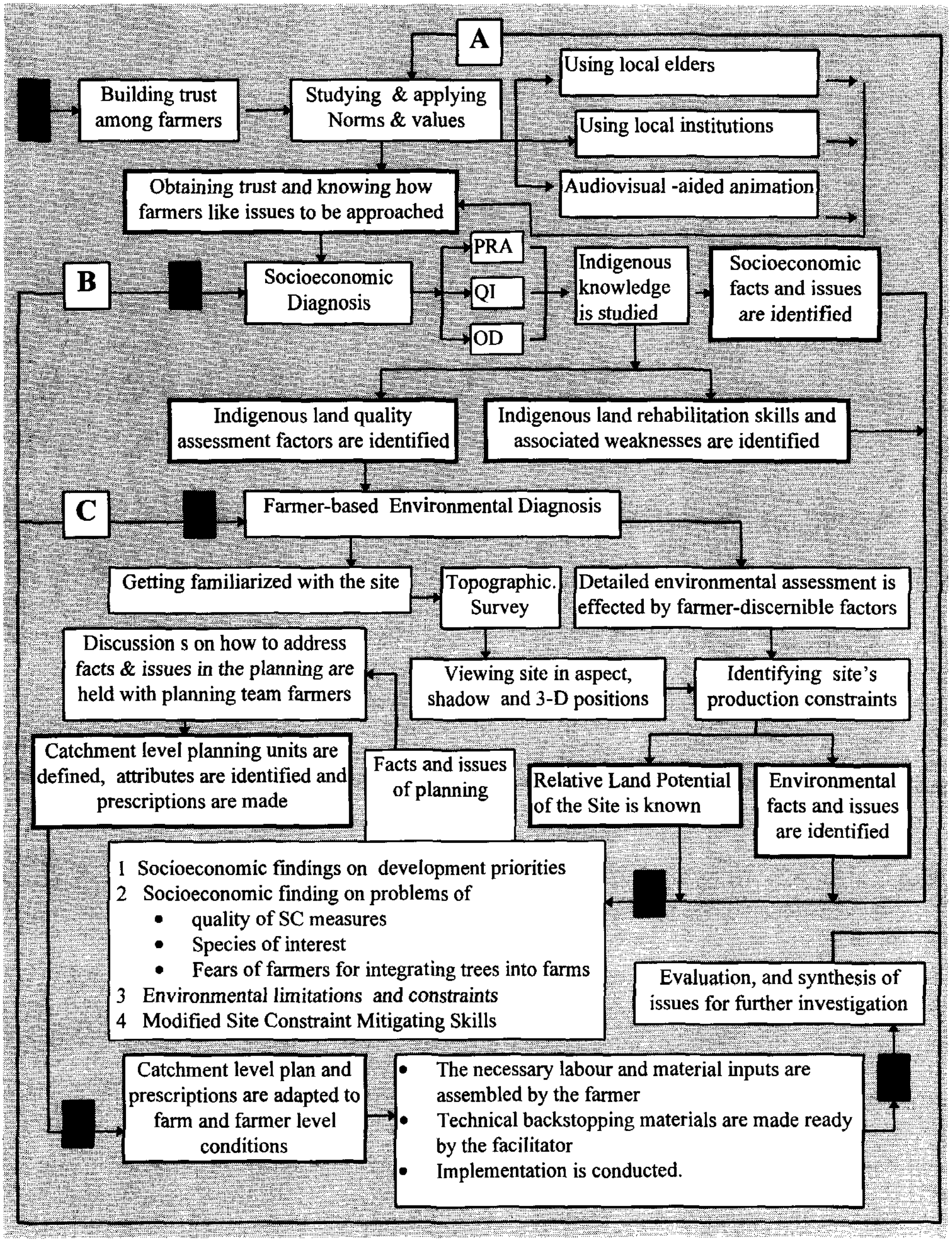


Figure 13.1 *Components and flow patterns of the processes of participatory agroforestry approach: A, B, and C are possible entry avenues for further improvement of the approach while 1, 2, 3, 4,5 and 6 indicate the distinct sup-processes of the approach*

The outcomes from the sub-process are:

- obtaining the required trust that has been missing in the implementation of soil and water conservation and reforestation programmes in Ethiopia.
- knowing how farmers like to be approached in socioeconomic diagnosis work and facilitation of developments.

The method by which the above indicated components are used and the outcomes are generated is a participatory learning and trust building method. This is illustrated in Figure 3.1. The second sub-process is a participatory socioeconomic diagnosis. It enables identification of socioeconomic facts and issues that are the basis for the fourth sub-process of the approach (Participatory planning). The socioeconomic sub-process further enables us to study indigenous land constraint mitigation skills and traditional land quality grading principles. The traditional land rehabilitation skills and associated problems that are identified by the application of this sub-process are useful for the functioning of the fourth sub-process. The indigenous land quality grading principles and variables that are the outcomes of this socioeconomic diagnosis sub-process of the approach are the basis for the third sub-process (participatory environmental assessment). The tools of this second sub-process are PRA, QI and OD as appropriate while the system of conveyance is the participatory learning and socioeconomic assessment method (Figure 3.2, Chapter 3). The third sub-process is participatory environmental assessment and has basic components of:

- familiarization with the site
- detailed site diagnosis
- identification of production potentials and constraints

The outcomes of this sub-process include categorization of the development site by relative land potential classes and enumeration of environmental facts and issues that all are the basis for the functioning of the fourth sub-process (participatory planning). The mechanisms of this environmental assessment sub-process are soil laboratory assessments, GIS applications and dialogue with farmers. The system by which the sub-process functions is illustrated as a participatory learning and assessment method (Figure 4.1, Chapter 4)

The fourth sub-process of the approach is participatory planning of soil and water conservation conscious agroforestry interventions at catchment level. It is concluded that the sub-process of the approach deals with:

- correction of the weaknesses of the indigenous land constraint mitigation skills
- determining compromised agroforestry intervention planning units by adjusted bounds of land quality grading variables
- compromising and associating the various production desires of farmers with the different production potential of the site
- determining on the attributes of the agroforestry intervention units and preparing compromised and adapted technical soil and water conservation and agroforestry prescriptions for each of the identified planning units

The sub-process is facilitated by the application of GIS and repeated and exhaustive discussions with the farmers in the planning team. The system by which the sub-process functions is illustrated as a participatory learning and planning method (Figure 5.1).

The fifth sub-process of the constructed participatory agroforestry approach is adaptation and implementation of catchment-level agroforestry and soil and water conservation plans to farm and farmer-level situations. The sub- process involves:

- identification and sketching of agroforestry and soil and water conservation implementation units of a farmland in accordance with catchment-level planning-unit specifications
- adapting the details of the attributes of the technical soil and water conservation and agroforestry prescriptions in accordance with the choices, priorities, capabilities and desires of the innovative farmers
- organizing and availing the required input
- catalyzing the implementation in action

The basic requirements of the sub-process are intimate friendship between the farmer and the facilitator, satisfactory knowledge and experience in development planning, soil and water conservation and agroforestry disciplines and continuous on-farm discussions with the individual farmer households. The method by which the participatory learning, farm-level planning and implementation sub-process is conducted is illustrated in Figure 6.1.

The last sub-process of the devised participatory agroforesty approach deals with evaluation of implemented agroforestry interventions and obtaining feedback from farmers who tried to copy the soil and water and agroforestry components of the interventions planned and implemented by the innovative farmers. The sub-process involves:

- determining on farmer-understood methods of assessment of land sustenance, productivity, economic viability and ease of adaptability of the implemented agroforestry interventions
- determining time frames that farmers consider valid for the assessment of effectiveness of their development initiatives
- conducting participatory evaluation and feed-back assessments in action.

The method by which these functions are fulfilled is illustrated in the learning and evaluating methodology of the approach (Figure 6.2, Chapter 6). The construction of the participatory agroforestry approach in an action research has resulted in an approach that involves methodical and technological elements in an inseparable form. Therefore, the success in the adaptation and application of the approach is strongly dependent in the quality of knowledge about both elements.

The devised approach assumes that circumstances change in either the social sector or the environmental setting or both through time. Therefore, new discovery of facts and adaptation to circumstances are envisaged to be essential. In line with such a proposition, the devised approach is cyclic in its set-up and gives an opportunity for updating itself in accordance with new findings of the evaluation.. The alternative venues of updating the approach are indicated as A, B and C in Figure 13.1. The alternatives are:

1. revising the whole approach by starting from the trust-building sub-process (Figure 13.1 A). This alternative is chosen when the evaluation and feedback signals that the understanding about the local values and customs is not firm, traditional land quality assessment principles are not exhaustively known and / or the trust built is not confidently reliable.
2. revising the approach by starting from the socioeconomic diagnosis sub-process (Figure 13.1 B). This alternative is considered when the facilitator is ascertained by the outcome of the evaluation and feedback sub-process that the trust-building sub-process is dealt with effectively, but not the other sub-processes.
3. revising the approach by starting the participatory environmental assessment sub-process (Figure 13.1C). This alternative is preferred when the facilitator is assured by the outcome of the evaluation and feedback sub-process of the approach that the trust building and socioeconomic assessment sectors are treated to the required standard and are valid to the current situations except that the environmental assessment requires updating.

In revising the methodology by which the updated agroforestry and soil and water conservation interventions can be effectively developed for willful implementation by farmers, the alternative avenues may change from time to time. The best yardstick in deciding the entry is the indicative result to be determined in accordance with the timely evaluating and feedback results.

13.2 Guide-interventions

One basic benefit of the development of the devised agroforestry approach is the possibility of developing agroforestry intervention categories for effective soil and water conservation and agroforestry development by farmers' will. From the development and application of the approach, it is realized that soil depth and slope bounds can be used for defining the intervention planning units in broad and detailed intervention categories. For moist *Weyna-dega* agro-climatic zone conditions, consideration of farmers' production aspirations, recognition and will of farmers for applying soil and water conservation and agroforestry development interventions and available traditional soil and water conservation skills has resulted in four broad intervention classes. These are the ones that:

- do not involve any man-made structural soil and water conservation measures except *Dinber* and biological soil and water conservation measures
- involve only *Kab* as a physical soil and water conservation measure in addition to biological soil and water conservation measures
- involve *Kab* and *Golenta* with accompanying biological soil and water conservation measures

- involve only *Golenta* as a physical soil and water conservation measure which is strengthened by biological conservation measures

This broad agroforestry and soil and water conservation intervention grouping is further subdivided by considering the soil depth and slope class differentiation. As a result, eleven agroforestry and soil and water conservation intervention categories are developed. These intervention categories have their own attribute and implementation specifications and can serve as a guide to similar social and site conditions. The guide intervention categories are:

- scattered tree-cultured
- *Dinber*-based tree and shrub integrated
- *Kab-based* shrub and tree integrated
- *Kab*-based shrub integrated
- *Golenta* and *Kab* -based tree and shrub integrated
- *Golenta* and *Kab*-based shrub integrated
- half plot cash-value shrub with tree-supported *Kab* and *Golenta* integration
- half plot cash-value shrub with fodder shrub-supported *Kab and Golenta* integration
- *Golenta*-based tree and shrub integrating silvipasture
- *Golenta*-based shrub integrating silvipasture
- ecosystem conservation.

The above indicated interventions and associated prescriptions can serve as a guide to catchment-level agroforestry and soil and water conservation interventions and prescriptions that are based on the soil depth and slope bounds. The same catchment-level interventions and associated prescriptions also serve as a guide to farm-level agroforestry and soil and water conservation planning and implementations in the same agro-climatic zone.

13.3 Manifestations

Important revelations are perceived from the case study subjected to development and application of the approach. The study has manifested that farmers have their own traditions of mediation and resolving issues and that heritage can be used to build the trust between development facilitators and the farmers.

According to the experience gained from application of the study, truthful socioeconomic diagnosis can be conducted only if the necessary trust, friendship and solidarity are established between the farmers and the facilitator. At the same time, it is noted that PAA functions through appropriation of basic elements of the succeeding sub-processes through completion of the preceding sub-processes. The sub-processes in the approach are strictly inter-linked and form a continuum.

Under confidently established trust, it is realized that different socioeconomic diagnostic tools have varying strength. PRA workshops are effective for approaching communities and diagnosing community issues. At the same time, formal questionnaire surveys are also useful in diagnosing very general issues of the community. Social issues that have cultural connotation or investigation of property and wealth can not be diagnosed by the QI method effectively. From the exercise, it is realized that the on-farm discussion method is the one that enables facilitators to investigate the nitty-gritty of the farming household and his farm more effectively than either of the PRA or QI.

Many other important conclusions can be drawn from the socioeconomic exercise. It is realized that farmers have local land quality grading variables. Farmers consider slope, soil depth, soil fertility (quality), agro-climatic zone and water logging as factors for grading land quality. When conditions allow, farmers do grading of their lands and associate production to land capabilities. One of the major socioeconomic findings is that cropping, livestock keeping and tree/shrub development are the major sources of income to the farmers of the moist *Weyna-daga* agro-climatic zone. All the three sources of production are commonly constrained by soil erosion. Though farmers are familiar with soil conservation benefits of trees/shrubs, farmers are cautious about integrating trees/ shrubs into farms. The most obvious objections are:

- land and tree tenure and
- heavy government tax

In total, they account for 30 % of the discouragement of farmers from integrating trees/shrubs into farms. It is also realized that farmers are constrained from using introduced physical soil and water conservation measures. Technical incompatibility and failures account for more than 75 % of the problem of the application of soil and water conservation measures on farms while ~ 25 % is attributed to the land tenure related factors.

From the participatory environmental assessment exercise, it is realized that farmers have great interest and ability in reading large scale maps of contrasting colors. They can understand, compare and contrast mapped information with actual site situations. This is made more practical when the maps are drawn in contrasting colours and include permanent reference features. Conducting the map reading exercise on a lookout place where map information can at the same time be compared with ground situations is very helpful.

The assessment has shown that useful environmental facts and issues can be realized from the application of the indigenous land quality assessment variables. It is further realized that, at a (mini) catchment level, relative land quality assessments can be performed by using few locally-appreciated and -used land quality assessment factors.

The participatory socioeconomic and environmental diagnosis work indicates that planning units that compromise on socioeconomic and environmental facts and issues can be defined in discussion forums with farmers. The planning discussions have resulted in identification of the various agroforestry attributes that are to be implemented in each of the planning units. In addition to contribution of the farmer discussants in defining planning units and determination of attributes that can be implemented, farmers are known to contribute a lot in the correction and mitigation of problems and weaknesses of indigenous soil conservation skills. Meaningful implementation prescriptions of the planned agroforestry intervention categories are obtained from such planning discussions.

It is now understood that defining agroforestry intervention units by slope and soil depth bounds and addressing the soil fertility issue in the prescription of interventions, is functional, simple and applicable to farmer-level conditions. Therefore, it can be concluded under similar conditions to that of Tikurso catchment, agroforestry intervention planning units can effectively be defined by slope and soil depth parameters. Catchment level planning is an exercise that involves a team of farmers from the community but requires to be succeeded by an adaptive planning which is conducted between the farmer and the facilitator in an on-farm condition. It is also realized that catchment level planning units and prescriptions can be used as guiding frameworks for the preparation of these adapted planning units.

The actual test for applicability of participatory agroforestry intervention plans is their possibility of being implemented by the farmers. However, effectiveness of the implemented agroforestry intervention plans can be more concretized by the performance evaluations. Performance evaluation and synthesis of issues that are refined through farm-level conditions are basic determinants in directing avenues (A, B, or C in Figure 13.1) that the improvement of the approach has to follow. At the same time, practical experience has demonstrated that performance evaluation and synthesis are more effectively conducted at farm and farmer-level conditions other than catchment level or community-level conditions.

It is realized that PAA enjoys willful involvement of farmers in implementation of land rehabilitation works. In addition to its ecological benefits and productivity qualities, the rate of adaptability of the agroforestry development by farmers has been significant. The performance of the agroforestry interventions in the field is known to most influence the will of neighbouring farmers for adopting or rejecting an implemented agroforestry intervention. The next dominant factor in influencing the will of farmers is the economic efficiency of the intervention discounted in a very short period of time (2 - 3 years).

The assessment of the amount of soil that farmers have arrested from eroding indicates that the applied interventions are effective. Farmers have also realized that the deposition of soil at the upper side of their *Kab*, which is manifested by the pin method, can be used for estimating the annual height increment of the *Kab* that they are constructing. Growth increment and the ability of the tree/shrub species in restoring healthy coexistence with the cereal crops is found to be one of the factors of evaluation of the agroforestry initiatives by farmers. The adaptability evaluation has also indicated that land rehabilitation measures that can not be handled by family labour and whose benefits are not restricted to one or few families and / or farms require mobilization of labour from the community that intern requires incentives.

The growth assessment indicated that the system is effective. Other land sustaining quality measures such as biomass growth and yield measurements demonstrated effective growth that indirectly proved the availability of moisture in the system. The productivity effect of the agroforestry developments is measured by considering cost benefit assessment of the agroforestry development effort. Over 38 % of the farmers rated the productivity of the agroforestry intervention 'very high' while only 8 % of them rated it as *good*. Over 50 %

of the farmers rated the productivity of their agroforestry developments *high* and none of them rated it low. In quantitative terms, the average net income of farmers on per hectare per year basis is raised by nearly ~ 57%. This is additional to the land conservation benefit of the interventions that would continue to be reflected in future harvests.

Community-level interventions such as cut-off-drains proved difficult to be constructed by individual farmers for various reasons. Initially, the food for-work culture which has been functional in the area by MoA was allowed to linger in activities such as a cut-off-drain, a foot path and spring development. Later after the required trust is built, food-for-work payment has been totally discontinued and cut-off-drain constructions have been effected by individual farmers who could create a work team. However, since the benefit of interventions such as cut-off-drains is for many farmers below the construction site, establishing responsibility for its construction is found to be difficult. Even when individual farmers develop the will for constructing them, the size of labour required becomes much more than the household can provide. At times, construction of cut-off-drains becomes a disadvantage to farmers whose farms are at sediment deposition site in the valley bottoms. Such farmers negate the effort toward the construction of cut-off-drains. The assessment of implementation of such activities by individual farmers in the study area has indicated that the activities need to be backed by supplementary incentives.

13.4 Participatory learning

Throughout the process, mutual learning has occurred between the farmers and the facilitator. For instance, it is learnt from the farmers that lining the foundation of physical structures with cut-brunches of shrubs/trees in strengethening the physical structures. But different farmers use it with different types of vegetation and different success rates are reported in the participatory discussion forums. After establishment of mutual understanding, now farmers have, in turn, realized the benefits of more spiny and thorny branches to maximize the friction and adherence to the ground and the structures and effectively act as connectives. The type of species are identified. In fact, according to the local saying of the farmers in the study area, " as the unity of singly-weak threads can chain a lion, it is the coordinated force of the physical soil conservation measures, the vegetation and the soil that can strengthen the physical structures and enable them to successfully arrest the sediment in run-off". At the same time, for many of the farmers in Region 3, the cause, process and effect of soil erosion is still obscured. They simply believe that only off-farm flood can cause erosion. If their land is not satisfied with the nutrients it use to possess and requires additional fertilizer to enrich it, it has become no different than the authorities who demand for bribe to enrich themselves and effect their normal functions. However, the fusion between the farmers' knowledge and the expert's knowledge proved to develop continuously as long as the two use dialogue, follow a soft-system approach and conduct action research for learning by doing.

In its totality, conducting the participatory agroforestry approach, producing prescriptions for agroforestry interventions and facilitating implementation of the interventions can:

- address production desires
- avoid fears of farmers for integrating trees into farms
- mitigate barriers of using soil conservation measures on private lands
- improve and involve indigenous land husbandry skills
- gain will and interest of farmers for adopting it

However, this all is a complicated and demanding exercise. It requires diversified knowledge in subject matters, integration techniques and above all strong mediation capabilities to be effective in working with participant farmers. Therefore, applicability of PAA at a larger scale preempts a profound learning about the new insight.

In addition, environmental assessment variables are studied as diverse as they are. Slope and soil depth information is organized in easily discernible maps. Lands are categorized by potentials. Knowledge on conservation requirement of each of the land categories is developed and synthesized as an outcome of the compromise. The fitness of the indigenous soil conservation skills pertinent to the various land categories is debated and re-examined. A more refined applicable indigenous soil conservation knowledge is developed. Applicable and participatory environmental assessment knowledge is produced. In general, PAA requires willingness to learn from the 'layman' (farmers) which has never been the case in the development extension traditions of Ethiopia.

CHAPTER 14

RECOMMENDATIONS

In general, the failures in reforestation and soil and water conservation in Ethiopia are attributed to biophysical factors, sociopolitical conditions and neglect of indigenous soil and water conservation technologies. The biophysical factors include the dissected terrain, cultivation of steep slopes, erratic and erosive rainfall and easily eroding soils. The sociopolitical factors include the genuine needs of the poor for continued food, fuelwood and fodder production, discouraging tenure and usufruct policies, prolonged civil war and the absence of a farmer-based approach in the design and implementation of agricultural developments. All have contributed to the decrement of genuine involvement of farmers in rehabilitation activities.

The participatory agroforestry approach (PAA) has evolved in the realm of:

- the needs for improved and holistic production of food, fuelwood and fodder by farmers
- inappropriately introduced and rejected soil and water conservation and reforestation initiatives
- an absence of a system approach for the design and implementation of land rehabilitation schemes

PAA contributes to the realization of the corrected versions of these situations and is strongly recommended for usage. At the same time, the work has revealed that applicability of the approach and the conditions for its application can be enhanced if the necessary environment and facilities are availed. The following recommendations focus on the possibilities of creating these lacking conducive environments and facilities for enhanced usage of the approach.

14.1 Application of the approach

1. Produce and protect

Farmers in Ethiopia are biased on cereal crop production. Though this could be relaxed through an emphasis on livestock development, they do not subordinate production of crop by another sort of produce. If the two fail (most obviously due to extended drought) the last means of escape route is the revenue gain from the sale of wood. Hence, soil and water conservation measures require to be designed with emphasis on production in either or all of these three means of subsistence. Soil and water conservation has to be designed to benefit from the spin-off of production not vice versa. This is the very reason why participatory agroforestry approach is devised to create a condition by which soil and water conservation could be considered not as a conservation measure but as an integral part of the production arena. In addition to the need for the involvement of the food crop, feed crop and forest developments at a certain site, the steps of the approach are a continuum. Therefore, overlooking either one of the agroforestry components and or any tendency of conservation priorities over production may not lead to effective results.

In addition to the production attributes, the sub-processes in the application of the approach are inter-linked, inseparable and continuous. Each of them are either the menace or the product of the other. Therefore, though it is impossible to conclude that the missing of one will completely halt the happening of the other, it is undoubtedly true that bypassing a major component will not enable to achieve the target at best. Therefore, usage of the approach in its comprehensive and holistic nature is strongly recommended. Production and conservation concerns of the farmer and the farm can be addressed by the application of this production-orientated conservation approach in its holistic sense.

2. The facilitator.

The approach involves the use of various disciplines both in technical and non-technical sectors. At the same time, it will be difficult for the group of farmers and individuals to interact and build trust with many facilitators in the application of PAA. Therefore, for a certain group of farmers, getting only one effective facilitator who can have technical advisors at his disposal and who is able to integrate and convene the information with the farmers is recommended.

Facilitators in Ethiopia are external and are often, having access to government bodies. Hence, farmers assume that facilitators represent threats to them. The assumption of farmers is more legitimate because development facilitators have been instrumental in collecting government taxes, recruiting militia men and partitioning and re-partitioning of land. Under such circumstances, creating the required trust and getting at the 'inside' of the farmer becomes exorbitantly difficult. Therefore, if facilitators are to be successful in the application of PAA, devoting them to only development roles is essential.

It is crucial that a development facilitator acquires the expected qualities and an intimate knowledge of the local dialect and its vocabulary. The difficulty becomes compounded if the facilitator who intends to use the PAA is foreign to the culture and customs of the society he intends to work with.

Though personal experiences, talents, beliefs and assumptions have significant influence in determining the rate of success in the application of PAA, ardent commitment and willingness for working with farmers and the probability of one in becoming free from technocratic approaches decide the outcome most. A new facilitator willing to use PAA as constructed here has to be one who is convinced that without prior gain of genuine trust from farmers, instigating farmers' will for participation in soil and water conservation is extremely difficult if not impossible. The gravity of the problem of exclusion of farmers in planning and implementation, neglect of farmers' indigenous knowledge in land husbandry and the ingrained commanding culture of past development facilitators calls for a campaign in disengaging them from their repressive approaches.

The facilitator needs to be equipped with the necessary animation facilities. However, in addition to such facilities that could be used to educate the farmers in sustainable and productive land husbandry initiatives, the facilitators need to be given the opportunity of being up-to-date in their professions. The development assistants need to be trained in participatory land use appropriation and mapping by considering locally appreciated parameters that the farm owner can easily understand. This can be made possible by having an organized and intensive in-service training and reading facilities.

3. Field guide

Since there has not been any systems approach to reforestation and soil and water conservation, there is no technical guide in pursuance of participatory rural development initiatives that can be used by a development facilitator. Development of such a technical field guide is much overdue. Unfortunately, the present description of PAA is not yet a technical field guide either. However, it can serve as resource for the production of such a guide. The justification for the start of this research indicates that the study is deep-seated on the county's pressing soil conservation problem and its outcome is not meant to be shelved for propensity reference. Adaptation and usage of the PAA for production of a technical guide has been a long-term interest. Therefore, development of a technical field guide for the application of PAA is highly recommended.

4. Have prominent consideration of trust building

It is realized that successful and improved land rehabilitation through willful involvement of farmers necessities building trust within farmers by the development facilitator. The problem tree (Figure 7.1) analysis indicates that mistrust of farmers on development facilitators has grown in Ethiopia. The highly interventionist approach to soil and water conservation has reduced farmers' confidence and willingness to invest in their land. This has been due to absence of genuine involvement of farmers in decision making in agricultural developments. A real *dialogue* has been missing. However, for a real *dialogue* to be established an intimate relationship has to be restored between contributing parties. For the effective contribution of the discussants, speaking a common language in its fullest meaning is essential. Once such trust is built successfully, convinced and participant farmers will be active enough in driving the subsequent agroforestry development activities. It is only then that farmer-real and farmer-accepted socioeconomic diagnosis and environmental appraisal works can be successful.

5. Play catalytic role

Exclusion of farmers from commanding their own developments on their own land is an instituted fact in Ethiopia. There is a tendency for development institutions to do many soil and water conservation activities by their own. In such a case, farmers are used as consultants and / or hired *labour*. This is due to falsely targeted superior ambitions and commitments for speeded up developments that are never realized. It is time that we have to learn from the sad fact of the failure in playing such a reactant role during the last two decades. In order to let the development continue smoothly even after the withdrawal of the development institutions, helping and enabling all the target farmers to realize their own problems, come up with compromised production targets, produce their own agroforestry intervention plans and raise their own seedlings is essential. This, of course, requires tiresome and effective persuasion of farmers by a lot of facilitators. However, once the interest of the farmers is raised, education, research and demonstration can continue at a farmer-to-farmer level. It is then, that, the use of agroforestry interventions for soil and water conservation can succeed.

Effective agroforestry intervention knowledge can be developed through iterative discussions between a facilitator and the farmers. The facilitator can vitalize the creation of the required knowledge from the catalytic role of:

- splitting facts and issues in discussions so that the discussant farmers can have a detailed consideration of knowledge from experiences
- reiterating the possible repercussions that arise from the opted actions
- indicating developed patterns and supplying side information and known facts
- synthesizing discussion outcomes for consensus and / or for further debates and discussions
- supplying clarifications on obscured ideas that may emerge from the discussion session.
- suggesting alternatives to stalemate positions in reconciliation of conflicting ideas in the discussion
- organizing facts and issues that may be input to succeeding discussions
- framing the discussion forums

- demonstrating implementation of the produced knowledge and supplying every advisory service required

6. Accredit the use of indigenous knowledge

Promotion and use of indigenous soil and water conservation skills of local farmers need to be considered as part and parcel of land rehabilitation and reforestation methods. It is then that economic progress and prospects for survival of the rural farmers will not be in conflict. Investigation of the real problems of farmers with regard to their production desires can not be remedied by real participation of farmers unless their knowledge is studied and used for integration of agroforestry practices into the mainstream of their farming systems.

7. Adapting PAA

PAA, as an approach, can be used, regardless of agro-climatic zone, for

- development of farmer-based and sustainable soil and water conservation and agroforestry skills
- integrating production concerns of farmers and conservation requirements of the production base
- initiating willful participation of farmers in land rehabilitation works.

However, the way the approach is to be convened, the soil and water conservation and agroforestry skills and their components to be implemented will vary depending on agro-climatic conditions as well as differences in traditional norms and local customs, farming cultures and species of interest among different societies. Therefore, though the general application of the approach is unconditional, the specifics of the approach would have to be adapted to local traditions and customs, agro-climatic zones and farming heritage of the local communities to be involved in the application of the approach.

8. Manpower

In the construction of PAA, it is realized that catchment-level -agroforestry intervention planning requires a university graduate. This higher education caliber demand of the PAA approach is compounded by the need for the application of GIS. However, though not widely spread, GIS is becoming more and more used in the country. Development master plans for river basins of Baro-Akobo, Birr and Koga, Omo-Gibe and Tekeze involve GIS applications. Locally-based consultant firms are available in the sector too. On the other hand, GIS-aided environmental assessments are required for catchment-level planning purposes. Farm-level adaptation of plans and prescriptions as well as implementations are not dependent on the application of GIS. In order to economize on the high education caliber facilitator, preparation of model mini-catchment-level intervention at the rate of only one plan per agro-climatic zone in a peasant association is recommended. Thereafter, farm and farmer-level adaptation and implementation processes of the PAA can be conducted by college level diploma graduates which are normally called Development Agent (DA) provided that the field guide is prepared and they are given in-service training in the application of the PAA. However, a strong participatory supervision component about the performance of the DA and generation of feedback about the performance of the prescriptions made and implemented by farmers needs to be conducted in the presence of the high education caliber facilitator. To conclude, for supervision and backstopping on the PAA usage, subject matter specialists are recommended. However, large scale field application of the PAA, those development agents who are given refresher training on the application of the approach can be deployed.

9. Use of farmer-field days

Farmers normally prefer to wait and see the successes of the efforts of other fellow farmers. To this effect, it would be preferred if the facilitators demonstrate with only innovative farmers in all sorts of development interventions they are to extend. The demonstrations would have to be complete and holistic with emphasis in short term production of food, feed and wood while guaranteeing the conservation of the resource base--land from the spin-off. These demonstration fields need to be established on real size holdings, non-fenced and truly governed and administered by the land owners. Organizing farmers' visit days at various stages of development and short hours training for those innovative farmers would help in persuading the '*wait until you see and get convinced*' farmers. It is necessary to be careful in that the demonstration should be successful and free of any obvious farmers' criticism as much as possible and the farmers would have to explain all the modalities of the development, management and benefits.

14.2 Policy

1. Land and tree tenure security

Legal directives and national and regional policy environments have a great role in determining the rate of adoption of PAA. The same is true to defining rights and responsibilities of farmers on land use. This prevailing policy-environment has a direct effect on the success of the future outcome of implementation of the agroforestry approach. The research finding indicates that agroforestry-mandated institutions and its staff as well as the expected adopters of the agroforestry technologies could only be effective if the necessary policy environment prevails.

The study has indicated that tree/shrub involving soil and water conservation by farmers is inhibited by nearly 30 % due to discouraging land and tree tenure policies. Titling of land will promote soil and water conservation and tree production if it is combined with increased tenure security. Initiatives for increasing the demand for land, supply of credit and creation of functioning land markets will boost the conservation spirit of farmers. This is especially so for those areas defined as ecosystem conservation intervention areas. Though farmers share the same opinion of treating this land under ecosystem conservation, which is a lengthy process, a significant portion of this area is not understandably protected by either of the community or the government support. Hence, burning the bush and the shrub cover, cultivating for even short periods etc. are the obvious threats in these areas. The prime reason why the farmers do what they do is known to be the lack of extended land tenure. Farmers have reiterated that the protection of these ecologically fragile areas could be successful if and only if land possession entitlement (land ownership certificate) is issued to the land owners and legal backing for control over their right is provided.

Another policy area is assurance of compensation in giving away agroforestry interventions. Farmers know and appreciate that land may continue to be re-distributed to accommodate those who do not have land. On the other hand, farmers are required to implement agroforestry interventions that can address long-term conservation requirement of the land. When doing so, it is a fact that planting perennial plants (bushes and shrubs) and building long lasting and *labour* intensive physical structures (for instance, strengthened *Kab*) are envisaged. Their benefits are to be obtained throughout the many years after their constructions. Farmers express that they can more intensively use such kind of agroforestry interventions for soil conservation if they are assured of compensation for their development efforts if they are to be sectioned and redistributed. It is certain that assurance of such long lasting efforts can have a significant impact on the intensification of the implementation of agroforestry interventions for soil and water conservation. Therefore, clearly stipulating and effectively communicating a policy that assures compensation of farmers when giving away their long lasting development efforts is essential.

2. Institutions

It has been realized that the development strategy is focused to agricultural development led industrialization whose basis is the use of rural land. But the strategies that come with it have not taken into account the importance of long-term conservation of natural resources. One basic justification to this is lack of vanguard institution for the conservation and development of natural resources of the country. In fact, the ministry of Natural Resources Development and Environmental Protection (then) MoNRDEP was dissolved at the time when the pillar theme was launched. As a result, conscious management of natural resources in general and reforestation and soil and water conservation in particular with a view to enhancing public participation is vacant.

The success in the construction of PAA in Tikurso catchment indicates that involving local institution leaders and community elderly facilitates successful environmental governance. The study has indicated that grassroots institutions are effective for building trust, social diagnosis, planning and implementation work. Therefore, they need to be strengthened and made an integral part of the land rehabilitation effort. Local institutions are internally governed and administered by influential *Yager-shimagile* and inclusion of them paves the road to true and active involvement of farmers in viable agroforestry developments. However, proper agroforestry development options, viable technologies and implementation possibilities could be realized if the indigenous people and their institutions are linked to the implementation-catalyst institutions. In the absence of agroforestry development mandated institutions, designing and developing packages of essential services, testing and refining the agroforestry development approach and creation of improved land rehabilitation technologies will undoubtedly be very difficult. Therefore, if PAA is to be efficiently successful, creation of natural resources conservation and development institution that recognizes, accommodates, promotes and strengthens local institutions, indigenous people and communities in the use of PAA is crucially essential.

14.3 Incentives

1. Tax reductions

It has been evident from the study that integration of trees into farms is affected by heavy government taxation and inability to transfer the tree products across Woreda and *Zonal* boundaries. At the same time, if physical soil and water conservation measures are to be strengthened, integrating trees and shrubs with the soil and water conservation measures is proved to be essential. Therefore, for large scale application of effective and long-lived soil and water conservation measures in the land rehabilitation efforts of Ethiopia, the heavy tax on trees and tree products needs to be reduced effectively (if not totally abolished).

2. Reward for best achievements

According to the findings of this research, conservation works such as cut-off-drains could not be effectively executed by individual farmers or groups of farmers because the benefits of the work can not be equally or proportionally shared by those who ought to contribute *labour*. In fact, the construction of *Golenta* uphill may be an advantage for the farmer immediately below the flood source because it protects his land from erosion. At the same time it becomes a disadvantage to the farmer in the flatter area down who is appreciating fertile sediment to be eroded from uphill for deposition on his land. Supporting construction of *Golenta* (cut-off-drain) becomes essential from a generation care taker (government) view point. This can be made possible by the supply of grain and oil. At the same time, *food-for-*

work in Region 3 used to function by equating the amount of payment to the amount of work done and is understood by farmers as a salary or wage other than incentive. Therefore, the *food-for-work* policy that is to be produced needs to be free from this equating.

One basic incentive which is deduced from the farmer-group discussions which were held in the four study *Woredas* (sub-districts) of Region 3 is allocation of the grain and oil for stimulating competition in construction of *Golentas* and other community-level soil and water conservation developments. This can be made operational by creating competition between farmer-groups in a community by rewarding on the basis of best achievements. The grain and oil can be given as a reward based on quality and quantity of the application of agroforestry interventions. It can also be done either between villages and / or between farmers in a village. The grain and oil reward can be given for a few most efficient farmers who have implemented successful and integrated developments too. Always, the farmers who are getting the reward need to be selected by the farmers among whom influential elders and local institution leaders are members. Supplying the reward at the site of good performance where "farmer development appreciation days" can be celebrated in a gathering can be helpful. However, what is to be done and on what kind of activity farmers are to compete for, is best identified by application of PAA.

3. Sponsoring help-the-poor occasions

In the problem tree construction (Figure 7.1), only the one way effect is analyzed. However, there are also signs that the final effect (poverty) creates favorable conditions for perpetuation of many of the poor land husbandry practices. It can be inferred that a apprehensible circle of poverty is established. Therefore, the solution to well facilitated tree, crop and livestock production necessitates not only facilitating genuine involvement of farmers but also economic support.

In Ethiopia, especially in Region 3, farmers indicate that it has been the tradition of farmers to help, the aged, the disabled, the sick, the widow and the lonely household leader provided that one can prepare a sort of food and drink for that occasion. Attaching this form of "*help the poor occasions*" with overnight *Mahiber* and getting *labour* support in the following morning from members of one's Mahiber used to be possible. Unfortunately, the majority of the farmers in the studied areas are now so poor to the extent that they can not afford to prepare food and drink for *Mahiber* at their places. As a result, overnight Mahiber in one's house is now almost non-existent. However, farmers still believe that if they could get assistance in preparing food and drink for the *labour* day, they could get their relatives and former Mahiber members for helping them in their soil and water conservation initiatives. Therefore, grain and oil support for sponsoring such kind of "help the unable occasion" activities such as *Golenta* construction can be considered as a very good incentive. The selection of appropriate effective agroforestry interventions to be considered and the unable farmers that can be eligible for the sponsorship can be executed by the application of PAA.

4. Guaranty of risk for new innovations

Farmers are reluctant to adopt new technologies unless they are sure of their success. They do not have a lot of land that they can gamble with. However, in a country such as Ethiopia where research is not practised widely, it is a must to borrow research results obtained in different regions of Ethiopia or even other countries. In such situations, one can not avoid risk. This is especially more risky for the farmers who do not have other sources of income other than what they produce from their land. At the same time, farmers are wanted not to shy away from trying new innovations even though they are not tried under their own situations. Hence, one of the possibilities for letting farmers adopt new innovations is securing risk compensation payments in the form of incentives.

14.4 Issues of further study

1. Adapting interventions

The intervention guides of the devised participatory agroforestry approach are reflections of moist *Weyna-dega* agro-climatic zone and communities in North Shoa. Because the agroforestry and soil and water conservation skills and attributes to be prescribed for every intervention category need to reflect the social and environmental situation of those areas where the approach is to be implemented, the interventions indicated in this study can not be appropriate to all other areas of Ethiopia. For instance, *Rhamnus prenoides* is considered to be a common component in the species mix in many of the intervention categories because the *Rhamnus prenoides* is a common ingredient in the day-to-day diet (local beer) of the communities in the Amhara region (Region 3). In addition, women in Region 3 have special affection for it because it can be harvested for home use and cash earning by women any time. Had it been in Harrar (eastern Ethiopia, Region 4), it may have been substituted by *Catha edulis* whose leaves are part of the day-to-day dietary systems of the people there. The potential of *Catha edulis* for serving in soil and water conservation purpose is similar because of similar silvicultural characteristics and management requirements.

In addition, the indigenous land constraint mitigation skills on which the attributes are built are manifestations of moist *Weyna-dega* agro-climatic zones. When the approach is used in areas of different agro-climatic zones, the indigenous soil and water conservation skills and species of interest prescribed for the intervention categories constructed in this study may not hold. Therefore, for successful application of the interventions, further adaptive study is strongly recommended.

2. Role of the local mediators

In the development of PAA, the potential of the social institution leaders and elderly influential (*yager-shimagile*) in mediating development has been acknowledged and used. Getting named after '*Yager-shimagile*' it has a respect connotation and failing in being up to *Yager-shimagile* status means loosing social credibility. Therefore, *Yager-shimagile*, by social standard of the community at Tikurso catchment, are free from negatively sanctioned activities such as bribe, remuneration or social disobedience. However, the differential impact of such mediators in line with their education, age, clan and wealth status is not studied. Knowing the significance disparity of their influence in mediating by these social factors will enable the facilitator to target the right mediator.

3. Farmer nurseries

The climatic and soil conditions of *Weyna-dega* agro-climatic zones are strongly challenging to plant growth. The situations in *Kolla* agro-climatic zones are worse. To this effect, potted seedlings have got more chance for survival. It is also true the preference of farmers to potted seedlings over bare rooted seedlings is now well established. The difficulty is getting the polyethylene tubes that makes the pots. Therefore, the use of substitutes such as calabash, banana leaves, as well as clay soils for raising seedlings needs research focus.

In the construction of PAA, the seedlings were raised by the facilitator only due to the time limitation of the study. Therefore, using the devised agroforestry approach and finding out the possibilities by which farmers can establish their own nurseries and raise their own seedlings is essential to the success in the application of agroforestry interventions for soil and water conservation in Ethiopia.

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Appendix A

Socioeconomic assessment questionnaire

1. Personal information
   a. Name of the household leader ....
   b. Gender: Male .... Female.........

2. Family information

Female					Male				
Age group	**Illiterate**	**R & W**	**ESC**	**HSC**	**Age**	**Illiterate**	**R & W**	**ESC**	**HSC**
< 3					< 3				
> 4 and <8					> 4 and <8				
>8 and<13					>8 and <13				
>13 and< 18					>13 and < 18				
> 18 and < 30					> 18 and< 30				
>30 and < 45					>30 and< 45				
>45 and < 65					>45 and < 65				
> 65					> 65				
Total									

R & W = Only reading and writing
ESC = Elementary school complete
HSC = High school complete

3. Size of land in hectare a. Own land .... b. Share cropped ....

4. Current land use appropriation in percent for
   a. Crop land .... b. Grazing ....
   c. Forest/plantation .... d. Home garden ....
   e. Out of use ....

5. Estimated land productivity decline as compared to the latest time you recall (if the time is more than 30 years) in %
   a no decline b. 0 - 4
   c. 5 - 9 d. 10-15
   e 16- 20 f. > 20

6. Factors considered in land quality grading
   a. ....
   b. ....
   c. ....
   d. ....
   e ....
   f. ....

7. Major source of income for the household
   a. .... b. ....
   c. .... d. ....

8. Major causes for reduction of
   8.1. crop yields (in order of significance)
   a. .... b. ....
   c. .... d. ....
   e. .... f. ....
   g. .... h. ....

   8.2 Livestock produces (in order of significance)
   a. .... b. ....
   c. .... d. ....
   e. .... f. ....
   g.. .... h. ....

9. Traditional land rehabilitation measures for:

   9.1 mitigating flooding
   a. ....
   b. ....
   c. ....

   9.2 slope reduction
   a. ....
   b. ....
   c. ....

   9.3 mitigating soil fertility problems
   a. ....
   b. ....
   c. ....

   9.4 maximizing soil depth
   a. ....
   b. ....
   c. ....

10. Reasons for not having soil conservation measures applied
   a. .... b. ....
   c. .... d. ....
   e. .... f. ....
   g. .... h. ....

11. Anticipated problems during integration of trees into farms

a.	....	b.	....
c.	....	d.	....
e.	....	f.	....
g.	....	h.	....
i.	....	j.	....

12. Major tree/shrub species appreciated by farming communities

a.	....	b.	....
c.	....	d.	....
e.	....	f.	....
g.	....	h.	....
I.	....	j.	....

13. If conducive environment such as secured ownership of land, tree tenure and reduced tax prevail, what would the extent of your tree development effort be?

----

14. Major criteria for selection and use of tree/shrub species by farmers

a.	....	b.	....
c.	....	d.	....
e.	....	f.	....
g..	....	h.	....

15. List of major food crops preferred in the area (in order of significance)

1st	....	6th	....
2nd.	....	7th	....
3rd	....	8th	....
4th	....	9th	....
5th	....	10th	....

16. List of major cash crops preferred in the area (in order of significance)

1st	....	6th	....
2nd.	....	7th	....
3rd	....	8th	....
4th	....	9th	....
5th	....	10th	....

17. The three most preferred level of institution for holding free and relaxed discussion of rural development issues with a development facilitator (in rank)

    a. First ....
    b. Second ....
    c. Third ....

18. Livestock owned

    a. cattle .... b sheep............ c. goats. ....
    d. mules............... e. donkey.......... f. horses ....

19. Source of fodder for livestock

    a. .... b. ....
    b. .... d. ....

20. Favored influential authorities for ~~mediating~~ willful acceptance of development initiatives by farmers (in rank)

    a. First ....
    b. Second ....
    c Third ....
    d. Fourth ....

21. Local norms and customs that a facilitator need to know and exercise with the community

    a. .... f. ....
    b. .... g. ....
    c. .... h. ....
    d. .... i. ....
    e .... j ....

22. Effective incentive for triggering involvement of farmers in development

    a. ....
    b. ....
    c. ....
    d. ....

Appendix B

Environmental Assessment data

Station ID#	Soil sample												Land Use Code
			Total	P	K	Score					Soil depth		
	pH	OC%	N %	ppm	ppm	OC	N	P	K	Cum	Cm	Score	
A1	6.74	1.501	0.154	73.59	220	3	3	4	1	11	20	2	5
A2	none	none	none	none	none	1	1	1	1	4	0	1	1
A3	6.97	3.691	0.084	52.55	2717	5	2	3	5	15	10	1	1
A4	6.85	1.254	0.176	38.27	1897	2	3	2	4	11	100	5	5
A5	6.5	1.218	0.121	41.49	2171	2	2	3	5	12	50	3	5
A6	6.68	0.636	0.063	11.51	2206	1	1	1	5	8	50	3	4
A7	6.8	0.922	0.04	33.94	3084	2	1	2	5	10	73	4	5
A8	7.02	1.179	0.083	19.73	1364	2	2	2	3	9	150	5	5
A9	6.18	0.997	0.098	61.12	5370	2	2	4	5	13	39	3	2
A10	6.89	1.73	0.125	3.3	1233	3	2	1	3	9	100	5	2
A11	6.83	0.494	0.049	56.63	1535	1	1	4	3	9	25	2	5
A12	7	0.651	0.046	16.76	1141	1	1	1	3	6	18	2	5
A13	7.42	2.666	0.325	10.53	1336	4	5	1	3	13	130	5	2
A14	6.94	0.362	0.051	14.93	1167	1	1	1	3	6	10	1	1
A15	6.53	1.49	0.177	18.29	1147	3	3	1	3	10	5	1	1
A16	6.42	1.182	0.083	20.32	1154	2	2	2	3	9	73	4	3
A17	6.2	0.634	0.043	43.5	1146	1	1	3	3	8	35	3	3
A18	6.77	1.136	0.073	13.34	1089	2	2	1	3	8	15	2	5
A19	7.03	0.606	0.071	19.82	1055	1	2	2	3	8	5	1	1
A20	6.81	1.425	0.077	7.91	1017	2	2	1	3	8	40	3	5
A21	6.86	0.791	0.056	9.68	1048	2	1	1	3	7	18	2	5
A22	7.01	1.501	0.088	3.1	1112	3	2	1	3	9	71	4	5
A23	6.79	1.103	0.071	9.86	1058	2	2	1	3	8	20	2	4
A24	6.61	2.242	0.13	18.68	1050	4	2	1	3	10	46	3	3
A25	6.46	1.006	0.126	13.88	1041	1	2	1	3	7	6	1	1
A26	6.86	1.863	0.145	3.88	1007	3	3	1	2	9	35	3	4
A27	7	1.666	0.169	3.56	1030	3	3	1	3	10	45	3	5
A28	7.13	1.254	0.139	14.07	1062	2	3	1	3	9	21	2	4
A29	6.74	1.661	0.117	6.7	1166	3	2	1	3	9	15	2	2
A30	7.12	2.714	0.248	10.24	1161	4	4	1	3	12	20	2	3
A31	7	1.176	0.111	6.31	1191	2	2	1	3	8	77	5	5
A32	6.77	1.849	0.144	8.08	1373	3	3	1	3	10	40	3	5
A33	6.83	2.371	0.229	8.5	311	4	4	1	1	10	19	2	1
A34	7.32	2.789	0.333	19.77	491	4	5	2	1	12	40	3	4
A35	7.5	2.178	0.254	17.94	427	3	4	1	1	9	55	4	5

Soil sample													Land
Station			Total	P	K	Score					Soil depth		Use
ID#	PH	OC%	N %	in ppm	ppm	OC	N	P	K	Total	Cm	Score	Code
A36	7.34	2.916	0.304	10.22	286	4	5	1	1	11	37	3	5
A37	7.15	1.957	0.13	4.81	156	3	2	1	1	7	45	3	5
A38	6.67	2.113	0.118	11.19	184	3	2	1	1	7	100	5	2
A39	6.69	1.078	0.053	10.41	236	2	1	1	1	5	25	2	2
A40	7.13	0.722	0.035	1.54	232	1	1	1	1	4	18	2	2
A41	7.06	1.037	0.056	7.32	111	2	1	1	1	5	3	1	1
A42	6.68	2.555	0.182	6.45	177	4	3	1	1	9	2	1	1
A43	6.82	2.124	0.177	4.32	95	3	3	1	1	8	23	2	3
A44	6.66	1.842	0.088	7.79	201	3	2	1	1	7	26	2	2
A45	6.72	1.634	0.107	5.75	146	3	2	1	1	7	34	3	2
A46	6.47	0	0	14.52	90	1	1	1	1	4	20	2	2
A47	6.48	1.616	0.11	10.81	110	3	2	1	1	7	74	5	2
A48	6.67	1.04	0.076	8.36	125	2	2	1	1	6	15	2	3
A49	6.83	0.831	0.071	6.12	92	2	2	1	1	6	16	2	3
A50	7.4	1.223	0.074	19.16	531	2	2	1	2	7	18	2	5
A51	6.8	0.719	0.064	12.02	306	1	1	1	1	4	58	4	2
A52	6.71	0.593	0.046	19.99	131	1	1	2	1	5	41	3	3
A53	6.84	0.97	0.06	23.32	146	2	1	2	1	6	30	2	5
A54	6.49	1.157	0.063	17.18	201	2	1	1	1	5	18	2	2
A55	7.12	1.142	0.062	11.87	164	2	1	1	1	5	73	4	4
A56	7	1.134	0.053	20.44	128	2	1	2	1	6	28	2	2
A57	7.34	0.738	0.048	7.98	191	1	1	1	1	4	42	3	2
A58	7.25	1.07	0.055	8.84	155	2	1	1	1	5	38	3	2
A59	6.97	0.269	0.026	5.33	129	1	1	1	1	4	20	2	2
A60	7.08	0.688	0.035	7.66	442	1	1	1	1	4	30	2	5
A61	7	1.312	0.087	84.08	286	2	2	5	1	10	100	5	5
A62	6.93	0.983	0.061	12.72	0	2	1	1	1	5	38	3	5
A63	6.9	0.996	0.073	23.41	136	2	2	2	1	7	65	4	5
A64	7.11	1.312	0.112	28.43	168	2	2	2	1	7	100	5	5
A65	6.81	1.494	0.133	67.68	266	3	2	4	1	10	54	4	5
A66	6.59	1.197	0.121	13.78	217	2	2	1	1	6	35	3	5
A67	6.81	1.24	0.101	12.64	207	2	2	1	1	6	75	5	5
A68	7.4	1.242	0.087	5.36	323	2	2	1	1	6	16	2	2
A69	7.22	1.701	0.119	28.05	344	3	2	2	1	8	15	2	2
A70	6.77	0.832	0.055	16.54	352	2	1	1	1	5	100	5	2
A71	7.07	1.757	0.161	13.47	430	3	3	1	1	8	40	3	4
A72	7.16	1.608	0.095	0.88	237	3	2	1	1	7	100	5	3
A73	7.04	0.734	0.085	19.04	196	1	2	1	1	5	100	5	5
A74	6.49	1.157	0.063	17.18	201	2	1	1	1	5	20	2	5

Soil sample													Land
Station			Total	P	K	Score					Soil depth		Use
ID#	pH	OC%	N %	ppm	ppm	OC	N	P	K	Total	Cm	Score	Code
B1	6.95	0.506	0.028	9.39	188	1	1	1	1	4	155	5	5
B2	7.05	0.806	0.052	13.62	185	2	1	1	1	5	162	5	5
B3	7	0.736	0.045	6.44	502	1	1	1	1	4	156	5	5
B4	7.95	0.718	0.047	5.47	161	1	1	1	1	4	110	5	5
B5	7	1.205	0.084	6.57	177	2	2	1	1	6	111	5	2
B6	6.54	0.885	0.068	5.91	125	2	2	1	1	6	124	5	5
B7	6.66	1.007	0.091	5.76	129	2	2	1	1	6	120	5	4
B8	6.82	0.672	0.037	3.23	145	2	1	1	1	5	138	5	4
B9	6.95	2.719	0.284	20.25	222	4	5	2	1	12	30	2	3
B10	6.96	3.122	0.228	5.64	105	5	4	1	1	11	117	5	4
B11	7.03	3.072	0.237	4.52	122	5	4	1	1	11	121	5	3
B12	6.96	2.178	0.238	29.57	123	3	4	2	1	10	65	4	3
B13	7.9	3.054	0.254	7.16	119	5	4	1	1	11	60	4	3
B14	7	3.162	0.253	6.92	124	5	4	1	1	11	42	3	3
B15	6.92	2.269	0.186	15.27	217	4	3	1	1	9	38	3	3
B16	7.33	3.187	0.262	38.09	330	5	4	2	1	12	45	3	3
B17	6.72	2.221	0.166	12.72	182	4	3	1	1	9	39	3	3
B18	6.71	1.425	0.112	12.77	121	2	2	1	1	6	40	3	5
B19	6.83	3.44	0.246	5.68	455	5	4	1	1	11	18	2	3
B20	7	2.406	0.192	5.73	392	4	3	1	1	9	8	1	1
B21	6.79	1.513	0.08	6.58	135	3	2	1	1	7	20	2	3
B22	7.19	2.39	0.133	6.51	809	4	4	1	1	10	3	1	1
B23	6.71	1.147	0.123	8.66	118	2	2	1	1	6	32	3	4
B24	7.12	3.41	0.244	5.64	643	5	4	1	2	12	2	1	1
B25	7.11	3.379	0.199	16.41	447	5	3	1	1	10	2	1	1
B26	7.13	3.308	0.204	43.62	501	5	4	3	1	13	2	1	1
B27	6.9	1.447	0.124	19.89	241	2	2	2	1	7	38	3	3
B28	6.87	1.449	0.124	53.06	1228	2	2	3	3	10	35	3	3
B29	6.59	1.223	0.117	13.4	106	2	2	1	1	6	3	1	1
B30	7.42	1.924	0.215	42.59	1102	3	4	3	3	13	2	1	1
B31	6.91	2.187	0.218	54.49	1178	3	4	3	3	13	2	1	1
B32	6.46	1.408	0.083	6.88	330	2	2	1	1	6	2	1	1
B33	6.92	1.407	0.129	56.01	868	2	2	3	2	9	3	1	1
B34	6.61	1.223	0.09	30.94	116	2	2	2	1	7	30	2	2
B35	6.89	2.011	0.144	54.05	709	3	3	3	2	11	2	1	1
B36	6.82	2.115	0.182	58.75	965	3	3	4	2	12	2	1	1
B37	6.57	1.671	0.137	6.7	235	3	3	1	1	8	40	3	5
B38	6.8	0.551	0.077	4.65	489	1	2	1	1	5	60	4	5
B39	6.84	1.289	0.117	12.99	248	2	2	1	1	6	74	5	5

Soil sample													Land
Station			Total	P	K	Score					Soil depth		Use
ID#	pH	OC%	N %	ppm	ppm	OC	N	P	K	Total	Cm	Score	Code
B40	6.47	0.809	0.057	26.67	98	2	1	2	1	6	50	3	5
B41	7.01	0.963	0.102	14.11	230	2	2	1	1	6	41	3	2
B42	7.44	3.385	0.157	96.98	1054	5	3	5	3	16	3	1	1
B43	7.07	1.061	0.095	33.89	125	2	2	2	1	7	50	3	5
B44	6.98	2.126	0.168	78.03	183	3	3	5	1	12	46	3	5
B45	6.88	0.931	0.103	53.2	199	2	2	3	1	8	6	1	1
B46	6.68	0.999	0.121	21.08	173	2	2	2	1	7	100	5	5
B47	6.63	1.082	0.069	6.74	519	2	1	1	2	6	8	1	1
B48	6.77	1.652	0.12	31.79	121	3	2	2	1	8	10	1	1
B49	6.25	0.413	0.022	51.72	102	1	1	3	1	6	32	3	2
B50	6.81	1.428	0.105	32.3	132	2	2	2	1	7	5	1	1
B51	6.65	2.463	0.217	85.2	410	4	4	5	1	14	50	3	5
B52	6.88	0.583	0.046	5.19	64	1	1	1	1	4	40	3	2
B53	6.88	1.331	0.07	4.73	70	2	2	1	1	6	15	2	2
B54	7.05	1.038	0.069	5.43	87	2	2	1	1	6	50	3	5
B55	6.77	1.155	0.081	8.88	60	3	2	1	1	7	20	2	5
B56	6.41	0.737	0.061	18.11	104	1	1	1	1	4	35	3	5
B57	6.41	2.289	0.193	16.01	116	4	3	1	1	9	40	3	5
B58	6.75	1.779	0.113	14.65	119	3	2	1	1	7	70	4	5
B59	7.13	0.985	0.172	10.81	130	2	3	1	1	7	50	3	2
B60	6.61	1.056	0.065	69.99	105	2	1	4	1	8	50	3	5
B61	6.54	1.409	0.08	10.96	84	2	2	1	1	6	25	2	2
B62	0%	0	0	0	0	1	1	1	1	4	50	3	2
B63	6.51	1.283	0.087	17.74	94	2	2	1	1	6	25	2	2
B64	6.5	1.3	0.136	7.06	200	2	3	1	1	7	30	2	2
B65	6.69	0.975	0.1	24.81	199	2	2	2	1	7	45	3	5
B66	6.79	1.267	0.092	3.4	533	2	2	1	2	7	70	4	5
B67	6.93	1.497	0.118	14.93	485	3	2	1	1	7	50	3	5
B68	7.78	0.895	0.116	2.2	85	2	2	1	1	6	50	3	2
B69	6.7	0.439	0.031	43.97	104	1	1	3	1	6	80	5	2
B70	6.79	1.096	0.052	47.93	311	2	1	3	1	7	60	4	4
B71	7.17	1.416	0.074	16.35	144	2	2	1	1	6	82	5	2
B72	6.74	1.422	0.123	71.01	1268	2	2	4	3	11	70	4	2
B73	7.32	3.212	0.102	27.4	2570	5	2	2	5	14	37	3	5
B74	6.77	0	0	8.24	231	1	1	1	1	4	40	3	5
B75	6.64	1.241	0.1	10.72	226	2	2	1	1	6	43	3	2
B76	6.27	1.298	0.112	6.36	213	2	2	1	1	6	44	3	2
B77	6.41	0.831	0.082	49.43	116	2	2	3	1	8	40	3	2

Soil Sample													Land
Station			Total	P	K	Score					Soil depth		Use
ID#	PH	OC,%	N ,%	ppm	PPM	OC	N	P	K	Total	Cm	Score	Code
B78	6.76	2.77	0.197	11.23	193	4	2	1	1	8	49	3	3
B79	6.82	1.477	0.116	93.73	492	3	2	5	1	11	40	3	2
B80	6.58	1.089	0.084	10.94	426	2	2	1	1	6	80	5	5
B81	6.62	0.763	0.102	343	209	2	2	3	1	8	65	4	5
B82	6.99	1.464	0.116	58.12	316	2	2	3	1	8	60	4	5
B83	6.42	0.213	0.025	15.03	107	1	1	1	1	4	34	3	2
B84	6.29	1.473	0.156	13.1	158	2	3	1	1	7	58	4	5
B85	6.3	1.191	0.151	15.77	149	2	3	1	1	7	60	4	5
B86	7.04	0.734	0.085	19.04	196	1	2	1	1	5	85	5	5
B87	7	0.987	0.081	16.59	124	2	2	1	1	6	48	3	3
B88	6.69	0.412	0.061	27.55	138	1	1	2	1	5	40	3	2
B89	6.73	0.12	0.028	17.31	117	1	1	1	1	4	45	3	2
B90	6.52	0.319	0.042	13.89	94	1	1	1	1	4	65	4	2
B91	6.45	0.319	0.035	31.32	58	1	1	2	1	5	40	3	2
B92	6.68	0.091	0.024	5.34	114	1	1	1	1	4	30	2	2
B93	6.71	1.197	0.118	3.63	67	2	2	1	1	6	51	3	5
B94	6.79	0.876	0.11	30.89	98	2	2	2	1	7	30	2	2
B95	6.76	1.889	0.145	20.08	403	3	3	2	1	9	35	3	2
B96	6.79	1.295	0.1	10.14	424	2	2	1	1	6	40	3	2
B97	7.11	2.108	0.189	92.71	101	3	3	5	1	12	60	4	5
B98	6.72	1.188	0.068	1446	547	2	2	1	2	7	80	5	2
B99	6.61	0.354	0.017	59.14	121	1	1	4	1	7	40	3	2
B100	6.45	0.459	0.014	51.5	240	1	1	3	1	6	40	3	5
B101	NA	0	0	0	0	1	1	1	1	4	0	1	1

Current Land use code

5	=	Cultivated
4	=	Forest/plantation
3	=	Bush and Shrub land
2	=	Grazing land
NA	=	Not applicable

Appendix C

Policy-centered diagnostic questionnaires posed to government authorities.

1. What is your opinion on the possibility of creation of a food aid dependency syndrome by grain and oil financed soil and water and reforestation *programmes*? How do you intend to use food aid in future land rehabilitation and development?

2. Farmers report that more support is given to communal efforts in land rehabilitation, plantation establishment than to individual initiatives. What problems do you envisage if lands to be rehabilitated and developed be partitioned as farm lands and if the required support is given to individual development undertakings?

3. A substantial number of farmers inform that peasant association executive committee members instruct farmers not to introduce perennial vegetation. What do you comment on this?

4. Farmers who have got Eucalyptus plantations complain about not being able to transfer and sell their trees to markets that are located beyond their *Woredas*. At the same time, it is known that there are no more than 2 licensed merchants at the zone and these merchants could fix their own prices. Being eligible for the 40 % tax, the merchants' price offered to the farmer is incredibly low. Don't you think that this is a disincentive to the farmers and an obstacle to land rehabilitation and development? What actions are you to take?

5. According to the information obtained from the core members (*Yekor-abalat*) of the PA council and manifesto of Amhara People Democratic Organization (APDO), it is understood that, if well rehabilitated and developed land with all its development assets such as terraces (*Kab*) and vegetation is to be partitioned and reallocated to another farmer for ownership, the following would happen.
   a) As much as possible the same farmer will be considered for continued ownership of the developed land.
   b) Even when a portion of the land is to be partitioned and allocated to some one else who did not apply such land care measures, due to compelling reasons, the first action is to give this portion of land to a landless farmer who is a member of the family of the previous land owner.
   c) If there is no eligible landless in the family for getting this portion of the developed and rehabilitated land from the family of the previous land owner, first the previous land owner will be allowed to harvest any salvageable products from this portion of land prior to allocation of the land to some one else and second the new owner will compensate for all the developments made. Is this directive practiced in your jurisdiction ? Since it is to a poor landless farmer that the land is to be allocated, it is surely the case that the farmer may not have the necessary wealth to compensate the previous land owner even in the foreseeable future. Do you believe it can be practiced?

6. Farmers who are asked for significance of the compensation in speeding up willful land rehabilitation efforts with permanent structures and vegetation, approve its significance but only few of them (mainly core members) confirm that this is communicated to the farmers. Almost all consulted staff of the *Woreda* MoA offices indicated that they have never heard of it. Why is it that it is not well publicized to the farmers by all possible means?

7. The '*development day*' activities that farmers conduct once or twice a week are only terracing. The necessary cut-off drains and waterways do not augment these terraces. Other soil and water conservation techniques such as manuring and inclusion of vegetative measures are not included. In a few cases, construction of terraces without having cut-off-drains may do more damage than protection. What else is the reason for launching these selected measures only?

Appendix D

PA and methods considered in assessment of conditions for large scale application

			Agro-climatic zone				Study approaches			
Zone	Woreda	Peasant Association	K	WD	D	W	SR	FGI	QI	OD
South Gondar	Simada	03		x	x		x			
		04		x	x		x			
		05		x	x		x			
		06 (sengoaga)			x		x	x	x	
		09		x	x		x			
		010		x	x		x			x
		039		x			x	x		
		040 (Goshmeda)		x			x			
		041		x			x			
		042		x			x			
North Shoa	Antsokia-Gemza	Afso		x	x		x	x		
		Albuko		x	x		x	x	x	
		Chancho		x	x		x	x	x	x
		Mekedes-Addis-amba		x	x		x	x	x	
		Mekoy	x	x			x	x	x	x
		Mesk		x			x	x		
		Ankarna Kobekob		x			x	x		
		Aglana-Majete		x			x	x		x
South Wollo	Mekdela	Debre Zeit		x	x		x	x		
		Amboferes		x	x		x	x	x	x
		Gebtiys		x	x		x	x	x	
		Defergae		x	x		x	x		
		Yekoso		x	x		x	x		
		Yewetet		x	x		x	x	x	x
		Gedam		x	x		x	x	x	
		Genatit		x	x		x	x	x	
		Mingash		x	x		x	x	x	
		Mon	x	x	x		x	x		x
		Mata-meda	x	x	x		x	x		x
North Wollo	Meket	01		x			x			
		05				x	x	x		
		016		x		x	x	x		x
		017					x			
		024		x		x	x	x		
		028		x		x	x	x		x
		036			x	x	x	x		x
		039			x		x			
		041			x	x	x	x		

OD = On-farm discussion K = Kolla QI = Questionnaire interview
Sr = Site reconnaisance D = Dega x = holds true for the specified PA
FGI = Farmer group interview WD = Weyna-dega

Appendix E

Issues considered for rating the strength of social diagnostic tools

Code	Issues	PRA	QI	OD
Q1	• Which method is most useful to understand the development potentials and constraints of agricultural communities as a whole?			
Q2	• Which method is best for investigating problems and solutions of agricultural lands tha the communities as a whole could devise?			
Q3	• If you are to select the diagnostic methods to be used in social diagnosis, which is best for identifying development problems, production desires and solution approaches of farming villagers or communities?			
Q4	• In which diagnostic method are you directly or indirectly, forced by other discussants to restrain from discussing your personal problems with development facilitators?			
Q5	• Which method enables better-off farmers to cover up the ideas of inferior farmers so that only their opinion will be noted?			
Q6	• In which method will farmers have difficulties to tell their personal feelings to development facilitators?			
Q7	• Unless fear of authorities, in which method would farmers appreciate not to participate?			
Q8	• In which method are farmers most afraid of their ideas being undermined by experienced speakers and those superior in social or political status?			
Q9	• Which method should facilitators use to investigate the factual problems and potentials related to farms and farming conditions?			
Q10	• Which method is more appropriate for diagnosing development-related problems that occur among neighbouring farmers?			
Q11	• Which method could enable development facilitators to investigate the farming culture, tradition and indigenous knowledge of communities?			
Q12	• Which diagnostic method is best for diagnosing the problems of the farm and the farmer, farming techniques, and general farming tradition and culture of individual farmers?			
Q13	• Which method could explicitly identify farm problems that could be overcome by the farm owners?			
Q14	• Which methods can best demonstrate the facts that are helpful for compromising the land's potential and limitations with the amount and type of production desire of a farmer?			
Q15	• Which diagnostic measure is best fit for understanding constraints and production desires of individual farmer's land use?			
Q16	• Which method is the one that you propose to development facilitators for investigating farmer's general agriculture-related problems?			
Q17	• Which method do you think is most suitable for separating best land care measures and production strategies of farmers from those that are infamous?			
Q18	• If you were to determine on the use of the best diagnostic methods, which one do you think development facilitators should use best for obtaining genuine problems and requirements of the farmers?			
Q19	• Which one of the diagnostic methods would enable a farmer to express his ideas more freely and clearly?			
Q20	• Which method is best suited to learning farmers' vast experience in traditional mediation and case settlement approaches?			

Summary

The rates of soil erosion and land degradation in Ethiopia are frighteningly high. Crop production, livestock keeping and energy supply situations are at risk. The highlands are the most affected. Past rehabilitation effort has been immense. Much labour, capital and trained staff have been mobilized to correct the situation, but the outcome has not been encouraging. There are a number of reasons for the failure. Methodical and technological problems are evident. Exclusion of farmers and their indigenous knowledge at all levels of planning and implementation, the use of uniform and 'foreign' soil conservation and reforestation technologies, mistrust between farmers and facilitators, farmers' bias to production over conservation, miss-use of food-for-work *programme*s in conservation works, lack of conducive land tenure and tree usufruct have all contributed.

On the other hand, it is realized that there are a number of indigenous soil conservation measures. Likewise, successful agroforestry systems are traditionally practised by the Ethiopian farmers (Getahun, 1978). Given the potential role of agroforestry in controlling soil erosion (Lundgren, and Nair, 1985) and production possibility of diversified and short-term benefits to the farmers, an agroforestry initiative appears to have potential contribution in remedying the problem of land degradation. Success in the effort calls for construction of an approach that can benefit soil and water conservation from the agroforestry interventions. In the approach, traditional soil and water conservation and agroforestry knowledge of farmers need be studied and adapted. Farmers themselves need necesserily be made central to the study, adaptation, implementation and evaluation of the rehabilitation work. The research objective emanated from these circumstances.

The objective of this research work has been to develop and test a productive, sustainable and adaptable agroforestry development approach for success in land rehabilitation and soil and water conservation works in Ethiopia. Four basic issues are contained in the objective and these are:

- formulating a participatory agroforestry approach that consciously fosters short-term production needs of farmers and addresses long-term soil and water conservation requirements of the their land
- constructing the approach by which the top-down interventionist approach is substituted by the real participatory approach and remedying farmers' hesitance for working with development facilitators.
- embracing the use of indigenous technologies and experiences in the approach
- devising the approach in a way it functions at catchment (community) level which can further be appropriated to farm (household)-level intervention.

In order to effectively address the above indicated objectives, a functional conceptual framework has been devised. In addition, the study's focus is concretized by six research questions. The research questions are:

1. How is trust built between farmers and facilitators?

2. How can socioeconomic issues (such as issues related to the use of soil conservation measures and development priorities of farmers) be detected?
3. How is it that farmer-understood and-accepted environmental assessment could be conducted?
4. How could farmer-based agroforestry interventions be developed in discussion with farmers?
5. How could farmer's implementation wills be built? What incentives are still needed?
6. How can the effect of farmer-based agroforestry interventions be measured in a farmer-understood manner to be used as a feedback for further improvements?

The conceptual framework and the research questions present the core issues and directions of this study. A site was chosen and communities with whom the approach is to be developed were identified. Therefore, the constructed approach is a process which is molded under a case study situation. Its sub-processes include participatory trust building, socioeconomic diagnosis, environmental assessment, participatory planning, implementation and effectiveness tests that are all grown in an action research.

The participatory trust building sub-process initiative included

- staying within the community,
- studying an applying local values and customs,
- identification and usage of local influential authorities in the community for mediating trust,
- learning and applying the appreciated manners by the facilitator that can successfully enable him to get rewarding acceptance from the communities
- knowing preferred levels of conducting meetings and size of discussants for conducting effective discussions
- identification of the preference of farmers on socioeconomic diagnostic methods when approached by a facilitator

The participatory socioeconomic diagnosis sub-process dealt with identification of:

- major production sources of farmers, associated problems as well as linkages of the problems one another
- factors of species choices by farmers and their ratings in prioritizing species
- barriers to integration of trees/shrubs into farms
- reasons of farmers for rejecting introduced soil and water conservation measures
- indigenous soil and water conservation skills in the area with their respective potentials and limitations
- factors of land quality grading variables that are functional and understood by farmers in the areas

For identifying the above indicated socioeconomic issues, participatory rural appraisal discussions, formal questionnaire interviews and on-farm discussions are used. The participatory environmental assessment sub-process has dealt with characterization of the case study area in terms of:

- aspect (facings)
- elevation categories
- slope classes
- soil fertility status
- soil depth categories

Topographic surveying, soil nutrient assessment and application of integrated land and water information system (ILWIS-GIS) are employed for the study. Farmers' participation has been facilitated effectively too. After generation of the above indicated parameters, the study area is classified into five relative land potential classes that reflect site limitation factors and extents.

The participatory planning sub-process is grown through continuous farmer-participatory discussions that dealt with:

- identification of production desires of farmers with their respective associated problems
- environmental facts and issues as compared to production desires of farmers
- problem mitigation possibilities of problems of production desires of farmers in view of the adapted traditional land constraint mitigation skills of farmers
- setting bounds of soil depth and slope to define planning units by adapted class boundaries of scientific and situation-compelling standards
- conducting exhaustive studies on traditional land constraint mitigation skills of farmers and associated problems
- criticizing the defects and potentials of the indigenous land constraint mitigation skills and introducing the required modifications
- enumerating possible production targets and land rehabilitation skills to be implemented in each of the planning units
- prescribing soil and water conservation and agroforestry attributes and application concerns of the attributes that are valid to every part of the study catchment categorized into various intervention planning unit

The implementation sub-process of the approach dealt with:

- adapting catchment-level plans and prescriptions to farm and farmer-level situations,
- availing the necessary backstopping
- *conducting actual implementation in action*

The evaluation sub-process of the approach involves conducting an assessment on effectiveness of the prescribed and implemented agroforestry and soil and water conservation interventions in terms of:

- sustaining the land
- cost effectiveness
- productivity

- ease of adaptability

The results from the effectiveness tests have demonstrated that the implemented agroforestry and soil and water conservation interventions are effective in all sectors of the evaluation test.

The evolved sub-processes indicate that the overall approach is nested in that the various discrete data and information generated in the sub-processes are hierarchical and built one in congruence with the other. The exceeding sub-process makes use of the conclusion and is guided by the information obtained in the preceding exercise. It is further realized that each sub-process is inter-linked and continuum. The approach is further characterized by intimate bondage of the farmers' knowledge with the scientific knowledge.

The constructed participatory agroforestry approach is molded from this farmer-participatory action research in a 'soft-system' approach. In the process, the steps that are initially perceived in their abstract form as a conceptual framework are transformed into more illustrated sub-processes. As a result, an agroforestry approach whose sub-processes (nested loops) are connected to form an infinite loop is evolved.

The constructed approach assumes that circumstances change in either the social sector or the environmental setting or both through time. Therefore, the need for continuous discovery of facts and adaptations to circumstances is envisaged. In line with such a proposition, the devised approach is cyclic in its set-up and gives an opportunity for updating itself in accordance with new findings of the evaluation. The alternative venues of updating the approach are indicated as A, B and C in Figure 13.1.

In revising the methodology by which the updated agroforestry and soil and water conservation interventions can be effectively developed for willful implementation by farmers, the alternative avenues may change through time. The best yardstick in deciding the entry is the result from the evaluating and feedback sub-process.

An additional benefit of the development of the devised agroforestry approach is the possibility of developing agroforestry intervention technologies for effective soil and water conservation and agroforestry adoption by farmers. During construction and application of the approach, it is realized that soil depth and slope bounds can be used for defining the intervention planning units in broad and detailed intervention categories. For moist *Weyna-dega* agro-climatic zone conditions, consideration of farmers' production desires, adapted soil depth and slope class bounds as well as usage of adapted traditional soil and water conservation and reforestation skills have resulted in eleven agroforestry and soil and water conservation intervention categories. Eight of them occur within the adapted cropping limit. The remaining three agroforestry interventions are devised for those lands that are out of the cropping limit (that are either > 45 % in slope or < 20 cm in soil depth).

The development of the eleven interventions has resulted in realization of agroforestry as a land use option by which soil and water conservation measures are combined with woody perennials and non-woody components on the same piece of land simultaneously. Therefore, PAA is an approach that deals with methodical and technological shortcomings of land rehabilitation in Ethiopia. The interventions and associated prescriptions serve as a guide to catchment-level agroforestry and soil and water conservation interventions and prescriptions that in turn can serve as a guide to farm-level agroforestry and soil and water conservation planning and implementation undertakings.

In addition to the development of the approach in an action research, the conditions for large scale application are studied under a case study situation. From the adopters side, thirty eight peasant associations are studied from four sub-districts. From the facilitators side, four NGOs, four sub-district level offices of the Ministry of Agriculture and four bureaus of the Council of Administrations are considered for such a study.

Finally, recommendations that are inferred from the study are given. The following are major areas of these recommendations:

- a change in emphasis from conservation-based development to production-based conservation
- enhanced qualities of the facilitator
- preparation of participatory agroforestry approach-based field guide
- prominent consideration of trust building within farmers by facilitators
- focus on playing catalytic roles instead of reactant role by facilitators
- the need for endorsement of indigenous knowledge
- adaptation and application of the participatory agroforestry approach in accordance with farmers' and site's circumstances
- issues that conducive policies should address
- type, area of usage and modalities of incentives in land rehabilitation
- issues that require further investigation

Sammenvatting

In Ethiopië zijn de mate van bodemerosie en landdegradatie schrikbarend hoog. Akkerbouw, veehouderij en energievoorziening zijn in de gevarenzone. De hooglanden zijn het meest aangetast. De tot nu toe uitgevoerde herstelpogingen zijn immens. Er is veel arbeid, kapitaal en getrainde staf ingezet om de situatie te corrigeren maar de situatie is niet bemoedigend. Er zijn een aantal redenen voor deze mislukking. Er zijn duidelijk methodologische en technische problemen. De uitsluiting van de boeren met hun lokale kennis op ieder niveau van planning en uitvoering, het toepassen van uniforme en 'vreemde' bodembeschermings- en herbebossingstechnologieën, wantrouwen tussen boeren en voorlichters, de voorkeur van de boeren voor productie boven bodembescherming, onterecht gebruik van voedsel-voor-werk programmas bij de uitvoering van bodembeschermingsprogramma's en een gebrek aan aangepaste rechten op land en het vruchtgebruik van bomen hebben allen daartoe bijgedragen.

Aan de andere kant realiseert men zich dat er een aantal succesvolle inheemse bodembeschermingsmaatregelen bestaan. Succesvolle *agroforestry* systemen worden eveneens in praktijk gebracht door de Ethiopische landbouwers. (Getahun, 1978). Gezien de mogelijkheden van *agroforestry* om bodemerosie te bedwingen (Lundgren en Nair, 1985) en de boeren op korte termijn de mogelijkheid te bieden om over verschillende producten te beschikken lijkt een initiatief op het gebied van *agroforestry* een bijdrage te kunnen leveren aan het oplossen van het probleem van bodemdegradatie.

Om dit initiatief te laten slagen is het nodig een benadering uit te werken waarin de traditionele kennis van bodem- en waterconservering en van *agroforestry* van de boeren kunnen worden bestudeerd en aangepast, terwijl de boeren zelf een centrale rol moeten vervullen bij de studie wat betreft de aanpassing, de uitvoering en de evaluatie van het rehabilitatie werk. Het doel van het onderzoek is ontstaan uit deze omstandigheden.

Het doel van dit onderzoek was het ontwikkelen en testen van een duurzame en praktisch toepasbare benadering van de ontwikkeling van *agroforestry* ten bate van land rehabilitatie en bodembeschermingswerk in Ethiopië. Vier fundamentele zaken zijn vervat in deze doelstelling en deze zijn:

- het formuleren van een participerende *agroforestry* benadering die bewust de productie behoeften van de boeren op korte termijn bevordert en de conserveringseisen met betrekking tot bodem en water van hun land op de lange termijn aaanpakt.
- een benadering uitwerken waarbij een z.g. top-down aanpak vervangen wordt door een wezenlijk participerende benadering en het overwinnen van de aarzelingen van de boeren om met de voorlichters samen te werken.
- het accepteren van het gebruik van inheemse technologieën en ervaringen bij de aanpak.
- de benadering zodanig opzetten dat deze toegepast kan worden op het niveau van een geheel stroomgebied en later aangepast kan worden aan de behoeften van een enkel bedrijfje (huishouden).

Teneinde de bovengenoemde doelstellingen te bereiken werd een functioneel ontwerp raamwerk opgesteld. Bovendien werd het doel van deze studie samengevat in de volgende 6 onderwerpen:

1 Hoe wordt vertrouwen tussen boer en voorlichter opgebouwd?
2. Hoe kunnen socio-economische problemen (zoals problemen betreffende de toepassing van bodembeschermings maatregelen en de prioriteiten van de boeren) worden geanalyseerd?
3. Hoe zal een door de boeren te begrijpen en geaccepteerde waardering van het milieu moeten worden uitgevoerd?
4. Hoe kunnen op medewerking met de boeren berustende *agroforestry* activiteiten tijdens gesprekken te berde worden gebracht?
5. Hoe kan bij de boeren de wil tot uitvoering worden bevorderd? Welke prikkels zijn daarvoor nodig?
6. Hoe kan het resultaat worden gemeten van op medewerking van de boeren berustende activiteiten met betrekking tot *agroforstry* in een zodanige voor de boeren begrijpelijke vorm dat ze kunnen worden gebruikt als een terugkoppeling voor verdere verbeteringen?

Het conceptuele raamwerk en de onderzoeksvragen laten de kernproblemen en de richtingen van deze studie zien. Een gebied werd gekozen en de gemeenschappen waarmee zou worden gewerkt werden vastgesteld. Deze vaststelling is dus tot stand gekomen onder in acht neming van de gegeven situatie. De subprocessen bestaan uit een participerend vertrouwen opbouwen, een socio-economische diagnose, een milieu-evaluatie, participerende planning, uitvoering, efficiency tests die allen voortkomen uit onderzoek tijdens de uitvoering van het project. Het onderdeel van het participerend vertrouwen opbouwen omvat:

- verblijven binnen de gemeenschap
- bestuderen en toepassen van lokale waarden en normen
- het opsporen van lokale invloedrijke gezagsdragers en deze er bij betrekken teneinde vertrouwen te wekken
- het leren en toepassen van door de bevolking gewaardeerde gedragscodes door de voorlichter zodat hij met succes nuttige contacten kan leggen
- de juiste niveaus leren kennen waarop vergaderingen moeten worden geleid en het vaststellen van de juiste aantallen deelnemers waarmee zinvolle discussies mogelijk zijn
- de voorkeur van de boeren leren kennen voor bepaalde economische diagnostische methodieken die door de voorlichter moeten worden gehanteerd

Het socio-economische diagnose participatie subproces omvat de volgende onderwerpen:

- de voornaamste productiebronnen van de boeren, de daarmee samenhangende problemen en de onderlinge verbanden daartussen
- de factoren die hun gewaskeuze bepalen en de normen voor een gewassen prioriteitsschaal

- de randvoorwaarden voor het integreren van bomen/struiken op de bedrijven
- de redenen waarom de boeren voorgestelde bodem- en waterconserverende maatregelen afwijzen
- kennis nemen van de lokale inheemse bodem- en waterconserverings methoden met hun beperkingen en mogelijkheden
- onderkennen van de factoren die van belang zijn bij de classificatie van de geschiktheid van het land en die door de boeren worden begrepen

Om de bovengenoemde socio-economische vraagstukken te leren kennen worden discussies gehouden met de plaatselijke bevolking, er worden interviews afgenomen met formele vragenlijsten en discussies op een bedrijf gehouden.

Het participerend milieu-evaluatie subproces beschrijft en classificeert de volgende karakteristieken van het gebied waar het onderzoek plaats vindt:

- ligging ten opzichte van de windrichting
- hoogte boven de zeespiegel
- hellingklassen
- bodemvruchtbaarheid
- dikte van de grondlaag

Voor de studie is gebruik gemaakt van topografische kaarten, bodemvruchtbaarheidsbepalingen en de toepassing van het geïntegreerde land- en water informatie systeem (ILWIS-GIS). Participatie van de boeren werd op een effectieve manier verwezenlijkt. Na het vaststellen van parameters voor de bovengenoemde karakteristieken is het studie areaal in vijf potentiëele klassen ingedeeld op grond van de beperkingen die door de limiterende factoren werden opgelegd en de oppervlakken van de diverse klassen werden bepaald.

Het participerend planning proces ontwikkelt zich door geregelde discussies met de deelnemende boeren over de volgende onderwerpen:

- identificatie van de wensen van de boeren in het gebied en de daarmee samenhangende problemen
- milieu aspecten en de daarmee samenhangende problemen in relatie met het door de boeren gewenste productie niveau
- de mogelijkheden om de problemen die samenhangen met de door de boeren gewenste productie te verlichten, steunend op de traditionele vakbekwaamheid van de boeren
- het bepalen van de grenzen van bodemdiepte en helling teneinde de planning eenheden te formuleren gebaseerd op een aangepaste indeling in klassen met wetenschappelijk verantwoorde en door de omgeving bepaalde criteria
- het uitvoeren van een diepgaande studie naar de vakbekwaamheid van de boeren om de nadelige effecten van ongunstige groeiplaats factoren te beperken en de daarmee samenhangende problemen
- een kritisch onderzoek naar de onvolkomenheden en het potentieel van de inheemse vakbekwaamheid teneinde de gevolgen van ongunstige groeiplaats factoren te beperken en de mogelijkheden van het introduceren van de vereiste aanpassingen te onderzoeken

- opsommen van de mogelijke productie doelstellingen en de toe te passen rehabilitatie technieken voor iedere planning eenheid.
- opstellen van voorschriften voor de water- en bodem conservering en het aanleggen van *agroforestry* aanplantingen en voor de problemen bij de uitvoering. Deze voorschriften werden opgesteld voor ieder onderdeel van het in diverse planning units onderverdeelde studie gebied.
- Het subproces van de uitvoering omvat de volgende punten:
- het aanpassen van de plannen en voorschriften die gelden voor het gehele stroomgebied aan de situatie van de individuele boeren en hun bedrijven
- het verstrekken van de nodige aanvullende diensten
- het uitvoeren van de werkzaamheden in de praktijk

De evaluatie van de aanpak houdt in het vaststellen van het effect van de voorgeschreven en uitgevoerde maatregelen op het gebied van *agroforestry* en water- en bodemconservering in het licht van een:

- duurzaam grondgebruik
- effectief kostenbeheer
- productiviteit
- gemak van aanpassing

De resultaten van deze effectiviteits toetsen hebben aangetoond dat de voorgeschreven *agroforestry* en bodem- en water conserverings maatregelen in alle getoetste sectoren van de evaluatie werden gehaald.

De ontwikkelde subprocessen geven aan dat de benadering van het geheel getoetst kon worden omdat de diverse data en informatie voortkomend uit de subprocessen in een hierarchisch verband tot elkaar stonden. Een volgend subproces maakt gebruik van de conclusies en de verkregen informatie van een voorafgaande oefening. Men realiseert zich verder dat alle subprocessen continu met elkaar verbonden zijn. Kenmerkend voor de benadering is verder dat er een nauw verband bestond tussen boeren- en wetenschappelijke kennis.

De opgebouwde participerende *agroforestry* benadering heeft vanuit het boeren-participerend 'action research' in een 'soft system approach' zijn vorm gekregen. In dit proces worden de stappen die in het begin in hun abstracte vorm als conceptueel raamwerk worden gezien in meer geconcretiseerde subprocessen getransformeerd.

Figuur 13.1 toont aan dat een *agroforestry* benadering waarbij de subprocessen als lussen in elkaar grijpen uiteindelijk in een continu proces is overgegaan. De opzet van deze studie heeft een continu en in elkaar grijpend karakter.

De nu opgebouwde benadering gaat er van uit dat de omstandigheden met de tijd zullen veranderen, op sociaal gebied. in fysieke zin of beiden. Het is dus noodzakelijk *continu nieuwe data op te sporen en zich aan te passen aan de omstandigheden.* De ontworpen benadering is daarom cyclisch van opzet en heeft de mogelijkheid van 'updating'. De alternatieve kanalen hiervoor zijn aangegeven als A, B, en C in figuur 13.1.

De methodologiëen van de interventies betreffende *agroforestry* en de bodem- en water conserverende maatregelen worden verder ontwikkeld teneinde op vrijwillige basis door de boeren te worden toegepast. Deze kunnen echter met de tijd veranderen. De beste maatstaf voor een nodig geachte verandering is gelegen in een analyse van het 'evaluating and feedback' sub-proces.

Een bijkomend voordeel van de ontworpen benadering is gelegen in de mogelijkheid *agroforestry* interventie technologiëen te ontwikkelen die door de boeren zelf kunnen worden uitgevoerd op hun eigen land. Tijdens de uitvoering van de diverse maatregelen realiseerde men zich dat de begrenzingen als gevolg van bodem diepte en helling gebruikt kunnen worden bij het vaststellen van de planning eenheden zowel voor de grootschalige als voor de kleinschalige categoriëen.

Onder de condities van de vochtige Weynadega agro-klimaatszone werden de wensen van de boeren ten aanzien van productie, aangepaste bodemdiepte- en hellingklassen alsmede het toepassen van traditionele bodem- en waterconserverings maatregelen en herbebossings vaardigheden in aanmerking genomen met als resultaat het formuleren van elf *agroforestry* en bodem- en waterbeschermings interventie categoriëen. Van deze vallen er acht binnen de voor de akkerbouw getolereerde limiet. De overige drie *agroforestry* interventies zijn ontworpen voor de arealen die buiten de gebieden vallen die geschikt zijn voor landbouw. (met hellingen van > 45% of een bodemdiepte van < 20 cm.

Het ontwikkelen van de bovengenoemde 11 interventies heeft tot gevolg dat *agro-forestry* een optie is voor landgebruik waarbij maatregelen voor bodem- en water-conservering worden gecombineerd met het gelijktijdig invoeren van meerjarige houtige en niet-houtige gewassen op hetzelfde stuk land. Daarom is PAA een benadering die de methodische en technologische tekortkomingen van de land rehabilitatie in Ethipië aanpakt. De interventies en bijbehorende voorschriften dienen als gids voor interventies op stroomgebied niveau en kunnen op hun beurt weer van nut zijn bij de planning en uitvoering van *agroforestry* en bodem- en water conserveringsmaatregelen op bedrijfs niveau.

In aansluiting op de ontwikkeling van de benadering via 'action research' worden de voorwaarden voor grootschalige toepassing bestudeerd in een 'case study' situatie. Van de zijde van de boeren werden 38 boerenorganisaties uit 4 subdistricten bestudeerd. Van de kant van de voorlichters komen 4 NGO's, 4 subdistrict bureaus van het Ministerie van Landbouw en 4 bureaus van de 'Council of Administration' in aanmerking voor zo'n studie.

Tenslotte volgen hier aanbevelingen die uit de studie zijn voortgekomen. De volgende zijn de meest belangrijke:

- verandering van de nadruk van op conservering gebaseerde ontwikkelingen naar op productie gerichte conservering
- grotere vakbekwaamheid van de voorlichter
- opstellen van een *agroforestry* veldgids gebaseerd op een participerende benadering
- een prominente plaats toekennen aan het proces van vertrouwen winnen van de boeren door de voorlichters
- de nadruk leggen op een katalytische in plaats van een reactieve rol voor de voorlichter
- de noodzaak om inheemse kennis als waardevol te erkennen

- de *agroforestry* benadering aan- en toepassen rekening houdend met de omstandigheden waarin de boeren en de terreinsgesteldheid verkeren
- zaken die een doelgerichte politiek zou moeten aanpakken
- type, plaats van toepassing en soort van prikkels ter bevordering van landrehabilitatie
- zaken die verder onderzoek vergen

About the author

The author was born on January 1st 1958 at Majete, North Shoa zone, Ethiopia. He completed his elementary school at Majete Elementary School. He completed his high school education in Debre Sina secondary school (grade 7 - 10), Haile Mariam Mamo Comprehensive Secondary School at Debre Berhan (grade 11) and Beide Mariam Laboratory School in Addis Ababa (grade 12). He continued his college level education at Wondo Genet Forestry College and graduated in General Forestry in July 1979 From his graduation to June 1982, he served as District Forest Officer (DFO) at Dire Dawa and Isa-ena Gurgura district. Between July 1982 and January 1984, he worked at the Regional Forestry and Wildlife Conservation and Development Office, Harrarghe region, Eastern Ethiopia.

During January 1984 to May 1986, he conducted his B. Sc. level education at Washington State University (WSU), Pullman, Washington and graduated in Forest Management. He continued his M. Sc. level education in the same WSU and graduated in Forest and Range Management with a specialization in agroforestry in 1988.

From February 1988 to April 1994, he served as an agroforestry senior expert and counterpart to expatriate advisors of the FAO technical assistant to soil and water conservation project of the (then) Community Forests and Soil & Water Conservation Development Department. At the same time, he served as a secretary for the secretariat of the International Soil Conservation Organization (ISCO) which had been housed in Ethiopia for organizing the 6th ISCO conference in two years time.

The author has thought diploma, B. Sc. and M. Sc. Level students at Wondo Genet College of Forestry, Alemaya University of Agriculture and Forestry for Ethiopians programme of the Swedish University of Agricultural Sciences respectively.

As of January 1994, he worked as a private consultant in the field of agroforestry / soil conservation and has been involved in a number of international and national consulting firms where he had been charged the task of developing forestry/agroforestry development master plan and agroforestry development pre-feasibility and feasibility plans. He has also conducted evaluation of rural development efforts of various NGOs and has developed a strategic plan for the use of agroforestry in soil & water conservation works for few of the national and international NGOs which are functioning in Ethiopia. He has authored and co-authored a number of study documents, books and articles in the field of forestry, soil and water conservation and agroforestry.

In May 1992, he joined Wageningen Agricultural University to pursue PhD studies in the field of application of agroforestry for soil and water conservation which is the subject of this document.