Achalu D. Negussie

Farm Forestry Decision-Making Strategies of the Guraghe Households, Southern-Central Highlands of Ethiopia

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DEDICATION

To my family and to the farm households of Ethiopia, for whom fulfilling the very basic life necessities remains always an unexplored challenge, I dedicate this work as an expression of my deepest respect and love.

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ABBREVIATIONS

AHP	Analytic hierarchy process
CBD	Coffee berry disease
CE	Certainty equivalent
DA	Development Agent
DAC	District Administration Council
DBA	District Bureau of Agriculture
DBE	District Bureau of Education
DBF	District Bureau of Finance
EARO	Ethiopian Agricultural Research Organization
EED	Enemor and Ener District
EEDBA	Enemor and Ener District Bureau of Agriculture
EUM	Expected utility model
FSA	Farming systems analysis
FSR/E	Farming systems research and extension
GDP	Gross domestic product
GZ	Guraghe Zone
GZBA	Guraghe Zone Bureau of Agriculture
ICV	Interest compounded value
masl	Meters above sea level
ME	Man equivalent
MoA	Ministry of agriculture
MPTS	Multipurpose trees and shrubs
NCV	Net current value
NGO	Non-governmental organization
NTFP	Non-timber forest products
OLS	Ordinary least square
PA	Peasant Association
PPS	Probability proportionate to size
spp.	Species
SPSS	Statistical package for the social sciences
UN	United Nations
ZBA	Zonal Bureau of Agriculture

SUMMARY

The farming communities in Ethiopia are currently exposed to increasing threats of food insecurity problems due mainly to the ever-worsening stochastic biophysical attributes and unabated degradation of natural resource bases. Lack of access to modern farming technologies and inputs only aggravated the problems of land and forest degradations. Consequently, the majority of the farmers are trapped in the vicious circle of resource degradation, environmental instabilities, declining food security, and unstable social structures. The rising population densities and worsening poverty levels brought land and ecological resources under increasing pressure by forcing rural communities to abandon the traditional sustainable resource management techniques.

This study was initiated with the contention that sustainable livelihood strategies and lasting environmental rehabilitation can be secured only through judicious resource conservation works and its efficient utilizations. One of the most viable means of sustaining the productive potential of land and water resources and sustaining rural livelihoods was identified to be integration of more multipurpose tree and shrub species in the existing land units. This could be done in any structural arrangement that suits the needs of the farmers and the agro-ecological conditions of the area.

Farm forestry decision criteria were elicited by adopting a behavioral decision-making study approach from households in ten PAs of the study district. Major decision objectives, available alternatives, constraints, and the likelihood of the chance events were elicited through a questionnaire survey, participatory observation, detailed discussion, and review of archival information.

It was found that farmers generally, plant various tree and shrub species for meeting various household needs and for generating cash incomes. The goal of cash generation is sustenance of livelihoods through fulfillment of various basic obligations and overcoming unforeseen contingencies. The three most economically important tree/shrub species were eucalypts, coffee, and t'chat. Eucalypt wood covers nearly all the construction needs of the households and constitutes a substantial part of fuelwood consumptions. Coffee and t'chat make up an important part of daily diets and are used in various ceremonies.

Whereas eucalypts are planted by all households, coffee and t'chat crops are grown only in the midland and lowland villages. Marketing of eucalypts is confined to PAs in the neighborhood of road networks and areas where local demand arises. Although higher altitude t'chat fetches higher prices, most t'chat growing farmers generate some cash from its sale. High coffee yields of acceptable quality often fetch modest cash income to the grower households.

Growing of eucalypts for cash income is mainly constrained by lack of access road, low farm gate prices, high competition with food crops for soil nutrients and moisture, and shortage of land and labor. The household uses and cash values of coffee are generally, undermined by high incidence of berry disease and lack of manure. Financial benefits of t'chat are weakened by high

local tax rates. Several other less important economic, ecological, and social uses were identified.

The relative importance of various risk factors that influence the decision to grow and the performance of various tree/shrub species in various agro-ecological zones was elicited and presented. Farmers also subjectively assessed the likelihood of various chance events that constrain their farm forestry decision-making processes and the performance and output of the adopted practice.

The logistic regression analysis confirms that agro-ecological zone, sex of household head, number of eucalypt trees owned, and age of household head represent important explanatory variables that explain farmers readiness to expand eucalypt woodlots. The model so constructed correctly predicted 84.1 % of the households that established additional eucalypt woodlots mainly for cash generation. The total number of eucalypt trees owned by households is significantly related to attitude of the household head towards eucalypts, wealth status, and landholding size of the household.

In male-headed households men make the bulk of the decisions to establish, manage, and commercialize tree and/or shrub plantations. Women are given only rare chances to make marketing decisions with the male partners. On the other hand, women possess full control over household food sources, preparations, needs, and improvements.

Households generate cash income from different farm and off-farm sources, *inter alia,* agricultural crops, livestock, trees/shrubs, and wage work are major ones. Agricultural crops represent main source of cash income for greater number of highland households. Whereas sales of livestock are more important in the highlands, cash incomes from sales of trees/shrubs as well as incomes from off-farm activities represent the dominant financial resort in the middle altitudes. Lowland households rely on sales of annual crops and coffee during good seasons. Furthermore, some households resort to credit facilities that are characterized by high interest rates. Remittance money represents an important means of augmenting cash incomes for households in nine of the ten PAs.

Financial viability of eucalypt woodlots was assessed through both methods of conventional economic calculations and Chayanovian calculations. Both methods confirmed the highly lucrative markets of eucalypt poles as compared to agricultural crop production. This is mainly because of lack of access to more profitable production techniques and low productivity of agricultural crops per unit area. Otherwise, farm gate prices of eucalypt poles are far from being attractive and outperforming that of agricultural crops.

Important recommendations were drawn for swift and efficient rehabilitation of deteriorating biophysical conditions and reversal of worsening farmers' living standards. Many of the recommendations pertain to policy interventions that are aimed at genuinely assisting farm households overcoming the farm predicaments. Promotion of appropriate agroforestry practices was viewed as a starting point in ameliorating farmers living conditions and improving farm

productivity. The number of current on-farm multipurpose tree/shrub species is too few to make land resource management and food production significantly sustainable.

Many of the problems currently facing the farmers are out of their control and much difficult to be left solely to them. Marketing problems require simple adjustments and committed control, so that farmers obtain more rewards from the backbreaking farm works. An important recommendation is also forwarded for future studies targeting sustainable livelihoods and poverty alleviation. Full understanding and capturing of farmers' decision-making strategies need to make up the foundation of efforts aimed at introducing innovative technologies.

ZUSAMMENFASSUNG

Aufgrund fortschreitender Degradation der natürlichen Ressourcen sowie der sich zunehmend verschlechternden biophysikalischen Umweltbedingungen verzeichnen äthiopische Bauern vermehrt Schwierigkeiten bei der Nahrungsmittelversorgung. Fehlender Zugang zu modernen landwirtschaftlichen Technologien verstärken die Probleme der Boden- und Walddegradation. Somit scheint die Mehrheit der äthiopischen Bauern im Teufelskreis von Ressourcendegradation, zunehmender Unsicherheit der Nahrungsmittelversorgung sowie instabiler sozialer Strukturen gefangen. Steigende Bevölkerungsdichten sowie zunehmende Armut führten zu erhöhtem Nutzungsdruck auf die natürlichen Ressourcen, so dass traditionelle nachhaltige Ressourcenbewirtschaftungsmethoden aufgegeben werden mußten.

Die Studie geht von der Annahme aus, dass nachhaltige *Livelihood*-Strategien und die Wiederherstellung der natürlichen Ressourcen den Schutz dieser Ressourcen sowie ihre effiziente Nutzung erfordern. Als eine mögliche Massnahme zur Erhaltung des Produktionspotentials von Land- und Wasserressourcen sowie zur Unterstützung ländlicher Livelihoods wurde die Integration von zusätzlichen Gehölzarten mit vielseitigem Nutzen (‚multi-purpose tree and shrub species') in existierende Farmsysteme identifiziert. Die strukturelle Anordnung der Gehölze muss sich dabei nach den Bedürfnissen der Bauern und den agro-ökologischen Bedingungen richten.

Entscheidungskriterien für bäuerliche Forstwirtschaft wurden unter Anwendung des *behavioral decision-making* Ansatz in Haushalten von 10 Bauernvereinigungen (*Peasant Associations*, PA) des Untersuchungsgebietes bestimmt. Wesentliche Entscheidungsziele, vorhandene Alternativen und Zwänge sowie die Wahrscheinlichkeit von Risikoereignissen wurden durch Haushaltsbefragungen (Survey), teilnehmende Beobachtung, Befragung von Schlüsselinformanten und die Analyse von Sekundärquellen erfasst.

Die Studie zeigt, dass Bauern verschiedene Gehölzearten pflanzen, um einerseits verschiedene Haushaltsbedürfnisse zu decken und andereseits um Geldeinkommen zu erwirtschaften. Dabei ist das Ziel der Einkommenserwirtschaftung vor allem die Absicherung notwendiger gesellschaftlicher Verpflichtungen und die Risikovorsorge. Die drei bedeutendsten Gehölzearten sind Eukalyptus, Kaffee und t'chat. Mit Eukalyptus wird nahezu der gesamte Bauholzbedarf des Haushalts gedeckt. Desweiteren wird diese Art als Brennholz genutzt. Kaffee und t'chat stellen einen bedeutenden Anteil der täglichen Nahrungsmittelversorgung und finden weiterhin Verwendung bei verschiedenen Zeremonien.

Während Eukalyptus von allen Haushalten angepflanzt wird, werden Kaffee und t'chat lediglich in den Dörfern der tieferen und der mittleren Lagen angebaut. Die Vermarktung von Eukalyptus ist auf PAs in Strassennähe begrenzte und findet auf lokaler Ebene nur bei aufkommender Nachfrage statt**.** Alle t'chat anbauenden Bauern erwirtschaften Einkommen durch Verkauf, wobei t'chat aus dem Anbau in höheren Lagen bessere Preise erzielt. Durch hohe Erträge und

ausreichende Qualität von Kaffee können oft ergänzende Geldeinkommen erwirtschaftet werden.

Eukalyptusanbau als Einkommensquelle ist vor allem begrenzt durch fehlenden Zugang zu Strassennetzen, geringe Erzeugerpreise, durch hohe Konkurrenz der Bäume mit landwirtschaftlichen Kulturen um Nährstoffe und Wasser sowie durch den Mangel an Land und Arbeitskraft. Die Kaffeeerträge liegen aufgrund von Krankheiten sowie dem Mangel an Düngemitteln unter den Möglichkeiten. Der Gewinn durch den Verkauf von t'chat ist durch die Erhebung von hohen lokalen Steuern eingeschränkt. Weitere weniger bedeutende ökonomische, ökologische und soziale Nutzen wurden identifiziert.

Die relative Bedeutung von Risikofaktoren, welche die Entscheidung beeinflussen, Gehölze in den verschiedenen agro-ökologischen Zonen anzupflanzen, wurde analysiert und dargestellt. Durch die Bauern erfolgte die subjektive Einschätzung der Wahrscheinlichkeit des Auftretens verschiedener Risikofaktoren, welche die Möglichkeiten für bauerliche Forstwirtschaft einschränken sowie die Abschätzung des Nutzens/Gewinns der praktizierten Methode.

Die logistische Regressionsanalyse bestätigt, dass die agro-ökologische Zone, das Geschlecht und das Alter des führenden Haushaltmitglieds sowie die Anzahl der vorhandenen Eukalyptusbäume wichtige Variablen darstellen, um die Bereitschaft von Bauern zur Ausdehnung individueller Eukalyptuspflanzungen zu erklären. Das aufgestellte Modell wies 84,1% der Haushalte als solche aus, die zusätzliche Eukalyptusanpflanzungen zur Einkommenserwirtschaftung anlegen wollen. Die Anzahl der Eukalyptusbäume in den Haushalten hängt signifikant von der Einstellung des führenden Haushaltmitglieds zu Eukalyptus, dem Wohlstand des Haushalts sowie der Betriebsgröße ab.

In von Männern geführten Haushalten werden die meisten Entscheidungen bezüglich der Anlage, der Bewirtschaftung und der Vermarktung von Gehölzplantagen von Männern getroffen. In diesen Haushalten sind Frauen wenig in die Vermarktung einbezogen, besitzen hingegen Entscheidungsgewalt in Ernährungsangegenheiten.

Die Haushalte erwirtschaften Einkommen in verschiedenen Bereichen wie Landwirtschaft, Viehwirtschaft, Bewirtschaftung von Gehölzen und Lohnarbeit. Die Landwirtschaft stellt für die Mehrheit der Haushalte im Hochland die wichtigste Einkommensquelle dar. Während im Hochland der Verkauf von Vieh große Bedeutung hat, wird in den mittleren Höhenlagen der größte Anteil am Einkommen aus dem Verkauf von Holz sowie durch außerbetriebliche Aktivitäten erwirtschaftet. Haushalte im Tiefland sind auf den Verkauf von annuellen Kulturen und Kaffee angewiesen. Weiterhin nehmen einige Haushalte Kredite zu hohen Zinskonditionen in Anspruch. Finanzielle Zuwendungen von Familienangehörigen stellt für Haushalte in 9 der 10 PAs eine wichtige Quelle zur Erhöhung der Einkommen dar.

Die Rentabilität von Eukalyptusplantagen wurde sowohl mit konventionellen ökonomischen Kalkulationsmethoden als auch mit der Chayanovian-Methode eingeschätzt. Beide Methoden bestätigen die lukrativen Vermarktungsmöglichkeiten von Eukalyptusstangen im Vergleich zu landwirtschaftlichen Produkten. Dies ist vor allem auf geringe landwirtschaftliche Produktivität

und den fehlenden Zugang zu verbesserten Produktionstechnologien zurückzuführen. Andererseits sind die Erzeugerpreise von Eukalyptusstämmen im Vergleich zu landwirtschaftlichen Produkten gering.

Die Empfehlungen der Arbeit beziehen sich auf die Rehabilitierung der biophysikalischen Umweltbedingungen und auf die Verbesserung des Lebensstandards der Bauern. Dabei zielen viele Empfehlungen auf politische Maßnahmen zur Unterstützung der Bauern ab. So wird die Förderung von Agroforstwirtschaft als ein wesentliches Element zur Erhöhung der Produktivität des Farmbetriebes und zur Verbesserung der Lebensbedingungen der Bevölkerung angesehen. Die Anzahl gegenwärtig verwendeter Mehrzweck-Gehölzarten ist zu gering, um die Nachhaltigkeit der Nahrungsmittelproduktion und der Landbewirtschaftung zu gewährleisten.

Zahlreiche Probleme der Landnutzung sind außerhalb des Einflußbereiches der Bauern angesiedelt und somit nicht allein durch diese beeinflussbar. Eine Erhöhung des Anteils der bei den Bauern verbleibenden Wertschöpfung erfordert strukturelle Anpassungen und eine Überwachung des Vermarktungsprozesses. Bezüglich nachfolgender Untersuchungen zu Livelihoods und Armutsbekämpfung wird empfohlen, die Einführung innovativer Technologien auf einem umfassenden Verstehen der Entscheidungsfindungsprozesse auf der Ebene der Bauernwirtschaft aufzubauen.

CHAPTER 1

INTRODUCTION

1.1 Forest cover rates of Ethiopia

The most frequently quoted figure on the extent of the original forest resources of Ethiopia seems to have emerged from the assumption that some 85 % of the highland areas over 1500 masl (that cover ca. 45 % of the total land area) were once covered with natural high forests of various species (Huffnagel 1961; von Breitenbach 1963; Pohjonen and Pukkala 1990; SFCDD 1990; Conn 1991; EFAP 1994a; EARO 2000; Pankhurst 2001). According to this estimation about 38 % of the total land area of the country was covered with dense natural high forests at the beginning of the last century.

This dogma was, nevertheless, remained vulnerable to the hard evidences of recent empirical studies. Among others, McCann (1998) challenges the accuracy of the figures and treats them as a conflation of estimates and speculations rather than being founded on the results of empirical field works. He asserted that highland landscapes of the late 20^{th} century exhibited a considerable heavy imprint of human action for more than two and half millennia. Eshetu and Högbergs's (2000) investigation on the basis of ^{13}C natural abundance confirmed that Ethiopian forests were subjected to a series of non-linear deforestation processes in which complex land uses were involved. Their results from Menagesha forest site indicate the long-term dominance of C_4 grass or cultivation of C_4 crops before the establishment of the forest more than 500 years ago. Similarly, an environmental history research team (cited in Pankhurst 2001) ascertained that the northern highlands of Ethiopia were never as forested as has been claimed and deforestation had longer history than normally anticipated.

1.2 Problem statement

The fact that Ethiopian economy heavily relies upon agriculture has exacerbated its vulnerability to seasonal climatic upsets. Agriculture accounts for 57.2 per cent of the GDP, 95 % of the foreign exchange earnings, and 85 % of the total employment in Ethiopia (FAO/WFP 1998). Despite the key roles agriculture plays in the national economy, per capita food production has been almost continuously declining during the last three decades. This was worsened by the effects of excessive human population, recurring climatic upsets, and technological backwardness and resulted in chronic food shortages, which since recent decades became the global identity of Ethiopia.

A key factor that worsened the performance of the agricultural sector and thus threatened food self-sufficiency targets is the excessive deforestation and consequent degradation of land resources due to accelerated soil erosion (SFCDD 1990; EFAP 1994a; EARO 2000). FAO (1988) attributes the problems of land degradation in Ethiopia to the high rate of removal of natural vegetation, improper land use practices, and overgrazing as well as some intervening climatic and habitat factors. Likewise, recent years witnessed considerable diversion of animal dung and crop residue from soil fertility amelioration to fuel use. In the year 2001, for instance, 85 % of the total energy

requirements were met from biomass sources like fuelwood, charcoal, crop residue, and dung (Teketay 2001).

To this end, results of scientific studies and experiences of elderly natives made decades of massive decimation of the Ethiopian forest resources crystal clear. Forest history of recent past reveals the conversion of a substantial amount of forested lands into agricultural uses. In contrast to the repeatedly reported high rate (160 000 to 200 000 ha) of annual deforestation in the past (e.g. Bishaw 2001), FAO (2003) gives only 40 000 ha for the period from 1990 to 2000. Deplorably enough, Ethiopia was restoring only 5 % (2000 ha) of the annual deforestation through plantations by the year 2000 (FAO 2001). By the year 2001, for instance, only the size (216 000 ha) of natural forest resources estimated to be lost to deforestation in any single year has been artificially replaced (EFAP 1994a; EPA 1997; FAO 2001).

EFAP (1994a) and Cheng *et al*. (1998) argue that Ethiopian forest cover rate has dwindled to about 3.6 % during the early 1980s and further diminished to 2.7 % by mid to late 1980s. According to SFCDD (1990) the forest cover figures for the year 1970 and 1990 were only 4 % and 2.8 % respectively with only about two-third (1.7 %) of the latter being closed high forest. On the other hand, Bekele (2003) quoted that undisturbed natural forests covered only 0.2 % of the country during the 1980s. It has been projected (UNDP/World Bank 1984; EFAP 1994a) that with the contemporary rate of deforestation, the remaining Ethiopian high forests would shrivel to scattered forest remnants in inaccessible areas by 2010.

Efforts to rehabilitate degraded lands and forest vegetation covers and to improve agricultural productivity were either trivial or aborted at the start. The use of integrated agroforestry practices for sustainable land management targets was quite limited. Moreover, planning and project preparation works were overwhelmed by unrealistically ambitious and often internally inconsistent target settings. The little planning work undertaken tended to be more financial than economic and piecemeal and ad-hoc rather than coherent. Constable (1985) blames a weak agricultural planning that has been segregated between up to 4 different ministries and numerous subordinate agencies for the slow growth of Ethiopian agriculture. The abrupt removal of agricultural subsidies during the last few years has significantly undermined the productive potential of farmers. Up-to-date farm forestry technologies and inputs are out of reach of most smallholder households. Research works have largely concentrated on commodity rather than integrated holistic approaches.

The prospect of future food security situation is also being threatened as a result of acute land scarcity and continuous degradation of natural resource bases. Unabated worsening of the latter may place the quality of the living environment at a stake. The failure to understand farmers' choice criteria has bewildered the success of development projects aimed at guaranteeing food security and improving rural livelihoods. The author wishes to share the view that majority of development programs imposed on rural communities have not yet contributed a significant breakthrough in alleviating poverty, enhancing food security, and rehabilitating the living environment. Deterioration of food availability coupled with the rapidly rising human population will continue threatening the well-being of the rural communities unless corrective measures are identified and

implemented with no further delay. This study is aimed at identifying means by which farmers' 'own' needs and aspirations could be addressed in farm forestry project planning and implementation.

1.3 Research rationale

Recurrent draughts and worsening food security problems necessitate exertion of concerted efforts in introducing innovative resource management techniques and enhancing the productive capacity of farmlands. MNRDEP (1994) stresses that the only solution to arrest environmental degradation and fuelwood shortage crises in the future is to adopt a stringent environmental protection policy and embark on aggressive plantation programs. Moreover, it has been recently recognized that growing of trees and shrubs in combination with crop cultivation and/or animal rearing in the agricultural landscape is the only sustainable way of augmenting forest cover rates and enhancing the productive and protective functions of forests. According to EFAP (1994b), nevertheless, there was no time, in recent past, in which on-farm tree management practices have been officially encouraged in Ethiopia. A UN mission (UNDP/World Bank 1984) has recommended that a total of 3.3 million and 6 million ha of all kinds of forestry need to be established by 1992 and 2015 respectively to resolve long-term household energy supply problems in Ethiopia. To the dismay of the mission, nonetheless, Ethiopia was able to establish only 6 % of the 1992 projected plantation size.

Integration of multipurpose tree and shrub species (MPTSs) in all appropriate land uses holds substantial potential in terms of technical and economic feasibility as well as social acceptability. Carefully planned and executed on-farm tree/shrub plantations could enormously enhance household food-security situations through improved and sustainable crop and animal production. Moreover, establishment of on-farm tree/shrub plantations and woodlots on marginal lands within the rural village settings plays key roles in abating environmental deterioration and increasing wood supplies. Promotion of on-farm woodlots could also greatly relieve the pressure on the remnant natural forest resources by providing variety of forest products. Improving the productivity of land resources and thus their carrying capacity would, in the short-term, probably represent one of the most viable options to cope with the skyrocketing human population. Successful promotion of farm forestry practices can be done only through adequate understanding of farmers' decision-making processes.

Nevertheless, as Teketay (2001) asserted, forestry alone cannot be viewed as a sweeping panacea for the diverse and intricate problems of resource degradation, declining food security situations, and rapidly increasing population pressure. Only integrated rural development approaches with the target of improving rural infrastructures and empowerment of the people can address the problems in their entirety.

The Guraghe Highlands, one of the most densely populated regions in Ethiopia, currently face a very serious land degradation problems and a decline in agricultural productivity. Effects of environmental degradation are further compounded by severe havocs of crops by diseases and wild animals. Various diseases and lack of nutritious fodder gravely hamper livestock production.

Hawando (1998) argues that the combined effects of weather, technological backwardness, small holding size, poor soil fertility, and high population density caused the recent rapid declining of agricultural production in the southern regions.

The present work is concerned with the ascertainment of the potentials, constraints, needs and aspirations of farm households in promoting on-farm tree plantations, the vital means of combating ecological problems of deforestation and wood shortage crises. The second target of this study is to identify institutional and policy arrangements that could encourage farmers to participate in and boost their confidence in reaping the rewards from farm forestry practices. This study is firmly based on the assumption that any development initiative that is directed at promoting farm households' productive capacities, livelihoods, and living environments will not produce the desired effect without full capturing of their decision-making behaviors.

1.4 Objectives of the study

This research will have the following general objective:

- to develop methodological approaches of farm households' decision-making studies and to create comprehensive understanding of farmers' behavioral choice criteria in on-farm tree/shrub management. The extent to which adequate understanding of farmers' decision-making processes contributes to the efforts of promoting on-farm tree management practices will be explored.

Under the umbrella of this broad objective the following specific objectives will be pursued in this study:

- to elicit a plausible framework of farmers' cognitive strategies in farm forestry decision-making and to model the specific criteria of various decision processes;
- to coherently establish the responses of farmers in varying socio-economic and physical environments to farm forestry choice risks and uncertainties; and
- to identify and prescribe alternative farm forestry decision-making approaches and policy interventions with special emphasis on the enhancement of sustainable agroforestry practices.

CHAPTER 2

DECISION-MAKING STUDY APPROACHES AND THEORETICAL SETTING

"In the middle of difficulty lies opportunity." Albert Einstein.

2.1 General overview

Decision-making is a process by which a person, group, or an organization identifies a choice or judgement to be made, gathers and evaluates information about alternatives, and selects from among the alternatives (Carroll and Johnson 1990). It involves five key elements: a) identification and comprehension of decision situation and objectives, b) ascertaining alternatives or acts among which a choice must be made, c) identification of possible events or state of nature that may influence the outcome of the decision, d) decision-maker's mental judgments on the chances of occurrence of possible events, i.e., probabilities of the uncertain events, and e) choosing the best alternative(s) and the ensuing consequence or payoff, in net value terms (Carroll and Johnson 1990; Öhhlmér *et al*. 1993; Clemen 1996).

The likelihood of each alternative to be chosen by a decision-maker is markedly influenced by its inherent characteristics (Train 1990). A single alternative can, however, receive different choice responses from various decision-makers owing to the differing relative values they attach to each characteristic. It is generally, accepted that the decision-maker chooses the alternative from which he draws the greatest relative happiness or utility.

Agricultural decision-making studies have been conducted in various disciplines, *viz*. agricultural economics, anthropology, ethnography, sociology, psychology, etc. A considerable body of experience has been accumulated and documented mainly during the last two decades (e.g. Barlett 1980a; Barry 1984; Nazarea-Sandoval 1995a; Hardaker *et al.* 1997; etc.). Each of these scholars employed different approaches in comprehending, measuring, and modeling decision-making processes and risk attitudes of smallholders. From the review, it seems that decision-making study procedures have not yet been fully crystallized into one compromising and concrete technique (e.g. Upton 1996).

Decision-making studies in farm forestry are rather limited and more scattered. Major contributions include, *inter alia*, Caveness and Kurtz (1993), Franzel (1999), Salam *et al*. (2000), and Fischer and Vasseur (2002). Farm forestry decision-making study in Ethiopia is confined to problems and prospects of tree growing by smallholder farmers (Teklay 1997), socio-economic issues that affect adoption of agroforestry practices (Tesema 1997), and local people's perception on large-scale plantations (Bekele 1998).

Generally, two broad study approaches can be distinguished in investigating the rationale behind individual decision-makings (Gladwin 1980; Johnson 1980; Kahneman and Tversky 1984; Huijsman 1986; Senkondo 2000). Careful analysis of the available information, however, exhibits the widespread application of three approaches. Smidts (1990) also agrees with the presence of three distinct orientations of decision-making studies under risk. The overwhelming conviction with the

latter idea makes brief illustration of the three approaches necessary. This review, however, does not claim or profess to present an exhaustive overview of decision-making study approaches.

2.2 Decision-making study approaches and analysis

2.2.1 Normative or prescriptive approach

This approach, also referred to as the *utility/decision theory approach***,** is mainly adopted by economists and mathematical psychologists. It is founded on the seminal work of von Neumann and Morgenstern (1947), in which a normative decision rule called the *expected utility rule* that prescribes the way the decision-maker ought to choose between alternatives was contrived. This model is strongly steered by a theorem derived from a set of axioms about individual behavior.

According to Nippa (2001) the economic school of decision-making does not focus on the question how human decision-making takes place. The researchers start the investigation by patching up together imaginative behavioral assumptions about the economic rationality of individual decision-making. Alternative models are then generated in mathematical-deductive forms (Johnson 1980) to test the validity of the underlying assumptions. According to Gladwin (1979; 1980; 1983) this approach attempts to examine the conformity of the observed behavior to the researchers' hypotheses about adopted decision rules. Most of the studies within the framework of this approach also fail to test the predictability of their models against actual decision-making processes (Gladwin 1980). She critically demonstrated not only the confusing, convoluted, time-consuming, and costly nature of this approach but also the inconclusive and even conflicting inferences of its findings. Saaty (1980) urges normative theorists to shy away from making simplifying assumptions to suit quantitative models and blaming politics and capricious human nature for lethargic models.

Huijsman (1986) argues, on the other hand, that normative approach gives a plain direction to the elucidation of the research question. Likewise, Anderson *et al*. (1988) argue that well-prepared hypothetical models help drawing conclusions about the real situation in shorter time and with lower financial expenses. Nevertheless, under conditions of scarce theoretical framework, on the basis of which research hypotheses are formulated, the normative approach proves extraordinarily labor intensive and iterative research methodology (Huijsman 1986; Senkondo 2000).

2.2.2 Positive or descriptive approach

This approach, also known as *behavioral decision theory*, focuses on the actual decision-making strategies. It entails close observation of the decision-making process in order to understand the type of decisions and the situations under which actors resort to them. It tries to identify decision criteria which are employed under varying situations, and assesses the degree of importance that different actors with different endowments ascribe to them. A theoretical model will then be developed on the premises of full understanding of real-life decision-making processes. It differs from the economists' methodical assumption that decision-makers can rank order all the available alternatives on preferences or indifferences.

The main protagonists (Gladwin 1976; 1979; 1980; 1983; Gladwin and Murtaugh 1980; Huijsman 1986; Senkondo 2000) have emphatically claimed that this approach helps not only constructing descriptive decision models but also developing and prescribing effective innovations and policy strategies to address decision-making constraints. Moreover, it has been asserted that such natural decision models have proven to be accurate predictors of farmers' decision-making strategies in a number of agricultural settings (Gladwin 1980; Gladwin and Murtaugh 1980). This fact renders them the empirical power of useful tools in agricultural development research.

The positive approach has not, however, escaped criticisms. According to Johnson (1980) the anthropologists and cognitive psychologists that employ this approach have essentially focused on elaborating ethnographic descriptions of individual cases that is overwhelmed by loosely phrased theoretical interpretations. Such models often undermine the effectiveness and rigor of formal models in reinforcing our reasoning and may in practice overemphasize the chaos and mystery of human economic behavior.

Whereas normative models emphasize the theoretical view of the utility theory, behavioral decision theory emphasizes the description of decision-making preceded by empirical research work. According to Smidts (1990) an added difference is that while the former theory is mainly concerned with the utility component of decision-making, *risk preferences*, the latter theory is concerned essentially with descriptive empirical views, *risk perceptions*. Normative and positive theories have been perceived respectively as spoon-feeding the decision-makers with advice on how to behave under risk in order to attain a specific goal and as attempting to describe how decision-makers behave towards risk (Werner 1983, cited in Senkondo 2000).

2.2.3 Ethnographical decision tree models

Gladwin (1989) presents a strong critic against both research approaches and developed a variant of behavioral decision theory (Figure 2.1). She discards the normative model for collecting data about people to test highly hypothetical models and complex mathematical derivatives. Moreover, the normative model is used as a black-box technique to test researchers' interpretation of farmers' culture. Both models suffer from heavy influence of researchers' own ethnocentricity, i.e., viewing of another culture through the lens of one's own cultural values and assumptions.

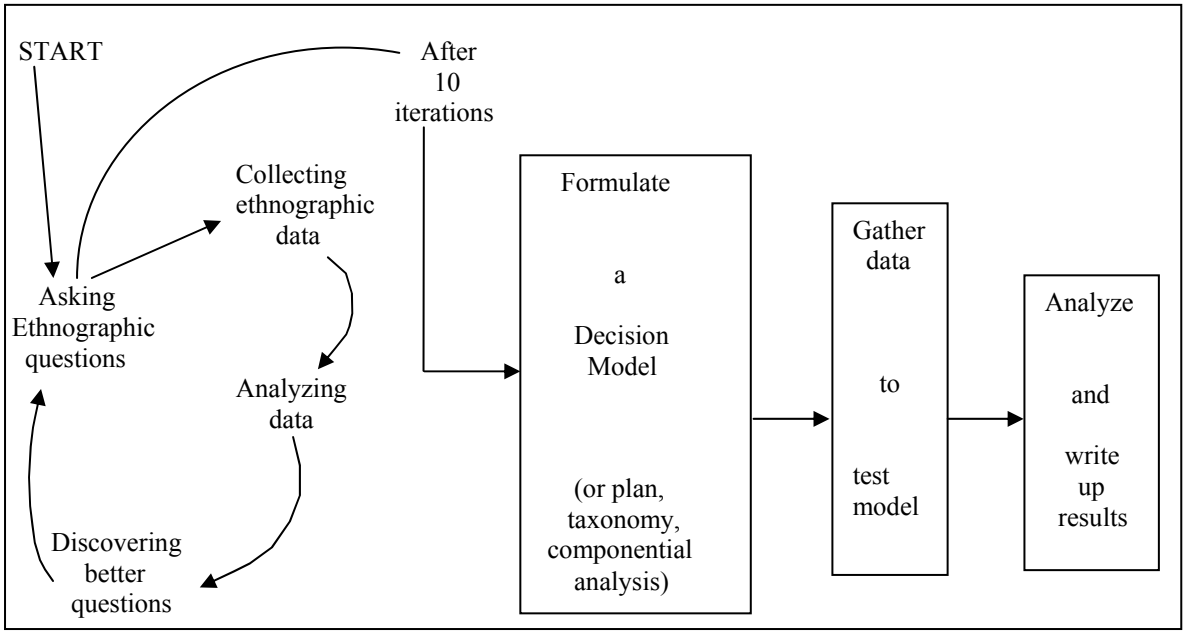


Figure 2.1 Combination of the ethnographic research cycle and linear hypothesis-testing plan
Source: Gladwin (1989).

In eliciting the decision criteria, the researcher commences by asking ethnographic questions and on-farm observations of farmers' practices and agro-ecological conditions. In-depth review and analysis of ethnographic records and iterative ethnographic procedures will help not only formulating better questions to ask but also grasping real farmers' goals, strategies, visions, and opportunities. This will often be followed by a straightforward linear research plan in which the decision model to be tested is constructed.

2.2.4 Decision analysis

2.2.4.1 Overview

Decision analysis is regarded as an arbitrator that tries to reconcile the divergence between the decision-making study approaches. Clemen (1996) argues that decision analysis provides analytical tools for decomposing and structuring complex decision problems into a framework that can be easily understood and analyzed. It demonstrates a set of hierarchical procedures and techniques that helps identify and prioritize all decision-making components so that the best alternative can be satisfactorily chosen.

Decision analysis makes immense use of behavioral decision theory since it clearly describes how and why people persistently engage in decision-making processes. In fact, thanks to the various decision analysis techniques, problems pertaining to its complex nature, inherent uncertainty, multiple objectivity and different perspectives leading to different choices have been fully decomposed into comprehensible parts (for details see Clemen 1996). Individual elements are then organized into structuring tools that render them comparable and analyzable to come up with the best choice.

2.2.4. 2 Hierarchical decision tree models

Hierarchical decision tree models were developed under ethnographic decision trees by Gladwin during mid 1970s. These models are inductively built and presuppose a farming systems research and extension program (FSR/E) in which the decision-maker, the farmer, is the leader. Two distinct stages are involved in the decision tree methodology, the *diagnostic stage* in which farmers' point of view and vision of the world are grasped and the *evaluation stage* in which various constraints and aspects of alternatives are comprehended. The two stages correspond here respectively to decision-making study and analysis. The use of these models has been attributed to two assumptions: a) people have limited information-processing capabilities and thus use procedures that simplify their decision-making calculations, and b) decision trees predict the actual choice of individuals (Gladwin 1979).

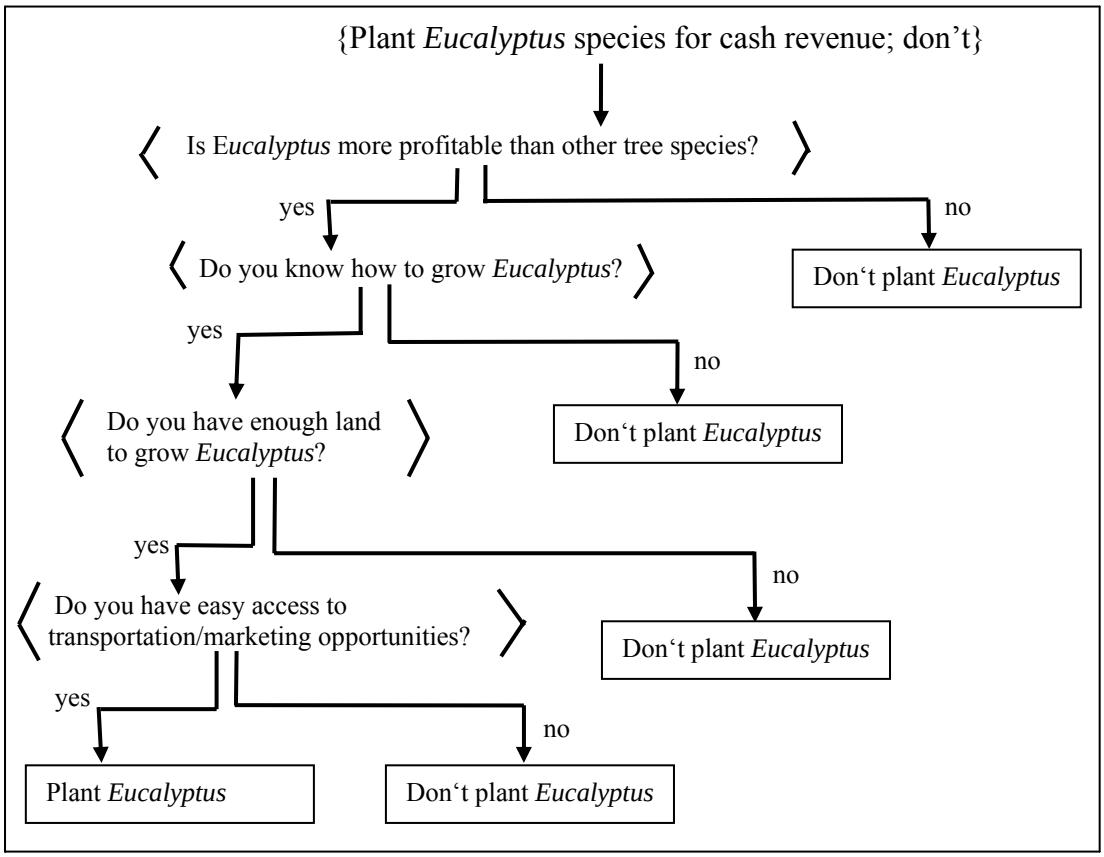


Figure 2.2 A hypothetical decision model of on-farm *Eucalyptus* planting for the market
Source: Adapted from Gladwin (1980).

As depicted in Figure 2.2 above, hierarchical models are quite simple to construct, with the choice alternatives in a set at the top of the tree, denoted by { }, and the decision criteria at the nodes or branching points of the tree denoted by < >, and decision outcomes or choices denoted by [ ] at the end of the branches (Gladwin 1979; 1983; 1989). Initially, the decision-maker is independently asked a set of questions in the criteria at the nodes of the tree and 'sent down' along one of the paths to a particular outcome where the process is repeated with other successive criteria. The criteria can be either ordering of the alternatives on some aspect or feature of the alternatives or constraints that must be passed or satisfied on a path to a particular outcome. The decision process is thus

deterministic rather than probabilistic, passing or failing a particular alternative with a probability of 1 or 0 respectively.

A decision to grow a particular crop depends on its potential to pass all the constraints of stage 1, elimination-by-aspects (Tversky 1972; Gladwin 1980) and stage 2, hard-core decision process (Gladwin 1980). Elimination-by-aspect refers to a situation in which the decision-maker rapidly and often unconsciously or pre-attentively eliminates all inappropriate alternatives without leaving any trade-offs among aspects. The real, conscious or hard-core decision takes place in the second stage. In this stage, the decision-maker chooses among the possible alternatives by carefully pondering over all aspects of the alternatives (Gladwin and Murtaugh 1980).

It is thus suggested (Gladwin 1983) that only alternatives that are likely to pass stage 1 constraints are included in the hierarchical models. Actual choice data is then collected from two independent samples of decision-makers, the first sample to elicit decision criteria and the second sample to test the model.

2.2.4.3 Influence diagrams and decision trees

An influence diagram is quite useful for developing the structure of a complex decision problem and displaying its aspects in a compact and intuitive form (Clemen 1996). Decisions are often made regardless of uncertainties about the future. Possible uncertain event is considered useful only if it will have some impact on at least one of the decision objectives. Consequences are expressed in terms of monetary values, improved production performance, increasing health, minimizing environmental impact, etc.

After the objectives are clearly specified and sorted, the next logical step involves structuring and modeling of the various decision elements. Influence diagrams graphically present the decision situation in which the relationships among decision alternatives, uncertain events and outcome, and consequences are depicted in boxes of various shapes. The decision elements, chance events, and consequences are displayed in rectangles, ovals and rectangles with rounded corners respectively, which are generally, referred to as nodes. The arrows that connect the various elements of decision indicate the sequence of the elements (predecessor or successor) and their influences (Figure 2.3). Influence diagram is a snapshot of the decision-maker's perception of the decision situation at a particular time rather than a flowchart.

Despite the tendency of easily exploding into a bushy mess, decision trees display considerably more information than do influence diagrams. Clemen (1996) emphasized that influence diagrams are better employed for structuring and representing large and complex problems and to help understand major decision elements. Decision trees, on the other hand, have an important role of specifying the sequence of the decisions and chance events and displaying details of a problem (Figure 2.4). Since the two decision modeling tools have different advantages and strengths for modeling various decision situations, they are viewed as complementary techniques of decision-modeling process.

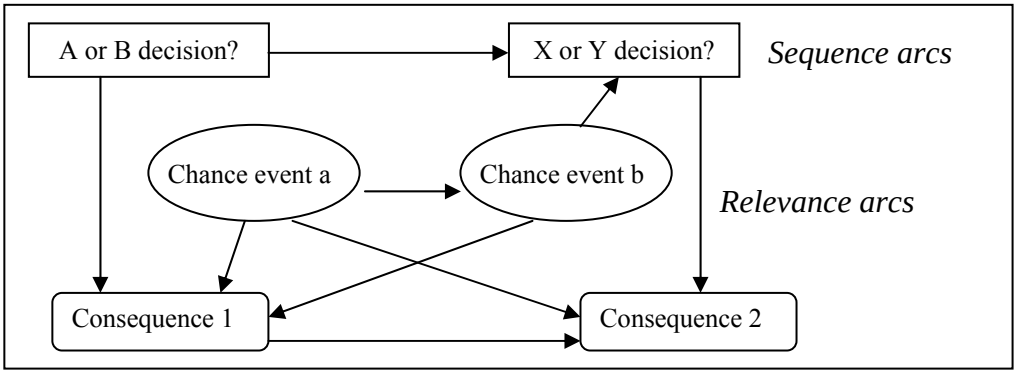


Figure 2.3 Simple hypothetical influence diagram
Source: Adapted from Clemen (1996).

A decision tree displays more of the details with squares representing the decisions to be made, circles representing the chance events, and branches radiating from circles representing the possible outcome of chance events. Every endpoint at the right of the decision tree specifies a particular consequence.

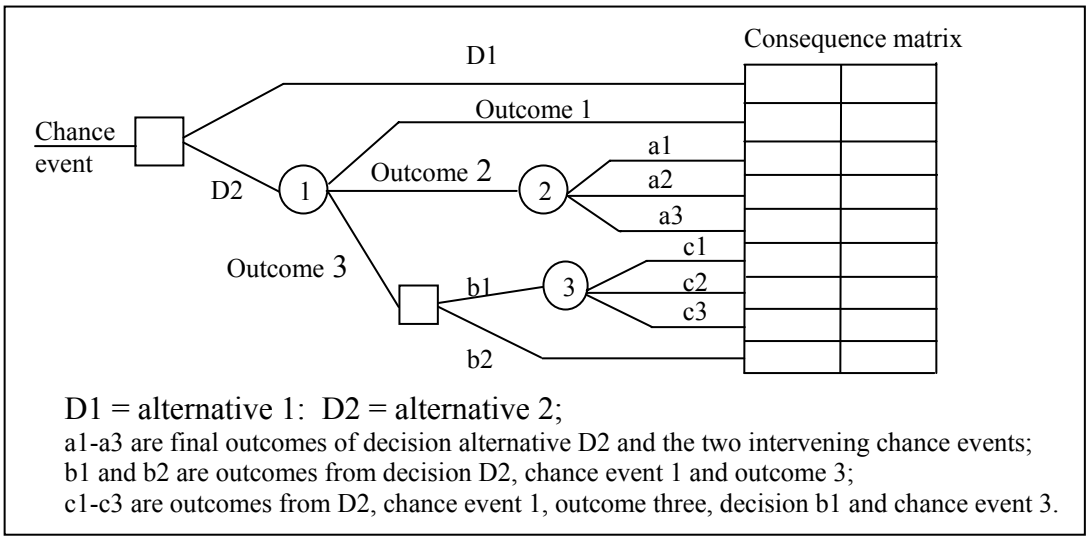


Figure 2.4 Simple hypothetical decision-tree representation of a decision conditional on a chance event
Source: Adapted from Clemen (1996).

In decision trees, the decision-maker is expected to choose only one of the branches that radiate from the decision node. Branches that radiate from a chance node must correspond to a set of mutually exclusive and collectively exhaustive outcomes. It is imperative to present the nods in a chronological order starting with a decision node. Dovetailing of decision and chance events is, therefore, as crucial as it is with influence diagrams. In Figure 2.4, the chance event on the left side indicates that the decision-maker has imperfect information regarding the decision to be made and thus awaits further information prior to making a decision.

Well-structured decision situations embody not only structural presentations of problems but also clearly defined decision elements. It is thus essential to specify probabilities of chance events and cash flows of decision alternatives or chance outcomes in the decision model. Probabilities basically

reflect decision-maker's beliefs about the uncertain events at different points in the problem. Similarly, cash flows (if necessary as net present values) are entered for each decision alternative or chance outcome either at the appropriate node of influence diagram or on the appropriate branch of the decision tree.

2.2.4.4 Analytic hierarchy process

Saaty and Vargas (1991) argue that the analytic hierarchy process (AHP) surpasses conventional decision analysis approaches for it reneges numerical guesses. It is a comprehensive, logical, and structural framework that helps setting priorities and making the best decision. It readily accommodates subjective judgments or aspects of a problem for which there is no scale of measurements. Reflecting on the way people actually think, AHP enables decision-makers to decompose complex decision problems into hierarchical structures and make simple pair-wise comparisons between decision criteria to arrive at overall priorities (Person 2001; ISNAR 2001).

AHP adheres to the principle that decision-makers provide subjective judgments based on feelings and intuitions rather than on thoroughly explicated logical reasoning. The AHP depicts the underlying mental process by which people arrive at overall judgments or decisions in situations that involve complex goals and criteria. ISNAR (2001) asserts that the AHP approach proves to be ideal for prioritization of agricultural research and development projects. Figure 2.5 exhibits hierarchical ordering of decision elements.

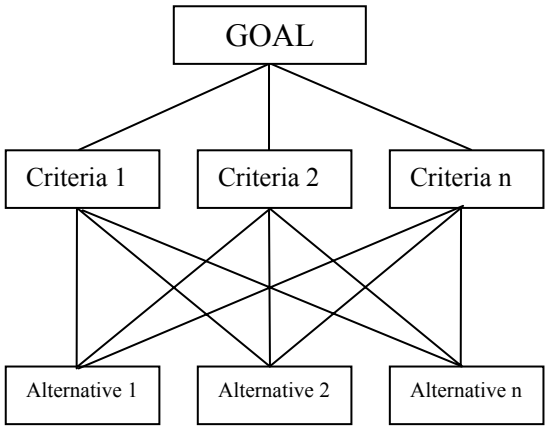


Table 2.1 Scale for comparisons

1	Equal importance
3	Slightly higher importance of one over the other
5	Higher or essential importance
7	Much higher or very strong importance
9	Highest or extreme importance
2,4,6,8	Intermediate values

Reciprocals: For inverse comparison

Figure 2.5 Hierarchy of a decision problem
Source: Adapted from Saaty (1995/96).

In general, the AHP methodology is based on three principal steps:

(a) formulation of objectives and decomposition of the decision problem;
(b) definition of criteria and comparative judgment of the elements; and
(c) synthesis of the priorities and selection of possible alternatives (Meixner 2000; ISNAR 2001).

Whereas the first step involves structuring of complex decision problems into hierarchic order, the second step is concerned with construction of pair-wise comparison matrix and weighing of alternatives and criteria (Table 2.1). In the latter case, each variable is subjectively weighed for its

relative importance and numerical values are assigned. In the last synthesis step, alternatives are prioritized with respect to each criterion and each criterion with respect to the overall goal.

The relative importance of the elements in a particular level is given by the principal right eigenvector of the matrix of judgments, the components of which sum to unity. Subsequently, the matrix is successively squared; the row values are summed up and normalized. Successive squaring of the output figures will be terminated when the difference between two consecutive computations is the minimum. The final eigenvector is used to weigh the elements in each level and to prioritize the alternatives with respect to each criterion. Further details can be consulted from Saaty (1980; 1995/96; 1999), Saaty and Vargas (1991), Han (1998), Meixner (2000), etc.

2.2.4.5 Summary

The analytic framework of farm household decision-making study approaches and decision analysis has been illustrated in Figure 2.6. The original figure is assembled by Werner (1983) and obtained from Senkondo (2000) and presented here enriched with ideas borrowed from Clemen (1996). As argued by Senkondo (2000), smallholder households basically behave rationally in weighing one alternative against the other and choosing the best. In reality, incomplete knowledge on objectives, alternatives, outcomes, probabilities of outcomes, or decision criteria compels farmers to make non-rational decisions. The theory of bounded rationality was presented during the 1950s to amend the shortcomings of rationality (Sonkkila 2002).

Techniques of decision analysis integrate the notions of both normative and positive decision-making study approaches and thus can be safely regarded as 'normative empirical'. Stringent literature review and examination of various decision analysis approaches compel the author to depart from Smidt's assertion that decision analysis is mainly concerned with the normative theory of suggesting the best alternative.

As Clemen (1996:4) clearly depicts, the ultimate goal of decision analysis is neither to usurp decision-maker's intuition nor to suggest alternative decision but to provide structure and guidance for systematic thinking to cope with difficult decision situations. It attempts to create profound insights and understanding of decision situation, uncertainties, objectives, and trade-offs and to simplify associated complexities. In fact, the application of decision analysis is attributed to the limited human expertise to process information and solve intricate problems (Huijsman 1986; Clemen 1996).

The method of decision analysis can be applied in any field of decision-making. A wide array of decision topics have been addressed with various decision analysis approaches the details of which have been described elsewhere (Anderson *et al*. 1977; Gladwin 1989; Saaty 1980; 1995/1996; Clement 1996; Hardaker *et al*. 1997; etc.).

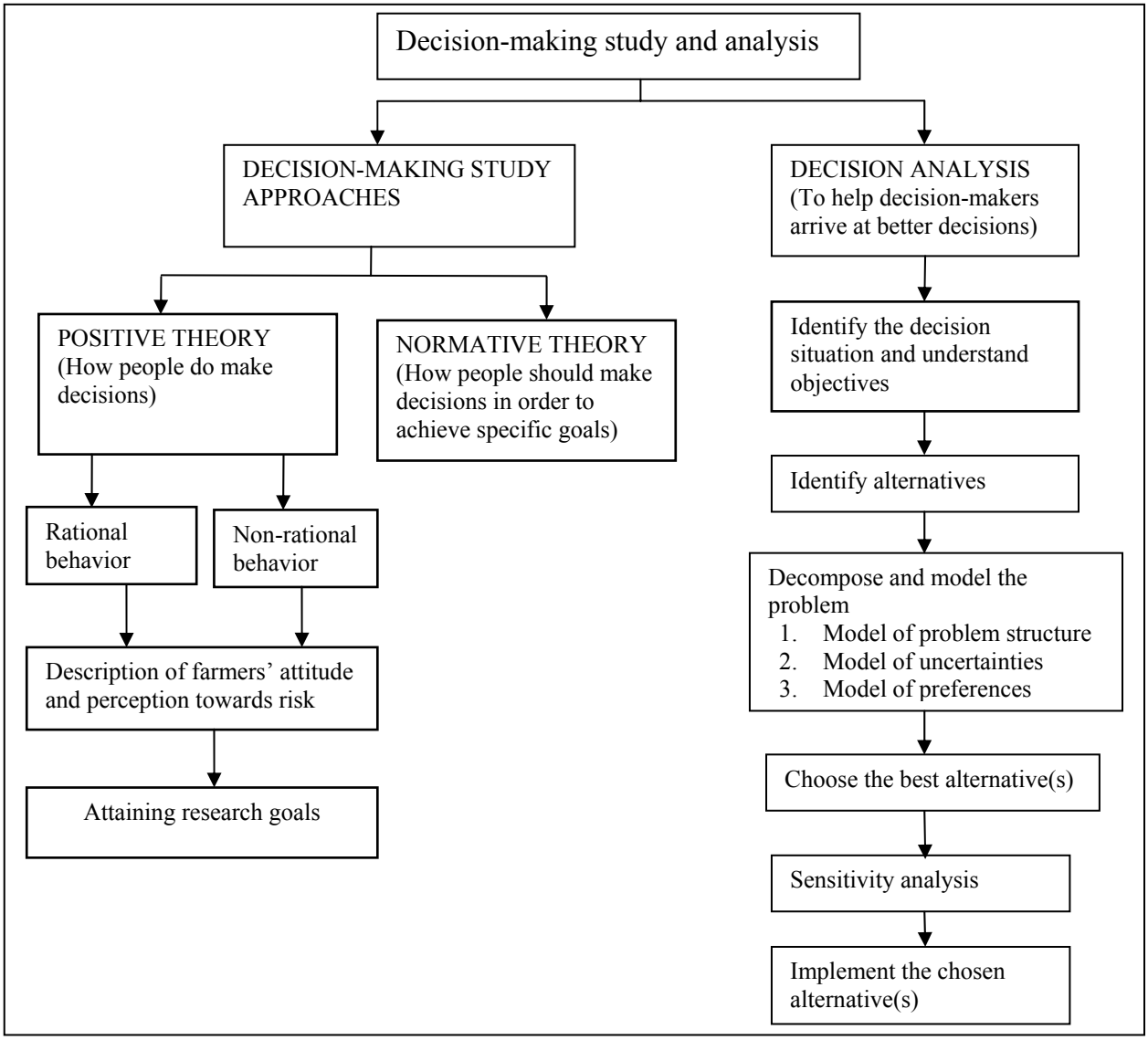


Figure 2.6 The analytical framework

Given the body of literature, it is imperative to select a method that can best be applied to smallholders' decision-making strategies. Full understanding of farmers' choice criteria positively contributes to problem identification and prioritization as well as to designing of socially acceptable, technically feasible, and environmentally sound innovations. The ultimate criteria for evaluating the merits of any study pertaining to smallholders need to be judged by its contribution to poverty alleviation and guaranteeing food security. Decision-making study methods should not be appraised for technical feasibility and simplicity *per se,* but for their predictive strength of the envisaged decision behavior.

By and large, there is a need to base agricultural/forestry decisions on empirical data sets that are elicited from the decision-makers, farmers themselves. Farm decision studies need to start from the notion that farmers are experts of the decisions they make although they often lack full awareness of the constraining factors and possible alternatives. Likewise, agricultural/forestry decision-making studies need to be actor-oriented and reflect farmers' real-world decision-making strategies.

2.3 Agricultural decision-making

2.3.1 Schools of agricultural decision-making study

According to Barlett (1980b), the basic divergence between economists and anthropologists is that the former are unenthusiastic in describing agricultural decision-making processes and often converge on how people can economize more intelligently, whereas the latter are concerned with ascertaining the way people economize intelligently. Öhlmér *et al.* (1998) argue that most of the teachings and research works have, so far, focused on farmers' decision events, i.e., how farmers should make decisions rather than on farmers' decision processes, i.e., how they make decisions. They also noted that past research efforts have emphasized concepts of expected utility at the expense of other aspects of optimization such as problem definition, learning, analysis, other decision-making rules, etc.

Despite the strong tendency of farm management students that lavishly received normatively skewed training to emphasize linear models, recent research works have refuted the practical applicability of such models in decision-making studies (Witte 1972; Mintzberg *et al*. 1976; Gladwin 1979; Gladwin and Murtaugh 1980; Carroll and Johnson 1990; Öhlmér *et al*. 1998). Linear models fail to take explicit account of time order of events and what is retained in memory.

Likewise, Öhlmér *et al.* (1993) assert that the normative models are of little value in practical decision-making process of farmers' livelihood strategies. The weakness of normative models is attributed to the failure to include problem detection, problem definition, and information gathering. Moreover, normative models include only the choice between alternative actions and oversimplify by assuming that the manager knows the problem, the actions, their consequences, and his/her preferences.

2.3.2 Risk and uncertainty in agricultural decision-making

2.3.2.1 Conceptions

The terms 'risk' and 'uncertainty' were defined differently by different authors at various times, the summary of which can be consulted in Barry (1984:7). The earliest distinction given by Knight (1921, cited in Senkondo 2000; Cancian 1980) indicates that whereas risk refers to imperfect knowledge where the probabilities of the possible outcomes are known, uncertainty occurs when probabilities of prospects are neither known nor quantified. Many economic literatures (e.g. Hardaker *et al*. 1997) protest that this distinction does not stand the test of the reality in the process of decision-making since cases where probabilities are objectively 'known' are exceptions rather than rules. Economic theorists instead view uncertainty as a state of mind in which the individual perceives a number of possible outcomes to a particular action, and risk as a degree of uncertainty in a given situation. Legesse (2000) quotes risk as denoting the possibility of undesirable state of reality due to natural events or human activities.

According to Cancian (1980), the original Knight's distinction between measurable risk and true, immeasurable, uncertainty is no more sanctioned by contemporary economists who apply the terms to refer to different aspects of the same situation. Likewise, Hujismann (1986) quotes several economic literatures that dismiss the distinction owing simply to the difficulty of assigning calculable figures to uncertainty. Among these, Sonka and Patrick (1984) argue that subjective nature of all probabilities under which actors make decisions invalidates the distinction between risk and uncertainty. Emana's (2000) rejection to employ the distinction in farm planning is attributed to the restriction of income distribution data to samples of short time series. In general, risk is not a well-defined concept to be readily assimilated in analytical models and thus studies on risks pertaining to agricultural decision-making are still at their infancy (Huijsman 1986). Adoption of risks in decision-making is thus limited to rather academic exercises.

It is thus imperative to presume clear distinctions between risk and uncertainty as pertains to the present work. Hence, in the absence of consensus on the definitions, risk has been adopted to refer to a situation in which the decision-maker is unaware of or uncertain about the outcome of a particular decision or action. Farm decisions involve considerable risks since the outcomes are prone to various uncertain events. On the other hand, uncertainty is viewed as a state of mind in which decision-makers perceive the occurrence of a particular event. A farmer who plants all his seedlings during the early spells of monsoon rains or who opted for adopting a new agroforestry technology is neither certain if the current rainy spell will continue for weeks to come nor knows how the technology performs under the local condition.

2.3.2.2 Sources of farm uncertainties and risks

Farmers' lack of control over physical conditions, biological events, political, social and institutional environments, as well as household social and financial status expose them to uncertainties and associated risks of production and marketing. Inherent nature of agriculture, being undertaken in the open air and embracing living plants and animals, particularly renders it susceptible to risks (Hardaker *et al.* 1997). Risk and uncertainty sharply reduce farm income and pose a heavy impact on farmers' decision-making processes and the efficiency of resource use in agriculture (Sonka and Patrick 1984; Kühl 2002). Table 2.2 summarizes major sources of farm uncertainties.

Table 2.2 Typical sources of uncertainties of smallholder households

Farm uncertainties	Specific uncertainties	Source
Stochastic environmental factors	▶ Unpredictable weather conditions; ▶ Damage by wild animals; ▶ Danger of disease and pest outbreaks; ▶ Market price fluctuations; etc.	Huijsman (1986)
Behavior of other decision-makers and organizations	▶ Demands of landowners; ▶ Targets of extension programs; ▶ Access to credit facilities; ▶ Change in government policy; etc.	
Household incidences/ characteristics	▶ Marriage; ▶ Merry-go-round ceremony; ▶ Sudden illness or death of a family member; ▶ Pregnancy and birth; ▶ Too many non-working household members; ▶ Loss of big asset to theft; ▶ Burning down of homes; ▶ Access to critical farm input; etc.	Own observations

Decision-making under uncertainty involves specification of the subjective probabilities of both risk attitudes and risk perceptions. It is, however, important not to mix up situations where the kind of risks involved in decision-making are known and where decisions are made under conditions of pure uncertainty with no risk considerations (Cancian 1980). Farmers that adopt new technology make decisions under conditions of ignorance and thus are neither aware of the odds of the gamble nor the outcome.

Dillon and Hardaker (1993) argue that risks and uncertainties often involve calamitous consequences for small, and particularly subsistence farmers. In summary, Kühl (2002) asserts that a household is said to be successful in coping with risks if it is able to subsist without irreversible damage to its members or their productive assets.

2.3.2.3 Risk attitudes and perceptions

Formal definition of risk attitude is given by Dillon and Hardaker (1993) as the extent to which a decision-maker seeks to avoid (i.e., risk aversion) or is willing to face (i.e. risk preference) risk. It is measured quantitatively by the coefficient of relative risk aversion or coefficient of absolute risk aversion. Risk attitude refers to farmer's valuation of the benefits he accrues from adopting a particular practice. It often embodies a long-term aggregate of feelings, beliefs, and behavioral tendencies.

Risk perception refers to a mental interpretation of the physical sensations produced by an external stimulus, e.g. risk. According to Senkondo (2000) risk perceptions (say, that of yield) often refer to a particular technique and are location and time specific. In other words, risk perceptions are likelihoods of various outcomes of a particular action. They are thus short-term and subject to change with the acquaintance of new information. The economic and social realities under which farm households embark on decision-making (household characteristics, access to and processing of

information, farm experiences, and nature and characteristics of crop production) influence risk perception pertaining to cropping system.

Decision-makers develop risk attitude and choice criteria on the basis of their perceptions about uncertain outcomes. According to Walker (1981; cited in Senkondo 2000) on-farm trials of new technologies are often conducted to bring rapid convergence of perception on the expected benefits. He noted that communities that have adopted a new maize variety have the same risk attitude with those who did not adopt. Differences in adoption decisions were entirely attributed to differences in risk perceptions. Accordingly, it is imperative for any farm decision study to clearly identify farmers' perceived sources of risks, the way their perceptions develop and change, and how their subjective judgments compare with objective measurements. Figure 2.7 graphically illustrates decision-makers' attitudes towards risk.

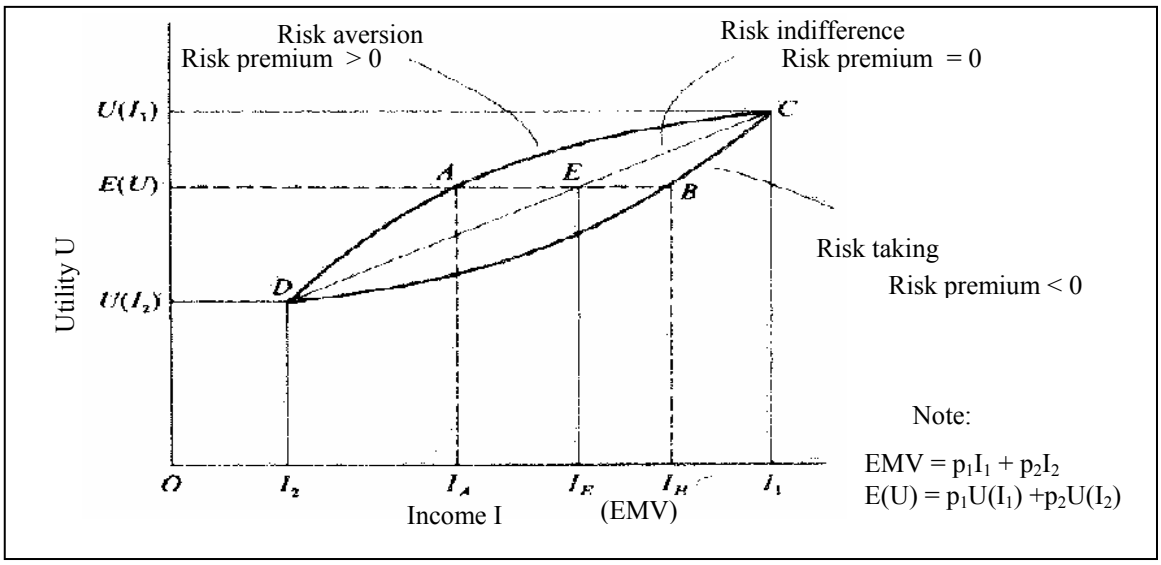


Figure 2.7 Graphic illustration of various utility functions involving risk
Source: Adapted from Ellis (1993).

According to Robison *et al.* (1984) farmers express their risk attitudes in such diverse ways as forward pricing, production practices, insurance, holding liquid reserves, diversification, liability management, etc. They also claim that the shape of decision-maker's utility function depicts his attitude towards risk. While a linear utility function implies risk neutrality, a function concave to the origin implies risk aversion, and a convex function implies a risk-preferring attitude[1]. Accordingly, the certainty equivalent (CE) of a risky action is always less than its expected monetary value for a risk averter.

2.3.2.4 Aversion to risks and uncertainties

The theory of risk aversion has been viewed (Senkondo 2000) as one of the important contributions of normative risk studies. Although economic models expect decision-makers to be indifferent between two distributions with the same expected value, they often prefer the distribution with the

[1] A decision-maker may exhibit a utility function of both concave and convex segments implying changes in risk attitude for different monetary outcomes.

smaller variance (Smidts 1990). In conformity to the theory of rational decision-making, actors are expected to choose an alternative with the highest expected utility. Kahneman and Tverskys (1979) present several empirical proofs that people's actual preferences systematically violate the theory of expected utility by overweighing outcomes that are considered certain relative to less probable ones. Such phenomenon of preference for certain outcomes to a lottery chance is defined as risk aversion.

A considerable wealth of experience has been accumulated on the risk-averse behavior of peasant farmers (see Adenew 2000). Hazel (1982) cautions that neglecting risk-averse behavior of farmers could lead to substantial yield overestimates, biased estimates of the supply elasticities of individual commodities and more importantly to overestimation of the values of farm resources and erroneous specification of farm technologies. Ellis (1993) argues that inadvertent risk-averse behavior of peasants results in inefficient use of farm resources. He also asserts that it results both in diversification of farming practices (spatially or mixed cropping) and inhibition of diffusion and adoption of innovations.

Analyses of risk aversion proved that farmers' attitudes towards risk are constrained by various personal (Moscardi and Janvry 1977; Binswanger 1980; Upton 1996) and socioeconomic characteristics (Feinerman and Finkelshtain 1996). Accordingly, the wealthier of two farmers can never be more risk-averse, and the less educated a farmer and the larger the size of his family the more risk-averse he is.

To this end, Huijsman (1986) asserts that many farmers' strategies and practices, that were often erroneously identified to emanate from risk-averse behavior, serve the dual purpose of reducing risk and attaining best economic outcome. By the same token, farmers cannot be simply classified as risk seekers or risk averters, but duly fit into both categories.

2.3.2.5 Farmers' responses to risks and uncertainties

Studies on assessing farmers' prediction of uncertain outcomes were bewildered by the inherent difficulty of analyzing the way individuals process information and perceive choice problems. Huijsman (1986) argues that most studies in this line were dominated by farmers' perceptions on yield variability of a single crop. Studies in the field of cognitive psychology and anthropology (e.g. Quinn 1978; Gladwin 1979; 1980; Ortiz 1980) are among the serious efforts to elicit the way farmers conceptualize choice problems and perceive uncertainties in the real decision-making environment.

Formal decision models shun the condition under which the actors adopt an action without sufficient knowledge of the odds involved or the range of possible outcomes. This is a decision situation at an early stage of adoption process. In contrast, it has been asserted (Tversky and Kahneman 1982; Smith and Desvousges 1988) that decision-makers often employ a limited number of heuristic principles and simplify the complex task of assessing probabilities and predicting values. They describe three heuristics that are commonly employed in making judgments pertaining to the occurrence of events. These are **representativness**, **availability**, and **adjustment and anchoring**. According to Huijsman (1986), in making judgments on the outcome of and the risks involved in an

action, people often directly discount for risk. In choosing between a high risk-high return and a low risk-low return prospect, people tend to reduce cognitive dissonance by scaling down the return of high risk venture in order to shun regretting the consequence of not choosing an opportunity with high potential pay-off. Such behavior of a person is often subjected to his wealth status and is explained by the tendency of risk aversion.

Cancian (1980) asserts, backing with empirical data, that risk remains fairly constant for both adopters and non-adopters of a given technology, although uncertainty was much greater for the early adopters. He predicts that rich farmers are more likely to adopt a new technology under risk whereas poor farmers are more willing to innovate under uncertainty since they have less to lose.

In examining decisions to gain a better understanding of the dynamics of peasant production, one should take a great care not to ally with Estes (1976; quoted in Ortiz 1980) to sidestep farmers' ingenuity in foretelling the likelihood of future events. Although most evaluations of future prospects are quite complex, farmers are exceedingly apt to construe the possibilities and relative frequencies of future farm events. Ortiz (1980) argues that in forecasting future states, farmers synthesize, from past information, the frequency of repetition, fluctuations, and the actual rate of change for each fluctuation.

In general, serious lack of knowledge on how farmers compare decision alternatives with various outcomes has been widely acknowledged. None of the hypotheses on risk-based decision criteria has been adequately tested to provide a good description of farmers' risk perception and risk bearing behaviors (Huijsman 1986). Senkondo (2000) also argues that many of the past studies suffer from lumping of risk attitude, risk perception, and choice criteria together under the topic of risk and uncertainty.

2.3.2.6 Normative modeling of risk attitude

Enormous amount of resources has been invested in the field of agricultural economics to conceptualize, model, and measure the risk attitude of decision-makers. The expected utility model (EUM) represents the dominant normative model adopted in the study of decision-making under risk. Its vulnerability to strong criticisms prompted other workers (e.g., Kahneman and Tversky 1979) to develop alternative models (see section 2.4). The EUM has passed through several evolutionary phases since its original conception by Bernoulli in 1738 (Smidts 1990). According to Anderson *et al.* (1977) utility function is a device for assigning numerical utility values to decision outcomes so that a consistent decision-maker should act to maximize subjective expected utility. Intermediate proponents, Neumann and Morgenstern (1947), of the model developed a set of assumptions (axioms) and proved that decision-makers that abide by these axioms should always prefer the alternative with the highest expected utility. More recently, these axioms have been formulated in a variety of ways and several workers have produced alternative and more vigorous theories under various names.

Main sets of axioms that provide the necessary basis for the EUM include ordering of prospects, transitivity among choices, continuity or CE among choices, and independence or substitution of

preferences (Anderson *et al.* 1977; Robinson *et al.* 1984; Smidts 1990; Senkondo 2000). The decision-maker has to obey these and several other axioms so that a utility function that reflects the decision-makers' preferences can be formulated. Moreover, utility functions are estimated through repeated applications of the CE axiom, which assumes that the utility of the CE equals the expected utility of the risky alternative. This is given as:
U(CE) = P(utility of best outcome) + (1-P) (utility of worst outcome) or simply
U(CE) = P(1.0) + (1-P) (0.0) = P.

The expected utility model finds its relevance owing to the abstract nature of expected monetary value and its weakness to explain many types of economic or financial behavior, i.e., it fails to distinguish between decision-makers' attitude towards additional wealth. Core elements of the model are concerned with Bernoulli's principle of an extra dollar is worth more to a poor man than to a rich man. The foregoing axioms are useful in deducing this principle for one-dimensional risky prospects. Possible actions are ordered by assigning a personalized and arbitrarily scaled utility value, which will then be weighted by its probability. Mathematically, the EUM can be given as:

a) a set of action choices $A = a_i$, i = 1, 2, …, n;
b) a set of outcomes $X = x_j$, j=1, 2, …, k;
c) a set of probabilities $P = p_i(x_j)$; i = 1, 2, …n; j = 1, 2, …, k where $p_i(x_j)$ is the probability of an outcome, x_j of an action, a_i.

Any decision that is made prior to certain specification of the values of these sets and the prevailing outcome involves uncertainty. Decision-making under uncertainty calls for representation of choice alternatives with corresponding probability distribution. The EUM is thus believed to clearly delineate between a decision-maker's perception of associated uncertainty and his attitude towards additional income.

2.4 Prospect theory

Prospect theory has been developed by two critics of the expected utility theory, Kahneman and Tversky, in 1979. They revealed that several choice problems violate the tenets of expected utility theory. The finding claims that people normally, underweight outcomes of lower probability in comparison to certain outcomes. Likewise, people generally, ignore components that are shared by all prospects under consideration and thus display inconsistent preferences when presented with the same choice in different forms. The results of their empirical survey disproved the axioms of expected utility theory. Under higher probabilities of winning people often choose prospects with the highest probabilities. On the contrary, under minuscule probabilities of winning, most actors choose prospects that offer greater benefit or gain. Similarly, most actors exhibit *risk-averse preferences* for a sure gain over a larger gain that is merely probable and *risk seeking preferences* for a loss that is merely probable over a smaller loss that is certain. Accordingly, people are expected to exhibit more risk seeking in deciding whether to accept a fair gamble than in deciding whether to purchase a gamble for a fair price. In rejecting the theory of expected utility, prospect theory asserts that people generally perceive outcomes as gains and losses, rather than as final states of wealth or welfare. Gains and losses coincide with the actual amounts that are received or paid.

Prospect theory distinguishes two phases of a choice process, *editing* and *evaluation*. In the editing phase, possible prospects are analyzed and presented in a simpler pattern. Evaluation phase involves weighing of the edited prospects and selection of a prospect of highest value.

2.5 Summary and adopted study approach

Detailed analysis of decision-making study approaches reveals that all of them suffer substantial pitfalls and are prone to criticisms. Normative study approaches that are employed to test utility theory suffer from severe drawbacks owing to their cognitively implausible axioms. The normative models seemingly represent the most unconvincing specification of smallholders' decision-making criteria. Mathematical models that are developed in office can never precisely predict farmers' cognitive processes in allocating scare resources to various productive and consumptive activities. In this regard, conventional few months of hectic field surveys and tightly scheduled interviews can also never fully capture important farm decision processes and criteria. Likewise, the behavioral decision-making study approaches are subject to biases from question format and survey approaches that could extract an erroneous data on the choice behavior of decision-makers (Kahneman and Tversky 1979; Senkondo 2000).

Actual farmers' choice criteria are by far, much more complex and can be elicited only through anthropological field studies[2]. Ethnographic data are generated through direct field techniques such as long-term participant observations and ethnographic interviews (Spradley 1979; 1980). Ethnography aims at grasping, depicting, and explicitly ordering into plausible accounts of the perspectives and actions of the portrayed actors (Spradley 1979; Strauss and Corbin 1998). Ethnographic fieldworks thus involve the disciplined study of what the world is like to people who have learned to see, hear, speak, think, and act in ways that are peculiar. The researcher should carry out an uninterrupted fieldwork for at least one full fiscal year to come up with tangible choice criteria. Although such a survey approach still fails short of capturing the entire management and utilization decision for perennial crops and livestock, it would enable the researcher to deduce quite useful and sound inferences.

The behavioral approach generates better descriptive theory of household decision strategies in attaining a livelihood and portrays the diversity of these strategies between individual households. It also describes the variables and conditions that are responsible for the emergence and consolidation of these diverse strategies. Last but not least, this approach helps predict future directions and long-term implications of agricultural/ forestry choice processes. The fact that this work aims to elicit farmers' choice criteria in farm forestry management practices and the lack of adequate theoretical framework necessitated adoption of the behavioral approach in the present study. In addition, methodological approaches of decision analysis are employed to elicit farmers' real-world decision-making processes.

[2] Spradley (1980) argues that an ethnographer participates in activities, asks questions, eats strange foods, learns a new language, watches ceremonies, takes field notes, washes clothes, writes letter home, traces out genealogies, observes play, interviews informants, and hundreds of other things.

According to Zabawa and Gladwin (1995), the ethnoscientific tools and survey data collected from individual farmers and verified by statistical tests provide sufficient grounds to describe events at farm level and to understand farmers' decisions made in response to those events. The behavioral approach is thus employed along with various statistical models to demonstrate the correlation between elicited choice criteria and farmers' behavior and other household characteristics.

In the present study, major emphasis was placed on eliciting pertinent information on the state, management objectives, and constraints of farm forestry in the study region. Within the allocated financial and time resources, this study attempted to extract all required data and the underlying facts. The outcomes represent a preliminary step in eliciting farmers' decision-making strategies under the prevailing risks and uncertainties. It also casts some light on intra- and inter-household decision-making differences and contributing factors.

2.6 Theoretical settings

2.6.1 Theories in social research

Theories have a unique role in social research arenas for specifying the variables of interest and their anticipated relationships (Miles and Huberman 1994; Boruch 1998). Social theories are valuable in answering one of the two fundamental questions of social research, *why?* (i.e., exploratory research). Silverman (1993) argues that in the absence of a theory that provides a set of explanatory concepts, there is nothing to research. It provides researchers with reasoning or mechanism to consolidate variables into a research question and is thus regarded as living entities that provide the impetus for the research. It has been stressed that any social research that is not supported by a theory or fails to make it explicit can easily be overwhelmed by irrelevant data that leads to vague inferences, faulty logic, and imprecise concepts (Neumann 2000).

Traditional model of science encompasses three basic elements that are chronologically executed: theory, operationalization, and observation (Babbie 1989). Social theory is defined as a system of interconnected abstractions or ideas that condenses and organizes knowledge about the social world (Neuman 2000). A process of linking a conceptual definition to a specific set of measurement techniques or procedures is referred to as operationalization. It involves a specification of steps, procedures, or operations employed in measuring and identifying the variables of interest (Babbie 1989; Neuman 2000). A survey questionnaire, a method of observing events in a field setting, or a method of measuring symbolic contents in the mass media could be an operational definition. An observation pertains to looking at the world and making measurements of observed variables through experiments, interviews, visiting and watching, etc.

2.6.2 Theories of farm decision-making process

Ellis (1993) argues that farm families attempt to achieve various goals simultaneously. Securing adequate food supply and essential subsistence goods for the family, maximizing cash income for purchase of outside goods and services as well as agricultural inputs with the object of meeting future projected needs and contingent emergencies, increasing leisure, avoiding risk, etc. stand on

the top priority list of subsistence farmers. On the other hand, maximization of gross margin, minimizing indebtedness, acquiring more land, reducing fixed costs, etc. constitute major objectives of commercial farmer (Romero and Rehman 1989). All relevant physical and social resources such as land, water, labor, capital, up-to-date agricultural information, and state of infrastructures play key roles in farmers' decision-making.

The decision-making process of smallholder households is generally, influenced by complex factors and is subjected to their needs and goals, strategies and resources available to them. Decision-making process of an individual emphasizes personal problem-solving and information processing behavior and ability. As quoted in Sonkkila (2002), individual differences are viewed under two related dimensions: personality and cognitive style. Whereas personality refers to the attitude or beliefs, cognitive style refers to the ways or methods, in which individuals receive, store, process, and transmit information. Moreover, farm households' decision-making strategies are culture-specific and thus are strongly guided by the composition of the household, i.e., life cycle stage of the family and personal characteristics of the household members (Wahab 1996).

The internal resource endowment of a household and its characteristics determine its risk tolerance capacity and endurance to wait for long-term products. Farmers' knowledge and perception, complex values, cognitive beliefs, and past experiences influence the way they view and react to external social and physical environments. The cultural and ritual environment, traditional customs, and social norms that govern the management of agricultural lands and crops are important considerations. Figure 2.8 presents categories of major decision-making criteria and possible interactions.

Exogenous factors can vary from daily communications between neighboring households to regional and global economic and political interactions. The natural ecological elements that consist of climate with all its constituents and fluctuations and water regimes as well as biological elements that consist of various fauna and flora place crucial pressure on farmers' decision-making processes. Demographic elements such as population pressure determine level of access to resources. Access to external information through mass media and/or extension services affects farmers' decision horizon. Level of exposition to experienced and successful farmers, private farm enterprises, and researchers represents an important consideration.

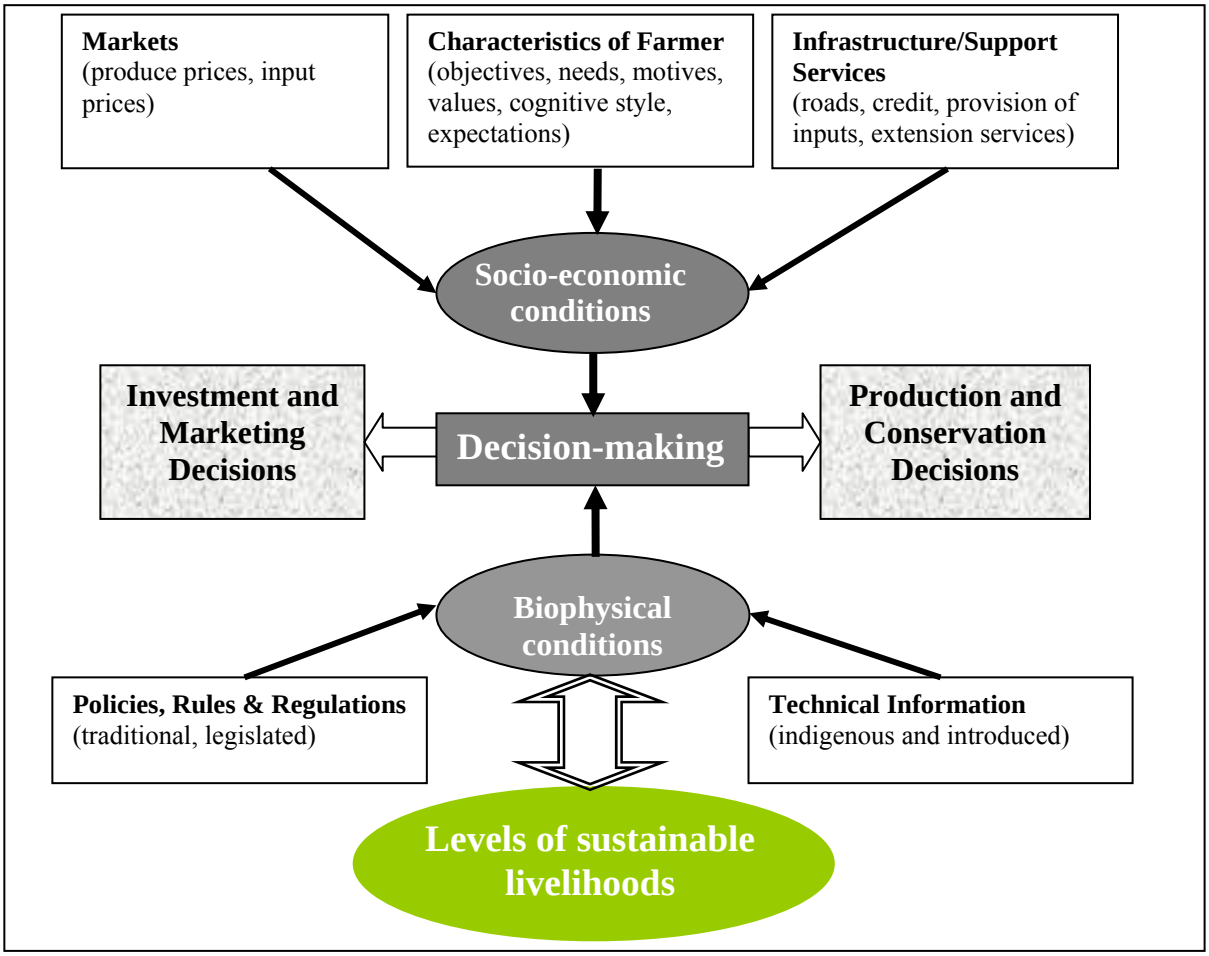


Figure 2.8 Factors influencing smallholders' decision-making and well-being
Source: Adapted from French (1995).

The political environment and policy regulations under which the small farmers operate pose a profound influence on their resource allocation and consumption decisions. At times, policies may completely bar farmers from growing some crops or provide high psychological motivations and resource subsidies to grow others. Significant impacts of foreign companies on smallholders' decision-making have been abundantly documented (Chossudovsky 2001). Theoretical model of the study as presented in Figure 2.9 embodies major factors that are relevant to the target farm households.

Scherr (1995) argues that financial discount rates, as well as farmers' implicit discount rates for different types of farm activities affect their decision-making processes, as does the degree of uncertainty of receiving benefits (goods or services) in the future. Limited access to production resources as well as insecure tenurial arrangements and lack of opportunities to market alternative crops are important determinants.

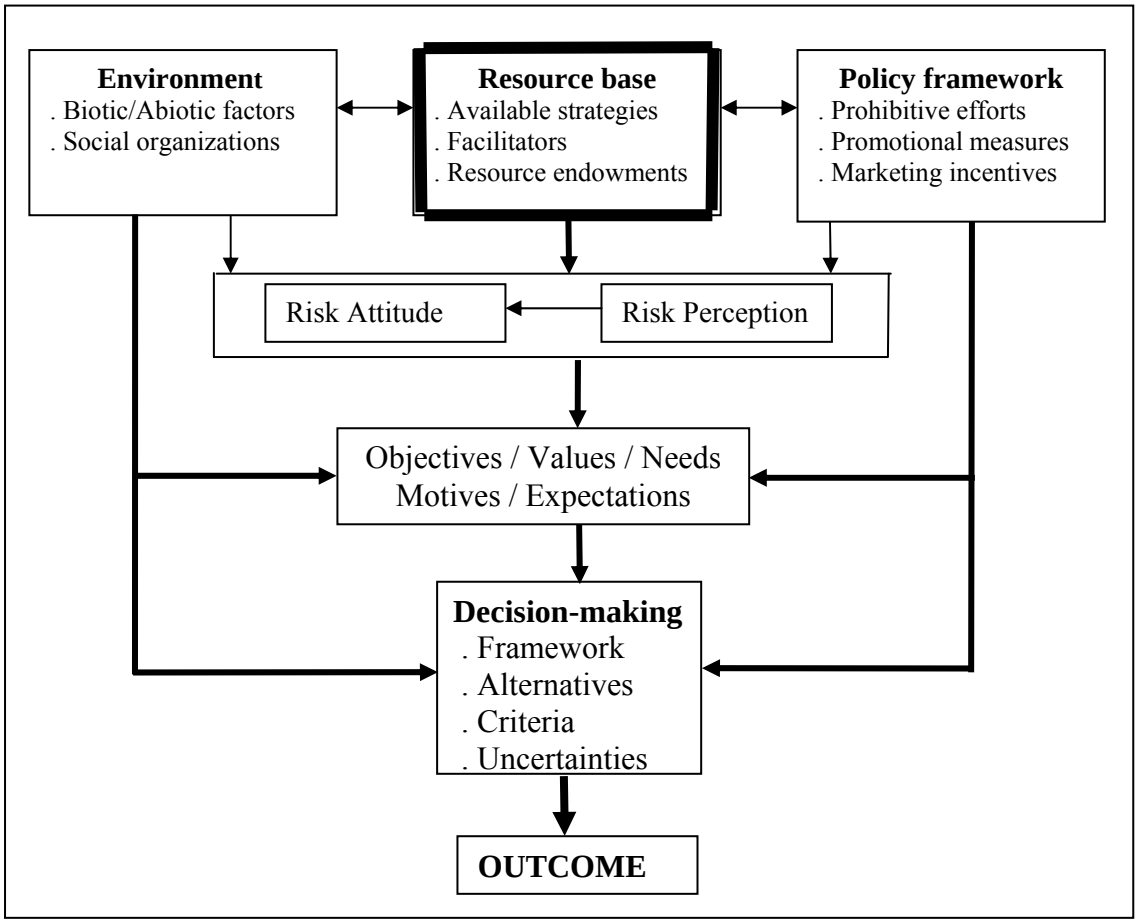


Figure 2.9 Conceptual framework of smallholders' resource allocation decisions

Farmers also choose between alternative cropping systems and agricultural and tree crops by using returns as basic evaluation criteria. Senkondo (2000) argues that farmers' selection of certain cropping systems is based solely on the expected aggregate returns of the various components. Diversification of farm products as an insurance against stochastic biophysical factors may probably be a more conceived goal of smallholder farmers in choosing various cropping systems and crop species.

Farmers in developing countries, in general and in Ethiopia in particular, commonly pursue 'welfare maximization' rather than 'profit maximization' approaches. The strategies that farm households follow in meeting their goals are subjected to the availability of and access to resources. Accordingly, farm households never conform to a linear decision-making process, but rather consider diversity of factors simultaneously.

Intra-household differences in access to and control over resources as well as resource allocation decisions need to be clearly understood. According to the widely accepted collective models of the household decision-making (Haddad *et al*. 1997; Quisumbing and Maluccio 1999), conflicting preferences can occasionally arise among household members, which need to be combined in various ways to reach a collective choice. It asserts that individual members have different preferences and bargaining powers and thus do not pool their incomes. Thus household decisions often reflect the bargaining powers of different members. Findings of Quisumbing and Maluccio (1999) suggest that assets controlled by women have a positive and significant effect on expenditure

allocations towards the next generation, such as education and children's clothing. In other instances (e.g., Dercon and Krishnan 2000), empirical evidences rejected collective models of household organizations.

Farmers synthesize past experiences and decision outcomes in making subsequent decisions. Good and/or lucky past decisions enhance farmers' financial position and food security status and thus reduce their risk aversion behavior in subsequent seasons. Commitment of government authorities to promote rural development projects and establishment of on-farm trials of farm forestry innovations would help farmers gradually eliminate their uncertainties and embark on intensive adoptions.

2.6.3 Operationalization of the conceptual framework

Operationalization of the conceptual framework is mainly concerned with the process of devising steps or operations for measuring the variables of interest. According to Sonkkila (2002), the validity of a model is measured by the degree of conformity between theoretical and operational concepts. Subsistence farmers' strategic decisions are mainly concerned with the selection of appropriate crop and livestock species, judicious allocation of the scarce land resources to the competing commodities and efficient use of the various outputs for the desired goals. Household decision-making is thus seeking an optimal compromise among several objectives, many of which are potentially in conflict.

In this study, major emphasis was given to farmers' primary goals as well as dominant constraints in planting various tree/shrub species in permanent woodlots, as well as in spatial arrangements and/or temporal rotations with other land use units. It cannot be attempted to investigate what a particular farm forestry decision-making approach ultimately results in, the work which otherwise would demand several years of continuous follow-up. Rather, the operational model depicts a one-year decision-making framework, which of course, can also be extended to a reasonable time frame in the future. Operational model of the present study is presented in Figure 2.10.

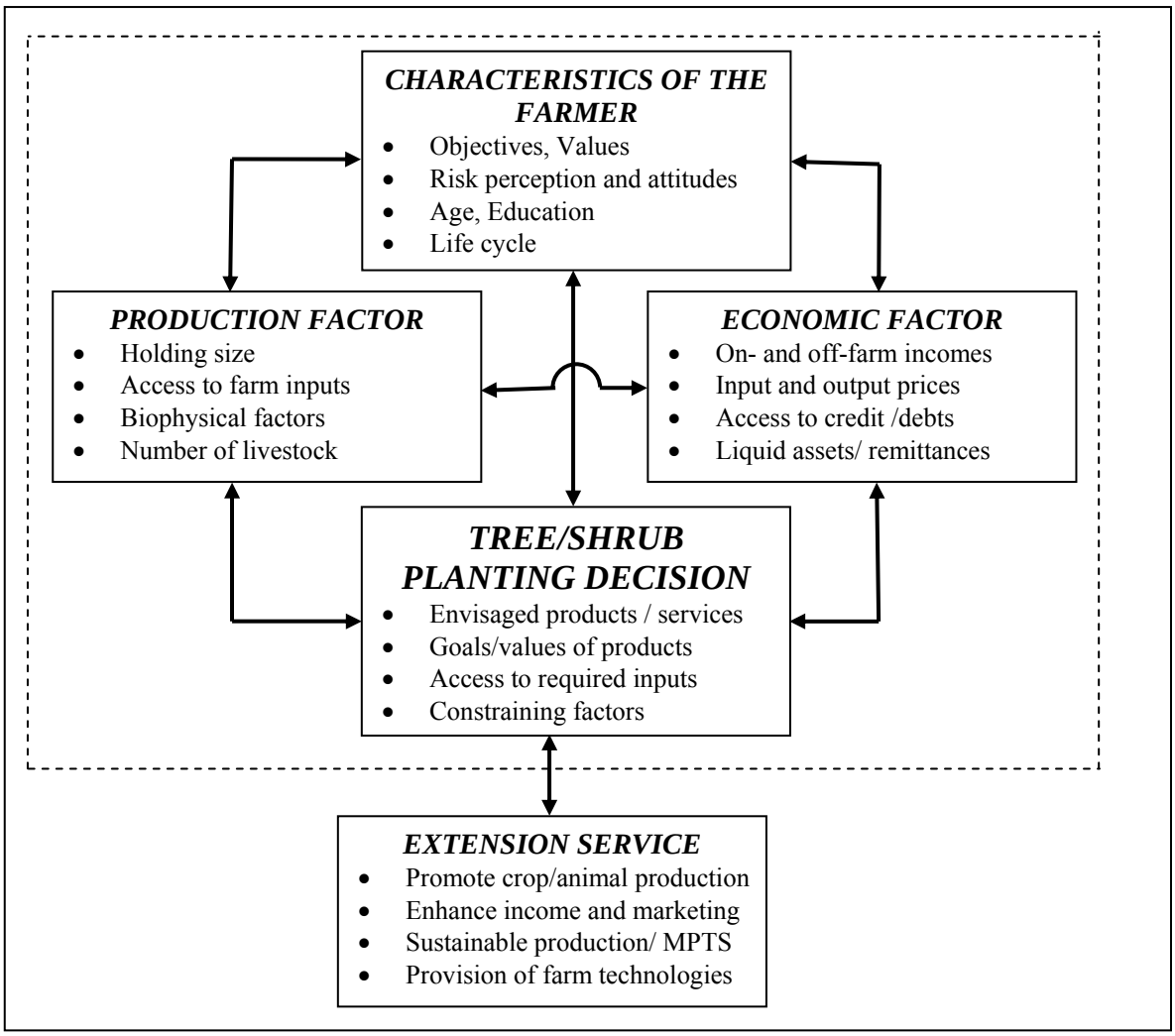


Figure 2.10 Operational model

It was practically not easy to include all relevant factors in the operational model. Some factors are dropped out owing to the difficulty of obtaining or ascertaining the output. Other factors (e.g., income, expenditure) cannot be fully substantiated and thus only partially covered. Such factors as annual off-farm income and income from sales of crops were ascertained indirectly.

Levels of farmers' endowments with production factors are measured by key factors like holding size, access to vital farm inputs, suitability of biophysical conditions, and size of livestock and ensuing manure yields. Financial status of the households is measured by the total revenues generated from different sources, market prices, access to credits and debt burdens, as well as possession of liquid assets. Level of familiarity of a household with a particular land management technique or agroforestry innovation, i.e. an attribute of the variable, perception is considered as an important indicator of farmer's readiness to adopt the practice. Further, the role and bargaining powers of household members in various farm forestry decision-making arenas were elicited and evaluated.

Whereas age, education, and life cycle of a farmer measure objective data, objectives, values, perceptions, and attitudes were based on farmers' subjective assessments. In measuring farmers' attitudes, care has been taken to cover as many pertinent attitudinal spectrums, regarding each

variable of interest, as possible. Impacts of extension programs are operationalized by methods employed in problem diagnosis and technology generation, available farm technologies, effects in alleviating poverty and enhancing sustainable production systems. Additional variables were measured by information obtained from extension personnel, farmers themselves, and statistical archives and substantiated by participatory field observations.

The depth and spread of the dimensions of each subject has, nevertheless, been constrained by paucity of research fund and time. The foregoing dimensions constitute part of the operationalization of the conceptual framework. Detailed operationalization of the conceptual framework (measurement procedures and levels, data analysis, and corollary notes) is presented in subsequent chapters.

2.7 Smallholders' decision-making study approach

Farming systems research (FSR) approach was developed to relieve the shortcomings of conventional "Top Down" approaches in identifying constraints and development potentials of rural communities in a comprehensive way (FAO 1990). According to Fresco *et al.* (1994), the emergence of FSR was further sparked by an increasing concern over the widening gap between the yields obtained on research stations and actual farmers yields. Conventional agricultural research approaches have concentrated on enhancing the potential of crops and livestock with little or no concern to the ecological adaptability, economic viability, and social acceptability of the technologies. As a result, many of the new findings failed to offer the envisaged benefits to farm households because either the technologies missed to target the felt needs and aspirations of the farmers or they demanded resource allocation patterns that conflicted with other activities.

FSR is a scientific method that focuses on farmers' circumstances and seeks to integrate farmers into the research process. The perceptions and expectations of small farmers and the constraints confronting them are of particular relevance. Dillon and Hardaker (1993) further elucidate that farming systems research adopts a farmer-oriented and problem-solving approach in which farmers' production systems, inter-household interactions, and the environmental variables - ecological, biological, socio-cultural, economic and political - that command farmers' decisions are fully recognized. FSR plays a key role in identifying major constraints to increasing farm output, and in providing improved understanding of farmers' circumstances and decision-making processes.

Accordingly, the main focus of the FSR is developing appropriate agricultural technologies for small farmers and thus to secure long-term stability of yields of a variety of cropping and livestock management systems. It aims therefore, at reducing production risks through diversification of crops and livestock production. Since FSA strives for:

a) describing the physical, biological, and socio-economic environments,
b) understanding the skills, knowledge, constraints, and aspirations of farmers,
c) assessing farmers' decision-making processes and evaluating the existing farming systems,
d) identifying the most constraining factors that require interventions, and
e) indicating potential improvements (Fresco *et al.* 1994), it is strongly opted for in the present study.

It was thus found imperative to commence with the analysis of the constraints that influence farm forestry decision-making of the Guraghe households, i.e. to start with both an area and a thematic approach. Detailed information on each farm component was solicited from the main actor. Attempts were made to exhaustively elicit all relevant alternatives, constraints, and associated subjective likelihood of occurrences. Farm fields were carefully assessed to cross check the authenticity of information given by farmers.

2.8 Research questions

According to Boruch (1998) the theoretical propositions made at the outset of the research specify a complete and logical (but hypothesized) series of casual events, connecting variables and constructs. Subsequently, research questions, what the research wants to understand, represent the heart of the research design. The better the initial research questions and ensuing theoretical propositions are constructed, the greater the likelihood the research yields fruitful results. The chore of describing research questions can never be viewed as a once-and-for-all task, which is completed at the initial stage of a research (de Vaus 1996). It is rather a continuous process through most part of the research life cycle. Research questions are commonly subject to refinement and amendments after the initial pilot study, collection and analysis of data, and review of archival data.

This study strives to address the following basic research questions. Discovering and ascertaining concrete relationships between new concepts during the preliminary research phase helped making the research questions progressively narrower and more focused.

(1) What are the distinctive socio-economic and biophysical features of the Guraghe farming system? Which farm constraints, potentials, opportunities, and priorities are typical to these households?
(2) What are the major constraints that impede farmers from aggressive integration of multipurpose trees and shrubs into their farm units?
(3) How can these constraints be addressed in order to encourage and motivate farmers in on-farm tree/shrub management schemes?
(4) How effective are current government extension programs in promoting farm forestry practices and thus helping farmers in reaping the rewards of agroforestry?
(5) How do farmers view the use values and alleged negative ecological effects of eucalypt species?
(6) What factors influence farmers' propensities for expanding eucalypt woodlots?
(7) How do farmers risk perception and risk attitude vary among households and with different agro-ecological zones under which they are operating?
(8) How are financial benefits from farm forestry practices distributing among different stakeholders?

CHAPTER 3

METHODOLOGICAL FRAMEWORK

3.1 Selection of the study area

Despite the dynamic socio-economic conditions of the Guraghe region, relevant information on farm forestry is quite scanty. This investigation is therefore, considered as an exploratory and pioneer research and thus attempts to concisely unveil the general socio-cultural and economic patterns and on-farm tree planting and management practices of the target farm households.

Selection of the Guraghe Highlands for the present study was attributed to three reasons.

First, the western aspect of the Guraghe Highlands, apart from being little explored in the past, was a quite appealing area of study in terms of the rapidly expanding farm forestry practices with *Eucalyptus* as a dominant planting species. Interest has grown to find out the rationale behind such a heavy reliance on eucalypt species whose ecological and social merits have been under intense controversy in various parts of the world. It would also be interesting to find out how these accusations of eucalypts are perceived by the farm households of the study district and their coping mechanisms. Moreover, it will be a considerable contribution to the scientific knowledge to quantitatively and qualitatively explore the economic and ecological sustainability of the evolving farming sub-system.

Second, while it is imperative to evaluate specific factors that are responsible for the worsening problems of drought and food shortages, the study district may give an excellent opportunity to develop contrasting scenarios between drought-hit and transitional regions.

Third, the fact that conducting diagnostic surveys on farmers' attitudes, perception, knowledge, and socio-economic variables in farm forestry was within the immediate priority setting of the newly structured Forestry Research Department of the EARO.

Selection of the study district was necessitated by its advantage of having considerable regional diversity in terms of agro-ecological zones and farm forestry practices. Enemor and Ener district, apart from representing diverse agrarian regions, has a salient man-made woody vegetation cover and a relatively well-developed market for eucalypt poles in the middle altitude. It is thus believed that a study of villages from different agro-ecological zones would likely explain variations in farm forestry decision-making processes.

3.2 Data collection phases, methods, and tools

3.2.1 General overview of field research

Fresco *et al*. (1994) attribute the accuracy and reliability of survey methods to the depth (regular visits) rather than the coverage (single-shot visits) with which they are conducted. This clearly implies the extent of tradeoffs between single-shot visits and repeated visits. Field surveys were thus carried out in two phases as a compromise between ensuring the reliability and

representativeness of the acquired information and optimizing the survey resources (financial and time budgets, etc.).

During the preliminary (Phase 1) survey, information were gathered and revealed through an in-depth, open-ended interview with heads of selected farm households, development agents (DAs), traditional and political leaders, and other relevant personnel. Major data collection exercise was carried out during the second phase of the fieldwork. This phase also involved participatory on-farm discussion and observation, extensive household questionnaire surveys, in-depth interviews with key informants, and market and plantation management surveys. Figure 3.1 summarizes specific survey phases and tools employed as well as major outputs.

3.2.2 Preliminary survey

3.2.2.1 Archival research

According to Dillon and Hardaaker (1993) the best and logically first step, in farm management data collection, is critical review of the available secondary data. A thorough analysis of available information helps identify the existing gap in knowledge, which needs to be filled by primary data collection. Moreover, collection and examination of documented secondary sources of information along with reconnaissance surveys facilitate detailed characterization of the existing land use system in terms of its socio-economic, biophysical, and cultural attributes and thus understanding of the decision-making strategies. All available sources of information such as national and local agricultural and forestry statistics, satellite images, aerial photographs, climatic and demographic data, land tenure and use systems, relevant policies; soil, relief, and marketing conditions; state of infrastructure, and cultural domains related to natural resource management and economic activity were consulted. The following secondary data were of great interest in the present study and have been carefully scrutinized: data on climatic conditions, land capability and land use, farming systems, demography, roles of gender in farm forestry practices, income sources, input and output prices, etc.

3.2.2.2 Reconnaissance survey

Franzel and Crawford (1987) suggest that informal surveys are better conducted during the growing season over a period of one week to two months. They further assert that in view of the acute scarcity of research resources in developing countries, informal surveys generate an effective and reasonably accurate information for developing an understanding of farming systems and identifying innovative interventions.

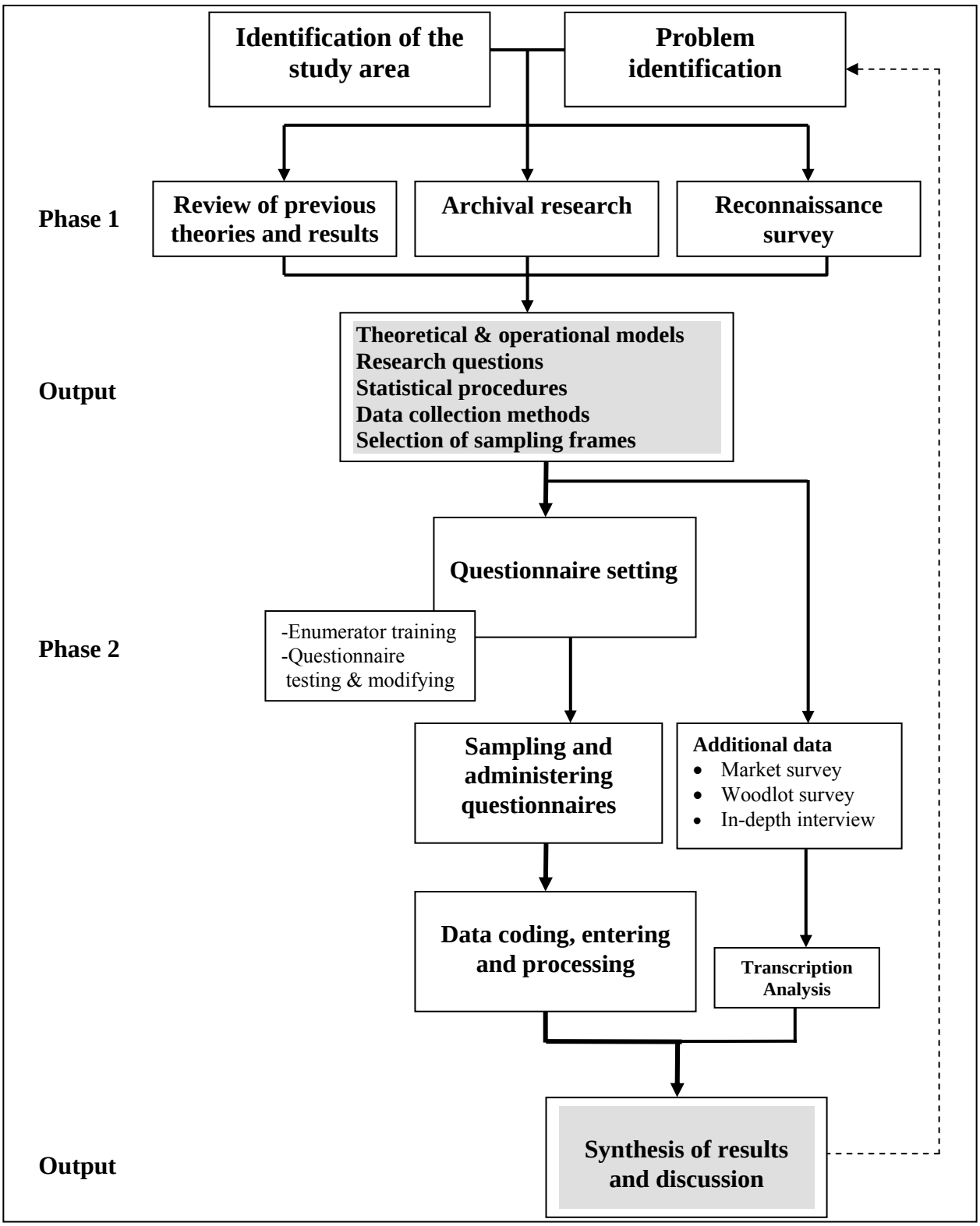


Figure 3.1 Research phases and data collection tools

Appraisal surveys are generally, simple, encourage dialogue, and accentuate informal discussions between farmers and researchers and thus enable the researcher to further probe critical issues (Duguma and Franzel 1996). They generate not only valuable information in as short time as possible, but also facilitate an ecological and socio-economic description of the study area such as demographic patterns, social interactions, main economic/forestry activities, and conspicuous farming system. Freudenthal and Narrowe (1991) argue that initial informal meetings with the

village government or traditional leaders help acquire permission, explain the purpose of the study, gain their support, and relieve natural suspicion. This stage aims also at quick generation of prioritized constraints, potentials, and aspirations of the farm households with the objective of identifying existing research gaps in promoting farm forestry practices.

To this end, reconnaissance surveys and direct field observations were conducted to acquire expeditious understanding of the biophysical and socio-economic attributes of the Guraghe households. This was complemented by informal discussions with key informants with the help of unstructured questionnaires. This stage also helped identify and ascertain sampling frames for the main survey works.

Elicitation of decision criteria involved purposive selection of 6-8 key informants from each of the following wealth categories: better off, medium, and poor from each of the four districts of the western aspect. This was followed by holding detailed discussion with each key informant on a wide range of topics related to farm forestry management practices with the object of understanding his beliefs, attitudes, and cognitive reasoning in routine farm forestry decision-making processes. This was followed by careful transcription of each interview, field notes, and taped materials. Ensuing data was immediately analyzed to generate research hypotheses.

In the transect walk, a detailed note and analysis have been made on land features, cropping patterns, animal rearing practices, land cover, indigenous and innovative soil and water management practices, soil erosion characteristics, farm forestry practices, farm constraints, potentials and opportunities, etc. These processes paved the way for easier acquaintance with target villages.

Discussions were held with both individual and group respondents that are believed to provide key information of interest. Walking around the study villages with a small group of community members has also encouraged the participants to take active and creative part in the ensuing discussions. This helped acquiring an unequivocal insight into farmer's attitudes, aspirations and perceptions on resource allocation decisions by posing such probing questions as 'what?', 'why?', 'how?', 'when?', and 'by whom?'

In addition, this preliminary stage facilitated identification of and acquaintance with the prevailing bureaucratic procedures and major stakeholders in the study district. Active development and conservation projects and existing traditional groups in the study area as well as present administrative structures of the peasant communities were distinguished. This is mainly attributed to the vital roles that community-level institutions play in any resource management programs (LUPD 1991).

3.2.2.3 Participatory on-farm discussion and observation

Participant observation combines participation in the lives of the people under study with maintenance of a professional distance that allows adequate observation and recording of data (Bickman and Rog 1998) and thus gives the researcher an opportunity of becoming an insider (Spradley 1980). A participant observer comes to a social situation with two purposes: 1) to engage

in activities appropriate to the situation and, 2) to observe the activities, people, and physical aspects of the situation.

Field observations are important tools to collect supplementary data, to validate information of the preceding stage, and to learn and record indigenous knowledge (IIRR 1996). However, although well-executed reconnaissance surveys warrant identification of major farm problems and pertinent interventions (Hildebrand 1981), the ensuing data is not obedient to statistical testing procedures and thus reliable inferences cannot be drawn (Franzel and Crawford 1987).

Participatory discussion and observation create an opportunity for the researcher to personally get involved in what the farmers are doing in the field of interest. Long-time intimacy permits the researcher to internalize the basic beliefs, fears, hopes, and expectations of the target community. Moreover, establishment of congenial relationship with the villagers helps gain access to matters, which otherwise the villagers would avoid to discuss (Bekele-Tesemma 1997; Kessy 1998). The researcher better meets the farmer(s) at the farm without any paper or pen and initiates friendly discussion with full enthusiasm. Mann (1988) argues that such survey brings the researcher close enough to the household communities to dissolve any uniqueness from other household members.

Participant observations and on-farm discussions were simultaneously conducted in order to get detailed understanding of the functioning of the farm units. This step also helped noticing peculiar farm forestry management practices and anticipated benefits that otherwise could have been easily overlooked by in-house interviews.

3.2.3 Household questionnaire survey

3.2.3.1 Objective

Questionnaire survey is commonly the simplest and cheapest method of data collection. The standardized and random sampling nature of formal surveys renders the acquired data fit into statistical testing procedures. The accuracy of interviewing method is, however, largely constrained by respondents' ability to remember events of the past and their willingness to reply.

Formal systematic surveys were conducted after the analysis of the initial field data. Major research issues identified in the preceding exploratory surveys were complemented by formal questionnaire survey to further the understanding of actual farm situations. Strauss and Corbin (1998) assert that only when exploratory interviews are antecedent to the formulation and final development of questionnaire instruments, could survey questionnaires tap 'reality'.

This survey was mainly intended to solicit quantitative socio-economic data from the target farm households. The principal reason behind the socio-economic survey was to find out the rationale and motives behind and to quantify the extent of on-farm Eucalyptus plantations from the actors' point of view. It is also envisaged to ascertain potentials and problems pertaining to farm forestry practices and to identify existing knowledge gaps in farm forestry practices.

Duguma and Franzel (1996) argue that exhaustive elaboration of the socio-economic and biophysical attributes not only enables to effectively determine key production objectives and

associated constraints but also enhances designing economically sustainable, ecologically sound, and socially acceptable alternative resource management approaches. Moreover, the results and findings of such examinations can be judiciously extrapolated to wider agro-ecological regions with matching socio-economic and biophysical characteristics.

3.2.3.2 Ethnographic interview

Ethnography is a means of learning from people rather than studying people (Spradley 1979). It is not only the work of describing a culture[3], but also involves the disciplined study aimed at grasping the native's point of view and relation to life, and realizing his vision of his world. Ethnography starts with a conscious attitude of almost complete ignorance in which the researcher presents himself to the people as a student.

An important task of this stage was acquiring knowledge on farmers' decision criteria as well as perceived alternatives and options and thus building models of resources allocation decisions with particular reference to farm forestry practices. The models so constructed incorporated relevant farmers' decision criteria, aspects, cognitive reasoning, and uncertainties.

3.2.3.3 Drafting of questionnaires

The types of questions to be asked are primarily governed by the research problem, the devised indicators of concepts, the interrelationships between variables and the mechanisms of their linkages, method of data analysis, and method of questionnaire administration (de Vaus 1996). In drafting survey questionnaires, a considerable attention was devoted to the elaboration of clearly understandable, unambiguous, and well targeted questionnaires. Care was also taken to avoid confusing and incomprehensible terms and leading questions, which could erode the confidence of the respondents. The use of borrowed questions from similar research problems has been encouraged by Czaja and Blair (1995). It was, therefore, attempted to assemble and review pertinent questionnaires already used by other workers at national and/or local levels prior to employing them. Moreover, various resource persons that are knowledgeable about the area were consulted for their useful inputs to further elaborate the questionnaires. Survey questionnaires were purposely steered towards acquiring detailed information of interest and parameters that address the set research questions.

The survey questionnaires were categorized into different modules in such a way to address the following main aspects: 1) general household profile, 2) livelihood activities, including constraints, potentials, and priorities, 3) land/tree tenure and access to resources, 4) tree planting and management activities, 5) sources of cash income, credit, and savings, 6) decision-making in resource allocations, 7) marketing infrastructure and patterns, and 8) governmental and non-governmental development interventions and success stories. For complete listing of survey questionnaire topics the reader is referred to Appendix 1.

[3] Culture refers here to the acquired knowledge and belief that people use to experience and generate social behavior.

3.2.3.4 Sampling frames

Miles and Huberman (1994) argue that the choices whom to look at or talk with, where, when, about what, and why all strongly constrain the type of the conclusions to be drawn and the confidence of the analyst about them. In this study, limited time and scarce other research resources necessitated the adoption of sampling surveys.

Administrative villages (PAs) within the Enemor and Ener district, the demarcation of which is primarily based upon ethnical settlement history of the area, and the household list of each village constituted the sampling frame of the present study. The final sampling frame was designed to constitute sample sizes proportional to the total population in each agro-ecological zone and statistically acceptable number of women household heads (see Table 3.1).

3.2.3.5 Sampling Methods

The method of sample drawing in a survey is mainly governed by the objectives of the study and the available sampling frame. Drawing of samples permits the researcher to obtain appropriate size of representative units from the pool of cases that are more manageable and cost effective to handle. If sampling procedures are precisely executed the researcher can draw accurate inferences for the entire population.

According to Neuman (2000) mismatches between the sampling frame and the conceptually defined population as well as between the theoretical and operational definitions of a variable are major sources of error that leads to invalid sampling and measurement procedures. Consequently, it is unwise to expect definition of a parameter with absolute accuracy in any social research method. Another key factors in drawing samples from a population are maintaining adequate structure of the sampling frame (target population) and ensuring its explicit representation of the population. With regard to the method of sampling, random process of sampling not only helps depict the target population with sufficient accuracy but also entitles the researcher to establish a statistical relationship between the sample and the population (the size of the sampling error) (Neuman 2000).

The size of the sample, on the other hand, is largely dictated by the level of the desired accuracy, the degree of variability of population parameters, and the number of variables intended for investigation. It is common, however, to adopt, as a rule of thumb, a conventional number of samples that meets the requirements of statistical method. In the present study, the survey questionnaires were administered to a total of 150 sample farmers in ten randomly selected Peasant Associations (PAs)[4] (Table 3.1).

[4] A Peasant Association (PA) is the lowest administrative unit consisting of about 330 to 1000 farm households living in villages adjacent to one another. Administrative affairs of a PA are executed by elected executive committee that is accountable to the district administration.

Table 3.1 Sample size by agro-ecological zones and PAs of the study area

Zone	Sample PAs	Number of households		Sample size (head)		% of cases	
		Male	Female	Male	Female	Male	Female
High altitude	Kuneber	498	9	12	1	2.41	11.11
	Genet/Gait	475	37	11	5	2.32	13.51
	Merabicho	640	76	15	8	2.34	10.53
Middle altitude	Achawede*	434	70	5	3	1.15	4.29
	Diamir	364	39	11	3	3.02	7.69
	Gardashie	651	69	19	3	2.92	4.35
	Lanka Tore	386	17	10	1	2.59	5.88
	Guareba	387	9	12	0	3.10	0.0
	Barewa	375	33	11	3	2.93	9.09
Low altitude	Doba	470	4	17	0	3.62	0.0
Total/Mean		4680	363	123	27	2.64	8.30**

* Sample size of male household heads was halved by serious enumerators' incompetence.
**Mean of villages with at least one sample.

In this study, it was opted for a two-stage stratified random sampling. This method of sample drawing has a substantial advantage of producing more representative and thus more accurate samples (de Vaus 1996; Neuman 2000). It also minimizes the possibility of the random process missing or misrepresenting the female-headed household stratum by chance as it is represented by a small percentage of the population. The initial stage involved classification of the entire district into three major agro-ecological zones. These are zones whose farming systems are dominated by distinctly varying on-farm tree/shrub species, different land resource endowment potentials, and farm practices. Stratification of the entire area into corresponding zones has been assisted by topographic map of the area, discussions with DBA staff and DAs, and results of the reconnaissance survey.

A total of 10 representative PAs from the three major agro-ecological zones were then randomly selected according to probability proportionate to size (PPS). Accordingly, three, six and one PAs were selected from the high, middle, and low altitudes respectively. The criteria for deciding on the number of sample PAs selected from each agro-ecological zone are that the size of the sample is sufficiently large for drawing valid statistical inferences and that they can be surveyed with the available financial and time resources. Hostile living conditions in the extreme part of the lowland reduced the intended size of the sample. A sampling frame of PAs in the district was obtained from the DBA. Lack of complete list of the farm households at the DBA office necessitated fresh enumeration of households in the sample PAs with the help of respective DAs and PA councils.

Following the selection of villages that represent the three major farming systems, the inhabiting farm households were stratified into two categories on the basis of the sex of the household head. The rationale to involve a statistically meaningful number of female-headed households was justified by the need to elicit their decision-making criteria and constraints in contrast to male heads. The final sampling procedure entailed a systematic random selection of households from each household category according to PPS. This sampling procedure was found most appropriate since the original list followed distinct sequence of settlement patterns of the households. Under this

condition, systematic random sampling would generate representative samples with lower sampling errors.

Although it was originally envisaged to sample a total of 180 households, various fieldwork constraints have curtailed the figure to only 150. The sample size of Achawede PA was significantly reduced by inefficient and untrustworthy working behavior of the extension personnel.

3.2.3.6 Selection and training of enumerators

In recruiting the enumerators, it was strongly envisaged that the recruits had to be quite familiar with the cultural traditions of the community and fluent in the local language and dialects of the target farm households. Moreover, they were required to competently administer survey questions to respondents of various backgrounds. In this view, candidates that are well accustomed to the rural working conditions could better endure the rigors of working in the rural areas under the prevailing hard fieldwork conditions and social norms.

During the main survey stage, 10 DAs, were employed to assist in administering the questionnaires owing to the bureaucracy and overlapping duties in releasing fewer for a specific period. It was then indispensable to train all the ten DAs afresh in a group of one to five persons by traveling throughout the district. It was thus so time-, energy-, and financial resource-intensive to train each group for four to seven days at an interval. In some cases, the lower perceptive aptitude of the DAs has rather exacerbated the problem. An added annoying experience had been the superficial pretense to have fully understood the content and procedure while very little has been comprehended.

In-office training session was then supplemented with enumerators' attentive observation of at least one complete interview conducted by the researcher in respective PAs. It was only then that the DAs were given full mandate to independently interview the selected households of their PAs. In most cases, the interviews were conducted in the presence of the researcher who was also persistently involved in the interviewing process. At the end of the interview sessions, each completed questionnaire was scrutinized for completion and accuracy and errors and omissions were adjusted subsequently.

3.2.3.7 Testing and administering survey questionnaires

Czaja and Blair (1995) assert that no matter how carefully the questionnaires are prepared or repeatedly and flawlessly used by others, they must always be pre-tested in the actual study area. They also caution that a number of questionnaire revisions and full incorporation of the respondents' interpretations are imperative. Careful prognostication of possible problems makes a difference between well and poorly executed studies.

To this end, pre-testing of the survey questionnaire was mainly performed to test its efficiency and adequacy in drawing the required data. Despite the painstaking attempt to phrase the questions in plain and easily understandable terms, it was found imperative to evaluate their comprehensibility from the actors' point of view. It was also attempted to carefully phrase economically and culturally sensitive questions so that they extract the required information without inciting respondents to

anger. Questions were also set in such a way that they sequentially test authenticity of the answers given and thus minimize collection of misleading or vague information.

Such meticulous setting of the survey questionnaires, nevertheless, could not override the need for pre-testing to assess the legibility of the questions not only for the interviewees but also for the enumerators. Accordingly, a total of 12 farmers were randomly selected from 4 adjacent PAs and employed for testing the questionnaires. A great deal of lesson was learned from the pre-testing practice, which necessitated, inter alia, translation into the official language, Amharic and substantial shortening of the survey questionnaire.

3.2.4 Additional data collection

Collection of supplementary data was believed to extract confidential household information and issues that are not openly discussed in the public. Such issues which are forbidden to be discussed openly or which are likely to be exaggerated or undermined in the presence of corrivals due to religious ideology, cultural taboos, or personal egos were further probed and discovered.

In-depth interviews with key informants: The informal and formal surveys were followed by detailed surveys carried out by the researcher by involving a relatively small number of farm households. The necessity of such detailed study is normally contingent to the results of the preceding surveys, informal discussions, and the needs identified by the administrative or traditional leaders (LUPD 1991). This procedure has permitted extracting as detailed information as possible pertaining to specific group of households. It mainly extracted information pertaining to activity calendar of male and female heads, access to resources, household food, construction, and fuel materials need, etc. Although the data does not easily lend itself to conventional statistical analysis, it generates very useful and detailed information that could easily be overlooked by formal questionnaire surveys. A total of 25 farm households from various socio-economic strata were randomly picked and involved in the detailed survey.

Market survey: Information on the major kinds of commercialized forest products and their market demand and supply situations was gathered through a market survey with special emphasis on on-farm plantation products. Such products as fuelwood, construction poles, matured trees, lumber products, etc. were surveyed. This was also aimed at identifying and understanding the seasonality of and access of gender to the various forest products. Contribution of forest product incomes to the overall household cash income was assessed and quantified.

External traders were also contacted to get an overview of price variations between local and central markets particularly in Addis Ababa. This was aimed at shedding some light on the distribution of revenues from sales of eucalypt poles between various stakeholders. This may help identifying alternative marketing strategies for tree and shrub products, which could eliminate unnecessary exploitation of farm households by intermediate brokers. Moreover, villages with inadequate transport infrastructure but favorable on-farm tree growing conditions could be nominated for possible support from concerned administrative bodies.

The market survey was also conducted to generate preliminary information on the financial viability of eucalypt woodlots as compared to marketable agricultural crops. Accordingly, the extent to which eucalypt woodlots are financially attractive as compared to teff has been determined. Moreover, the relative importance of income from sales of eucalypt poles was ascertained by comparing with incomes from other cash generating activities.

Plantation management survey: The target of this participatory plantation management survey was to investigate and understand the various plantation management practices adopted by farmers. This study covers the entire plantation establishment, management, harvesting, and transportation processes as practiced by individual farmers. Methods of seed collection and sowing as well as nursery management such as watering, manuering, weeding, protection, lifting, transporting, marketing, and other handling processes before and shortly after planting were assessed.

Growth assessments of selected eucalypt woodlots were performed with ordinary tree mensuration methodologies. Heights of standing trees were measured with clinometer. The lengths of various pole assortments were measured at various loading and marketing centers with a measuring tape. Diameters were measured with a caliper. Area of woodlots was approximated with visual observations.

3.3 Analytical method

A clearly defined method of data analysis is a crucial prerequisite for ascertaining the type of data to be gathered. Dillon and Hardaker (1993) assert that after the survey objectives are clearly established and the general type of information to be gathered has been specified, it is imperative to set the analytical procedures to be adopted. It has been also noted that careful planning of the method of data analysis helps avoiding unnecessary mistakes and omissions in the design and execution of field surveys. Methods of data tabulation and analysis are commonly governed by method of data collection (Mann 1988), survey objectives which may also be formulated in a form of research hypotheses (Dillon and Hardaker 1993), as well as the complexity of the research questions (de Vaus 1996). Careful planning of data analysis, therefore, helps gathering all pertinent data, excluding unsolicited data, and handling them in a form appropriate for future analysis.

In the present work the collected data was systematically tabulated, analyzed, and organized to clearly reflect the real situations of the study farm households and their farm practices. It was possible to address the research questions and attain the study objectives only after the collected data was adequately analyzed. All the three main levels of measurements of variables viz. nominal, ordinal, and interval/ratio were employed as deemed necessary. All methods of data analysis, univariate, bivariate, and multivariate, were used. In addition, both descriptive and inferential analytical techniques have been applied, as deemed appropriate, for summarizing various categories of variables.

Preliminary data of the exploratory survey were analyzed immediately in the field and shortly thereafter and used to generate complementary research questions that are addressed in the formal household survey. In the formal questionnaire survey, data processing practice was commenced with

the immediate check-up and edition of the completed questionnaires. This stage of data processing ensures that no question is left unattended and unanswered for subsequent data analysis. The next main task was converting the field data into a form that could be entered into an SPSS (Statistical Package for the Social Sciences) software for further analysis. All gathered raw data were then coded and entered into an appropriate registry book before feeding into the SPSS program. Coding of each response variable has involved a scrupulous pre-determination of appropriate value types (nominal, ordinal or interval/ratio) for subsequent analytical procedures. Summaries of analyzed data are presented in a form of tables, graphs, and/or regression lines in subsequent chapters.

In studying farmers' adoption of agricultural technologies where the responses are often qualitative, it was common to apply non-linear regression models instead of continuous linear models such as Ordinary Least Square (OLS) (Dadi 1992; Alavalapati *et al.* 1995; Yirga *et al.* 1996; Negassa *et al.* 1997; Negatu and Parikh 1999). According to Hosmer and Lemeshow (1989) and Aldrich and Nelson (1984) incorrect specification of linear models for Bernoulli response variables, which are designated as dichotomous variables, leads to unrealistic and erroneous inferences about the data and systematic violations of probability rules. They plainly demonstrated the application of logistic models to the behavioral sciences that involve, inter alia, rational choices and asserted that these models lend themselves to a biologically meaningful interpretation. It is thus decided to adopt logistic regression to identify key decision criteria that contributed to recent eucalypts expansion.

Accordingly, data on farm forestry decision-making strategies were analyzed with a function form of choice probabilities, logistic regression models. These models represent, by far the most developed and widely adopted non-linear models (Train 1990; Aldrich and Nelson 1984). Similarly, Hosmer and Lemeshow (1989) and Andersen (1997) applauded the models for estimating the outcome of binary or dichotomous response variables. Furthermore, logistic regression allows direct estimation of the probability of an event occurring (Norusis 1993). As illustrated in Norusis (1993), the logistic regression model for the case of a single independent variable is given by:

$$P_{(event)} = \frac{e^{B_0 + B_1 X}}{1 + e^{B_0 + B_1 X}} = \frac{e^{Z}}{1 + e^{Z}} = \frac{1}{1 + e^{-Z}} \qquad [1]$$

where Z is the linear combination, $Z = B_0+B_1X_1+B_2X_2+\ldots+B_pX_p$, and represents log of the odds called a logit; $P_{(event)}$ ranges from 0 to 1, given explanatory variable X_i; Xi represents set of possible explanatory variables; β_o is the intercept representing the value of the log-odds in favor of the event if explanatory variables are zero; and β_i stands for the coefficients estimated from the data (slope). The slope measures the rate at which log-odds in favor of eucalypt planting change with a unit change in explanatory variables. The probability of not planting eucalypts is given by $1- P_{(event)}$ and can be specified as:

$$1 - p_{(event)} = 1 - \frac{1}{1 + e^{-(Z)}} = \frac{e^{-Z}}{1 + e^{-Z}} = \frac{1}{1 + e^{Z}} \qquad [2]$$

The natural logarithm of the odds ratio in favor of an event, i.e., the ratio of the probability that a household will plant eucalypt to the probability that it will not plant eucalypt makes up the log-linear which is given by:

$$\ln\left(\frac{p_{(event)}}{1-p_{(event)}}\right) = \beta_o + \beta_i X_i \qquad [3]$$

Estimation of logit model by taking account of stochastic disturbance term into account requires rewriting of equation (3) as follows (Ramanathan 1992):

$$\ln\left(\frac{p_i}{1-p_i}\right) = \alpha + \beta X + \mu \qquad [4]$$

In this decision analysis, a number of factors were believed to be accounted for the differences in recent household eucalypt planting exercises. The following empirical model was adopted to estimate recent expansion of eucalypt woodlots.

$$Y_i = \alpha + \beta_1 TOT + \beta_2 LAN + \beta_2 LAB + \beta_3 ATT + \beta_4 ECO + \beta_5 SEX + \beta_6 AGE + \beta_7 WEA + \mu \qquad [5]$$

where : Y_i is the value of the dependent (dummy) variable on the i^{th} observation, α is the constant/ intercept; β_is are the coefficients of each explanatory variable and μ is the disturbance term.

3.4 Presentation of results

The results of the study presented in subsequent chapters have been organized in such a way that they clearly depict the linkages between the various research components. Chapter four presents the description of the study area and socio-economic characteristics of the target households. This chapter mainly presents analysis of secondary data. Whenever deemed necessary, results of archival data analysis were complemented and contrasted with firsthand data collected during the fieldworks.

Chapter five discusses major farm and off-farm activities. It was attempted to identify and reveal apparent potential and constraints of both farm and off-farm activities. Selected farm forestry decision-making strategies are presented in Chapter six. Elicited farm forestry decisions, intervening chance events, and envisaged consequences are highlighted. This chapter also exhibits household features that are responsible for furthering of eucalypt woodlots.

Chapter seven presents farm and off-farm sources of cash revenues and their relative importance. Distribution of revenues from sales of eucalypt poles among the various stakeholders is also exhibited in the second part of the chapter. It also presents a simplified comparison between financial values of eucalypt woodlot and teff production.

Chapter eight wraps up with the summary of the major findings, conclusions, and recommendations for further improvements.

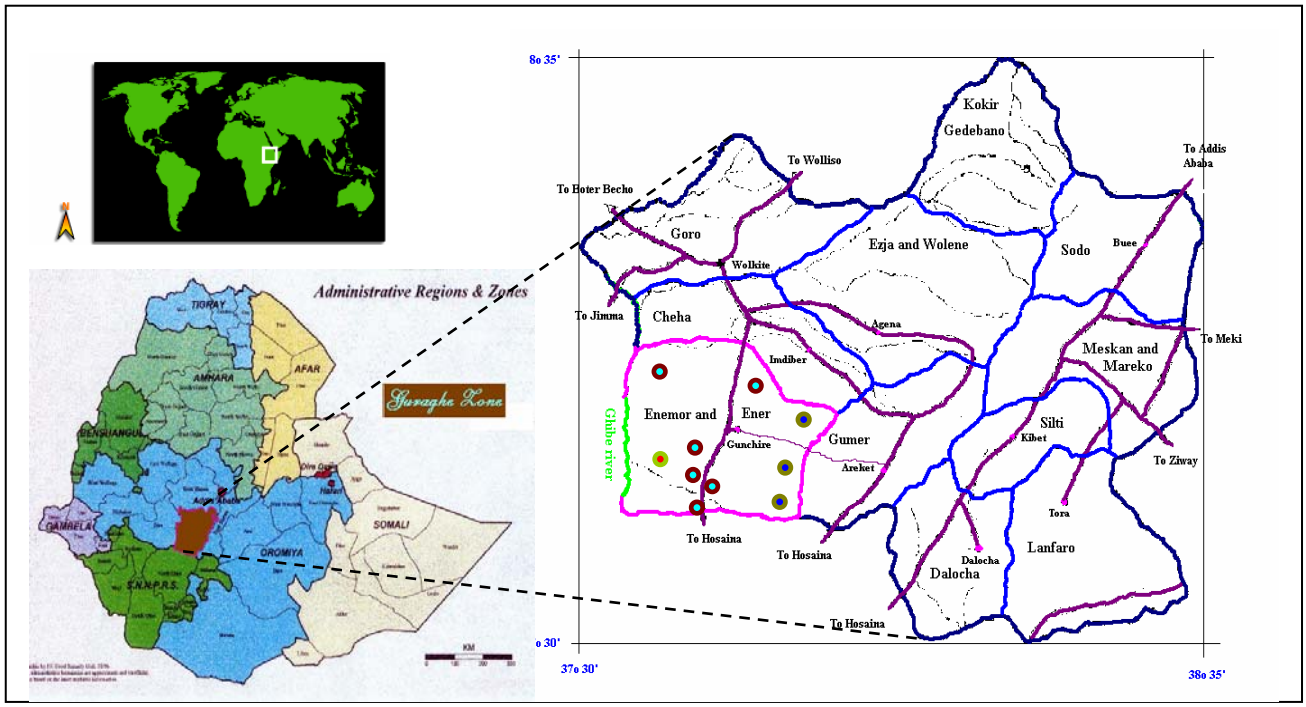
CHAPTER 4

DESCRIPTION OF THE STUDY AREA AND SOCIO-ECONOMIC FEATURES OF THE FARM HOUSEHOLDS

4.1 Study area

4.1.1 Geographic location

The Enemor and Ener district (EED) is located in the southwestern part of the Guraghe Zone (Map 4.1). From the total area (764 500 ha) (Hawando 1998) of the Guraghe Zone, the EED comprises about 122 714 ha (DBA 2000), representing the biggest of all the 11 districts. The district is bordered with Yem District to the west, Hadiya Zone to the south, and other zonal districts in the north and east (Map 4.1).



Map 4.1 Sketch map showing geographic location of the study district and sample PAs
Low land = ●, Middle altitude = ○, and Highland = ●

EED consists of 65 PAs and two small towns. At the beginning of 2001, however, it was split into Endegagn district with 17 PAs and Enemor and Ener district with 48 PAs and 2 small towns.

4.1.2 Climatic conditions

Climatic data of the area shows a pronounced seasonal variation in mean maximum temperatures (see Appendix 2). Rainfall is often bimodal, with major rainfall from June to September and small showers in Belg[5] (from March to May). The rainfall data also depicts a strong tendency of drought years at an interval of about 10 years. The dry period from October to February is often

[5] Belg is an Amharic term that refers to the season of small rains from March to May during which growing of some cereal crops is practiced.

characterized by extreme low night temperatures that occasionally drop below 0^{o} C. The resulting frost restricts the cultivation of susceptible food and tree crops at places close to and above 2000 masl.

In general, the climatic conditions in the district vary from dry lowlands to sub-humid highlands. The highlands are often characterized by lower mean annual temperatures and higher mean annual rainfall, while the reverse prevails in the lowlands with middle altitudes as a transitional zone. Highlands are thus more conducive for agricultural uses and the lowlands are often subjected to seasonal water shortages as well as pest and disease infestations. As a result, highlands are characterized by high population densities.

As indicated in Appendix 3, the mean annual rainfall for the period between 1969 and 1999 is 1218 mm. Further, the data shows that there was high rainfall variability with a coefficient of variation of 23.2 %. Monthly rainfall distribution pattern is posted in Appendix 3. In general, regular good rainfall years in the low and middle altitudes are exceptions rather than rules, since unpredictable rains represent one of the major sources of risk in farmers' decision-making processes.

4.1.3 Geology, geomorphology, and soil characteristics

Various geologic events of different eras have contributed to the diverse physiography of Ethiopia and the subsequent kaleidoscope soils (Abebe 1998). The widely varying climate, topography, parent materials, and management systems resulted in different soil types.

The geology of the Guraghe Zone consists of underlying volcanic substratum that leads to the development of different soil types. High plateau and valley slopes are mainly characterized by low relief and composed of deep reddish-brown and heavy red soils of volcanic origin. These soils are generally characterized by high sodium contents and are highly prone to erosion. Flat plateaus in the middle altitudes and bottom of wide valleys are commonly dominated by Vertisols, which are highly susceptible to erosion. Vertisols are Oalcareous and tend to desiccation and cracking during the dry season. Moreover, they tend to superficial accumulation and precipitation of iron, aluminum, and sodium hydroxides and sesquioxide, as well as to silting and leaching during the rains (von Breitenbach 1963). A layer of red clay soil that exists between the brown soils and Vertisols represents one of the most erodible soils in the zone (MWR 1996a). Major soil types of the Guraghe zone include Phaeozems, Vertisols, Andosols, Nitosols, Fluvisols, Litosols, Luvisols, and Cambisols.

PEDD (1998) reports that the soils of the Guraghe Zone, generally, have high contents of potassium, nitrogen, organic matter, and cation exchange capacity and low phosphorus. On the other hand, soils of the Ghibe catchment area had reportedly (Murphy 1968) high available phosphorus, potassium, calcium and magnesium. Some 29 % of the soils in the zone have a depth of less than 25 cm, whereas 44 % and 27 % of the soils are between 25 and 50 cm and deeper than 50 cm respectively (PEDD 1998).

Despite the foregoing generalizations, it is imperative to note that soils under enset crops by no means represent the natural soils, since they have been subjected to significant modifications by

heavy application of farmyard manure and organic residues. Addition of ashes to fertilize enset plants has also increased soil pH.

4.1.4 Topography and agro-ecological zones

Highlands of the Guraghe Zone are typically characterized by rugged topography that is frequently dissected by deep gorges with slopes ranging from nearly flat to very steep. The highlands consist of all forms of land features, ranging from rugged mountains through hills, plateaus, plains, valleys, gorges, deep gullies, etc.

An agro-ecological zone refers to a land resource-mapping unit, defined in terms of climate, landform and soils, and/or land cover, and having a specific range of potentials and constraints for land use (FAO 1996). Detailed description of the existing agro-ecological zones is thus said to be the best way of recapitulation on the resource endowment and productive potential of an area.

Ethiopia has been roughly divided into three climatic zones since time immemorial. Recent efforts of the late 1970s and early 1980s have modified the traditional climatic zonation and increased the number of climatic zones to five (see Aalbæk 1993; Bekele-Tesemma 1997). Past classification approaches were based on altitudinal variations, which had direct bearing on mean temperature. By and large, the traditional classifications lack distinct information on the great variations that exist within a specific zone. Detailed characterizations of the five agro-ecological zones are presented in Appendix 4. Rural households and many of the local agricultural and forestry institutions widely employ this classification and thus is adopted in this study.

The more recent work by the Natural Resources Management and Regulatory Department of the Ministry of Agriculture (MOA) has delineated 18 major agricultural zones and 62 sub-zones with distinct physical and biological potentials and constraints (Jemal *et al.* 1995). The study has produced a map with a corresponding descriptive memoir concerning the agro-ecological zones (AEZs) of Ethiopia. Three major production zones have been generally, identified: a) high potential cereal zone (HPCZ), b) low potential cereal zone (LPCZ), and c) high potential perennial zone (HPPZ). Major criteria for delineation of these production zones are altitude, temperature, and rainfall.

Agro-climatic classification of the study district indicates that 44 %, 42 %, and 14 % respectively of the total area makeup the *Dega* (highland), *Woina dega* (midland), and *Kolla* (lowland) climatic regions (DBA 2000). The highest and lowest elevations of the district respectively are about 3200 and 1050 masl. The district is gradually descending from higher altitudes in the east to lower extreme altitudes in the west.

According to EARO's (2000) latest zonation, the study area falls within the hot to warm sub-humid gorges (SH1-4), hot to warm sub humid low- to mid-highland mountains (SH1-7), and tepid to cool sub-humid plateau (SH2-6) sub-zones. These delineations are however, subjected to overlapping biases and lack of distinct specifications of the intervening criteria.

4.1.5 Forest cover

Natural forest cover of the Guraghe Zone (GZ) has been deteriorating over the last several decades and now reached a stage of extreme disappearance (NCS 1993; MWR 1996a; PEDD 1998; ZBA 1999a[6]). Vestiges of gigantic native species that have been retained for ritual and service roles are living evidences of their abundance in the past. Such inferences have been repeatedly echoed and supported by archeological and palynological studies (Deheuvels and Derrey 1998).

Survey of literature only proves a substantial contradiction between figures on the extent of the original vegetation cover that often lack empirical foundations. According to PEDD (1998) natural vegetation of *Juniperus, Podocarpus, Hagenia, Acacia*, and various bush and shrub species cover about 9 % of the total area of the GZ. ZBA (1999a) gives a detailed account of past and present vegetation cover rates of the zone. It claims that the natural forest resources that covered most part of the Guraghe Mountains before half a century have sharply dwindled to only 8108 ha in 1997. The report also notes that the rate of annual deforestation for the period 1994 through 1997 amounted to 7 000 to 8 000 ha. This figure appears, however, a highly implausible contemplation as highland natural forests either highly shrunk or entirely disappeared earlier.

NCS (1993) asserts that productive forests constitute only less than 6 % of the total (14 %) vegetation cover rate of the zone. Hawando (1998), on the other hand, worked out the natural and man-made vegetation cover rates for six of the eleven districts to be 5.0 % and 5.8 % respectively. Counting on extensive field surveys, the most authoritative report of the MWR (1996a) notes that the GZ is entirely devoid of contiguous natural forests and deprived of the potential for timber production.

Though, there were signs of significant expansion of on-farm and communal plantations in recent years. The ZBA (1999a) reports that the total size of plantations in the GZ increased from about 15 700 to 27 300 ha between 1994 and 1997. Furthermore, traditional forms of scattered agroforestry plots in the GZ and EED cover respectively only 0.25 % and 0.05 % of the total cultivated land areas.

By the year 1997, the total areas of natural forests, community woodlots, and private forests in EED were 850 ha, 175 ha, and 8950 ha respectively (ZBA 1999a). These figures place the district on the top list in terms of the forest cover rate. High rate of on-farm plantation raised the proportion of private plantation cover rate to 7.3 %, surpassed only by Gumer district. More recent forest cover is estimated to be about 3200 ha of natural forest, 9200 ha of plantation forest, and 3600 ha of shrubs and bushes (ZBA 1999b; DBA 2000). Although Feed the Children project raised and distributed about 10.5 million seedlings for communal plantations during the period from 1986 to 1997 (Pers. Comm.), the actual size of communal plantations in the district is not more than about 100 ha.

Data on vegetation cover rates of various agro-ecological zones is entirely missing. Observations during the fieldwork showed that most of the natural forests in the district are confined to the uninhabitable Ghibe gorges, very steep and broken slopes, as well as around sacred sites. Most areas

in the highlands are completely devoid of natural vegetation and replaced by fragmented farmlands interspersed with eucalypt and bamboo plantation strips at marginal sides. Other scattered natural tree species recorded in the highlands over 2300 masl include *Croton macrostachys, Ekebergia capensis, Juniperus procera, Olea europaea, Hagenia abyssinica, Podocarpus gracilior, Bersama abyssinica, Ficus sur, Pittosporum abyssinicum, Cordia africana, Buddleja polystachya, Erythrina brucei, Dombeya torrida*, etc. Exotic species in the highlands include Eucalyptus spp., *Acacia melanoxylon, Cupressus lusitanica, Acacia decurrens*, etc.

Major species of isolated ritual stands are *Podocarpus gracilior, Ficus sur, Juniperus procera*, and *Ekebergia capensis*. These stands serve as location of paying tribute to the Waq, creator God. Although planting within the stand is possible, it is highly sacred to collect any product. The middle and lower part of the vegetation in the lowland is dominated by various Acacia and *Combretum* species.

Eucalyptus camaldulensis, coffee, and t'chat make the bulk of on-farm plantation species in the middle altitude. Other plantation species include *Acacia decurrens, Juniperus procera, Sesbania sesban*, avocado, and papaya. Some farmers have planted few *Cordia africana* seedlings in their farms, although commonly only natural regeneration is maintained.

4.2 Socio-economic features

4.2.1 The people, demography, and ethnic composition

The Guraghe people belong to a group speaking Semitic languages (Tigre, Tigrai, Amhara, Guraghe, Harari, Argoba, and Arabs). The present Guraghe community is believed to be descended from different origins. This claim has been further supported by Westphal (1975) who linguistically delineated the Guraghes into three: Eastern (Selti, Wolene), Western (Cheha, Ezja, Muher, Enemor), and Northern (Aymallal). Deheuvels and Derrey (1998) quoted that the first inhabitants of the Guraghe country came from Southern Sudan 3 000 years B.C. Local authors, however, trace the roots of the Guraghe people in the Tigray, the Addere, the Gojam, and the Sidamo region.

The total population of the GZ, in 1994, was estimated to be 1 555 145 of which 95 % were living in rural areas (CSA 1996). EED was then inhabited by a total population of 196 455, representing the third most populous district. DBA (2000) reports a total population of the district to be 285 523 with mean population density of about 233 persons per km^2, close to the lower population density range for the zone (200 to over 400 persons per km^2) (Brandt *et al.* 1998).

As evidenced in the present work, there is a considerable variation in the total population and number of household members between various PAs. From the current survey, the total number of households living in each PA varies between 400 and 720 with an average of about 504. The ratio of women-headed households to the total households ranges between 3.2 % (DBA 2000) and 7.2 % (mean of 10 PAs in the present survey).

[6] The manuscripts (ZBA 1999 a and b and DBA 2000) were originally written in Amharic. Useful excerpt of the manuscript were translated into English and adopted in the present work.

Results of field survey show that whereas the number of females and males in the early ages is more or less equal, the number of males in the middle age (18-48 years) is less than that of females. This is apparently attributed to an unparalleled rate of out-migration of more males than females to urban centers. One study indicated that in the year 1994, 25 % of the Guraghe population lived in towns, and constituted 18 % of the population in Addis Ababa (Deheuvels and Derrey 1998). Per the results of the present study, some 56 % of the households have 1 to 6 family members in different towns.

The fact that the number of female household members more progressively declined than that of males with increasing age shows less life expectancy of women. The number of household members ranges between 2 and 12 in the district with an overall average of 5.8, more than the regional average by 1. Majority of the households (69 %) have 5 or more members. Only 5.3 % of the households, however, have 10 or more family members. Potential labor force situation of the survey households, which plays key roles in farm forestry decision-making, has been summarized in Figure 4.1. The figure presents labor categories that were adopted in assessing labor force availability and dependency rates rather than a conventional population pyramid.

Ethnic composition of farm households in the study district is nearly homogeneous with the northern, western, and central part of the district being entirely inhabited by the Guraghes. The ethnic composition of the southern and eastern parts of the district appeared to be heterogeneous. With the exception of Genet PA, however, other ethnic groups constitute only a fraction of the total population. Other ethnic groups inhabiting the district include Hadiya, Alaba, Endegagn, Geto, Selti, and Amhara (Pers. Comm.).

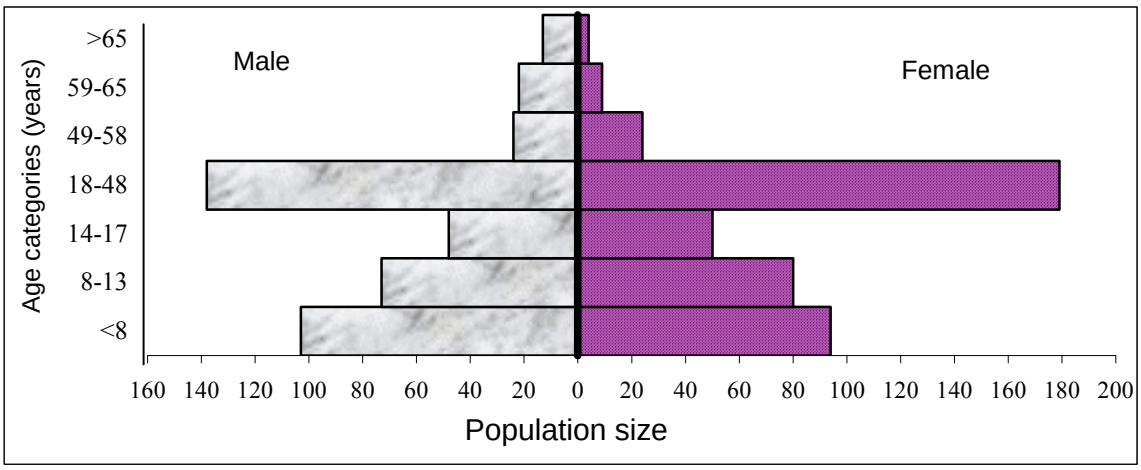


Figure 4.1 Number of household members with respect to age categories and sex
Source: Field survey (2001).

Religious composition of farm households of the district cannot be accurately quantified. Survey data exhibited that three main religious confessions are commonly attended by the district farm households. These are the Christian Orthodox, Muslim, and Protestant in the order of decreasing number of followers. It is nevertheless, noted that there are variations in the composition of various religious groups in different villages.

4.2.2 Settlement, land use, and land coverage patterns

Households of the study district generally, exhibit a distinct pattern of settlement, particularly in the midlands. Residence houses are often built along the ridges of plateaus. Erecting houses on the top of the ridge offers an advantage of better drainage of rain water, channeling animal manure to enset fields by gravity, less labor for soil leveling work, and easier turning of the earth clods in manual cultivation. It also helps in distancing homegardens from vegetation that harbor wild animals.

Houses are aligned in roughly straight lines facing each other and separated by grassland strips of about 30-50 m width, locally known as Joforo. The strip is considered to be a communal land that is freely used for grazing and for ritual and social ceremonies. Widely scattered trees of various species are either intentionally left to grow or purposefully planted for shade and aesthetic reasons. On the backsides, farmlands are often sloping down into a watercourse that separates two adjacent settlements. A summary of land cover information of the Guraghe Zone is given in PEDD (1998) and presented in Figure 4.2 a.

In contrast to that of the zone, the district land coverage pattern is not dominated by a particular land use unit. Cultivated land, for instance, represents 52 % and 26 % of the total area of the zone and the district respectively. Forest and shrub land coverage rate of the district is quite better than that of the zone (cf. Figure 4.2 a and b). The district land cover type is slightly more detailed as it includes water bodies as well as settlements and infrastructures. Plates 1 to 3 portray major land use patterns in the three AEZs.

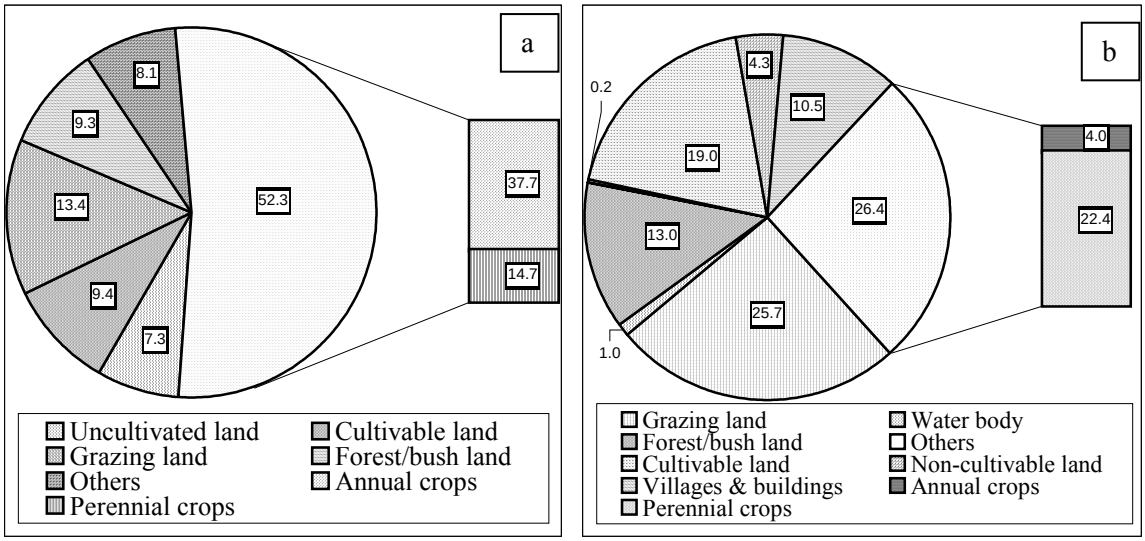


Figure 4.2 Land coverage types: (a) of the GZ; and (b) of the EED
Sources: (a) PEDD (1998). (b) DBA (2000).

Current farming practices of the study district display no departure from the traditional subsistence-oriented peasant farming. The use of improved agricultural technologies is quite rare. There is thus an unprecedented rate of resource losses and extremely low output to input ratios. Traditional sustainable resource conservation techniques (e.g., shifting cultivation, extended fallowing, etc.) were disrupted by alarmingly increasing population. Quite backward agricultural tools and lack of access to commercial fertilizer and chemicals substantially debilitated the productive potential of the

farmers. In the low and middle altitudes, lack of manure and draught power as well as ruinous wild animals restricted expansion of crop cultivation. Shortage of arable land and high rate of soil erosion are the major constraints in the high altitudes.

Traditional economic and social life of the Guraghes and their farming systems are best explained by a wonder plant, enset. Enset is predominantly grown by every household particularly in the western aspect of the Guraghe highlands. Households in the western aspect not only draw their staple food, pride, and reputation out of enset plants, but also attribute the vital security of their being to this crop. Enset is also used as fodder during adversity, for making fiber, local carpets, medicinal purposes, fuelwood, etc. Its extreme endurance in the face of seasonal droughts incited relevant government authorities to initiate experimental studies in recent years. By the year 2000 some 17 % of the total land area of the district and 73 % of the total perennial crops grown were constituted by enset crop (DBA 2000).

Other major crops, coffee and t'chat (*Catha edulis*), are mainly grown in the middle and lower altitudes for household use and cash generation. Coffee and t'chat constitute about 10 % and 16 % of the perennial crop area in the district respectively. Popular tree species in coffee plantations are *Cordia africana, Sesbania sesban, Albizia schimperiana, Millettia ferruginea*, various *Acacia* spp., etc. The widely practiced integration of various annual and perennial crops in enset plantations, although intuitively appealing, has not yet been ratified as an agroforestry practice. Other perennial crops include banana, various fruit trees, and gesho (*Rhamnus prenoides*). Such annual crops as maize, teff, guraghe dinich (*Plectranthus punctatus*), taro, yam, pepper, and the like are grown in the middle and low lands. Barley, wheat, horse bean, field peas, potato, and the like are predominantly grown in the highlands. Local cabbage (*Brassica carinata*) is grown by every household and consumed along with kocho. Despite considerable potential, vegetable growing is neither yet widely adopted nor aggressively promoted.

Fallowing is much more practiced in the highlands due mainly to lower soil fertility status, high erosion rate, and the need to provide grazing land. In the middle and low altitudes, only a portion of the holding size is cultivated year round with infrequent crop rotation. At the lower extreme altitudes, an age-old type of agroforestry practice, shifting cultivation, is practiced to a lesser extent.

The Ethiopian highland reclamation study (Constable 1985:19-20) asserts that cropping can be reasonably undertaken on slopes up to 5 % without the need for conservation structures and with no significant erosion hazards. It further notes that slopes above 5 % could be cropped with supporting conservation structures and those above 30 to 50 % should be used only for perennial crops, grass and/or forest land. Farming practices in the highlands of the study district entirely negate these propositions. Farmers resort to cultivate every piece of land available in their surrounding. The author witnessed several areas of between 50 and 75 % slope converted into annual crop cultivation. Use of draught power is inconceivable on such exceedingly steep slopes and thus can only be worked by hand with great care (Plate 4).

4.2.3 Land tenure changes and current holding sizes

Menelik's expansion expedition of the late 1880s brought about an emergence of new land titles and social relations in which emperor's troops and dignitaries were issued with large estates and tenants by expropriating up to two-third of the land. The remaining one-third was rewarded to the local war chiefs who provided key support in the conquest expedition (Mengisteab 1990:49). This has essentially converted all the southern farmers, specifically the Guraghe farmers, to sharecroppers. According to Deheuvels and Derrey (1998) the ensuing new settlement of the Amhara soldiers necessitated conversion of extensive forest and grazing lands into cultivation and thus contributed to accelerated soil erosion and resource degradations.

The land tenure situation that emerged has continued until the land reform of 1974 that brought the whole land under state ownership. The 1974 land reform was the first ever attempt, in the history of the present Ethiopian empire, directed at fair sharing of the land to those who need it most. In the new legislation, farmers were given only usufructuary right to the land they cultivate and land sale and purchase thereafter was forbidden. However, farmers exercise much freedom to temporarily lease out their holdings to meet immediate financial needs. Permanent sale of land takes place only rarely. This might be incited by recent new land use policy, which according to Teklay (1997) has appended corrective measures to abolish further redistribution or granting of land. Figure 4.3 a and b depicts mean landholding size of households in the study district.

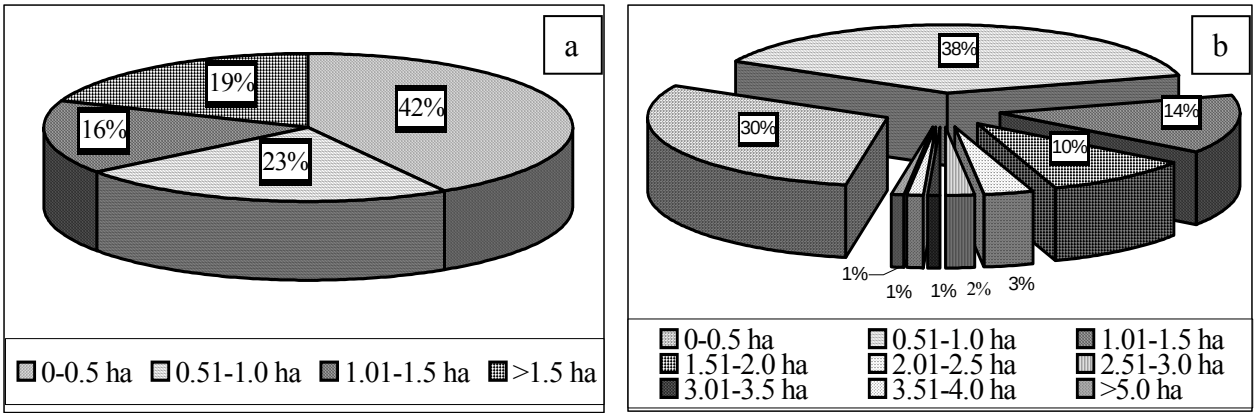


Figure 4.3 Landholding size distribution:
(a) among households of the EED; and (b) among sample households
Source: (a) DBA (2000). (b) Field survey (2001).

Regardless of the legally binding tenure legislation, four major traditional land ownership types are recognized in the Guraghe community (NCS 1993). These are communal land ownership, individual land, church or mosque land, and government land. Traditional mediators still exercise strong mandates in resolving disputes over land, although this may occasionally enter in conflict with the legally mandated body.

Information on landholding sizes for the GZ cannot be obtained. DBA (2000) sketches that about 42 % and 23 % of the total households in the district possess only 0.5 ha or less and between 0.5 and 1.0 ha of land plot respectively (Figure 4.3). Results of the present survey exhibit, on the other hand, that whereas 30 % of the households possess 0.5 ha or less, some 38 % of the households posses

between 0.5 and 1.0 ha. This discrepancy could be attributed to exclusion of lowland households from the first data.

Landholding size is significantly related to the three agro-ecological zones. Plot size of 2.5 ha or more per household is quite exceptional in the highlands. Households in the lower altitude seize ample opportunity to extend their holding sizes.

4.2.4 Rural institutions

Rural people of the study district are organized into various traditional associations, most of which are also popular in other rural parts of the country. Idir and Gez are the two most popular mutual aid and help associations. Equb is a kind of saving association. These were presumably established in response to various accidental incidences and hardships that were proved cumbersome to be born by the resources available to a household.

Idir is mainly targeted at helping members during periods of extreme disaster and/or loss of close family member(s) by death. In events where residence houses are burned down, farmers around the affected households are morally and culturally obliged to provide the necessary material and labor support to help the victims get adequate shelter immediately. Similar humanitarian assistances are accorded in cases of major loss, such as death of household member or loss of crucial farm resources such as an ox. Gez, on the other hand, represents a mutual aid agreement that serves the interest of the members in turns. Members receive labor aid in house construction, farm operations, etc. and offer food and drinks in return. Equb brings people of similar interest who make contributions of certain amount of money at regular intervals for each member in a lottery turn. With special sanctions needy people can be granted their share at earlier stage.

Farm households in the district are also governed by hierarchically organized political institutions. At grassroots level, PA councils take the administrative responsibilities. It is accountable to the District Bureau of Agriculture (DBA). Major entry route of DBA into the farm households is through its extension branch. Development agents (DAs) supposedly link the extension office with each and every farmer. In reality, nevertheless, a DA that serves up to 700 households is much less effective than the planned mandates. A group of 3-5 DAs are organized under one supervisor who is mandated to oversee the work of the former and serve as a vital link between the DAs and the extension office of the DBA. Farmers' questions are first received by respective DA, passed to supervisors, and then to the head of the extension unit in the DBA.

Traditional local leadership, composed of elected elderly persons exists in each community. Important local-level legislation, marriage customs, for instance, are drafted and effected by this body. High level disputes, such as murder cases, are mediated and settled by senior local leadership. Duties and responsibilities of various local-level leaderships are clearly defined. A Person who violates the traditional rules brings strict sanctions not only to himself, but also to his close kinship.

4.2.5 Infrastructure

4.2.5.1 Communication

Compared to other rural areas in Ethiopia, the GZ is well endowed with better road networks that are constructed by the Guraghes themselves. The study district is connected to the zonal town in the north, to Gumer district in the east, and to Hosaina in the south with all-weather road networks. An all-weather road runs north-south dissecting the district in halves. Another road runs perpendicular to the first road through the district town and eastern half and connects to Gumer district.

The district town is connected to other towns through radio-operated telecommunication system. Access to telecommunication network is highly abridged or non-existent for the rural households that need to travel long distances to the nearest town. Similarly, only 19 % and 7 % of the farm households own radio and cassette recorder respectively. Unlike the Chinese farmers who access various information and attend distance agricultural education programs on own TV sets (Jun 2001:34), none of the farmers in the study district owns or possesses an access to a TV set.

Rural households in Ethiopia, in general and those of the study district, in particular have no access to newspapers and agricultural information pamphlets. Independent newspapers and research articles are not known in rural areas. By and large, farmers' lack of information can be explained not only by extremely limited access to, but also by low attention given to the dissemination of agricultural information. Full-fledged forestry extension service is not known in the area.

4.2.5.2 Energy sources

Biomass fuels constitute the major source of energy both for the rural and urban dwellers. Crop residue and animal dung contribute about one-fifth of the total energy supply in the GZ. It is nevertheless, not common for the households of the study district to burn animal dung that makes the survival of their staple food, enset a reality.

National per capita fuelwood consumption has been estimated by different workers (see Poschen-Eiche 1987). The mean per capita woodfuel consumption estimates for the years 1978 to 1984 range between 0.93 and 1.38 m^3. The latest estimations are given in Amous (1999) and FAO (2003) and present slightly inconsistent figures of about 0.83, 0.81, and 1.35 m^3 for the years 1995, 1996, and 2002 respectively.

In the GZ, only the capital town (Wolkite) and one of the district towns (Imdebir) in the western aspect are supplied with electricity from the Ethiopian Electric Power Corporation (EEPCO). Few private small diesel power generators are commonly seen in rural towns and shops. The use of solar energy is rarely seen particularly in Gumer district. It is rumored that a considerable number of solar panels are haphazardly piled in the warehouses of the EED.

The district has a considerable potential in solar and wind energy sources. Nowhere in the rural areas of the district has the use of such renewable energy sources been noticed. All rural households resort to the use of biomass fuels to meet their cooking and heating needs. The use of renewable

energy sources would greatly relieve the pressure on woody vegetation and release animal dung solely for soil fertilization.

4.2.5.3 Education

There are a total of 24 elementary schools, 13 junior secondary schools, and one senior secondary high school in the district. One of the major problems in the education sector, however, is the highly biased gender representation in schools. Girl students generally, represent only 30 % of the total pupils. Although recent years have witnessed a dramatic improvement in balancing the gender ratio, many of the registered girl students withdraw each year (Pers. Comm.). Only a fraction of the total students though complete their high education (Figure 4.4).

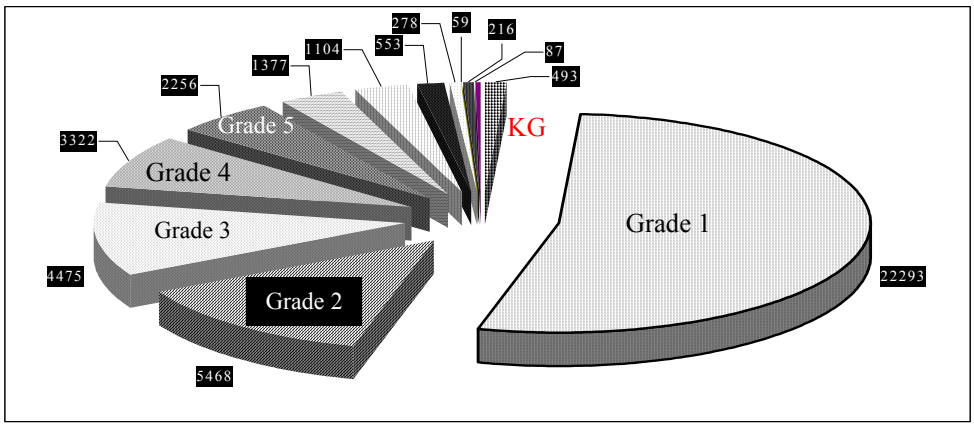


Figure 4.4 Number of students enrolled in various classes in the 2000/01 academic year
Source: DBE (2001).

In evaluating the educational status of the district, a mere assessment of the total number of schools, teachers, and students does not satisfy the deriving curiosity. The quality of the education system is highly determined, inter alia, by the qualification status of the teaching staff, adequacy of library and laboratory facilities, practical exercises and learning aids (audiovisual aids and educative visits). Only 9 B.Sc. and 20 Diploma holder staff are involved in the teaching and academic administration offices of the district. Majority of the staff (359) are graduates of Teachers Training Institutes (TTI).

Discussions with the head of District Bureau of Education (DBE) explicated that the district is in a dire need of more qualified teaching staff, reference books on specific subjects, and general knowledge books as well as laboratory equipment. The later can, however, be promoted only in combination with power generators or access to direct electric lines.

The empirical data confirmed that there is no variation between PAs of various agro-ecological zones with regard to the educational levels of the household heads. Overall, 71 % of the entire household heads and 91 % of the spouses are illiterate. The illiteracy rate for male and female household heads constitutes about 66 % and 93 % respectively with non-significant (χ^2 = 8.615; P≤0.07) association. Whereas none of the female household heads entered into the junior high school or above, 4 % of the male household heads attended the same level of education. This finding largely negates literacy rate figures of DBA (2000) in which about 29 % of male and 50 % of female

rural inhabitants of the district are professed to be literate. It is hard to believe such figures, since women are generally, less exposed to education opportunities, not only in the past, but even today.

4.2.5.4 Health

Health facilities in the district are also found in a poor status. Most common diseases in the district were reported to be malaria, tracheal infections, dysentery and diarrhea, as well as eye and skin diseases. Children in the middle altitude are much exposed to eye diseases that are highly contagious by superfluous flies during the small rainy season (Pers. Comm.).

Farmers are often forced to walk very long distances in search of medical treatments. The GOAL medical center in the district and the Atat Hospital in the neighboring district are the only two centers that offer acceptable medical treatments to the district rural families. There are few health stations from where farmers can purchase drugs. Farmers of survey PAs travel between 2 and 23 km to reach drug store and/or medical center.

4.2.5.5 Marketing centers

Although the major appealing target of agricultural practices is meeting subsistence food needs of the households, generation of some cash revenue is also indispensable. Apart from purchase of goods and services and meeting various obligations, cash revenue would also enable farmers to overcome the challenges of unforeseen contingencies. Few better off farmers may need to convert surplus perishable agricultural products into capital goods and cash for future use.

Unlike other communities in Ethiopia, the Guraghes often lead a highly market-oriented life. Their unparalleled dependence on markets enabled them to be involved in inter- and intra-village trading activities. Local traders travel for over 40 km with mule and horse loads of grains in search of better prices. Women often sell most of their petty products in the nearby small markets. Old topographic maps show that today's small towns were once just commercial gathering places where people were selling and buying goods. With rapid population increase, there are nowadays several local commercialization centers that are gradually developing into small towns.

Traveling to big markets is often justified in search of more profits for sizable products and cheaper commodities for household consumption. Local traders are mainly buying consumable goods from big markets and sell in small local markets at retail prices. Farmers often mentioned only names of markets in major towns as the main agricultural commercialization centers. Farmers in the sample PAs often travel on average from one to two and a half hours (one way) in search of better marketing opportunities. It is imperative to note that each marketing level of farm produce (local to national) involves a considerable price variation, the local being the cheapest. Sales of eucalypt poles generally, take place on-site by negotiating with a buyer.

4.2.5.6 Drinking and irrigation water

Discussions with farm households and careful participatory observation exhibit that lack of potable clean water stands among the top priorities of the households. None of the sample PAs though has

adequate access to clean water. As a matter of fact, lack of easy access to any kind of water during the dry season poses a significant threat.

Lanka Tore PA was found to be the most favored in terms of access to potable water. It has one pipeline and three springs. Barewa has five natural springs that meet drinking water needs of about 25 per cent of its population. Achewede has one spring and two manual water pumps, Gardashie has one spring and one manual pump, Guareba has 2 natural springs, Diamir has one manual water pump and Doba has one natural spring in one village. The worst situation was observed in the three highland PAs where farm households have access to only stream water and seasonal springs. Most streams in the highlands flow in highly dissected deep gorges, making water fetching an arduous task.

Despite the presence of a considerable number of perennial rivers in the district, none of them has so far been formally utilized for irrigation purposes. The rugged topography and deep gorges in which most major rivers (Wunke, Tiliku Haram, Tinishu Haram, Gogware, Gwantana, Derke, Zikir, Dogosa, etc.) flow undermined their irrigation potential. On-farm discussions with farm household heads revealed that lack of irrigation facilities was not considered as a major farm constraint, simply because it is taken for granted as a non-existent opportunity.

4.3 Livestock resources

DBA (2000) reports that there are a total of 240 395 various household animals in the district. Number of households that possesses various numbers of oxen as reported both by DBA (2000) and ZBA (1999b) has been summarized in Figure 4.5. From the present study, only 2 % of the total households own a pair of oxen, the main draught power in the district, whereas 11 % have one ox and the remaining 87 % do not own at all. On the contrary, only 29 % and 59 % of the households possess no cow and calf of their own respectively (see Figure 4.6).

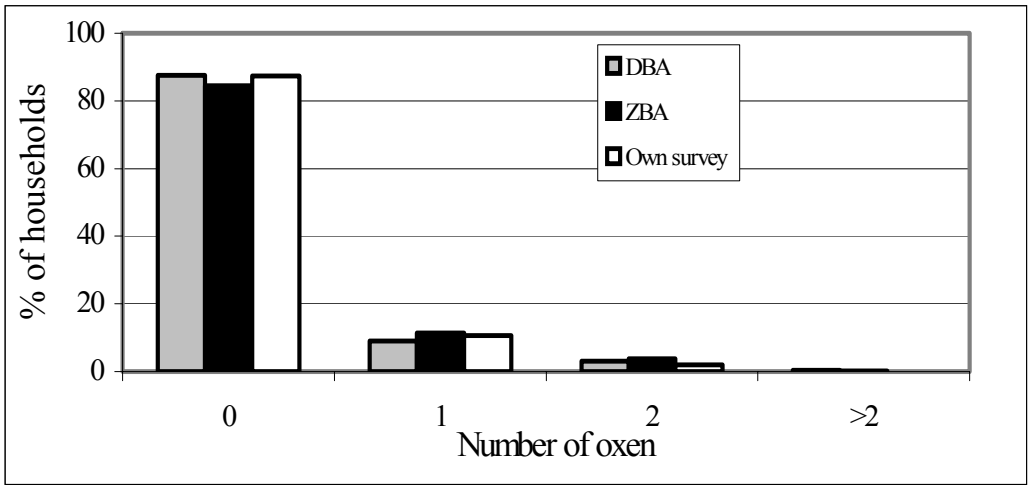


Figure 4.5 Distribution of number of oxen among district households
Source: ZBA (1999b); DBA (2000); and Field survey (2001).

Number of various household animals that was given in DBA (2002) was summarized and presented in Figure 4.6. Reported total number of livestock in the district, however, revealed a great

divergence. Accordingly, a slight discrepancy has been noted between the reported total number of oxen and that computed from Figure 4.5. It proves, the inconsistency of basic data not only among various offices but also within the same office, and thus indicates the low reliability of local level data. DBA asserts that households in the district possess a total of 7200 oxen, 8950 bulls, 16 000 heifers, 40 560 cows, 29 042 calves, 5401 donkeys, 4993 horses, 4020 mules, 19 028 sheep, 15 945 goats, and 89 256 chickens.

The number and type of animals that are reared by households vary with holding sizes, labor availability, and wealth status of the households. In general, farmers of the study villages keep more cows and calves than oxen and bulls (Figure 4.6). The district agricultural experts blame the Guraghe religious festivals that claim considerable number of oxen and bulls. At the Meskel[7] holiday, for instance, each family is expected to slaughter a bull. Many farmers do not agree with or would be reluctant to admit this claim. Those in the lower altitudes put the blame entirely on the higher susceptibility of oxen to seasonal animal diseases. Once attacked, oxen have much lower chances of recuperation as compared to cows and calves owing to their excessive physical fatigue.

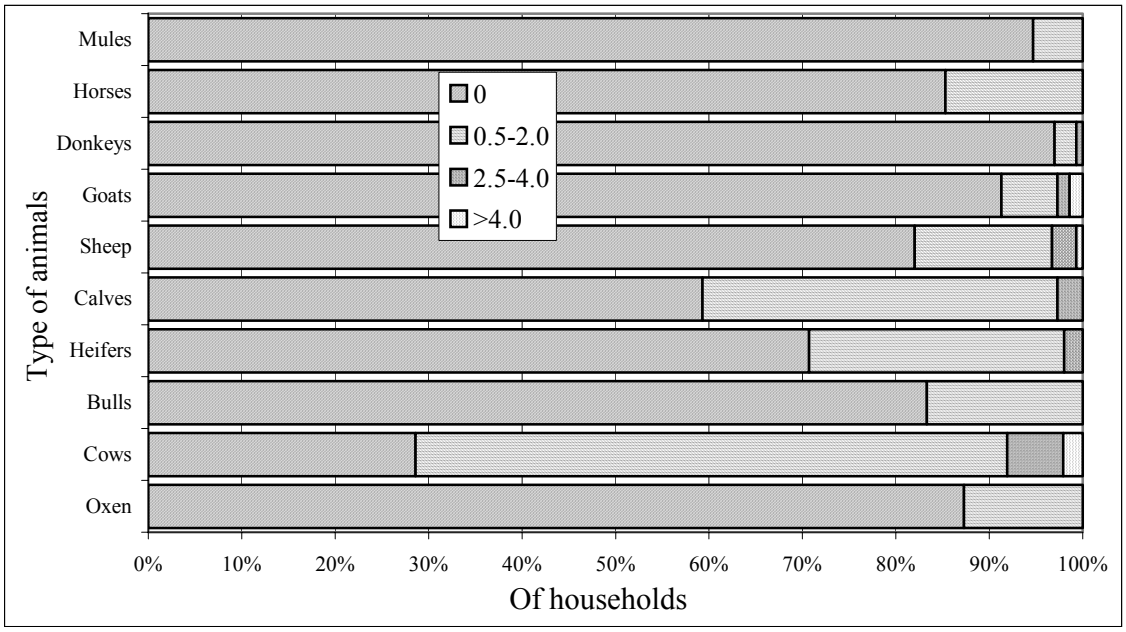


Figure 4.6 Possession of various animal types by the households
Source: Field survey (2001).

Overall, 3 % of the total survey households (2, 5, and 0 % of households respectively in the highland, midland, and lowland) do not keep any animal. About 15 % of the total respondents (4, 25, and 6 % respectively in the same order) do not own animals. Whereas 2 and 7 % of the male- and female-headed households respectively keep no animal at all, 12 and 30 % of respective households have no possession of their own animals.

A farmer that cannot afford to purchase his own animals resorts to 'share-rearing' in which he looks after animals of a neighbor or a relative and uses their products in return. As long as the farmer is

[7] Meskel ("cross" in Geez) festival is one of the vivid events in the Ethiopian culture and spiritual life of Christians. The meskel festival commemorates the finding of the true cross on which Jesus Christ was crucified in Golgotha.

entrusted with the rearing of the animals the household can enjoy the benefit of all the products including draught power. The owner, however, reserves full right to take away his animals at any time he feels convenient.

Accordingly, apart from animal possession figures depicted in Figure 4.6, a considerable number of households keep animals of relatives and/or neighbors for their by-products, primarily cow dung and milk. Although such figures are missing from both the DBA and ZBA reports, the present study confirmed that some 1 %, 19 %, 8 %, 15 %, and 14 % of the total households keep respectively oxen, cows, bulls, heifers, and calves of other people. Similarly, 4 %, 3 %, 5 %, and 1 % of the households keep respectively sheep, goats, chicken, and horses of other people. None of the households though keep beehives, donkeys, and mules of others.

Pearson's coefficient of correlation ($r = 0.319$) for the relationship between total landholding size and the total number of livestock (excluding chicken and beehives) reared by the households was found to be statistically significant ($P \leq 0.01$). It was also found that about 5 % of the households keep no animal of this category. Further, χ^2 test proves that the number of livestock per household has no relation with the agro-ecological zones. An overall range of the number of animals of this category per household lies between 0 and 24, with the majority owning between two and six.

4.4 Stakeholders

The study district is characterized by many stakeholders that have diverse and sometimes contradicting interests. The DBA has direct and indirect (through its field staff) interactions (consultation, persuasion, and censoring) with the households. DAs are said to be the vital media for the introduction and adoption of agricultural packages. DAs are entrusted with the dissemination of information and input packages that are levied from the ZBA and DBA.

Staffs of the DBA pay regular short visits to development centers to hold brief discussions with a group of DAs as well as to issue new plans and collect activity reports of the preceding month. In some cases, actual field observations, on carefully selected farms, are carried out by DBA staff. Field visits are quite rarely accompanied by staff of ZBA who otherwise travels to DBA offices only for urgent issues. Figure 4.7 indicates the major stakeholders and their relationships.

Other major stakeholders in the district include t'chat and eucalypt pole traders. The traders either buy the poles directly from the farmers or from the intermediate suppliers that bought from the farmers and undertaken some initial processing before reselling. The intermediate traders often buy the whole woodlot standing in the field with the consent to harvest the yield in a specific period of time. It is the responsibility of the seller to look after the woodlot during the intervening time.

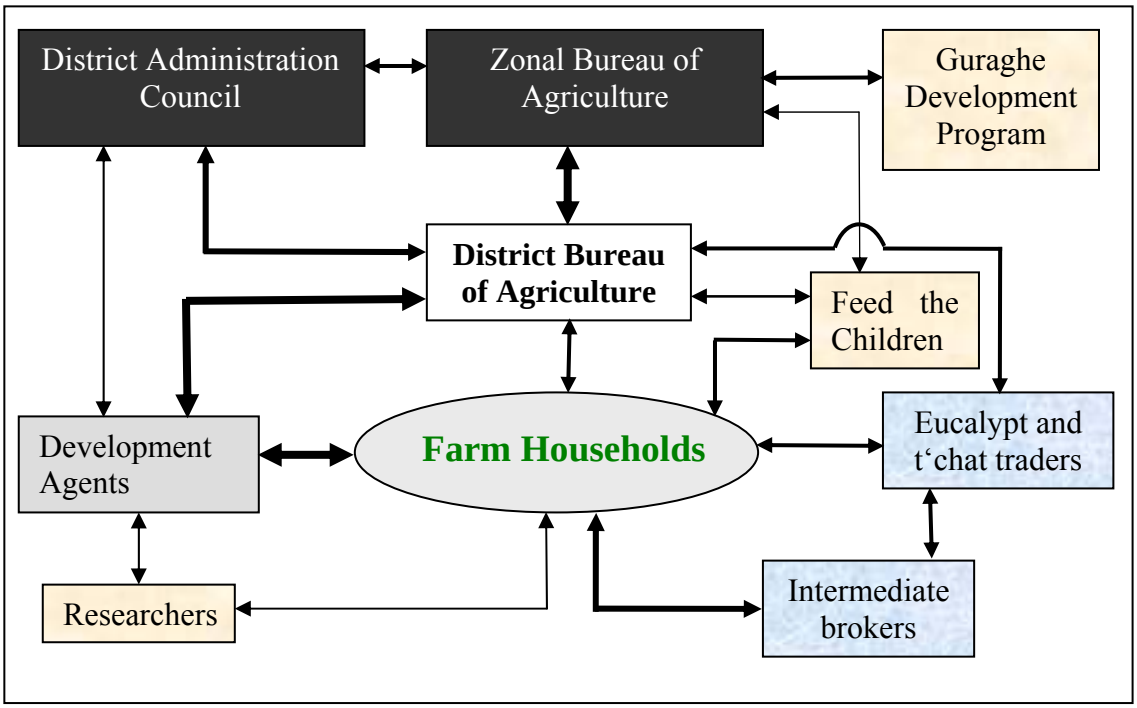


Figure 4.7 Major stakeholders and their interaction patterns with farm households
— Weak and rare interaction, ━ strong and frequent interaction, ↔ back and forth interaction

Various NGOs are operating in various parts of the district, each with specific objectives. The Food for the Children program was initially involved in woodlot establishment projects. Its current target is dissemination of seedlings of vegetables and fruits with the objective of improving access to balanced diets. The Guraghe Development Program (GDP) is mainly assisting the soil and water conservation projects and provision of improved agricultural inputs. Its prominent accomplishment, so far, can be seen only through its spacious and lavish office building in the zonal capital, Wolkite.

A hidden lack of harmony between NGOs and the DBA has been perceived in various field operations. Some DAs tend to be furious at unplanned and unconsulted movement of the NGO staff within the PAs under their domain. The DAs accuse the NGO staff for distributing vegetable and fruit seeds and/or seedlings free of charge, which obviously reduce attainment of selling quotas of inputs providing companies[8]. In fact, any deliberate or unintended action that undermines the selling quota of the DAs seriously threatens the very survival of their career. Any future promotional rewards are entirely based on the accomplishment of the top-down set input selling quota i.e., number of farm households participated in agricultural extension packages, regardless of its actual impact on farmers' livelihoods.

Paradoxically, the DBA would have been greatly relieved if part of its responsibilities can be effectively shouldered by NGOs (which often have more material and financial resources). Otherwise, an inevitable consequence of one of the Ethiopian famous sayings[9] will emerge to make farmers' lives even more miserable.

[8] Most agricultural extension package inputs are provided by international companies that entered into lucrative partnership with government agencies and distributed through their local level intermediaries.
[9] When two elephants fight it is the grass that suffers most.

4.5 Summary

The study district consists of all the three agro-ecological zones. In terms of agricultural crop and livestock production as well as human population densities, the highland is the most important agro-ecological zone. Soils of the district are extremely susceptible to seasonal soil erosion, the fact that makes integrated land management practices indispensable.

Complete conversion of natural forests into agricultural uses threatens environmental stability and sustainable food production. The widespread use of quite backward farm practices and tools coupled with recent abandonment of farm subsidies further weakened the targets of achieving food self-sufficiency. Smallholders of the district do not get sufficient food and balanced diet even during the normal years. Farmers unanimously proclaim the deterioration of the living environment and livelihoods.

The study district is characterized by one of the highest population densities and growth rates in the country. The region is also still characterized by the highest rate of rural-urban migration of people, although this reciprocates by providing remittances. However, about half (51 %) of the total households blamed shortage of labor for poor performance of farm forestry practices. Labor shortage problem is particularly crucial for female-headed and lowland households. The number of household members in the active working age (18 – 48 years) is, for instance, only 71 % of that in the younger age group.

Current landholding size is claimed to be insufficient for about two-thirds of the households. This will continue to fragment with further redistribution among descendants of a household. However, large size of cultivable land is still available in the region, with greater part of the productive land being located in the lowland valleys of the Ghibe river. Current land tenure system was not viewed as vital constraint to farming practices.

The study population, generally, has very limited access to basic infrastructure like medical, education, and communication facilities as well as potable water. Small farmers lack access to reliable credit facilities and appealing marketing system. Prevalence of diseases and pests and erratic nature of rainfall severely hinder sustainable livelihood.

In the face of the sharply declining holding sizes and skyrocketing population, improvement of the productive potential of the landholding has no compromise. This study is viewed as a step forward in understanding farm forestry decision criteria and helps identify means of embarking on successful agroforestry practices in the study region and similar areas.

CHAPTER 5

DECISION-MAKING IN FARM AND OFF-FARM ACTIVITIES

5.1 Overview

This chapter attempts to describe the various farm and off-farm activities of the study households in relation to their decision-making processes. It will also shed some light on the labor and time requirements of various farm and non-farm operations and the responsibilities entrusted to various sexes and age groups. It will also examine the discrepancies between the decision-making process and actual accomplishment of the tasks. Full understanding of the entire practices helps designing appropriate intervention technologies directed at abating the severity of choice problems. Figure 5.1 illustrates the major components of a smallholder farm system and their interactions.

To this end, it is vital to clearly understand the roles of household members in various decision-making processes and actual operations of the task. This is mainly prompted by a recent axiomatic finding on the collective decision-making approach of a household (see Haddad *et al.* 1997), which professed that preferences of individuals within a household are combined in various ways to reach a collective choice. This work has exhibited several empirical evidences on the need for deeper understanding of intra-household decision-making processes in order to compromise the sometimes-conflicting preferences of the household members and thus ensure the success of policy interventions. Erroneous assumptions or neglect of intra-household decision-making process and failure to fully appreciate the dynamics of household resource allocation patterns could easily result in unwanted consequences of projects.

5.2 Crop production

5.2.1 Share of cropping in the land use system

Farm plots that are temporarily leased from the DBA for annual crop production in conjunction with agricultural extension packages are not considered in this analysis. Regardless of the agro-ecological zones (AEZs), enset (*Enset ventricosum*) represents the major food crop grown in the area. It also occupies a considerable proportion (47 %) of the total cultivated area as compared to other crops. In the middle and low altitudes, enset often constitutes a predominant proportion of the cultivated plots.

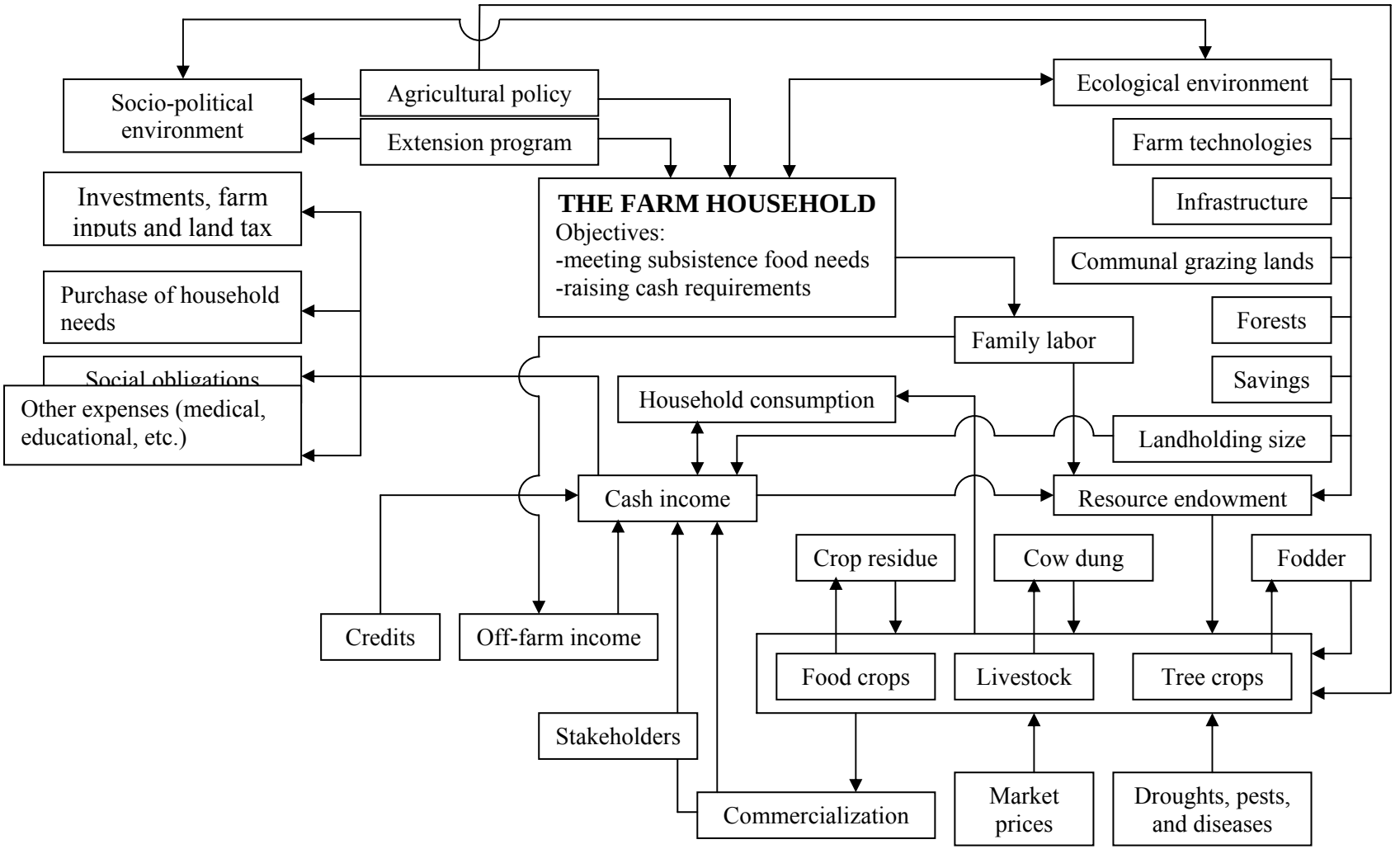


Figure 5.1 Structural model of smallholder farm system in the Guraghe region and interaction among components
Source: Adapted from Beets 1990; Upton 1996; Dillon and Hardaker 1993; Ahmed 1999.

The proportions of plot sizes allocated to various land use types are depicted in Table 5.1 below. There is a need not to be overwhelmed by the resemblance of the figures across the PAs and to treat them with great cautions. Considerable variations between the sizes of land units among various PAs are concealed in the table. The size of grazing land and eucalyptus woodlots in Gardashie, for instance, is by far more extensive than that of the other PAs. These figures need to be viewed only as a yardstick in conceiving more comprehensive and representative figures.

Table 5.1 Land use distribution of case study households in ten PAs

Land units	Highland			Midland						Lowland
	Kune	Mera	Gene	Acha	Bare	Diam	Gard	Guar	Lank	Doba
	% of total holding size (n=37)									
House compound	6.8	10.0	7.7	8.4	13.8	6.4	4.6	6.6	3.6	2.1
Enset & inter-cropping	14.9	19.4	33.8	22.6	34.5	22.7	13.9	35.6	29.9	17.0
T'chat, Coffee	2.6	0.0	0.0	11.4	5.1	19.9	3.7	1.7	16.9	30.1
Annual crops	4.4	41.2	20.7	14.3	21.5	0.0	13.8	3.1	1.9	0.0
Grazing	29.2	28.4	33.6	34.7	22.6	43.0	46.1	36.8	17.9	39.8
Eucalyptus/ Arundinaria	42.1	1.0	4.2	8.6	2.5	8.0	17.9	16.2	29.8	11.0

Data is derived from 37 farmers whose farm has been thoroughly surveyed and size of land use units have been approximated by the researcher (2001).

Perennial crop cultivation (apart from enset) is more popular in the middle and low altitudes. Although enset is mostly grown in mixture with other crops in the low and middle altitudes, monocultural stands of enset are not ruled out. Major food crops that are intercropped with enset include coffee, t'chat, maize, taro, cabbage, etc. Growing enset with other annual and/or perennial crops is most common in Gardashie and thus monocultural enset stands are quite rare. Crops amid enset plants benefit from heavy year-round manure application and partial shading during early growth stages. Farmers also exploit an added advantage of combined maintenance work.

Size of cultivated land in the mid- and lowlands is restricted, *inter alia*, by the amount of animal manure. The major factor thus is the inherent low soil fertility status and seasonal high rate of soil erosion. Consequently, farmers attempt to strike a balance between grazing and croplands. In addition, shortage of labor and/or draught power also represents an important constraint. Wealthier households allocate greater proportion of the land to crop production by resorting to commercial fertilizers and wage labors. Appendix 5 presents a rough illustration of partial land use patterns in the middle altitude of the study district.

5.2.2 Farm calendar

Farming practices are mainly restricted to rain-fed cropping of annual crops as well as biannual and perennial crop production. Nowhere in the district has the use of formal irrigation system been observed. Traditional private boreholes that are used on a very limited scale in other districts were not seen in the study district. A young active farmer has successfully grown good quality potato and other vegetables during the dry season with water manually fetched from the nearby river. Few

farmers adopt rainwater conservation methods to raise fruit and coffee seedlings in the backyards (Plate 5).

Agricultural calendar slightly varies from one AEZ to the other. The small rainy season (March to May) seems to be the peak season for the low and middle altitude farmers whereas the main rainy season (June to September) is the peak season for those in the high altitude cereal zone. Although farmers engage in various farm activities throughout the year, the period from March to August offers them a special opportunity of raising and growing various crops. Some crops are planted well in advance of the first rains and remain heavily mulched. An agricultural calendar is generally, applicable to the entire farm households within identical AEZ with very minor discrepancies between field operations. The working calendars presented in Figure 5.2 describe seasonal tasks of major farm operations performed by male household heads.

Working calendar of enset is quite peculiar from other perennial crops. In the middle altitude the initial process of enset multiplication starts in January/February by burying a corm with short pseudo-stem with the terminal shoot completely dugout and cemented with dry soil. The bunch of the seedlings is distributed in a group of about 3 - 9 in March. These are further separated into singles and planted at a spacing of 1 x 1 m in February the following year. Dispersed seedlings remain on the site for two years and finally planted at a spacing of 2 x 2 m. These make up the final enset plants. Once planted, enset requires seasonal clearings and yearly digging to loosen the soil, needless to mention the continuous year round application of manure. So, unlike other crops the workload in enset management is distributed over the year.

Trees are often planted in the months of June and July. Seedlings are raised before the onset of the rainy season. In contrary to the recommendations of forestry experts, farmers generally, maintain eucalypt seedlings in the nursery for one year and prefer to plant seedlings of about 1 to 1.5 m height. It is important to note that major crop cultivation and weeding tasks take place at the same time, and thus are competing severely for labor with tree and shrub planting works.

5.2.3 Cropping patterns

Farming practices of the three AEZs are distinctly different. Whereas farmers in the low and middle altitudes mainly grow a variety of crops in mixture, highland farmers predominantly grow monocultural crops. More soil working by draught power and less on-farm trees are thus expected in the highlands. In recent years, farmers in the midland grow more monocultural crops on communal plots allocated by the DBA.

PAs	JANUAR	FEBRU	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEM	OCTOBE	NOVEMB	DECEMB
Achawede	4		6		1 2		1 9	9 3		4	4 16	4 6 8
Gardashe	6 7	8 17	8 15	9	1 2	1 3	2 9	2 9		4	4 5	4 6 8
Barewa	4 6 8	9			2	13 3 9	9	2 14	10	11	12	4 6
Guareba	6 13			1	2	9 3	9	2		4 11	4	4 8
Merabicho	4 6	8 17	8 1	1	1 2	9 3	9	2 14	2 14	2 16	4 16	4 6 7
Genet	6 15	8	8 1	1	1	9 3	9 3	2 14	2 14	16	12 4	4 7
Doba	6 4	17 9	15 1	1 9	1 2	9 3	9 3	2	2 10	16 11	12 16	4 5

Figure 5.2 Work calendar* of major farm forestry activities in the survey PAs

1. Plowing; 2. Weeding/harrowing; 3. Tree/shrub planting; 4. Harvesting; 5. Land cleaning; 6. Enset planting; 7. Threshing; 8. Digging; 9. Sowing; 10. Coffee harrowing; 11. T'chat harrowing; 12. Enset harrowing; 13. Loosening soil; 14. Herbicide application; 15. Digging in enset plantation; 16. Burying enset corms; 17. Potato, taro, and/or *guraghe dinich* planting.

* It should be noted that no farmer in the region adheres to a daily or monthly working plan. A farmer performs a number of works in a single day. The above bars only portray major farm practices along with approximate time of performance. A particular task may extend over several weeks or a number of tasks may be undertaken in a single week.

A clear difference between the three AEZs in the proportion of the dominant land units has been observed. Highland households place most part of the landholding under crop cultivation with nearly balanced share between enset and annual crops. In some middle and low altitude PAs, only a portion of the holding size is placed under cultivation that is often dominated by perennial crops.

Mechanical cultivation is virtually unknown, and in fact, unthinkable in some highland areas because of the terrain. Better-off farmers in the middle altitude hire tractors at a cost of about 30 USD per ha. This is often confined to farmers that are allocated with communal land plots. Lack of access roads restricted the use of mechanized plowing in the lowlands. For majority of the farmers in the low and middle altitudes, a two-pronged tool (locally known as *Maresha*) represents the main soil-working device (see Plate 7).

What makes crop production patterns of the study area distinct from other neighboring areas is the compact and more or less linear nature of the farm plots. As a result, adjacent households often adopt more or less uniform cropping patterns. Main differences between the sizes of farm units of adjacent households are often attributed to their objectives and level of resource endowments.

5.2.4 Land-labor ratios

According to Storck *et al.* (1991) the labor intensity of a farming operation is generally, described through the land-labor ratio. Although the size of cultivated land is a function of several factors, labor intensity can be regarded as a key determinant of peasant land working capacity. The productive potential of household labor force depends, *inter alia*, on its size, composition, and type of farm tools employed. Performance of family labor force is commonly assessed by converting the household members into *Man Equivalent* (ME) or similar standards. This method, however, involves some acknowledged weaknesses such as failure to account for differences among individuals' vitality, aptness, and diligence.

In developing the conversion factor adopted in this study (see Appendix 6), it was attempted to carefully evaluate the labor contribution of family members to the performance of the entire farm operations. It was found irrelevant to entirely exclude members of below 10 years and to stuff up all members above 50 years in one category.

Household members from 8 to 65 years of age were taken for granted as economically active as they make variable contributions to the welfare of the family. It is however, important to note that the closer the age to the extreme ranges the more conspicuously skewed the balance from production towards consumption. This implies that members in the extreme age limits often consume more than they produce. A crude dependency ratio is determined by considering children less than eight years and elders above 65 years of age as entirely dependent on the economically active work force. Dependency ratio, calculated by dividing the total number of household working force by the total number of dependents, shows that there are about 4 household working members for every dependent household member. Dependent groups in the children and elderly categories constitute 23 % and 2 % of the entire household members respectively. Table 5.2 presents landholding size and labor force distribution per household.

Table 5.2 Holding size and labor force distribution per household

Peasant Association	Landholding size per household (ha)			Labor force/household (ME)		
	Mean	Range	Std. Error	Mean*	Range	Std. Error
Achawede (8)	0.52	0.13-0.71	0.08	2.39	1.0-4.3	0.386
Diamir (14)	0.78	0.15-3.69	0.28	1.97	0.2-3.8	0.289
Kuneber 13)	0.64	0.16-1.89	0.14	3.54	1.6-7.7	0.434
Gardashie (22)	1.45	0.47-3.21	0.14	2.20	0.5-4.5	0.209
Doba (17)	1.01	0.30-3.00	0.18	2.81	0.9-6.7	0.333
Lanka Tore (11)	0.81	0.30-1.69	0.14	2.96	1.9-4.0	0.215
Guareba (12)	0.85	0.25-2.00	0.14	2.68	1.1-4.4	0.278
Barewa (14)	1.33	0.22-5.38	0.36	3.01	1.2-5.3	0.390
Merabicho (23)	0.94	0.13-2.00	0.09	2.92	0.9-7.0	0.288
Genet (16)	0.56	0.11-1.50	0.10	2.76	1.3-5.2	0.296
Sex of household head						
Female head (27)	0.79	0.13-2.50	0.11	2.28	0.5-5.6	0.264
Male head (123)	0.97	0.11-5.38	0.07	2.81	0.2-7.7	0.110
Agro-ecological zone						
Highland (52)	0.74	0.11-2.00	0.07	3.04	0.9-7.7	0.193
Midland (81)	1.05	0.13-5.38	0.10	2.49	0.2-5.3	0.124
Lowland (17)	1.01	0.30-3.00	0.18	2.81	0.9-6.7	0.333
Total	0.94	0.11-5.38	0.06	2.72	0.2-7.7	0.103

* Man equivalent is significantly ($\chi^2 = 69.34$; $P \leq 0.015$) related to sex of household head.
Source: Field survey (2001).

With the overall mean figures indicated in Table 5.2, a total of 2.7 MEs are available for all farm and off-farm activities of a household. Among these, young children between 8 and 17 years and older people over 49 years contribute 21 % and 10 % of the total family labor respectively. A crude male and female family labor ratio calculated on the basis of field data shows an average contribution of about 51 % and 49 % of the total family labor respectively. Women within agile age group (between 18 and 48 years) contribute the highest (35 %) family labor of all the 12 categories adopted (see Appendix 6) followed by male of the same age group (34 %). This could be attributed to much greater out-migration of males in the same age group. Table 5.2 exhibits that the mean land holding size and ME for the sample PAs range from 0.5 - 1.5 ha and 2 - 3.5 respectively.

Although no attempt has been made to depict the share of each farm and off-farm work categories, most part of the adult male labors are employed in farm operations whereas female labors are mainly devoted to food processing, water fetching, marketing activities, etc. Young children of about six years age often participate in looking after younger babies, herding animals, and fetching water and easily accessible fuel materials. Old people do participate in farm operations that do not demand arduous physical work.

With regard to the size (in ha) of land available to be worked per household labor force, the two highland PAs, Kuneber and Genet, have the highest (5.5 and 5.2 respectively) ME to total holding size ratios. High ME to land size ratio of Kuneber is attributed to higher work force concentration while that of Genet is rather because of smaller mean holding size per household (Table 5.2). Gardashie, with the most extensive mean landholding size, has the least (1.5) ME to land size ratio. This indicates that leaving off-farm activities aside, only 1.5 ME is available to work 1 ha of land. In

reality, however, the size of cultivated land accounts for only a mere fraction of the total holding size and thus the ME to cultivated land ratio, particularly in some middle altitude and lowland PAs, is much larger (see Table 5.1).

5.2.5 Farm inputs

Use of animal manure represents an indispensable input particularly for homegarden crops such as enset, coffee, etc. In some middle altitude PAs, growing of agricultural crops without the application of animal manure is totally unthinkable. Enset growing without animal manure is exceptions at the expense of an unavoidable major loss of flavor of the ensuing food product. Only extremely poor and incapable households (5 %) afford to grow enset without animal manure (Table 5.3).

Table 5.3 Adoption rate (% of households) of various agricultural inputs by households during the 1999/00-cropping season

Agro-ecological zone	Manure**	Crops*	Fertilizer	Crops*	Improved Seed	Crops*
Highland (n=52)	(284.8) 100.0	1-8	82.69	6-10	32.69	6,7
Midland (n=81)	(272.1) 95.1	1-5,8	34.57	4,7,9,	8.64	4,7,9,
Lowland (n=17)	(241.1) 88.2	1-5	5.88	4	0.00	-
Overall mean	(273.0) 96.0	1-8	48.00	4,6-10	16.0	4,6,7,9
	$\chi^2 = 133.61$; P≤0.014		$\chi^2 = 43.01$; P≤0.000		$\chi^2 = 17.28$; P≤0.000	

* 1 = Enset; 2 = Coffee; 3 = T'chat; 4 = Maize; 5 = Taro; 6 = Barley; 7 = Wheat; 8 = Potato; 9 = Teff; 10 = Horse bean/Field peas

** Figures in parenthesis represent mean total amount of manure, in *Matrasha*, produced by households in each zone. One *Matrasha* weighs approximately between 20 and 40 kg.

Source: Field survey (2001).

Despite heavy infestation of fruit trees and coffee berries by various diseases, the use of chemicals is quite limited. Farmers' access to chemicals is constrained both by lack of money and delays in timely provisions. Use of chemicals against coffee berry disease is, for instance, very time specific and should be applied repeatedly at intervals during the flowering/fruiting stage. Only 10 %, 9 %, and 0 % of households in high, middle, and low altitudes respectively declared adopting herbicides mainly in teff and wheat crops. None of the survey households admitted using chemicals against crop diseases during 1999/00-cropping season.

It has been observed that the distributions of agricultural inputs are sometimes in conflict with farmers' needs and priorities. In some cases farmers are unjustly coerced to receive planting materials in pairs or triples without their needs. A farmer has limited maneuvers to choose between the two commercial fertilizer types as well as between different 'improved varieties' that were provided by the DBA. In some instances, the use of Urea fertilizers without the interest of the farmers led to incessant lodging problems and loss of substantial yields (Pers. Comm.). In another instance, farmers complain for being denied access to Urea fertilizer.

Hired labor was set in various operations by 17 % of the households in all PAs but Guareba. For some female-headed households it is obligatory to hire male labor for certain operations. Some 18 % and 15 % of the male- and female-headed households respectively employed hired labor. Total number of man-days employed by male- and female-headed households amount to 588 and 103

respectively. The use of more (41 %) hired labor in Gardashie than in any other PA may be attributed to both larger mean holding size and less mean family labor force. Lanka Tore (36 %), Kuneber (21 %), Barewa (21 %), and Genet (19 %) represent moderate employers of wage labor.

Highland households are by far the highest consumers of modern farm inputs. They represent, for instance, 60 % and 71 % of the total households that employed fertilizer and improved seed respectively during 1999/00-cropping season. Whereas only 6 % of the lowland farmers adopted fertilizer, none of them used improved seed. Low adoption rate of extension packages in the lowlands is attributed mainly to the weak extension services, better inherent soil quality, and higher risk of crop production. Lower mean size of manure in the lowland is attributed to fewer mean numbers of livestock per household and possibly to lower feed intake and conversion rate.

Comparisons between female- and male-headed households in the use of various farm inputs failed to demonstrate statistical significance. The proportion of female- and male-headed households that adopted fertilizer and improved seed amounts respectively to 44 % and 49 %; and 15 % and 19 %. Mean amount of animal manure used by female- and male-headed households was respectively 254 and 277 *matrashas*.

Farmers in the highlands are advancing much faster in adopting farm inputs, partly because of the monocultural cropping of cereals and partly because of the poor soil conditions owing to excessive soil erosion hazards. An added reason could be the comparatively better financial position of the highland farmers owing to lower disease and wild animal problems. The lower mean annual temperature may also help the highland farmers devote more time to farm operations than those in the lower altitudes. Likewise, the low levels of crop risks enable them to produce more per unit area (see Appendix 7).

5.3 Livestock husbandry

Livestock rearing represents an important farm operation that provides key input, manure, for the production of the staple food crop, enset. Moreover, apart from supplementing nutritional diets, animal rearing is considered to be an important farm activity that meets crucial cash needs of the households. The role of livestock as insurance against contingencies is attributed to its ease of liquidation. It also constitutes an essential means of displaying prestige and a key mechanism of saving household wealth for future use. Table 5.4 illustrates major feed sources and means of feeding animals.

Table 5.4 Major feed sources and means of feeding livestock

Methods of feeding	Sources of feeding
Tethering/Stall feeding	Hay; Weedy plants; Stunted crop plants; Crop leaves; Enset stem/leaves; Stalk of crops
Grazing	*Joforos*; Private grazing lands; Communal grazing lands; Communal forests; Fallow lands; Post harvest grazing
Browsing	Communal forests; Isolated bushes/shrubs; Planted tree/shrub spp.

Source: Field survey (2001).

The predominant means of animal feeding in the area is open grazing, stall-feeding, and/or tethering. In the latter two cases, animals are confined in one location and fed through cut-and-carry system of fodder production. Grass harvesting is chiefly the responsibility of male household head which, depending on the size of the stock, consumes a considerable amount of farm time. Some households in the highland (8 %) and middle altitude (14 %) admitted collecting fodder from forest trees and/or shrubs. Enset leaves and stems make up an important feed supplement during the dry season, when other sources of fodder are scarce. Grazing on farm plots is also common during off-seasons. In some PAs, *Joforos* are the only open grazing sites during the rainy seasons as private grasslands are securely protected.

In the lowland and some middle altitude villages that have extensive communal grazing lands, open grazing of a huge herd of animals is not uncommon. Large herds of a group of neighboring families are often looked after by a member of one household, a task that rotates among member households on daily basis. Provision of supplementary stall feeds during the evenings is commonly practiced.

5.4 On-farm tree and shrub management

5.4.1 Establishment and tending operations

On-farm tree and shrub management works constitute one of the labor demanding farm operations. The major tasks involved in this domain include site selection, plowing, hole digging, planting, and subsequent tending. Early fencing operations are done for block plantations bordering humans or animals trespassing routs. Coffee and t'chat plantations require regular weeding and loosening of the soil. *Cupressus lusitanica* and *Juniperus procera* trees often undergo repeated and harsh pruning operations. Naturally regenerating tree/shrub species also receive some maintenance works. *Cordia* and *Podocarpus* species undergo, *inter alia*, infrequent pollarding operations. In the lowlands, it is quite common to regularly clear and burn encroaching shrub and bush species either to win more farmlands or to shy wild animals away from farm plots.

Plantations of eucalypts can either be established from seedlings (raised on private seedbeds and/or purchased) or by directly spreading seed-laden twigs on the planting site. Establishment and management of nurseries often necessitate either periodic provisions of water or setting up a heavy shade during the long dry season to help the seedlings survive the desiccating evapo-transpiration stress (see Plate 6). In some places, nutrient supply of the seedbed soils is temporarily enhanced by burning the soil. The seedlings receive adequate protection against trampling and regular weeding.

Plantation sites are cultivated either by hand or oxen prior to the onset of the rainy season and the clumps are broken and holes are dug just before planting. Following planting, a semi-permanent fence is erected around the woodlot. The first hand plowing operation is often the most time and labor consuming work. In the low and middle altitudes, land cultivation is predominantly done manually by a group of two to four people engaged in labor exchange (Plate 7). Almost all on-farm tree planting and management tasks are shouldered by male household heads. Grownup male children take over the task partially or fully. Share of household labor in on-farm tree/shrub management practices is presented in Table 5.5.

Table 5.5 Labor share of male-headed household members in on-farm tree/shrub management

Management operations	Male head	Female (wife)	Both	Son	All	Hired labor	Others
	% share of family members* (n=123)						
Land preparation decision	92.6	0.0	3.3	3.3		0.8	
Land preparation	71.9	0.8	4.9	8.5	4.9	8.2	0.8
Weeding decision	91.9	1.6	2.4	3.3		0.8	
Weeding operation	69.2	1.6	16.3	12.2		9.0	1.6
Niche selection decision	92.7	1.6	1.6	4.1			
Planting niche selection	87.7	0.8	0.8	9.4		1.2	
Species selection decision	91.9	1.6	1.6	4.1		0.8	
Tree/shrub spp. selection	87.9	0.8	1.6	8.8		0.8	
Seedling raising decision	89.4	0.8	2.4	4.1		0.8	
Raising seedlings	85.3	0.0	1.6	9.4		1.2	
Tree planting decisions	92.5	0.8	1.6	5.1			
Tree planting	82.4	0.4	0.0	13.2		3.9	
Pruning/pollarding decision	90.0	0.0	0.8	5.9		0.8	
Pruning/pollarding	71.1	0.0	0.8	14.2		8.1	0.8
Harvesting decision	90.0	0.8	3.3	5.1		0.8	
Harvesting	78.8	0.0	1.6	10.6		8.3	0.8
Tree product sales decision	82.9	0.8	4.1	4.1			
Selling tree products	76.9	4.3	4.1	6.7			

* Shared works are segregated among individual labor units for ease of presentation.
Source: Field survey (2001).

In contrary to that of male-headed households, about 74 % of land preparation decision and 16 % of the actual task of female-headed households are performed by women. Similarly, more than half of all decisions pertaining to on-farm tree/shrub establishment and management works of female-headed households are taken by female heads. Apparently, 28 %, 15 %, and 20 % of female heads respectively raise seedlings, plant tree/shrub species, and sell tree products by themselves.

Results of this empirical work proved that only 1 % of the entire households reneged to plant tree/shrub species during the previous two years. These were households headed by widow women who neither have grownup male children nor could afford to hire male labor. Some 6 % of the total households, constituting 2 % and 22 % of the male- and female-headed households respectively, were not engaged in raising tree seedling. None of the wives in the male-headed households engaged in raising and planting tree seedlings as well as pruning/pollarding and final harvesting operations.

In general, participation of women in on-farm tree/shrub management decisions and works is extremely low. However, no taboo or special belief that discouraged the participation of women was identified in the study district. The practice is merely not accustomed and may be instigated by rather full engagement in other tasks designated solely for women. Experiences from Kenya though show that participation of women in farm forestry greatly contributes to the promotion of multipurpose tree and shrub species that have direct household benefit in the homegarden.

5.4.2 Plantation species

Despite little support and rather non-demand driven coercion by government agencies, tree and/or shrub planting is quite common in the study district. Ironically, although *Eucalyptus* spp. are mostly blamed by conservationists and local authorities for their undesirable effects on local ecology, they represent the most frequently planted species (Table 5.6).

Table 5.6 Species planted by households during the 1998/99 and 1999/00 and respective sources of seedlings

Species	Year (n=150)		Sources of seedlings*					
	% of respondents							
	1998/99	1999/00	1	2	3	4	5	6
Eucalyptus spp.	42.7	28.7	72.3		27.5	0.2		
Coffea arabica	27.3	20.0	38.8	32.5	28.5	0.2		
Catha edulis	8.0	3.3	76.5		5.9	11.8		5.9
Persica Americana	12.0	8.7	6.5	74.2	16.1		3.2	
Carica papaya	4.7	4.7	28.6	50.0	7.1	14.3		
Cupressus lusitanica	4.7	3.3	25.0	8.3	50.0	16.7		
Cordia africana	2.0	0.0		33.3		33.3		33.3
Psidium guyava	2.0	2.0		100.0				
Mangifera indica	0.7	2.0		50.0	25.0		25.0	
Sesbania sesban	3.3	0.7	16.7	67.7				16.7
Juniperus procera	1.3	0.7	33.3					66.7
Citrus sinensis	2.0	2.0	83.3		16.7			
Arundinaria alpina	0.7	0.7	50.0			50.0		

* 1 = Own nursery; 2 = District Bureau of Agriculture nursery; 3 = Local market; 4 = Gift from a relative; 5 = Obtained through school children; 6 = Wildling
Source: Field survey (2001).

Such species as avocado, guava, papaya, and bamboo are planted in small numbers, often not more than five and maximum of ten per household per year. This is mainly attributed to scarcity of seedlings and the large space claimed by fully grownup trees. Newly introduced fruit species also involve uncertainties over possible performances. On the other hand, *Eucalyptus*, t'chat, and coffee are planted relatively in larger numbers but at infrequent intervals. The most frequently observed ranges of annual planting for the three species were 20 - 1500, 20 - 200, and 50 - 500 respectively.

The results depict that *Eucalyptus* spp., coffee, t'chat, and avocado are the most widely planted species. Despite DBA's abandonment, farmers often raise enough seedlings of eucalypts to meet their planting needs. Excess seedlings also fetch a small amount of cash income. Although DBA is attempting to promote disease resistant coffee varieties, 39 % of the planters still use their own seedlings. Some farmers possess accumulated wealth of experience in selecting disease resistant and bushy varieties as well as raising and handling of coffee seedlings. Many farmers, although appreciate the disease resistant nature of the new varieties, do not approve the growth nature (branching characteristics) for good yield. Farmers evaluate the merits of new crop varieties on the basis of their multiple positive attributes for meeting multiple objectives (see Emana 2000).

5.4.3 Plantation survival rates

A brief account on the survival rate of the planted species is relevant since a great variation arises between ecological zones and individual household plots. The observed differences are mainly attributed to management practices and climatic variables rather than to the species themselves. Plantations of lower altitudes are often subjected to frequent rainfall irregularities, higher evapo-transpiration stress, and subsequent desiccation and thus end up with lower survival rates than those of higher altitudes. The reported range of survival rates, from complete failure to 100 %, almost applies to all species. Table 5.7 exhibits reported range of survival rates for selected species planted during the 1999/00 year.

Table 5.7 Ranges of survival rates (%) for selected on-farm tree/shrub species planted in 1999/00 by agro-ecological zones

Species	Highland (n=52)	Midland (n=81)	Lowland (n=17)	Major reasons*
Eucalypts	0-100	0-100	-	Extended drought[1,2,3]
T'chat	100	67-100	-	Animal trempling[1]
Coffee	70-100	0-100	2-70	Poor soil quality[1]
Avocado	25-100	50-100	-	Poor management[1,2]
Bamboo	-	50	-	Water logging[2]
Cupressus	11	100	50	Escaped fire[3]
Juniperus	100	-	-	

* 1 = Highland; 2 = Midland; 3 = Lowland.
Source: Field survey (2001).

About 42 % of the total plantation failure was attributed to extended drought in the year immediately after establishment. It was not mentioned, however, by households of Diamir and Genet as a cause of seedling deaths. Under optimum climatic conditions and management regimes, poor soil conditions represent an important constraint in the middle and high altitudes. Other reasons that were mentioned in a decreasing order of importance include: no idea, poor seedling quality, late/early planting, trampling damage, water logging, frost attack, lack of fertilizer, lack of know-how, short dry spell after planting, planting under tree crowns, seedling theft, escaped bush fire, and hail damage.

Survival rates of communal woodlots are often exaggerated in official documents. The actual survival rates of communal woodlots often lie below 50 % (Pers. Comm.). Apart from self-initiated plantations, farmers also plant seedlings produced in central nurseries and distributed by the DBA.

According to a senior expert in the DBA, the officially registered annual survival rate for the seedlings obtained from the DBA ranges often between 80 and 90 %, a figure which appeared highly unrealistic and far exaggerated. Further, he asserted that the inverse of these figures would probably represent the actual survival rate. If these figures were true, the district would have been completely covered by plantations by now. Main drawbacks are weak follow-up and tending operations and haphazard survival counts at the wrong time (end of the rainy season).

5.4.4 Preferred trees/shrub species

Farmers' immense agricultural wisdom enables them not only to mentally document undesirable effects of various tree species but also to pin down pertinent candidates that address felt needs. In the present study, 83 % of the sample farmers precisely indicated their first choice species to be integrated in crop fields. Table 5.8 displays farmers' prioritized preferences for various species.

Table 5.8 Farmers' prioritized preferences for various tree/shrub species in crop fields

Species	% of farmers voted for		
	First	Second	Third
Don't know	17.3	17.3	17.3
Cordia africana	33.3	8.0	2.0
Coffea arabica	10.7	2.7	1.3
E. abyssinica	8.0	4.0	0.7
Sesbania sesban	5.3	3.3	2.7
C. macrostachys	4.7	3.3	2.0
P. Americana	4.0	4.0	2.7
Carica papaya	3.3	4.7	2.0
Ficus sur	2.0	0.7	0.7
J. procera	1.3	1.3	1.3
Catha edulis	0.7	3.3	2.0
A. abyssinica	0.7	1,3	0.7
M. ferruginea	2.0	4.7	

Species	% of farmers selected as		
	First	Second	Third
R. prenoides	2.0	1.3	
H. abyssinica	1.3	2.0	
F. albida	0.7		
A. schimperiana		3.3	0.7
Citrus sinensis		2.0	0.7
M. indica		1.3	3.3
A. senegalensis		0.7	0.7
P. gracilior		0.7	0.7
V. amygdalina		1.3	
J. schimperiana		0.7	
A. decurrens			0.7
Eucalyptus spp.			0.7
No species preferred	2.7	2.0	2.0

First, second, & third preferred spp. are mentioned by 150, 110, and 67 respondents respectively.
Source: Field survey (2001).

With increasing number of preferred species the number of respondent farmers progressively declined. It seemed that farmers' familiarity with and overall perception of popular leguminous multipurpose tree and shrub species are quite low. The only species mentioned for soil fertility maintenance, provision of shade, animal feed, fuelwood, and the like is an indigenous *Sesbania sesban*, a shrub planted only by a handful of farmers (Table 5.8). The main driving reason for planting this species, however, is its fast growth rate, minimum competition for space and soil nutrients, rapid provision of shade for coffee plants, and ease of getting rid of the stumps.

5.4.5 Undesirable trees/shrub species

Various tree and shrub species are disliked by the households either for their negative ecological effects or direct harmful effects on agricultural crops. In farmlands, the production of food crops cannot be compromised for tree products. Integration of trees and shrubs in farmlands is thus tolerated only as long as they do not seriously interfere with food production targets. This justifies the planting of aggressively competing species well separated from the homegardens.

As depicted in Table 5.9, the majority (87 %) of the farmers disrepute eucalypt species as candidates for integrating into cultivated fields. The fact that *Juniperus procera* was mentioned as an undesirable species by 28 % of the respondents places it on the second position next to eucalypt species. *Cupressus lusitanica* stands in the third place.

Table 5.9 Farmers' assessments of the negative effects of various tree/shrub species

Species	Priority	Effects of the species*						P**
		1	2	3	4	5	6	
		Number of respondents						
Eucalyptus species	First (n=137)	62	43		5	7		0.000
	Second (n=94)	4	5			1	1	
	Third (n=49)		3					
Juniperus procera	First (n=137)	3	4					
	Second (n=94)	12	12		3			0.000
	Third (n=49)	2	5	1				
Cupressus lusitanica	First (n=137)		3			1		
	Second (n=94)	8	17		1	4		0.000
	Third (n=49)	5	1					
Arundinaria alpina	First (n=137)		1					
	Second (n=94)	1	1			1		
	Third (n=49)	5	5			2		
Podocarpus gracilior	First (n=137)							
	Second (n=94)	2	2	1				
	Third (n=49)	2			2	1		

*Legend

1 = intense competition with crops;
2 = drying up the soil;
3 = harboring wild animals;
4 = competes with crops and harbors wild animals;
5 = competes with crops and dries up the soil;
6 = shedding leaves damage crops.

** P = Significance level of χ^2 test for relationship between tree species and the corresponding reasons for not planting.
Source: Field survey (2001).

Farmers' perceptions on the negative effects of trees on the associated food crops strongly influence their decisions to integrate and the density of trees in their crop fields. Farmers therefore, often plant only fruit species. Other tree/shrub species are planted only when targeted to cater shade in their cultivated plots. Farmers also developed effective practices to minimize negative consequences of useful species. Plate 8 presents one of the many strategies in minimizing the stunting effects of eucalypt species on the growth of crops and grasses. Under this management condition, a land planted with eucalypts is expected to produce mainly poles and twigs for construction, sale, and fuelwood. Despite the claim that *Cordia* leaves and fruits inflict damage to enset shoots and sheath, a considerable number (36 %) of the farmers still maintain few *Cordia* trees in their enset and coffee fields, for the potential benefit outweighs the intermediate negative effects. Table 5.9 presents the most frequently mentioned species that proved harmful and their possible effects.

On the other hand, despite slight efforts of the DBA to promote MPTS in the existing farming systems (for instance, by distributing some 170 000 seedlings of *Sesbania sesban* between 1996/97 and 1999/00) (Appendix 8), only 5 % of the interviewees were growing the species. Most seedlings raised and distributed by the DBA, with the exception of coffee and fruit species, are almost entirely planted for aesthetics, shade, and/or live fences around houses or in *Joforos*. This is attributed to either lack of integrating the end-users in the species selection process and/or farmers' strong skepticism about the potential benefits of those species.

5.4.6 Uses of communal forests

No designated state forest or national forest priority area has been detected in the study district. This section thus predominantly dwells on communal forests to which the community exercises various degrees of access. Although communal plantations in the midland are managed by the owning PAs,

individual farmers often have limited direct access to them. A series of administrative procedures are required to get permission to use communal plantations. Whereas middle altitude and lowland households possess respectively limited access to communal plantations and uncontrolled access to natural forests, highland farmers possess access only to riverine and scattered clumps of vegetation. In general, households of any village possess full access to scattered vegetation and shrubs on communal lands. Such woody vegetations are mostly used to collect fuel materials and various non-timber forest products (NTFPs).

Deliberate use of trees and shrubs for animal feed is virtually unknown in most PAs. Initially, communal plantations were established without adequate planning for their intermediate and end uses (see Humphrey 1998). Major plantation species were exotics (e.g., *E. camaldulensis* and *C. lusitanica*) which under the prevailing planting density and management regimes, totally excluded understorey vegetations (Plate 9). The prime target was provision of financial and material incentives for the participating farmers and to increase forest vegetation cover of the area (Pers. Comm.). Only few farmers were thus allowed to participate as wage laborers rather than as partners and beneficiaries.

It is reported that there is no communal forest in two of the midland PAs (Achawede and Barewa) and two of the highland PAs (Kuneber and Merabicho). The best situation was observed in Doba (lowland) where more than 88 % of the sample households collected one or more products from communal natural forests. Main forest products that are harvested include fuelwood, fence posts, construction sticks, tool handles, leaves for carpet making, and other NTFPs. The next best situation was observed in Lanka Tore and Diamir in which 18 % and 14 % of the sample households respectively have collected at least one forest product from communal woodlots. Lowland households that reside nearby natural forests rarely fell eucalypt trees solely for fuelwood use.

Farmers also indicated that a number of naturally grown species are browsed by animals, particularly bovines and ovine. In Doba PA, for instance, animals browse on leaves and fruits of some tree and shrub species. The greater number of palatable species in the lowlands is simply because of the greater diversity of natural vegetation in contrast to highly selected economic species in the middle and higher altitudes.

Lowland households make maximum use of natural forest vegetation to meet their construction, fuel, and to a lesser extent timber needs. Farmers often collect species like *Clerodendron myricoides* and *Rhus glutinosa* for house construction as well as *Combretum* spp. and *Euclea schimperi* for fencing. Animals browse on species such as *Combretum* spp., *Cordia africana*, *Grewia velutina, Rhus glutinosa, Euclea schimperi*, (*espet, baddano*)[10], etc. Major risk of lowland vegetation though is the frequent attendance by wild fires particularly during the driest months (January-March). Important uses of major tree species in the district are summarized in Appendix 9.

[10] Local names of species for which Latin names could not be obtained.

5.5 Off-farm activities

5.5.1 Type of off-farm activities and labor share

Farmers of the study region participate in an assortment of off-farm activities as a means of diversifying livelihoods. Off-farm activities are often diverse and complex, varying greatly from one household to the other. Such vital activities as local trades, handicrafts, farm employment, marketing of farm products, and purchase of basic commodities are considered as off-farm activities. Mandatory and voluntary social events (see section 5.4.5) represent important off-farm activities. Only the most relevant and important off-farm activities are selected and briefly reviewed in the following sections because of their strong connotation on farm labor allotment.

Some household heads prefer to invest much of their time in off-farm activities to generate cash revenues. This may also involve out-migration of the male household heads which at times proves detrimental to household food security unless offset by remittances and periodic follow-ups. The majority of male heads that involve in off-farm activities, however, either remain on farm or out-migrate only for short time.

Other household members of the study district dedicate a considerable part of their time to off-farm activities. A brief glimpse at the intra-household labor division exhibits that men rather than women and children spend much more time in farm fields. Women's participation in the farm is often limited to regular dispensation of animal dung into crop fields, assisting during planting/sowing, casual weeding operations, and enset processing works. In female-headed households, many of the physical fieldworks become the responsibility of the women. This necessitates a corresponding shift of time allotment from off-farm works to farm operations. On the other hand, female household heads resort to hiring male labor for specific tasks, the fact that increases participation in off-farm activities to generate sufficient cash. In many instances though substantial part of their original farmland remains idle, largely infested by weeds (Plate 10).

5.5.2 Cash generating works

Wage employment refers to the situation in which a member of a household engages in any activity that generates cash income through daily wages. This may involve working at neighbor's farm in seedbed preparations, weeding, harvesting, and/or processing of agricultural products. Any wage work in which the household member (excluding the household head) remains away for over 6 months period has been excluded from this review.

The need to participate family members in off-farm wage labor is subjected, *inter alia*, to the status of household labor force, the urgency for cash needs, and the availability of employment opportunities. Some 55 % of the households did not participate in any off-farm cash generating activity (Table 5.10) and only 6 % participated in more than one off-farm activities. As can be gleaned from the results, off-farm activities substantially contribute to the participating households' financial stocks.

Table 5.10 Participation of households in off-farm cash generating activity during the 1999/00-production year and amount of cash generated

Off-farm variables	Agro-ecological zone			Household category	
	Highland (n=52)	Midland (n=81)	Lowland (n=17)	Male-headed (n=123)	Female-headed (n=27)
	% of total respondents				
Not involved	67.3	48.1	52.9	50.4	77.8
Daily wage work	19.2	21.0	23.5	23.6	7.4
Work in town	1.9	3.7	5.9	3.3	3.7
Local trade	3.8	21.0	11.8	15.4	7.4
Grass sale	0.0	1.2	0.0	0.8	0.0
Handicraft	0.0	1.2	0.0	0.8	0.0
House construction	7.7	1.2	5.9	4.1	3.7
Grain mill operator	0.0	1.2	0.0	0.8	0.0
Persons involved*	1,2,4	1,2,3,4	1,3,4	1,2,3,4	1,2***
Mean income (Birr)	1110.50	531.33	254.50	586.67	1240.83
Standard error	294.58	117.18	64.49	93.50	787.35

* 1 = husband; 2 = wife; 3 = daughter; 4 = son. *** χ^2 test is significant at 0.001.
Source: Field survey (2001).

Off-farm activities did not show any relationship with various AEZs. Daily wage work represents the most important source of off-farm income, followed by local trade, which mainly is performed with various agricultural products. The widest and narrowest income ranges were recorded in the middle and low altitudes respectively. The highest yearly income (about 536 USD) was generated in Merabicho (highland) from local trade in livestock followed by Barewa (530 USD) in which the husband worked in town throughout the year. The highest income from the second off-farm activity was generated in Gardashie (midland) from local trade in grain and flour.

In male-headed households, husbands represent by far the most dominant (69 %) participant in off-farm cash generating activities. Housewives and daughters constitute 13 % each of the total participants. In female-headed households, corresponding figures for women and daughters are 67 % and 0 % respectively. Women generally, participate in activities that generate much lower cash income (often less than 35 USD a year) than men. All households that participated in the second off-farm activity were from the middle altitude and male-headed households.

Participation of a household in off-farm cash generation activity is much more related to its labor force status than to its wealth status. This is mainly because some migrating male heads can raise a considerable amount of cash and accumulate modest capital while the family keeps the farm running. On the other hand, those who stay on-farm often use the cash to meet immediate financial needs rather than to accumulate capital. In general, it is not common for farmers of above average wealth status to participate in local farm wage works.

5.5.3 Fuel gathering and water fetching

Fuelwood constitutes the sole source of cooking and heating energy for the rural households in the study area. Kerosene lamps and hand torches provide additional sources of lightening, with the former being widely utilized by almost all households. Fuelwood collection thus claims a considerable farm labor and time only in PAs that still maintain free access to communal forests and

woodlands. For almost all of the households in the high altitudes and majority of households in the middle altitude, private on-farm plantations and collection of dried branches and twigs (from within a radius of about one km) from neighbors' farms represent the major sources of fuel materials.

Unlike other regions, fuelwood gathering in the study area is predominantly the task of children and, to a lesser extent, male household heads with partial involvement of housewives (Table 5.11). Nevertheless, in male-headed households, husbands make 79 %, 69 %, and 77 % of all fuelwood related decisions in the high, middle, and low altitudes respectively. In female-headed households, women make 79 % and 100 % of all fuelwood related decisions in the high and middle altitudes respectively.

Corresponding figures for female- and male-headed households demonstrate the shift of men's tasks to women and children in the former case. The share of husbands in male-headed households in fuelwood collection constitutes 33 %, 34 %, and 27 % in the high, middle, and low altitudes respectively. Similar share of wives in the female-headed households constitutes 37 % and 18 % in the high and middle altitudes respectively. The remaining part of the task is performed by children. This is an indication that women and children in female-headed households burden much more tasks than those in male-headed households. Shortage of labor forces predisposes female-headed households not only to inferior acquisition of basic needs but also to preadolescence fatigue of children.

Table 5.11 Share of male-headed household members in fuelwood collection and water fetching

Household member	Highland (n=38)		Middle altitude (n=68)		Lowland (n=17)	
	Fuelwood collection	Water fetching	Fuelwood collection	Water fetching	Fuelwood collection	Water fetching
	% of total task					
Husband	33.1	0.0	33.8	0.0	26.5	0.0
Wife	8.4	38.9	6.7	61.1	1.0	70.6
Children	54.6	57.5	57.0	37.4	72.5	29.4
Others	3.9	3.6	2.5	1.5	0.0	0.0

Fuelwood collector and zones are significantly ($\chi^2 = 38.912$; $P \leq 0.028$) related.
Source: Field survey (2001).

Majority of the households in the district collect fuel materials on daily basis although collecting from distant sites is done less frequently. The longest, one way, travel distance to fuelwood collection site (2.5 h) was recorded in Diamir, and refers to fuel gathering from communal plantation further away from homes. In contrast, all household fuel materials in the highland villages are collected within a walking distance of about 15 minutes or less. Only 12 % and 9 % of the households in the highland and in the middle altitude respectively admitted purchasing fuelwood during the 1999/00.

During the dry season, crop stalks makeup major sources of fuel materials. This is particularly important in the mid- and lowlands where maize and sorghum stalks are used. Preparing cow dung cakes for burning is quite uncommon and considered as a traditional taboo against soil fertility maintenance. Unlike general consensus among social forestry scholars, high- and midland farmers thus establish woodlots with fuelwood production as one of the major end uses. However, as plainly

demonstrated in Table 5.12, lowland households primarily rely on communal forests for meeting fuelwood demands.

Table 5.12 Sources of fuelwood and distance of collection site

Sources / Collection distance	Agro-ecological zone			Chi-square test
	Highland (n=52)	Midland (n=81)	Lowland (n=17)	
	% of households			
Own farm	73.1	48.1	11.8	
Neighbor's farm	1.9	3.7	0.0	$\chi^2 = 71.367$
Communal forest	0.0	1.2	5.9	
Own & neighbor's farm	13.5	37.0	5.9	P≤0.000
Own farm and communal forest	9.6	9.9	76.5	
Purchasing from neighbors	1.9	0.0	0.0	
Walking distance (Minutes) 1-20	94.2	81.5	41.2	
21-40	5.8	9.8	41.2	$\chi^2 = 44.015$
41-60	0.0	1.2	17.6	
More than 60	0.0	7.4	0.0	P≤0.000

Source: Field survey (2001).

On the other hand, water fetching from rivers or, in few cases, from central fetching points, is the responsibility left aside for women and daughters. Per the information obtained from PA council members, manual pumps and springs cater drinking water to only between 5 % and 8 % of the total rural population in the district. Majority of the households still rely on river and rain waters as a sole source of drinking, cooking, washing, and other household uses.

Water fetching claims more labor force in the middle altitude owing to not only less abundance of perennial rivers but also rapid drying up of springs and seasonal rivers. The longest, two ways travel distance (180 minutes) was recorded in Diamir PA. No male household member is involved in water fetching and young children rarely take part. In female-headed households, children's shares in water fetching in the high and middle altitudes constitute 63 % and 82 % respectively. Apparently, these differences in participation rate of children of the two household categories authenticate the forgoing finding on workload differences in fuelwood collection.

5.5.4 Commercialization

Marketing represents an essential part and parcel of the lives of the Guraghe community. Major marketing activities claim a considerable part (from half a day to full day depending on the walking distances) of farming time. Women rather than men were found to be more frequent visitors of small local markets which mostly last about 4 hours (late afternoon). Marketing of major farm products is often performed either solely by men or by both men and women. Some products are entirely left to the discretion of women for marketing. One way walking distance to major marketing centers varies between less than 30 minutes and over 150 minutes. Some 15 % of highland and 14 % of midland households travel over 2 hours to the major markets. In the present work, labor force shares in decision-making and marketing of crop and livestock products were elicited and presented in Figures 5.3 and Table 5.13.

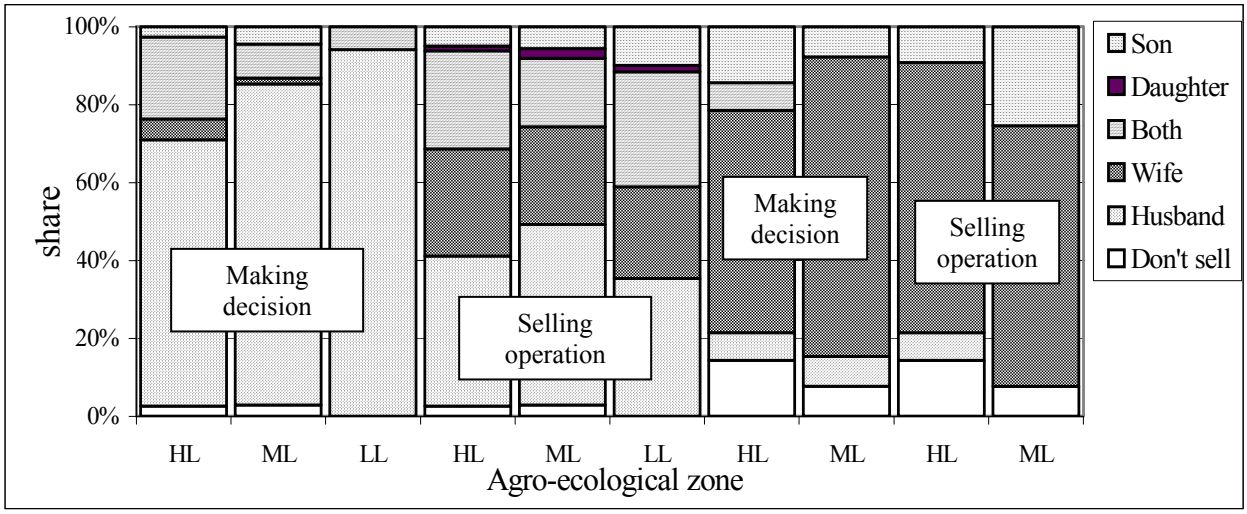


Figure 5.3 Labor force share of households in selling agricultural crop products
The first six bars represent male-headed households, the last four female-headed households.
Agro-ecological zone: HL=highland; ML=midland; LL=lowland.
Source: Field survey (2001).

Women's role in production and marketing decisions of agricultural crops is more pronounced in the highlands. Among married couples, more than one-third of all crop-marketing operations are carried out by women. In the lowlands, men are more reluctant to devolve crop-marketing decision-making power to their wives. Women household heads shoulder more than two-third of crop marketing operations in both ecological zones.

Table 5.13 Share of livestock selling decisions and marketing operations among members of male-headed households

Family member	Agro-ecological zone					
	Highland		Middle altitude		Lowland	
	% of respondents					
	Decision*	Sell*	Decision*	Sell*	Decision*	Sell*
Don't own	0.0	0.0	2.9	2.9	0.0	0.0
Husband	68.4	75.7	82.4	81.7	94.1	88.2
Wife	0.0	0.0	1.5	1.5	0.0	0.0
Both	28.9	20.4	8.8	5.9	5.9	5.4
Son	2.6	3.8	4.4	6.5	0.0	6.4
Relatives	0.0	0.0	0.0	1.5	0.0	0.0

* Figures shared among two or more household members were segregated into individual labor units.
Source: Field survey (2001).

From the empirical data, it became obvious that participation of women in both crop marketing decisions and actual selling operation as well as in livestock marketing is quite low. As indicated in Table 5.13 both decision-making and marketing of livestock are predominantly the responsibility of men. Cases in which women decided and sold livestock are exceptions. Accordingly, livestock marketing decision is either solely left aside for husbands or jointly made by both husbands and wives. Women in the highlands seize much more access to joint livestock marketing decisions and actual marketing operations. Participation of women in joint marketing operations is generally low. Women household heads obviously make the bulk of livestock marketing decisions, 57 %, and 62 %

in the high- and midland respectively. Figure 5.4 depicts a contrasting labor share pattern in marketing tree crop products.

A significant number of female-headed households in both ecological zones neither had enough tree products to sell nor have sold in the past. Young boys in female-headed households are entrusted with more tree product marketing duties. Compared to marketing of agricultural crops, absentee husbands take more active roles in marketing of tree products, particularly in the highlands. As depicted in Figure 5.4, major parts of the decision-making and marketing operation of tree products in the male-headed households are performed by male heads. In the lowlands, for instance, 88 % of the male heads take all the decisions to sell tree products alone, whereas 41 % of the total male heads involve women partners in joint tree product marketing operations.

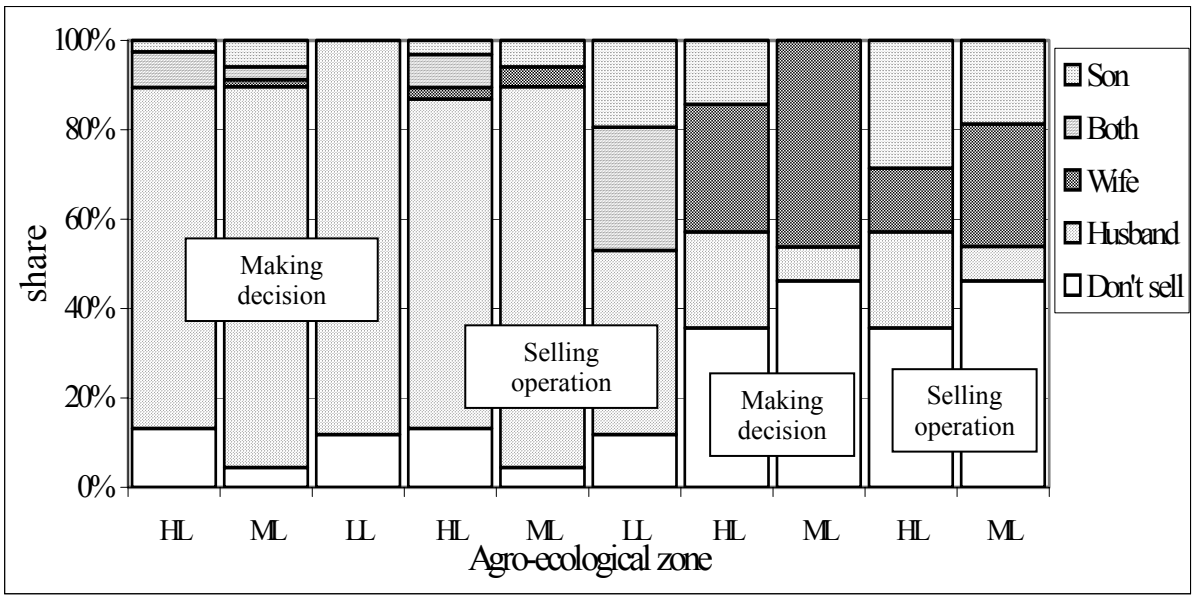


Figure 5.4 Labor force share of household members in selling tree crop products
For legends see Figure 5.3.
Source: Field survey (2001).

Household members generally, carry out marketing of a wide array of products. Marketing of handicraft products is often done directly by the main actor. Grownup children can commercialize their own resources or byproducts. Milk and enset products are commonly marketed by women. T'chat is a type of product that can be marketed by women, men, and young children as well. Basic household food items and accessories are often purchased by women.

5.5.5 Social and cultural performances

For farm households of the study district, it is not only a moral perseverance but also a social obligation to persistently attend religious congregations and traditional ceremonies. Among other rituals, wedding and funeral ceremonies, church/mosque congregations, merry-go-round gatherings, public meetings, mutual aid arrangements in time of adversary, coffee and t'chat gatherings, and the like constitute the major performances that demand farm labor. Locally elected elders have wide-ranging traditional responsibilities including mediation and settlement of disputes, constitution of

local level rules and regulations, and finding solutions for communal problems. Farmers often adjust the dynamics of social events to be performed on holidays[11].

5.6 Summary

Farmers' frequent rejection of technologies often emerged from lack of understanding of the technologies and their incompatibility of with the socio-economic realities. Many of the designed technologies were insensitive to farmers' constraints, priorities, and needs. Full understanding and capturing of farmers' traditional and evolved farm practices help tracing appropriate interventions that promote farmers' livelihoods.

Livelihoods of the study households are largely characterized by the target of meeting subsistence food needs. Farming is performed manually by employing quite traditional farm tools. Crop cultivation is highly dependent on the use of animal manure. Rain-fed crop production is the sole means of meeting subsistence food needs. Consequently, recent climatic upsets increasingly subjected farm practices to the risk of repeated crop failures. Modern farm inputs are not adopted by most of the farmers mainly due to lack of the necessary capital. As a result, large portions of private landholdings in the mid- and lowlands are left idle.

The threats of wild animals and various diseases sharply reduce both crop and animal productions. Animal diseases pose a double-edged negative effect on peasant production. On one hand they reduce the direct output of livestock such as milk and meat production, cash income, and provision of draught power. On the other hand, reduced production of cow dung greatly influences both the quantity and quality of crop production. Inherent poor soil qualities worsen the staggering low productive capacity of the land.

The adoption rate of various farm forestry practices is largely diminished by lack of adequate knowledge and planting materials of valuable species. Current farm forestry programs are emphasizing on-farm planting of exotic timber species, which so far have proved largely a failure. An integration of judiciously selected agroforestry species into the existing farm units can fully or partially substitute some costly farm inputs and boosts crop and animal production. Careful analysis of on-farm tree/shrub management regimes and the potential of agroforestry helps identify effective farm forestry technologies.

Farmers' desires to augment cash income through off-farm activities are thwarted by extremely low wage rates and lack of employment opportunities. Of particular concern are widowed female household heads that need to raise cash revenues to hire male labor for specific farm works. Low level of women's participation in farm decision-making and operations are not considered as a drawback in this study, since they also possess full control over all forms of in-house duties and decisions such as food selection and preparation, time of cooking, and whom to feed what and how much as well as what part of it to sell.

[11] At least eight days in a month, excluding Saturdays and Sundays are considered as non-working holidays among Christians in the study area.

CHAPTER 6

FARM FORESTRY DECISION-MAKING AND OPERATIONS

6.1 Decision criteria of *Eucalyptus,* coffee, and t'chat woodlots management

6.1.1 State of *Eucalyptus,* coffee, and t'chat woodlots

(a) Eucalypts

On-farm planting of eucalypt species does not lend itself to a compromise among the households of the study district. It is the privilege and simultaneously the obligation of all households not only for meeting household wood requirements and to generate cash revenues but also to preserve social pride and reputation. The wider ecological ranges of various species help all households in the study district cultivate eucalypt species. However, as indicated in Table 6.1, there is a tremendous variation in the number of eucalypt trees per household and individual PAs.

Table 6.1 Mean number of eucalypts, coffee, and t'chat per PA and percentage of planting households

PA[1]	*Eucalyptus* species			Coffee			T'chat		
	Mean	St. Error	%	Mean	St. error	%	Mean	St. error	%
Achawede (8)	275.0	112.60	100	163.8	56.03	100	170.0	110.98	50
Barewa (14)	525.7	242.26	100	310.4	208.39	93	305.8	104.17	86
Diamir (14)	1140.0	470.35	100	136.6	33.54	100	461.8	146.98	100
Doba (17)	1001.8	573.40	100	734.7	316.07	88	485.0	245.68	71
Gardashie (22)	1970.5	575.48	100	296.4	73.70	100	265.0	235.00	9
Genet (16)	585.6	140.26	100	0.0	-	0	0.0	-	0
Guareba (12)	112.1	27.52	100	52.3	19.36	67	177.3	40.12	92
Kuneber (13)	483.6	177.05	100	62.7	27.35	50	318.1	241.05	57
Lanka Tore (11)	130.0	30.90	100	106.0	34.23	91	368.8	70.04	73
Merabicho (23)	452.1	152.46	100	0.0	-	0	28.0	3.00	9

[1] Figures in parenthesis indicate sample sizes.
Source: Field survey (2001).

Analysis of survey data confirmed that farmers in the middle altitude have much better prospect to establish larger eucalypt woodlots. This is mainly attributed to better marketing opportunities and presence of relatively large uncultivated land sizes. About 7 % of the households in the middle altitude planted between 3500 and 10 000 eucalypt trees, whereas the maximum number of eucalypt trees planted by highland households was 3000. Whereas one farmer in the lowland planted 10 000 trees, the rest own only 1500 trees or less. The least numbers of eucalypt trees per household was recorded in the highland (5) and middle altitude (10). The Chi-square test, however, failed to confirm the significance of the relationship between the number of eucalypt trees per household and the three agro-ecological zones (AEZs).

No significant differences in the total number of eucalypt trees per household were observed between male- and female-headed households. The effect of male household head absenteeism is not as significant and abrupt on perennial crop production as it is on annual crop production. Where the original rootstocks of eucalypts perpetually coppice for up to 6-8 rounds, absence of male

household head starts to show effect only after several decades. Moreover, it is not a common practice to plant eucalypt seedlings every year. In the study district, women rarely participate in the establishment of eucalypt woodlots and thus their woodlots would gradually decline in size if not taken care of by grownup male children and/or hired labor.

The significant (χ^2=364.458; P≤0.029) differences between survey PAs in terms of the number of eucalypt trees per household is mainly attributed to substantial anomalies between PAs within the same AEZ. In Gardashie and Diamir (middle altitude), for instance, some 68 % and 29 % of the surveyed households respectively own eucalypt woodlots with 1000 or more trees each. On the contrary, although located within the same AEZ, none of the households in Achawede, Guareba, and Lanka Tore owns woodlots with over 1000 trees. These PAs are, generally, characterized by small private landholding sizes per household. Despite the presence of extensive communal grazing lands in Achawede, the possibility of embarking on large private woodlots of commercial value is restricted to private landholdings.

In Figure 6.1, a distinct pattern of association between land holding size and number of eucalypt trees per household has been revealed. The corresponding correlation coefficient (*r*) was 0.349 and is significant at 0.01 level. Slight heteroscedastic distribution of the points, however, calls for careful interpretation of this association.

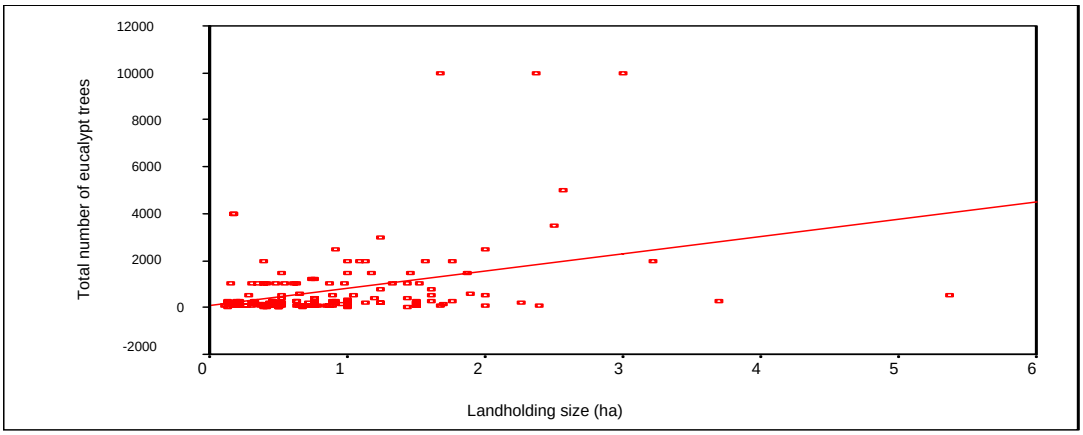


Figure 6.1 Relationship between landholding size and number of eucalypt trees
Source: Field survey (2001).

Signs of gradual eucalypt woodlot expansion are obvious in Diamir and Gardashie where recent soaring demands for eucalypt poles are inspiring many farmers to convert marginal plots into eucalypt woodlots. Households in other middle altitude PAs are largely constrained by small landholding sizes and long distances to market centers. Whereas farm households in the highlands are constrained by acute scarcity of land plots and rugged topography, those in the lowlands are mainly constrained by lack of access roads.

(b) Coffee and t'chat

Not only growing of coffee and t'chat is closely related to the agro-ecological attributes of the district but also the quality of berries and edible young leaves and twigs respectively are highly

influenced by mean annual climatic variables. Both crops are commonly grown from as low as 1600 to as high as 2450 masl. In the lower altitude range, both crops become susceptible to various disease organisms and pests. The quality of lowland t'chat is low and thus it often encounters less market demands (Pers. Comm.).

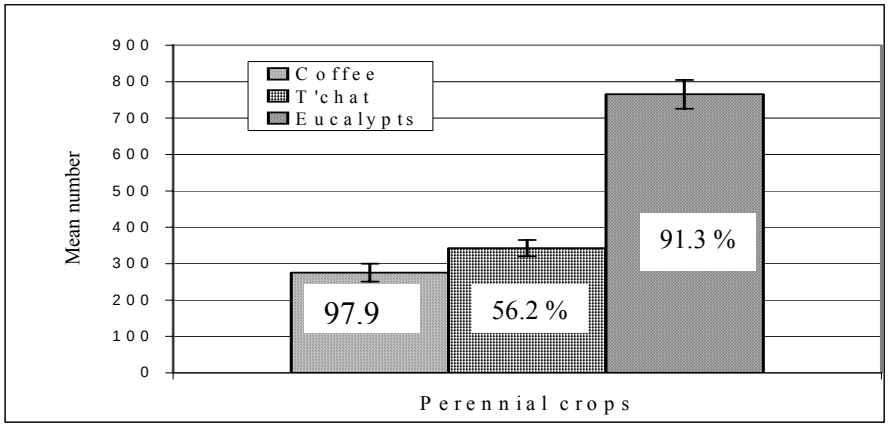


Figure 6.2 Mean total number of stems of the three perennial cash crops per household
Figures in the bars indicate percentage of households willing to continue growing in the future.
Source: Field survey (2001).

In general, only 49 % and 65 % of the total respondents grow t'chat and coffee respectively. Figure 6.2 exhibits the mean total number of the three perennial cash crops per household (excluding non-growing households) with respective standard errors of the mean. These figures confirm the complaints of many farmers against excessive government tax that was recently imposed on t'chat. A farmer was quoted as saying that t'chat was the core of their livelihoods had it not been for the recent soaring tax impositions.

6.1.2 Influence diagrams

6.1.2.1 Elicitation techniques

It was observed that farmers occasionally fail to enumerate all relevant constraining factors of tree crops on accounts of insufficient in-depth analysis of the situation and prompt comparisons with food crops. A considerable number of survey household heads, for instance, profess at a first glance that there is no constraint that prohibits them from planting eucalypts on their holding sizes. Up on deeper probing, however, they gradually explicated a wide range of conditions under which they carry out further plantings. This observation during the preliminary field survey stage prompted the researcher to contrive a well-refined data collection procedure that helped eliciting farmers' decision-making criteria in the most plausible manner.

Comprehensive farmers' decision criteria on the management of eucalypt woodlots and coffee and t'chat plantations were thus elicited in three stages:

(a) the first round questions were designed to give farmers full maneuvering opportunities to recapitulate all pertinent consequences and chance events;

(b) this was followed by presenting unattended consequences and chance events one by one in order to assess their applicability to the survey farmer;
(c) last but not least, corresponding subjective judgments on the likelihood of the chance events were elicited and the mean values of all the survey farmers were employed in modeling the decision-making processes.

The list of the reference consequences and chance events were drawn from the results of the preliminary field surveys.

6.1.2.2 *Eucalyptus* woodlots for household use

Main goals

The decision to grow eucalypts is predominantly engendered by the need to meet household wood demands (Table 6.2). Most part of household fuel and construction wood demand is met from own eucalyptus woodlots. Fuelwood forms not only the major source of energy for cooking and lighting but also an indispensable source of heating for the household particularly during the cold seasons. Moreover, eucalypt is the second most preferred wood for roof pillars (some farmers rated first) and underground construction works, next to *Juniperus procera*. The inherent growth quality of eucalypts makes their poles quite ideal for the roofs of traditional tukul houses that have long inverted V shapes (Plate 11). Sturdy and long poles (12 to 15 m) with reasonable flexibility and lightweight are preferred candidates. No other substitute has so far been employed as roof supporters, straight and sturdy eucalypt poles of about 5-7 meters long provide a stalwart support to the upper part of the roof by stepping on the 'waist' and 'shoulder' of the main pillar. Long eucalypt planting experience also enabled the community, to a lesser extent, to carve the wood into various household tools.

Table 6.2 Subjective overall assessments of parameters pertaining to goals of eucalypt growing

Parameters	Mean value	Parameters	Mean value
Grow now[1]	1.00	Household utensils value[2]	3.79
Total number of trees	765.07	Reputation value[2]	3.05
Plant in future[1]	1.09	Saving value[2]	2.86
Cash generating value[2]	2.28	Aesthetic value[2]	3.75
Construction value[2]	1.30	Erosion control value[2]	2.91
Fencing value[2]	1.44	Soil improvement value[2]	3.99
Fuelwood value[2]	1.49	Fodder value[2]	4.00

[1)]: 1 = yes; 2 = no. [2)]: 1 = very good; 2 = good; 3 = fair; 4 = not used.
Source: Field survey (2001).

Eucalypt wood also lends itself to many other uses in house construction. Noteworthy mentioning is the scaffolding structure which serves as a supporting ladder during roof construction and other works. Moreover, stunted young shoots of about 3-5 meters height are often employed as roof rafters. Fencing along farm and individual plot boundaries is commonly done with eucalypt branches and twigs. Eucalypt logs are also commonly employed as a heavy-duty bridge on most water streams.

Many farmers admit that they intentionally plant eucalypt seedlings for ecological and social services. Eucalypt seedlings were planted on degraded and erosion prone grounds such as gully banks and inside gullies to reduce landslide and soil erosion (Plate 12). In some cases, eucalypt woodlots were established for land reclamation purposes on plots that otherwise cannot support the growth of other vegetation. Eucalypt woodlots also bestow a considerable reputation and social value to the owner. Reputation values of eucalypt woodlots depend very much on the size of the woodlots and thus it was often mentioned by better off households. The chance events of eucalypt planting for household use, however, influence only the size of woodlots rather than completely impending the decision to plant eucalypts.

Male- and female-headed households exhibited nearly identical assessment results for most of the use parameters. Only assessments on construction and erosion control values resulted in statistically significant (respectively $\chi^2 = 9.50$; $P \leq 0.009$ and $\chi^2 = 8.59$; $P \leq 0.035$) differences between the sexes of the household heads. Whereas 73 % of the male heads valued construction use as 'very good', 63 % and 7 % of the female heads valued respectively as 'very good' and 'fair'. Similarly, whereas 70 % of the female heads valued eucalypts as 'not used' only 42 % of the male heads gave similar valuation on its erosion control uses. Major roles of eucalypt species in the study area are summarized into Figure 6.3.

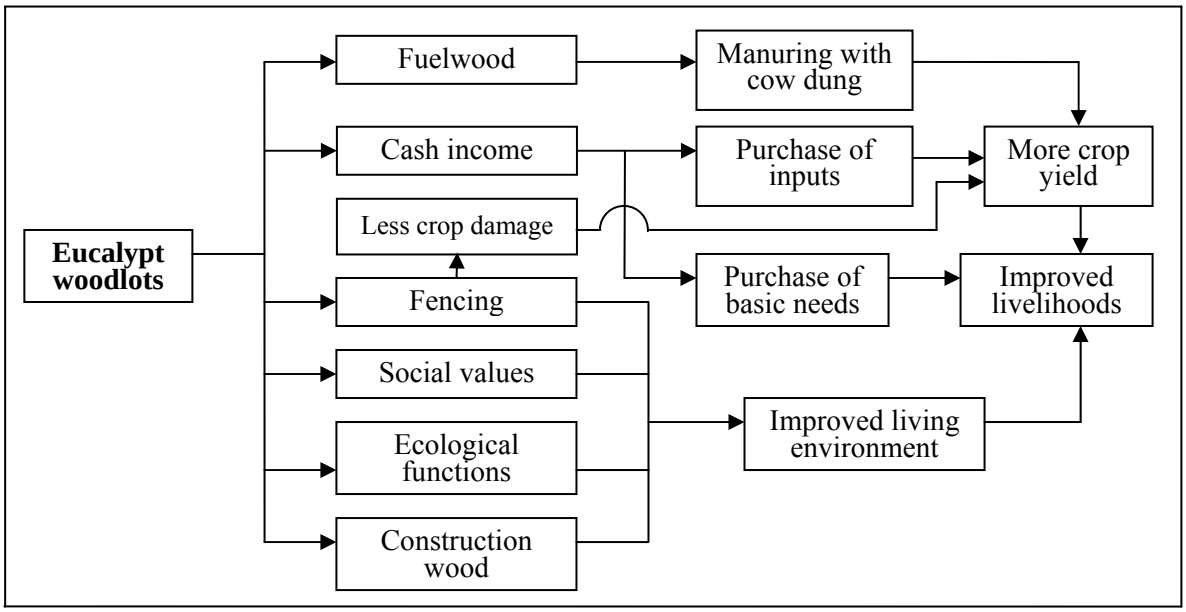


Figure 6.3 Roles of eucalypt species in the livelihood strategies of the Guraghe households

Unlike several documented results, the current empirical finding refuted any variation between the two sexes' assessments on the fuelwood value of eucalypts. This can be mainly attributed to the fact that although women are the main consumers of fuelwood, husbands often shoulder more of fuelwood-gathering tasks (see section 5.4.3). On the contrary, most previous works (Bradley 1991; Evans 1992; Nair 1993; Prasad and Bhatnagar 1995) describe fuelwood-gathering as the main task of women and suggest that issues pertaining to fuelwood are better explained by women. The cash, erosion control, and reputation values of eucalypts were not only less frequently mentioned but also greatly varied between the three AEZs (c.f., Table 6.3).

It was noted from the empirical data that middle altitude farmers have better perception on the cash generating values of eucalypt woodlots followed by lowland households. Although more number of households in the higher altitude sold eucalypts between 1995/96 and 1999/00 relatively lower proportion of households mentioned cash value as an important objective. This inconsistency indicates that farmers in inaccessible villages often plant eucalypts without definite objective of using for cash generation. In this case, marketing of eucalypt products is confined to the emergence of irregular local demands. The tree products are used by the households unless attractive local demand arises. Figure 6.4 depicts influence diagram of farmers' decision to plant eucalypt species primarily for household use.

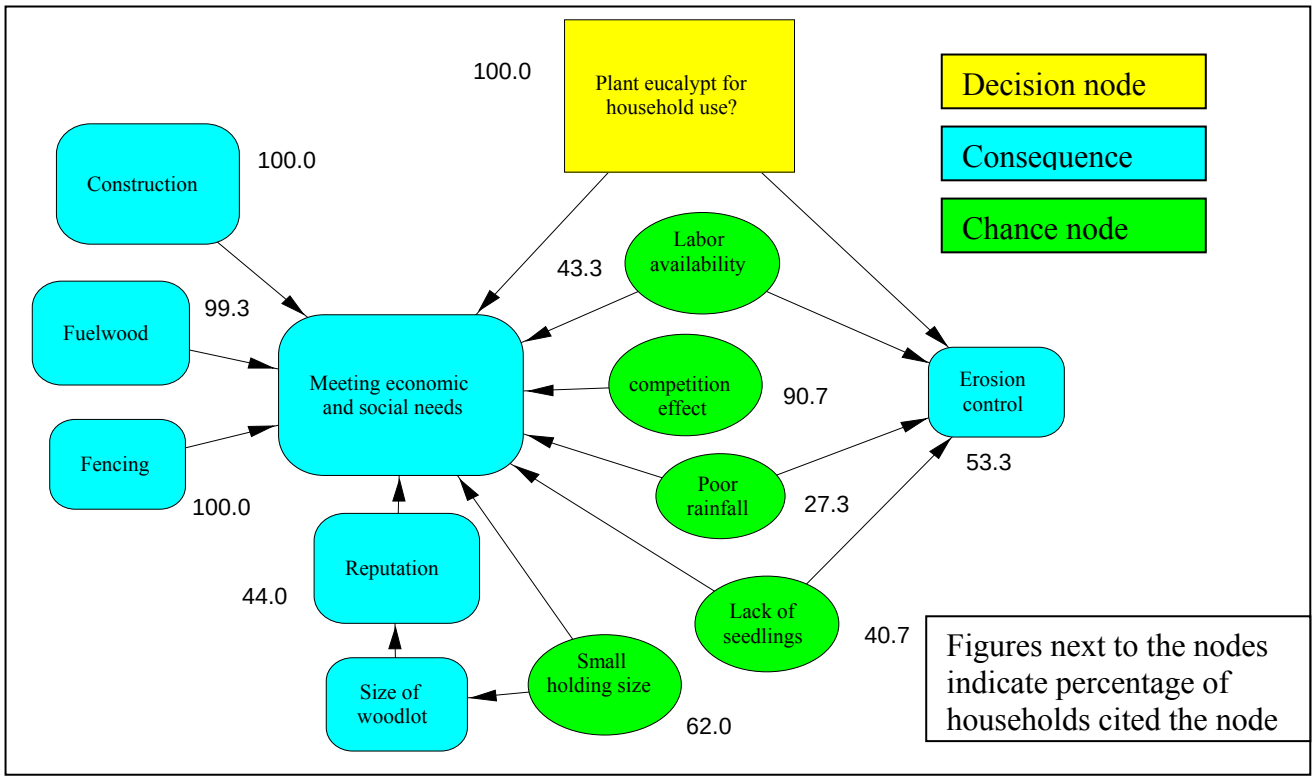


Figure 6.4 Model of farmers' decision to establish eucalypt woodlots for household use

The erosion control value assessment results seem quite interesting. In the highlands, where most farm plots are extremely prone to soil erosion, farmers plant eucalypts only for gully stabilization purposes rather than for stabilizing terraces. Despite the widespread planting of eucalypts along and within gullies, the trees alone cannot keep the soils of some hillsides intact against the detaching powers of torrential floods (see Plate 12). Some two-thirds of the total households consider erosion control as one of the objectives of eucalypt woodlots management. Erosion is not considered as a serious farm problem both in the low and middle altitudes. The reason why more than three-fourths of the households in the low altitudes consider the same objective in eucalypt management is not clear. The fact that all responses to the erosion control value of eucalypt trees in the lowlands were given after being prompted reduces the vigor of the information. Table 6.3 illustrates farmers' subjective valuation of various eucalypt-planting objectives.

Table 6.3 Use values of eucalypt trees as subjectively assessed by farmers in different AEZs

Goals	Highland (n=52)	Midland (n=81)	Lowland (n=17)
	% of total households		
Construction	100.0	100.0	100.0
Fuelwood	100.0	98.8	100.0
Fencing material	100.0	100.0	100.0
Cash revenue	67.3	91.4	70.6
Erosion control	65.4	39.5	82.4
Reputation	17.3	53.1	82.4

Reputation, which very much depends on the size of the woodlot owned, more or less, reflects the reality. Households in the low and middle altitudes consider reputation as an objective of woodlot management more than those in the highlands where woodlots are often much smaller in size.

Chance events

The decision to plant eucalypts is influenced by various internal and external factors. The impacts of some influential constraints are more felt by households in one locality than those in another. This is mainly attributed to the extent and prevalence of the constraint and, more importantly, to the wealth status and perception levels of the farmers. Major chance events of eucalypt woodlot management for household use include family labor force, landholding sizes, poor rainfall condition, and availability of seedlings. The other chance event worth mentioning is competition effect of eucalypt trees.

It is, however, prudent to note that the sizes of family labor and marginal land most seriously influence the size of eucalypt woodlots for household use. A family with excess labor force, c*eteris paribus*, is more likely to plant all available marginal lands with eucalypts. Relationship between selected household characteristics and number of eucalypt, coffee, and t'chat plants is summarized in Table 6.4.

Table 6.4 Correlation coefficients of association between number of eucalypt, coffee, and t'chat plants per household and selected household variables

Species	Household characteristics					
	Land size	Wealth	Age	Labor	AEZ**	Sex**
Eucalyptus	0.349*	0.405*	0.081	0.027	0.106	0.274
Coffee	0.212*	0.413*	0.092	0.374*	0.000	0.413
T'chat	0.005	0.294*	0.167	0.243*	0.023	0.905

* Correlation is significant at the 0.05 level. ** Significance levels of Chi-square tests.
Source: Field survey (2001).

In general, establishment and management of eucalypt woodlots can be regarded as one of the least labor-intensive farm operations. Labor force, however, represents an important decision criterion for women-headed households and households with over-aged male heads that do not have grownup male children. This is mainly attributed to the heavy site preparation and planting tasks. Once it is planted and properly established, the only tending operations before harvesting are casual weeding and protection against trampling and climbing by animals and humans. It is thus essential for a

female farmer to make sure that enough workforce could be acquired for site preparation and planting operations of the intended woodlot size.

Although seasonal weather conditions may slightly influence the timing of eucalypt planting and subsequent survival rate, it is generally, not considered as a critical decision criterion unless turned out into an extended drought. Unfavorable weather condition minimizes the rate of seedling survival both in the nursery and plantation site and thus markedly reduces the size and stocking of the woodlots. About 40 % of the survey households that experienced exceptionally low survival rates of eucalypt seedlings during the 1998/99 planting season attributed to insufficient rainfall. The eucalypt planting decisions and/or the performance of woodlots of about 91 % of the households in Gardashie (the most affected PA) are influenced by low rainfall. Households of Genet, Guareba, Barewa, and Merabicho are hardly influenced by rainfall patterns.

Farmers with good access to water sources during the dry season can raise seedlings both for household use and for sale. Some farmers also establish woodlots simply by spreading seed-laden twigs on well-prepared seedbeds before the onset of the main rainy season. Among those who planted eucalypts during the 1998/99 and 1999/00, respectively 73 % and 70 % used seedlings produced in own nurseries. The remaining 25 % and 30 % of the households resorted to purchased seedlings respectively. Unlike seedlings of other species, exchange of eucalypt seedlings among households as a gift is not common. This constraint is most severe in the lowlands where low annual rainfall and high temperatures make raising seedlings a difficult task for more than two-thirds of the households.

Governmental nurseries that were raising eucalypt seedlings to full capacity completely abandoned the production since recent years (cf., Appendix 8). An elderly farmer has expressed his disappointment by noting that authorities were discouraging them from planting eucalypts to the extent of uprooting planted seedlings, as if they had not rewarded model farmers for planting large number of eucalypts just a decade ago.

Eucalypt woodlots are often confined to eroded and/or degraded marginal plots furthest away from the home compounds. Landholding size is considered as an external factor upon which farmers have very little influential maneuvers. In relation to landholding size, competition effect of eucalypts was alluded to by 91 % of the households and thus its association with the AEZs failed to show statistical significance. It represents a major factor that keeps eucalypt woodlots and farm plots furthest apart. The slightly lower value of competition effects in the highlands (Table 6.5) confirms the findings of Cossalter and Pye-Smith (2003) that fast-wood plantations use more water that often causes a problem mainly in dry areas. As a result, almost all recent plantings are confined to either marginal or grazing lands furthest away from the homegardens. The significance of various chance events in different AEZs is presented in Table 6.5.

Table 6.5 Household valuation of chance events in eucalypt woodlot management

Chance events	Agro-ecological zone		
	Highland (n=52)	Midland (n=81)	Lowland (n=17)
	% of respondents		
Competition effect	84.6	93.8	94.1
Lack of seedlings	44.2	33.3	64.7
Low market demand	5.8	17.3	52.9
Poor rainfall	15.4	40.7	11.8
Labour shortage	34.6	42.0	76.5
Small landholding	94.2	46.9	35.3
Shortage of draught power	0.0	9.9	23.5

In this study, it is confirmed that 68 % of the total survey households possess plots less than 1 ha. Though, small landholding sizes do not constrain decisions of 38 % of the total households to plant eucalypts. Table 6.5 clearly demonstrates that small holding size constrains almost all households in the highlands, not only because of smaller mean holding sizes but also because of cereals-dominated farming systems. For majority of the middle and lowland households, other constraining factors take more precedence over landholding sizes. Whereas 100 %, 93 %, and 91 % of the households in Genet, Kuneber, and Merabicho respectively claimed that small landholding sizes constrain the decision to establish eucalypt woodlots, 71 %, 68 %, and 65 % of the households in Barewa, Gardashie, and Doba respectively indicated that landholding sizes did not thwart their decisions to plant eucalypts.

Lack of draught power in majority (see section 4.3) of the lowland and midland households influences the decision to establish large sized eucalypt woodlots. Its effect is particularly perceived by households with higher proportions of young family members. Productive labor forces of such households are often tied up with the objective of subsistence food production. The use of draught power enables easier and faster seedbed preparation than manual hand cultivation. Empirical data revealed that draught power was not considered as a constraining factor for 92 % of the total households that claimed eucalypt is not planted with oxen plows. Problems pertaining to draught power prompted more responses in the lowland possibly because of larger landholding size per household and higher scarcity of oxen.

By and large, eucalypts are not susceptible to any notorious disease incidences to the extent of influencing farmers' decisions to plant. Some 95 % of the farmers asserted that they have all the necessary eucalypt woodlot establishment and management know-how. Similarly, poor soil quality did not appear to place a significant influence on farmers' decisions to grow eucalypts. Nevertheless, 12 % of the households proclaimed that performances of their eucalypt woodlots were affected by the quality of their land plots. Soil quality hardly constitutes an important eucalypt planting decision criterion in Achawede, Diamir, Doba, Genet, and Merabicho.

A wide range of other constraining factors has been mentioned by fewer households each. Damage from wild animals that mainly climb young saplings and render them crooked has been complained by 7 % of the households. Although shortage of money has been noted as a major constraint by 4 %

of the households it fails to represent an independent constraint. Health problem of household heads has been cited by 3 % of the total households. Other constraints of lower significance include high initial labor demand, the risk of harboring wild animals, frost attack, low survival rate, lack of tools, drying up of rivers, and damage by domestic animals.

6.1.2.3 *Eucalyptus* woodlots for the market

Main Goals

It should be noted from the outset that any cash generation activity of the households from sales of farm products is part of subsistence livelihood strategy rather than pursuing of market-oriented economy. Although in principle only surplus products should be marketed, all farm households sell any available resources when confronted with unexpected emergencies. Moreover, majority of the households sell products that fetch high prices and resort to consumption of cheaper products.

Eucalypt poles are highly regarded among certain households as an important source of cash income. *Eucalyptus* is often viewed as a living bank account that can be liquidated upon emergencies. Accordingly, eucalypt woodlot was preferred respectively as a first, second, third, and fourth resort to be liquidated in cases of emergencies by 9 %, 14 %, 33 %, and 22 % of the respondents that replied. Commercialization of eucalypt poles is, however, expected only at an interval of 1-5 years depending on the temporal arrangement, type of the product, size of the woodlot, and growth rates of the trees. Eucalypt marketing patterns by households of various AEZs as well as number of households that owned more than 500 trees are illustrated in Table 6.6.

Some 14 % of the total survey households in the district have sold various eucalypt products between 1995/96 and 1999/00 (Table 6.6). The maximum amount of cash generated by a household in any particular year was claimed to be 175 USD. Most of the sales were carried out by households in Gardashie and Kuneber and to some extent in Diamir PAs. When the time frame is narrowed down to one year (1999/00) only 9 % of the households sold eucalypt products, mainly poles, with mean annual income of 14 USD. Among these, Gardashie alone accounted for 39 %, whereas Achawede, Diamir, and Kuneber accounted for about 15 % of the total each.

Table 6.6 Distribution of households by commercialization patterns and size of eucalypts woodlots among the three AEZs

AEZs	Commercialization		Woodlot size	
	Sold eucalypt (n=22)	Did not sell (n=128)	Own ≤ 500 trees (n=108)	Own > 500 trees (n=42)
	% of households			
Highland	11.5	88.5	76.9	23.1
Mid altitude	18.5	81.5	71.6	28.4
Lowland	5.9	94.1	58.8	41.2
	χ^2=2.415; P≤0.299		χ^2=2.095; P≤0.351	

Source: Field survey (2001).

The decision to plant eucalypts for the market is often proceeded by a careful planning process and weighing of the intervening chance events. Households that have sold eucalypt products during the

previous five years were believed to provide adequate insights into the decision criteria pertaining to eucalypt planting for the market. No conspicuous differences have been noted between different AEZs in terms of the number of households that sold eucalypts during this period. About 40 % of the households in the midland that sold eucalypt poles did so on average, 2.5 times during the reference period. On the other hand, although 41 % of the households in the lowland own more than 500 eucalypt trees each, only 6 % sold eucalypt product. This is attributed to both lack of marketing networks and low local demands.

There appeared significant (χ^2 = 73.130; P≤0.000) differences between households of the three AEZs in evaluating the cash generating potential of eucalypts. The cash value assessments of households that sold and did not sell eucalypt products resulted in significant differences too. Whereas 86 % of those who sold eucalypt products appraised its cash generating potential as 'good' and 'very good', only 57 % of those who have not sold the product during this period accorded similar weight. Assessments pertaining to cash generating potential of eucalypts however, did not significantly vary with the total number of eucalypt trees per household and sex of the household head.

Chance events

Empirical data proved that poor rainfall, lack of know-how, and prohibitive government policy represent important external decision criteria of eucalypt planting for the market. Farmers' confidence in finding means of selling the product *in situ* and/or means of transporting to local market centers plays crucial roles. Farmers' perceived aspiration to accrue viable financial returns at lower overall costs from the undertakings is equally important. Among internal factors, competition effect, status of family labor, and lack of seedlings make up the dominant decision criteria.

Competition effect of eucalypts as a constraining factor was unanimously cited by all households that sold eucalypt products. Accordingly, competition effect, lack of seedlings, and low market demand did not reveal statistically significant differences between the two household categories. Though, none of the farmers in Genet, Guareba, and Merabicho admitted that low market prices discourage them from planting eucalypts. Various internal and external factors that constrain the decision to expand and the performances of eucalypt woodlots in relation to different eucalypt growing household categories are presented in Table 6.7.

The fact that low market demand represents an important chance event for more than half of the lowland households indicates the high potential of eucalypt woodlots in augmenting household incomes. On the contrary, only 6 % of the highland households cited low market demand as an important chance event. Contrary to the logical expectations, lack of know-how to establish and manage eucalypt woodlots was found to be significantly (χ^2 = 8.914; P≤0.03) associated with the two household categories.

Table 6.7 Effects of various decision criteria on various household categories

Decision criteria	Planted eucalypt (n=74)	Did not plant (n=76)	Sold eucalypt (n=22)	Did not sell (n=128)
	% of households constrained			
Competition effect	93.2	88.2	100.0	89.1
Lack of know-how	6.8	3.9	*13.6	3.9
Lack of seedlings	39.2	42.1	31.8	42.2
Low market demand	*6.8	27.6	18.2	17.2
Poor rainfall	29.7	27.6	***59.1	23.4
Poor soil quality	14.9	9.2	13.6	11.7
Government policy	12.2	10.5	**36.4	7.0
Lack of draught power	2.7	13.2	18.2	6.2
Labor shortage	33.8	52.6	63.6	39.8
Small holding size	**50.0	74.3	45.5	64.8

*, **, and *** = χ^2 test for the opposite group is significant at 0.05, 0.01, and 0.001 respectively.
Source: Field survey (2001).

Quality of the soil was mentioned as an important condition for establishing and/or performance of eucalypt woodlots only by less than 15 % of the households in each of the four categories. A statistically significant (χ^2 = 17.355; P≤0.002) difference was found between seller and non-seller households in their perceptions on prohibitive government policy. These findings clearly suggest that government policy as a prohibitive tool is more influential in villages that commercialize eucalypt products. Figure 6.5 summarizes major chance events in cultivating eucalypt woodlots for the market.

A highly controversial issue in this regard is the alleged 'undesirable ecological effects' of *Eucalyptus* species. To many of the 'conservationists', eucalypt species represent 'explosively invading creatures' that wipeout the native vegetation and accelerate ecological degradation. Such notions are being loudly echoed by regional and local administrators and government authorities with little courtesy to the needs and aspirations of the farmers. These allegations exposed eucalypt species to open denunciation and prompted local authorities to discourage farmers from planting. Another chief point that can be gleaned from this finding is that labor shortage represents a crucial decision criterion for households with greater opportunity to establish eucalypt woodlots for the market.

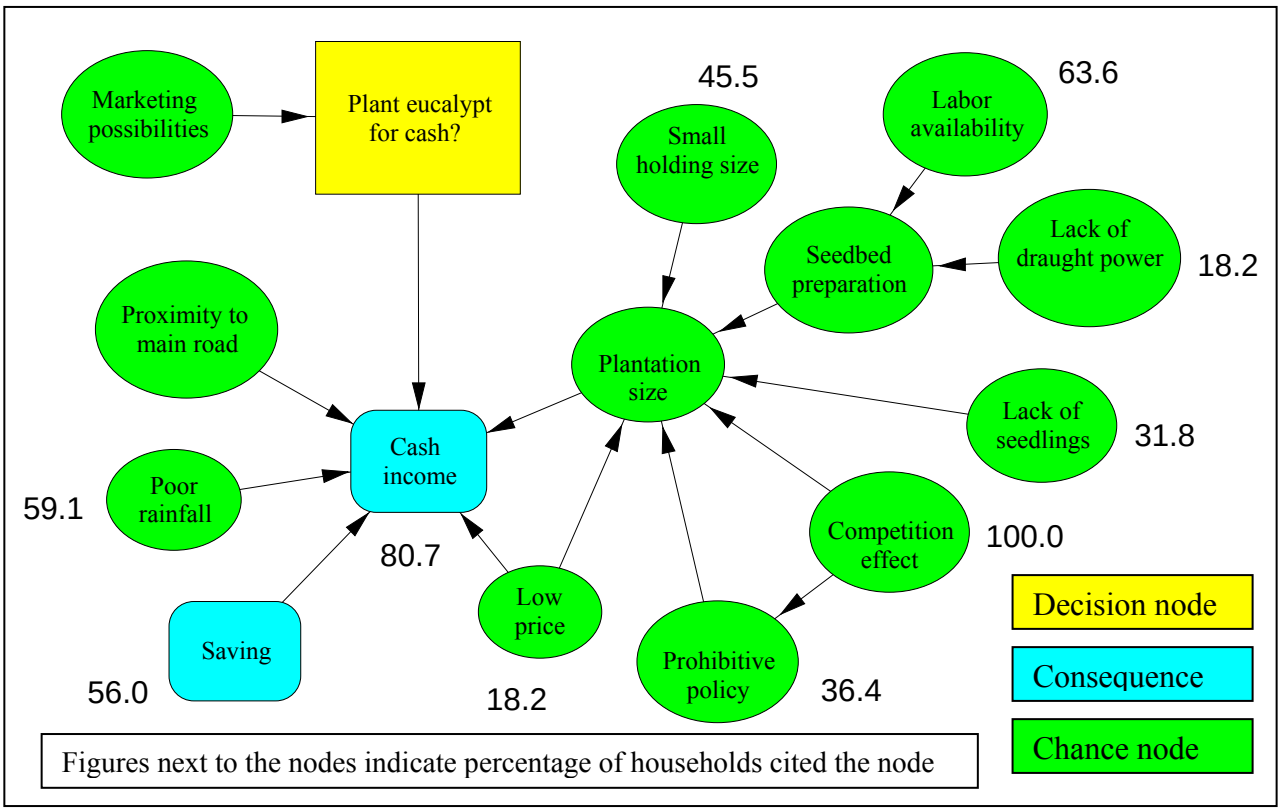


Figure 6.5 Model of farmers' decision to establish eucalypt woodlots for the market

Farmers in the highly rugged highlands and largely inaccessible lowlands find little, if any, incentive to establish big-sized woodlots beyond the needs of their households. This, of course, does not rule out establishment of large woodlots by few households in the low and high altitudes either in anticipation of local market demands or simply for social reputations. Decision nodes in the influence diagram thus apply mainly to households that possess access to central and/or local marketing channels to generate supplementary revenue with minimum labor input. Although not quantified, the closer the woodlot to the main discharge route to the central market the slightly higher farm gate price.

In general, poorer farm households often concentrate on producing subsistence crops rather than growing trees as cash crops, although infrequent discrepancies (e.g. Saxena 1994) to this notion have been documented. Better off households have financial capability and mental readiness to allocate more resources to commercial tree growing in anticipation of long-term financial rewards. As observed in the present study, very poor households were much less prepared to commit their resources to commercial tree growing, the benefits of which can be accrued after years. Even when poorer households have ample labor from share groups, they prefer to engage in daily wage works to generate cash income for immediate needs (Pers. Comm.).

6.1.2.4 Coffee and T'chat

Grower households

Some 51 % of the respondents that did not grow t'chat and 35 % of the respondents that did not grow coffee were dropped from the analysis. Whereas 34 % of the households that grow coffee do not grow t'chat, only 11 % of those who grow t'chat do not grow coffee. About 61 % of the households that planted only coffee are from Gardashie mainly due to poor soil conditions. Doba and Achawede contributed each 12 % of the households that grow coffee but t'chat. About 9 % of the households that grow only coffee come from Lanka Tore. Barewa and Kuneber shared 3 % each of the households that grow only coffee.

Main goals

Farmers in the study district, generally, grow coffee and t'chat both for household consumption and cash generation. Whereas coffee represents one of the culturally and socially valuable dietary sources and an essential means of social communication for the entire community, t'chat is often chewed mainly by adult men for its mildly euphoric effects. In most cases, coffee along with some roasted pulses replaces one or rarely two diets of each day. It also accompanies any regular dish of the day. Coffee has also a unique position in the candid hospitality and guest-welcoming nature of the Guraghes.

On the contrary, t'chat chewing claims a considerable size of the productive time. It can, however, be easily waived or chewed while working in the farm. The number of people that condemn t'chat chewing for indulging a sense of addiction and encouraging indolence is increasing. Discussions with survey farmers and relevant stakeholders confirmed that in spite of substantial amount of cash that is generated from both domestic and export sales, current local policies are frustrating t'chat growing. In reality, however, overall demands for and local and foreign revenues from the product are on the rise (FAO 1995).

Both coffee and t'chat are highly valued for generating cash incomes and to serve as a bank account. Figure 6.6 depicts the relative importance of the three perennial crops as a source of cash income. The fact that evaluation ranks of eucalypts were given by all the survey households (selling and non-selling) has considerably reduced the size of the first two bars. Obviously, coffee surpasses eucalypts and t'chat not only because of high revenue per unit area but also because of heightening government promotion measures. Nevertheless, current extreme ravages by berry disease and falling market prices make t'chat and eucalypts the popular cash crops.

Coffee and t'chat are valued as first resort to be liquidated in times of emergencies by 7 % and 2 % of the respondents respectively; second resort by 7 % and 12 % respectively; and third resort by 1 % and 7 % respectively. About 41 % and 20 % of the total respondents in low and middle altitudes respectively favored coffee as one of their cash sources in cases of emergency. On the other hand, 6 % and 35 % of the total respondents in low and middle altitude respectively liquidate t'chat in cases of emergencies. This may be because of lower quality of and demand for lowland t'chat.

Households in Genet and Merabicho grow neither coffee nor t'chat due to ecological limitations and none of the highland households claimed to have liquidated both crops.

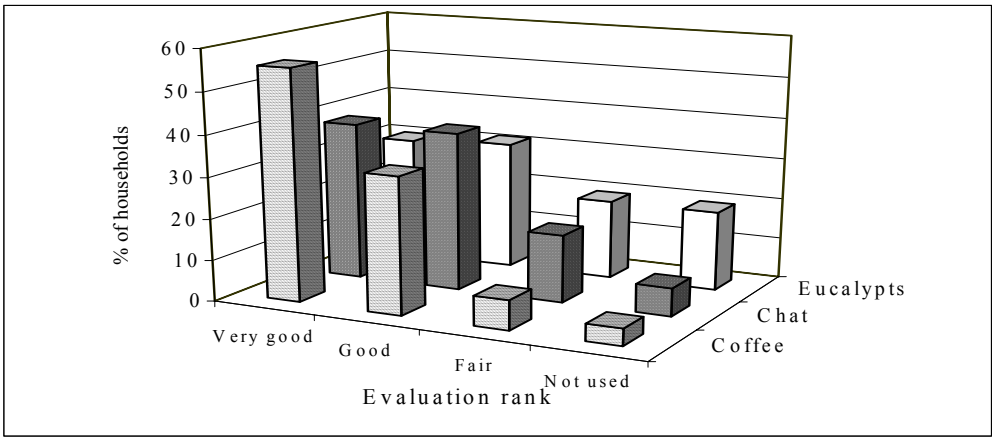


Figure 6.6 Household evaluations on cash values of the three perennial crops

Other use values of coffee and t'chat which were less frequently mentioned by respondents include reputation, and use of dried branches for fuelwood and fencing. Further, t'chat leaves provide an important supplementary animal fodder particularly to ovines. In few cases, soil improvement and erosion control values of the two species have been revealed as subsidiary management objectives.

Chance events

Growing of coffee and t'chat involves complex set of chance events. Two types of coffee diseases are commonly known in the study district. Coffee berry disease (CBD[12], locally known as *Yebuna Kolera*) infests young berries and renders them futile. It is regarded by many lowland and middle altitude households as the most serious and devastating coffee problem. The second and, in fact, less serious coffee disease (locally known as *Bunnaa*) dries up the entire bush mainly during the dry season (Plate 13). Other constraining factors of lower significance in coffee growing include lack of seedlings, poor rainfall conditions, shortage of labor, small holding size, damage by wild animals, and low market price.

Such constraining factors as lack of draught power, poor soil conditions, and lack of know-how were mentioned by only less than 20 % of the growers (Figure 6.7). Lack of know-how in coffee growing implies only superficial assessment of the current incapacity to accrue viable benefit from the crop and extensive devastation by coffee diseases. Farmers were inquiring for the possibility of regaining normal production patterns with some innovative management approaches. Otherwise, farmers boast a long tradition and wisdom of coffee cultivation. What farmers are lacking and looking forward to is interfacing their indigenous knowledge with relevant research innovations in order to reap the full rewards. Few farmers are already successful in selectively growing disease resistant and high yielding varieties by their own traditional trials.

[12] CBD is caused by the virulent strain of *Colletotrichum coffeanum*. The fungus lives in the bark of the coffee tree and produces spores which attack the cherries.

The fact that only about 24 % of the coffee growers complained about low market price is quite idealistic to prove the fairness of the current coffee price. According to BBC (2002) coffee price has gone down by 70 % since 1997. The elicited complaints of the households indicate that low price constraint was overshadowed by extreme devastation of coffee berries by CBD (Figure 6.7). In other coffee growing regions of Ethiopia, many farmers were compelled to uproot coffee bushes and replace with t'chat for its attractive price and with cereals (WIC 2002). Despite continued agitation through media and provision of extension package, coffee production is generally, dwindling at an alarming rate. Details of major objectives and chance events are presented in Figure 6.7.

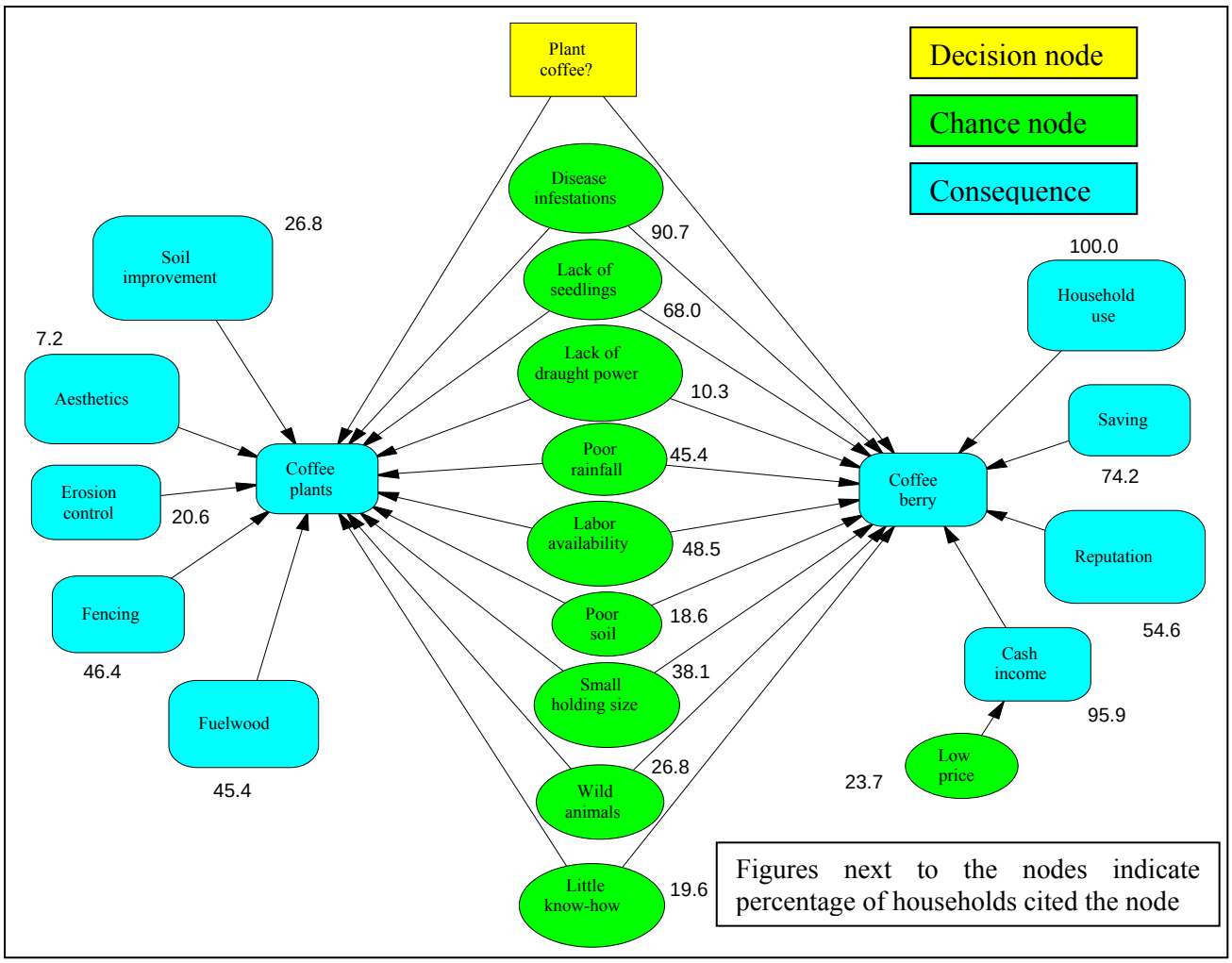


Figure 6.7 Influence diagram of farmers' decision to grow coffee

Most of the households that do not grow t'chat are mainly constrained by biophysical attributes and edaphic factors. In addition, small holding size, shortage of family labor, lack of manure, and disease incidences play a key role in constraining t'chat cultivation. Details of aspects for which t'chat is eliminated from the choice alternative list of the non-growers are not entertained in this section. Rather, major objectives and chance events that were mentioned by the growers will be illuminated.

Low market price was found to be an important decision constraint in t'chat cultivation (Figure 6.8). As compared to coffee, some two-thirds of the t'chat growers complained about low market prices,

indicating that it is an important decision criterion. Low market prices owing to high tax rates represent an essential sequence arc both in the current and future t'chat planting decisions. Unlike on-farm coffee growing which receives not only full government backing but also substantial motivation, t'chat growing is constrained by the negative attitude of local authorities and inequitable appropriation of cash revenues. Likewise, damage by wild animals, poor rainfall, lack of draught power, and much tending requirement (each mentioned by less than 20 % of the growers) play less important roles in the decision to grow t'chat.

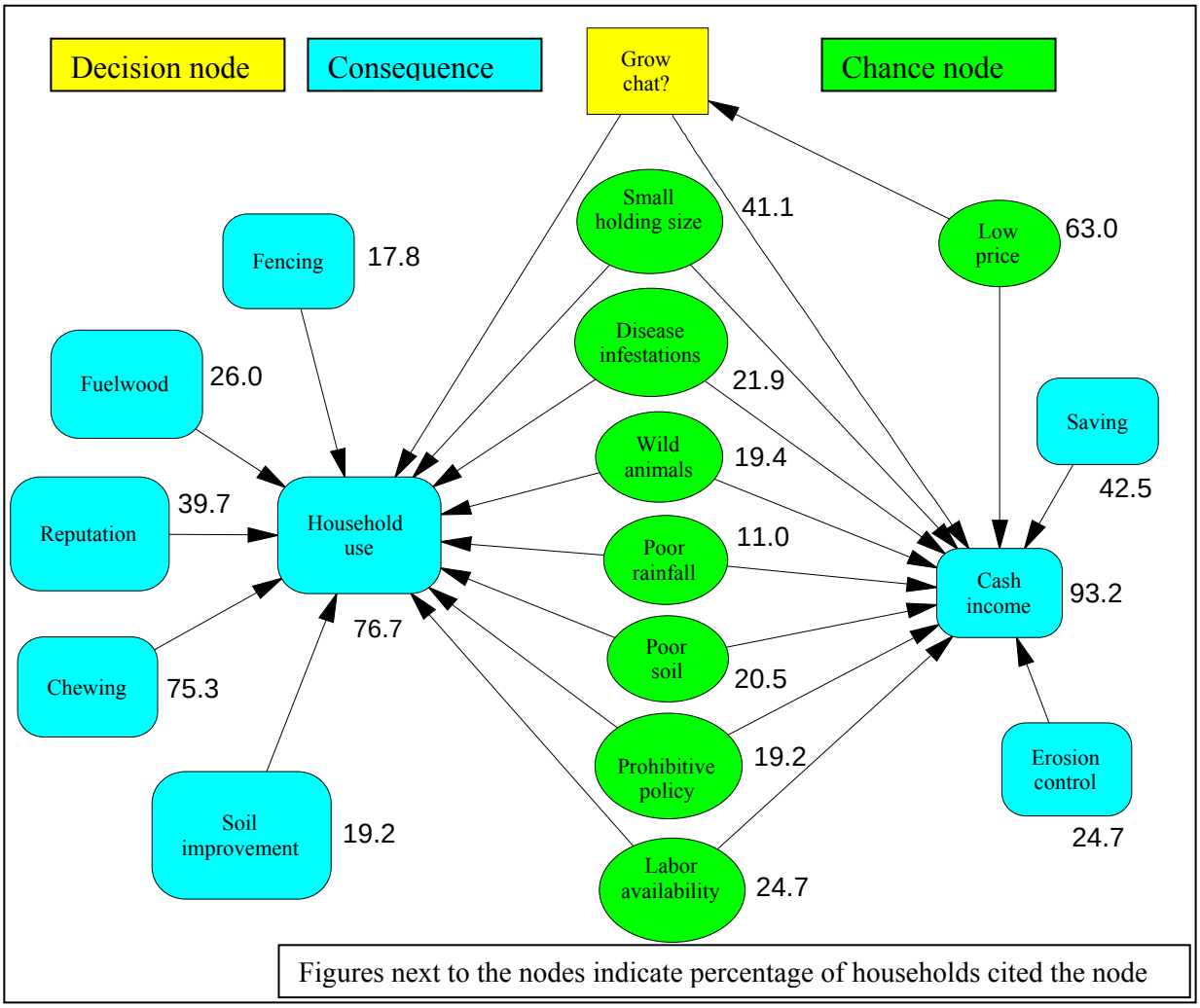


Figure 6.8 A graphical representation of a decision to plant t'chat

Moreover, some Muslim households are refrained from t'chat growing on accounts of religious denominations. Although some non-chewer households still grow t'chat solely for the market and for visiting guests (see Figure 6.8), other non-chewers prefer to totally abandon growing the plant. On the other hand, many of the followers of the same religious denomination (Muslims) plant the crop both for household use and the market.

Whereas only 7 % of the respondents revealed the competitive nature of coffee plants, 19 % of t'chat growers implicated its competitiveness with other crops. Unlike coffee, only 22 % of t'chat growers indicated disease incidences as an important decision criterion.

6.2 Summary

Households in the study area generally, follow a subsistence livelihood strategy by growing divers crop species. Among these, trees and/or shrubs are mainly planted to meet household demands for various products. The three tree/shrub species selected and discussed in the preceding sections are economically the most important ones.

The wood-extensive nature of the traditional tukuls (about 50 m^3 of eucalypt wood each representing trees of 3 to 40 years of age) (Negussie *et al.* 2003) makes planting of eucalypts quite imperative. Moreover, scarcity of natural forest vegetation in the highland and midland villages and high opportunity cost of cow dung compel the households to resort to the use of planted species for fuelwood. Eucalypt wood is also employed for a diverse construction works. Consequently, it is unwise to expect a satisfactory livelihood of the households in these two agro-ecological zones without eucalypt woodlots.

Eucalypt poles also fetch the highly demanded cash revenue, particularly in villages with better road networks. Households of some midland villages with conducive prerequisites are currently expanding eucalypt woodlots in expectation of alternative sources of cash income. Only local small marketing opportunities are available for households in the remote lowland and highland villages.

On the other hand, coffee and t'chat are mainly planted both for household consumption and cash generation. Although only surplus product is expected to be used for augmenting cash income, occasionally all available products can be sold in response to contingencies. Farmers also sell the best quality product for better cash generation.

Where ecological conditions permit, farmers grow various sizes of the three crops to meet at least part of the household demand. Additional cultivation of the three crops is largely dictated by the resource endowment factors of the households and the ecological conditions of the area. *Inter alia*, the landholding size, labor force, and location of the household are the most predominant factors that influence the decision on the size of the three crops grown. Furthermore, expansion of the three crops beyond the need of the household is contingent to the availability of attractive marketing opportunities.

In addition to the physical size of landholding, the quality of the soil and pest and disease incidences seriously influence the decision to grow and the yield of coffee and t'chat crops. The availability of cow dung is critical in areas where soil qualities are inherently poor. Whereas coffee is seriously rampaged by CBD, the quality of t'chat product is affected by climatic conditions and soil characteristics. Anticipation of good coffee product without stringent protective measures against berry disease is not possible.

To this end, euclypt species are the most resilient species that can be grown on marginal areas even where some of the native species cannot thrive. It is not subjected to any serious biological threats. Coffee and t'chat, on the other hand, often demand continuous and extensive manuering and tending operations. Extensive tending operations of eucalypt woodlots are, in contrast, confined to the first year.

6.3 Size of on-farm eucalypt woodlots

6.3.1 Decision criteria of woodlot expansion

In this section, it was attempted to identify major factors that were responsible for furthering of eucalypt woodlots during the 1998/99 and 1999/00 planting seasons. This section answers the question why some farmers did plant eucalypts and others did not during this period. The hypothesized model also helps determining the type of farmers that have more propensity to plant more eucalypt trees in any particular year. This model, however, does not necessarily hint that a farmer with positive explanatory variables will keep on expanding eucalypt woodlots indefinitely.

It is presumed that most socio-economic characteristics such as wealth status, land holding size, family labor force, as well as sex and age of household head play a key role in altering farmers' decision to plant additional seedlings. Similarly, easy access to road networks is expected to be an important decision factor in expanding eucalypt woodlots. Moreover, the total number of eucalypt trees already planted by a household is considered as an influential factor and included in the list of explanatory variables. Details of adopted explanatory variables are presented in Table 6.8.

Table 6.8 Definition of explanatory variables in eucalypt woodlots expansion model

Variable	Description
EXP	1 if a household established eucalypt woodlot during the previous two consecutive years; and 0 otherwise
TOT	total number of eucalypt trees owned by a household
LAN	landholding size in ha
LAB	sum of household man equivalent
SEX	1 if household head is male; 0 otherwise
WEA	sum of household wealth points
ATT	sum of household attitude points
ECO	1 if the household is in the highland; 2 in the mid altitude; 3 in the lowland
AGE	age of household head in years

Household attitudes towards eucalypt planting and wealth status levels were derived from indexes that were developed from structured questionnaires (Appendix 10). Data on labor force (ME) was derived from respective indicators as demonstrated in Appendix 6. All the three data were used in this analysis without further collapsing into categories. It was decided not to collapse the data into categories because of the ambiguity in drawing distinct cut-off points. Although it was appealing to categorize the household wealth status into three logical categories (better off, medium, and poor) absence of any distribution pattern overruled the desire.

In addressing this question, it is taken for granted that analysis of households that planted eucalypts could generate useful information on the key factors that are responsible for farmers' decision. Overall, 49 % of the total households planted eucalypt seedlings during the reference years. Whereas 77 % and 42 % of the households in the high and middle altitudes respectively planted eucalypts, none of those in the lowland did so. Hence, Chi-square test exhibited significant (χ^2 =

34.143; P≤0.000) results. The proportion of female- and male-headed households that involved in establishing additional eucalypt woodlots accounts for 37 % and 52 % respectively.

The effects of household perception formation on the adoption rate of technologies have been well documented in the field of agriculture (Adesina and Baidu-Forson 1995; Yirga *et al*. 1996; Negassa *et al*. 1997; Negatu and Parikh 1999). It has been well grounded that such psychological feelings express household values, beliefs, and aspirations. Psychological perception of households towards cash values of eucalypt planting is thus believed to pose a strong influence on the size of woodlots.

Explanatory variables were selected after thoroughly assessing their impacts on household decision processes. Education levels of household heads had been omitted from the model since more than 85 % of the household heads are either illiterate or have only attended village literacy campaigns. It also failed to show acceptable association with the propensity of expanding eucalypt woodlots.

Table 6.9 Correlation matrix of explanatory variables, Pearson's correlation coefficients, and Pearson's χ^2 significance level *(italics)*

Variables	Wealth	Age	Attitude	ME	Numb	Land	Zone	Sex
Wealth	1.000							
Age	0.206	1.000						
Attitude	0.174	0.115	1.000					
Man equivalent	0.430	-0.021	-0.024	1.000				
Number of eucalypt trees	0.405	0.081	0.440	0.027	1.000			
Landholding size	0.343	0.173	0.159	0.104	0.349	1.000		
Agro-ecological zone	*0.626*	*0.742*	*0.329*	*0.502*	*0.106*	*0.077*	*1.000*	
Sex	*0.888*	*0.866*	*0.709*	*0.015*	*0.274*	*0.521*	0.034*	*1.000*

* = Cramer's V.
Source: Field survey (2001).

Strength of statistical relationships between the explanatory (exogenous) variables was determined and presented in Table 6.9 to check whether they exhibited *multicollinearity* (see Bryman and Cramer 1999). The result of the correlation analysis evinced that *multicollinearity* does not stand to threaten the stability of the variables used in the model.

A statistically sound approach (Bryman and Cramer 1999:188) has been adopted in ascertaining the bivariate relationship between these diverse variables. As suggested, method of *crosstabulation* and *Chi-square* as well as *Pearson's Correlation* have been applied in order to examine statistical relationships between sets of ordinal and interval variables, on one hand, and set of dichotomous and interval variables, on the other hand, and sets of interval variables respectively. Accordingly, Table 6.9 displays the result of crosstabulation and chi-square tests for sex and AEZ as well as other variables, *Pearson's correlation* tests for interval/ratio variables, and Cramer's V for strength of association between sex of household head and AEZs.

Mean values of explanatory variables are presented in Table 6.10. The response variable was scaled down to discriminate households that planted eucalypts during the 1998/99 and 1999/00 seasons and those that did not plant at all. Mean values of sex of household head and AEZ should not be taken for granted as indicators of actual variations.

Table 6.10 Values of descriptive statistics for explanatory variables adopted in the on-farm eucalypt planting models

Variable	Sample (n = 150)		Planters (n = 74)		Non planters (n = 76)	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Agro-ecological zone	1.77	0.64	1.46	0.50	***2.07	0.62
Wealth	17.39	12.80	19.80	14.07	*15.05	11.04
Age	46.89	12.88	44.99	12.88	48.75	12.69
Attitude	0.96	1.05	1.07	1.22	0.86	0.85
Man equivalent	2.72	1.26	2.95	1.20	**2.49	1.29
Number of trees	765.07	1568.14	1003.24	1808.33	*533.16	1261.75
Landholding size	0.94	0.75	0.89	0.67	0.98	0.82
Sex	0.82	0.39	0.87	0.34	0.78	0.42

*, **, and *** indicate significance at 0.05, 0.01, and 0.000 levels respectively.
Source: Field survey (2001).

The results of the above statistics indicate that the actual values of wealth, attitude, man equivalent, and number of eucalypt trees are higher for the planter than for the non-planter households. Younger household heads with shorter duration in agricultural operations displayed slightly more tendency towards furthering on-farm eucalypt planting. The expected positive influence of landholding size on the expansion of eucalypt woodlots has been refuted by the empirical data. Statistically significant differences were observed only for data on AEZ, wealth status, family labor status (ME), and number of eucalypt trees. Similarly, the more educated the household head the slightly enhanced propensity towards establishing additional on-farm eucalypt woodlots (not included in the analysis).

Statistical analysis was done on the same parameters for households that sold eucalypts during the last six years and on those who both sold eucalypt poles and established additional woodlots. In both cases though, attitude towards eucalypts and perceptions on prohibitive government policies resulted in significant differences. Low number of households within these two categories (22 and 14 respectively), however, delimits the credibility of these results and enlists the topic as future researchable area. It was thus decided to focus this analysis on the households that planted and did not plant eucalypts in the last two consecutive years. Results of the logistic regression analysis (this particular part is analyzed both by SAS and SPSS statistical software) are presented in Table 6.11.

Table 6.11 Results of logistic regression analysis for assessing household binary choice models in expanding eucalypt woodlots

Explanatory variables	Logistic coefficients	Standard error	Wald statistics	Odds ratio estimates		
				Point estimates	95 % Wald confidence limits	
AEZ	-2.4300	0.4406	30.4134	0.088	0.037	0.209***
Sex	1.7749	0.5699	9.7000	5.900	1.931	18.028***
No. of trees	0.000417	0.000163	6.5374	1.000	1.000	1.001**
Age	-0.0316	0.0162	3.8038	0.969	0.939	1.000*
Constant	3.9594***	1.0190	15.0979			
Model Chi-square	59.3500***					
Overall correct prediction	84.1 %					
Wealth	0.0232	0.0231	1.0053	1.023	0.978	1.071
Attitude	0.2249	0.2226	1.0207	1.252	0.809	1.937
Family labor status (ME)	0.1036	0.1950	0.2822	1.109	0.757	1.625
Landholding size	-0.3028	0.3439	0.7753	0.7387	0.377	1.449
Constant	3.3732***	1.1303	8.9071			
Model Chi-square	62.5756***					
Overall correct prediction	84.9 %					

*, **, and *** imply statistical significance at 0.05, 0.01, and 0.001 levels.
Source: Field survey (2001).

The first part of Table 6.11 shows independent variables that were selected through forward stepwise selection and backward stepwise elimination methods for their superior predictive powers. The second part of the table presents a situation in which all the eight explanatory variables are included in the model. The entire explanatory variables resulted in a frequency of correct prediction of 84.9 %. The four bottom variables contributed only 0.8 % to the frequency of correct prediction, and thus make their inclusion in the model very unsatisfactory.

Multiple coefficient of determination (Nagelkerke R^2) value (0.455), the likelihood ratio test statistic (Chi-square value = 62.576), and the frequency of correct prediction (i.e. eucalypt woodlot expanding and non-expanding households) (84.1 %) exhibit an acceptable explanatory power of the model. The percentage of individuals correctly classified by logistic regression and the ROC curves (with all eight and four significant explanatory variables respectively) presented in Appendix 11 also confirms an acceptable prediction capacity of the model. According to the discussions presented by Afifi and Clark (1996) the cutoff point of about 0.46 correctly classified approximately 80 % and 78 % of the planters and non-planters respectively.

Expansion of on-farm eucalypt woodlots by households has been estimated with the model presented in equation [5]. Equation [1] ascertains the probability of a household with certain values of explanatory variables to plant additional eucalypt seedlings in any particular two consecutive years. The explanatory powers of the independent variables are expressed by the logistic coefficients and corresponding odd ratio estimates presented in Table 6.11. The logistic coefficients are interpreted as the change in the log odds associated with a one-unit change in the independent variable (Norusis 1993). They are, however, not linearly related to the probability of a household

occurring in one of the eucalypt woodlots expanding categories, it is thus difficult to interpret in an intuitive manner (see Afifi and Clark 1996).

The odds ratio estimates provide a directly understandable statistic for the relationship between the response variable and an explanatory variable when all other explanatory variables are kept constant. They are interpreted as the odds of the first category of an explanatory variable belonging to the first category of the response variable. From Table 6.11, the odds of a male household head being engaged in eucalypt planting are 5.9 times that of a female household head. Similarly, the odds of establishing eucalypt woodlots in two consecutive years are expected to be 0.729 (i.e., exp(10b)) of what it would be if a household head were 10 years younger.

Only the coefficients on AEZs, sex, number of eucalypt trees, and age resulted in statistically significant differences. As expected, the physical location of the farm households that has exceptional implication on access to marketing road networks of eucalypt products and the presence of male head within active working age significantly influenced the decision to expand eucalypt woodlots. The impacts of most explanatory variables maintained consistency with the logical expectations, as can be witnessed from the signs of their respective coefficients. AEZ, and age are found to inversely affect the decision to establish additional eucalypt woodlots. Absolute holding size with a logistic coefficient of -0.303, indicates the reverse of the logical expectations. The odds of establishing eucalypt woodlot are decreases by a factor of 0.74 for a household that possesses 1 ha of more land. This finding also confirms the less propensity of lowland households (often with larger landholding sizes) to establish additional eucalypt woodlots. In this regard, it is vital to draw a clear distinction between the actual uncultivated land size differences in the cereal crop-dominated highland zones and perennial crop-dominated mid- to lowland zones.

From the results, changes in sex, attitude of household head, and size of family labor trigger by far the biggest change in the likelihood of establishing additional eucalypt woodlots. This is mainly attributed to the fewer categories of each of these variables. Coefficient on age of household head has the greatest inverse relation to the response variable.

6.3.2 Number of eucalypt trees

This section presents findings and arguments pertaining to the number of eucalypt trees planted by households, the only on-farm tree species that is grown in all AEZs. Prohibitive effect of government policy is included in the explanatory variables to confirm farmers' claims that it has relatively a long history (about five years). If it had any meaningful influence on farmers' decisions to plant eucalypt seedlings, it had to be reflected in the total number of trees that farmers planted.

The significance of farmers' perceived values of the envisaged products in household choice strategies to adopt a particular practice has been emphasized in several works (e.g., Adesina and Baidu-Forson 1995; Alavalapati *et al*. 1995; Yirga *et al*. 1996; Negatu and Parikh 1999). Smallholders' perceived values are concerned with both the economic use of and low risks associated with the crop. Farmers thus opt to grow a particular crop only when they fully perceive the economic, ecological, and/or social values of the crop. It is thus found relevant to include

attitude of farmers towards eucalypts management in the explanatory variables. The rest of the independent variables show the socio-economic conditions of the households.

Relationships between the number of eucalypt trees per household and explanatory variables that are nominal, ordinal, or dichotomous have been ascertained with the analysis of variance employing means. In the 'means procedure' eta-squared provides a measure of strength of relationship. Variables reported in this analysis of variance include sex of household head, perception on prohibitive government policy, and AEZs. Accordingly, the number of eucalypt trees per household is not significantly (at $P \leq 0.05$ level) related to all the three variables (Table 6.12).

Table 6.12 Relationship between total number of eucalypt trees per household and nominal, ordinal, or dichotomous variables

Variables	Category	Mean	Standard deviation	F-value	P	Eta-squared
Sex of household head	Male (n=123)	810.12	1669.52	0.562	0.454	0.004
	Female (n=27)	559.82	979.89			
Prohibitive government policy perception	Yes (n=17)	1417.65	2371.31	3.373	0.068	0.022
	No (n=133)	681.65	1425.60			
AEZ	Highland (n=52)	501.64	646.81	1.165	0.315	0.016
	Midland (n=81)	884.51	1767.48			
	Lowland (n=17)	1001.77	2364.19			

Source: Field survey (2001).

As demonstrated in Table 6.12, the number of eucalypt trees per household failed to exhibit statistically significant differences among the various AEZs. This is, in fact, attributed not to the absence of differences between AEZs but to the extreme variability within individual AEZs. By and large, there is a clear association between the total number of eucalypt trees per household and the three AEZs. On the other hand, perception to prohibitive government policy failed to show any association with the total number of planted eucalypt trees. The empirical data rather confirms the reverse of logical expectations in that farmers that perceived prohibitive government policy planted by far the largest number of eucalypt trees. The analysis resulted in a statistically significant (at $P \leq 0.10$ level) association (Table 6.12). This is probably due to the fact that most prohibitive campaigns were directed towards households that planted relatively more number of eucalypt trees. As discussed earlier, sex of household head has no significant influence on the total number of planted eucalypt trees.

The effect of interval/ratio explanatory variables on the total number of eucalypt trees is assessed with the OLS regression analysis and presented in Table 6.13. Although one may expect more factors to influence the number of on-farm eucalypt trees, only three have assumed statistical significance. As expected, the contribution of household wealth status, attitude, and landholding size to the coefficient of determination (R^2) is highly significant (Table 6.13). All the three variables demonstrated a statistically significant positive influence on the number of on-farm eucalypt trees per household.

Table 6.13 Factors constraining the number of eucalypt trees within the farm compound: results of ordinary least-square regression analysis

Variable	Coefficient[a]	Standard error	t-value	Coefficients[ab]
Attitude towards eucalypts	526.828***	102.987	5.115	539.679***
Wealth status	42.615***	9.914	4.298	33.572***
Landholding size (ha)	418.242***	150.665	2.776	413.569***
Age	-8.374	8.446	-0.991	
Household labor force (ME)	-170.069	93.284	-1.823	
Constant	-20.333	469.281	-0.043	-725.849***
R^2	0.356			
F-value	15.932***			

[a] *** P≤0.007.

[b] Analysis was performed by stepwise procedure in which only independent variables that meet the package's statistical criteria were entered.

Source: Field survey (2001).

Wealth ranking criteria are quite related to the economic and psychological strengths of the households. Better-off households find it much easier to allocate the necessary resources for establishing large size woodlots either in anticipation of long-term profits or for a relaxed household use and social reputations. Poorer households, on the other hand, often concentrate on subsistence food production and lack the confidence to engage in long-term farm investments. They also lack enough labor force to set aside for tree planting activities.

Among the three variables that are significantly associated with the total number of planted trees, attitude of the household head towards the use values of eucalypts woodlots has the greatest elasticity followed by landholding size. An increase in the total point of attitude by 1 (*ceteris paribus*), for instance, increases the number of eucalypt trees by 540. This indicates that a household with above average perception on the use values of large eucalypt woodlots gradually expands the plantations within certain limits. Majority of eucalypt woodlot expansion works have been underway for several years rather than being limited to a few years. This finding is an underpinning evidence that farmer's personal conviction and attitude towards establishment and management of additional woodlots are of paramount importance in planting more eucalypt trees.

Availability of marginal land that is neither suited to crop production nor grazing and/or uncultivated plots is found to be the second important choice criterion in terms of planting more number of eucalypt trees. As depicted in Table 6.13, landholding size critically constrains the number of trees farmers grow, since the plots have to be partitioned among basic food crop production and grazing as well. It is thus obvious that majority of the farmers who own above 1000 eucalypt trees possess at least 0.4 ha of land. In fact, landholding size is the most important decision criteria in the future, since attitude and wealth status can be easily modified through strong awareness creation campaigns and capital accumulation respectively. There is no opportunity for some of the middle altitude and all of the highland farmers to increase their landholding sizes under the prevailing socio-economic and demographic conditions.

All other factors including AEZ and labor force (ME) fail to exhibit a statistically significant influence on the number of on-farm eucalypt trees. Households with better resource endowments and adequate financial income from remittance or off-farm activities can afford to hire labor. In the present study, however, regression analysis failed to reveal significant correlation between off-farm incomes and the number of eucalypt trees per household. Off-farm income and remittance money are mostly received at irregular intervals and thus are used to meet urgent food needs, for special investments like holiday celebrations, or to repay debts. Only relatively long-term and regular off-farm incomes can be used for hiring labor to set in woodlot establishment. The sum of entire off-farm income (in Birr) contributed only 1.9 % to the R^2.

The claim that households which entirely rely on agriculture as a main source of income often find it difficult to allocate family labor for tree planting (see Salam *et al*. 2000) was not sanctioned by the present empirical findings. Farmers in the highlands, although generate most of the household cash requirements from food crop production, still grow considerable number of eucalypt trees mainly for household uses. This also applies to remote lowland households that still have good access to natural forests to collect various forest products. They grow eucalypt trees mainly for house construction. In general, in areas where the households have no access to external forest product sources, tree and/or shrub planting is equally indispensable as food crop production.

Tree planting for commercial purposes, nevertheless, requires careful assessment of marketing possibilities and the cash values of the envisaged products. Agricultural economists generally, reached consensus that farmers embark on commercial tree planting only if the expected benefits outweigh the benefits they accrue by allocating the land, labor, and capital to the next best use (cf., FAO 1985; Salam *et al*. 2000). Since the recent past, slightly attractive financial and management competitiveness of eucalypt poles prompted a gradual expansion of woodlots in the absence of external motivations and with no provision of support services. Similar experience has been documented from northern Ethiopian highlands (Jagger and Pender 2000). Long tradition of eucalypt growing in the area helped farmers raise sufficient planting stocks to meet local demands.

Likewise, strong support services like provision of credit facilities, technical forestry advice, and planting materials as well as strengthening of marketing infrastructure substantially motivate farmers to plant more trees on their farms. Provision of such basic necessities also encourage farmers to integrate diverse multipurpose tree and/or shrub species in their farming systems and enable them to exploit the potential of agroforestry in producing basic goods and generating cash revenues.

CHAPTER 7

HOUSEHOLD FINANANCIAL DECISION-MAKING AND ALTERNATIVES

7.1 General overview

This chapter assesses the contribution of each cash-generating activities to the target of sustainable livelihoods. It also examines external sources of cash income and their relative importance and contribution to the overall sustenance of livelihoods. Household labor allocation patterns in various cash generating works and major means of cash generation in various agro-ecological regions will be illuminated. Distribution of cash incomes from sales of eucalypt poles among the various stakeholders is ascertained to reveal inadequacy of farm gate prices as compared to consumer prices. Financial viability of eucalypt pole production is assessed in comparison with the production of selected food crop, teff. It also highlights major constraining factors and potentials of cash-generating activities in order to identify possible interventions for improvement.

Data pertaining to household consumption needs was obtained from women through detailed case studies, whereas data on crop production activities were obtained from male heads. Women provided relatively more persistence figures than men. Only major sources of revenues ascertained through formal questionnaire survey and costs obtained through detailed study are presented along with personal assumptions.

In this analysis, farm household is considered as the unit of production and consumption. Occasional high costs and consumption rates because of holidays, ceremonies, visiting guests, etc. were only partly accounted. Among these, expenses at the *Meskel* holiday represent the single major expenditure for the Christian households. Muslim households celebrate more holidays each of which costs a substantial amount of money.

7.2 Sources of household incomes and expenditures

Small farmers perceive costs and benefits quite differently from conventional economists as well as agricultural and forestry specialists (Arnold 1984). Smallholders, unlike business-oriented big farmers, strive to minimize household risks rather than to maximize financial profits. For smallholders, any embarkation on cash crop production is often part of subsistence livelihood strategy and risk minimization. Evidence from Tigray region confirmed that even under conditions where eucalypt poles fetch about 884 % of the total discounted net revenue of barley over 12 years period, farmers still maintain a fair proportion of various land use types (Teklay 1997).

Among the study households, there is a tendency of collective control and decision-making on various sources of cash incomes. Men often control incomes from resources that generate large sum of cash while women possess control over many of the petty cash sources. Whereas incomes from sales of most livestock are controlled by men, women control incomes from animal byproducts and minor grain sales. Incomes from sales of handcrafts are mostly controlled by the main actor. Children possess partial control over incomes of resources that belong or were granted to them.

On the other hand, pooling of available financial resources or pledging some amount of resources to emergency needs is not uncommon. When a household faces a challenging shock, any available resource, regardless of who owns it, should be sacrificed to save the families from the impact. In doing so, resources that are directly controlled by the victim are mostly liquidated first. Major sources and components of farm incomes that are available to a household are outlined in Figure 7.1.

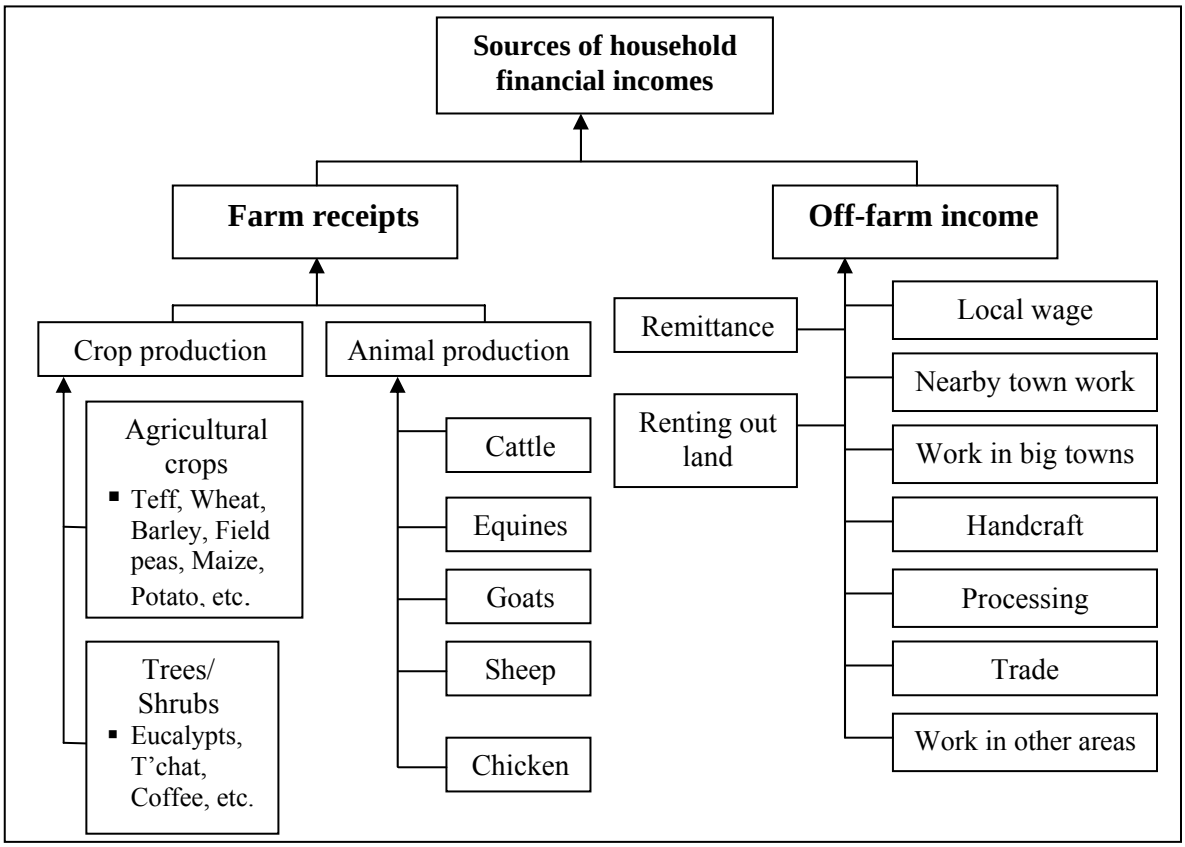


Figure 7.1 Income sources of a farm household
Source: Adapted from Dillon and Hardaker (1993) and Lamphoune (2001).

Households generate cash income from various sources among which sales of livestock and byproducts, grain, tree products, processed utensils, and off-farm wage works represent the major ones. Remittance money and credits also contribute to the financial stock of about one-fourths of the households. On the expenditure side, household consumption, clothing and house construction, ceremonies and holidays, farm inputs and land tax, and contributions for social welfare represent dominant sources. Medical and educational expenses are also among the indispensable expense lines.

7.2.1 Household cash sources

7.2.1.1 Income from crop production

Information on household agricultural product marketing is often dissipated and inconsistent since prices show much variation with seasons and locations. Household sales of agricultural products are not registered and done in a series of cycles rather than as one-time-wholesale process. Assessment of the values of products sold over several seasons obviously results in erroneous outcomes unless

carefully followed up on a daily basis. Farmers often face difficult challenges in describing numerical figures particularly when it refers to a distant past. A uniform marketing pattern of agricultural products cannot be expected as farmers often resort to commercialization in response to contingencies and compelling incidences.

In the study area, selling prices of a particular crop show substantial variation from household to household, owing mainly to differences in product quality and season of selling. In such cases, mean prices for each ecological zone is adopted. Since the number of households that sold each crop is too small, no statistical comparison is attempted. It should also be noted that products that are sold in small quantities mainly by women for purchase of commodities are difficult to remember. Only purchased inputs are included in the cost calculations. Household labor and animal manure as well as by-products from croplands such as grasses, leaves, hay, and stalks are not considered as costs.

Table 7.1 displays major crops that were sold and accrued revenues during the 1999/00-cropping season in respective agro-ecological zones. Other crops of lower financial significance include pepper in the low and middle altitudes; sugar cane and taro in the middle altitude; as well as garlic, horse bean, and sesame in the high altitude. In general, 65 %, 20 %, and 18 % of the total households in the high, mid, and low altitudes respectively have sold at least one crop during 1999/00 cropping season. The least (2.50 USD) and the highest (187 USD) revenues from sales of agricultural crops were generated in the middle and high altitudes respectively. Relationships between total revenues from sales of agricultural crops and AEZs, nonetheless, failed to demonstrate statistical significance.

Table 7.1 Income generated from crop sales during the 1999/00-cropping season in various agro-ecological zones

Agro-ecolo. Zone	Mean revenues generated (Birr)							
	Enset	Barley	Wheat	Teff	Peas	Banana	Potato	Maize
Highland	66.00 (9.6)	133.54 (23.1)	289.57 (57.7)	0.00 (0)	194.17 (11.5)	0.00 (0)	0.00 (0)	0.00 (0)
Mid-altitude	0.00 (0)	0.00 (0)	235.00 (3.7)	269.67 (14.8)	0.00 (0)	17.50 (2.5)	110.00 (2.5)	70.00 (2.5)
Lowland	150.00 (5.9)	0.00 (0)	0.00 (0)	330.00 (5.9)	0.00 (0)	40.00 (5.9)	0.00 (0)	0.00 (0)

Figures in parenthesis indicate percentage of households in each AEZ.
Source: Field survey (2001).

The number of marketed crops per household showed a highly significant ($\chi^2 = 33.066$; $P \leq 0.000$) relationship with the AEZs and wealth status of the households ($r = 0.247$; $P \leq 0.01$). This finding implies that despite the greater potential of growing more marketable crops in the middle altitude, households often use only a limited number of crops to supplement cash revenues. Inherent poor soil characteristics assume major responsibility. In the highlands, not only about two-thirds of the households generate revenue from sales of agricultural crops but also the distribution of gross revenue is highly positively skewed. Total number of crops sold per household is indicated in Figure 7.2.

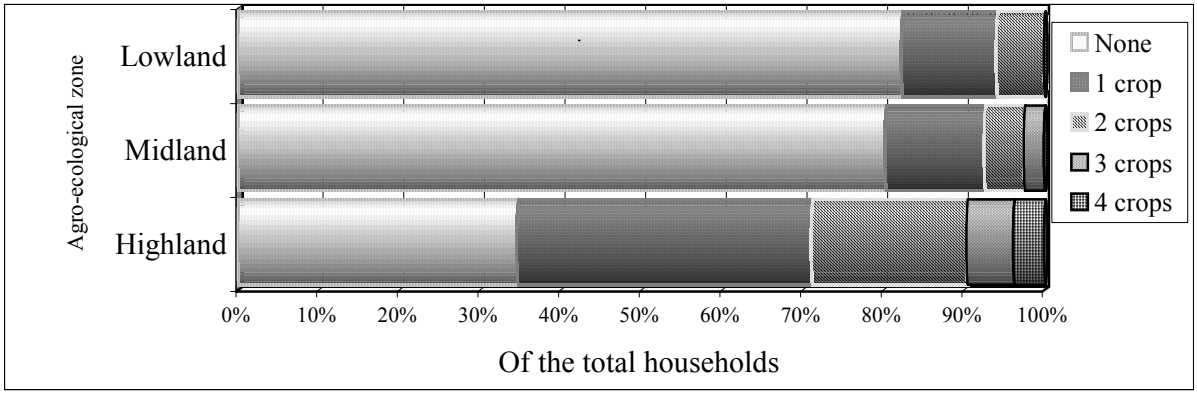


Figure 7.2 Number of agricultural crops marketed per household during the 1999/00- cropping season in various ecological zones

Figures on total revenue from crop sales and number of marketed crops, however, do not necessarily reflect food self-sufficiency levels of the households, since farmers are at times forced to sell food crops to repay government debts and unforeseen contingencies, regardless of family food security situation. It is nevertheless, noted that the lowest and highest extreme income ranges were generated respectively by households that did not and did guarantee food self-sufficiency. In other cases, farmers of above average wealth status resort to sell other resources to repay input debts and thus retain crop produce for household consumption. Cases whereby crops grown with agricultural extension packages are heavily or completely destroyed and forced farmers to repay the debt from other source are not rare.

7.2.1.2 Income from animal husbandry

Income generated from sales of animals represents an important source of risk mitigation in cases of major hazards. The size and importance of incidences determine the type of animal that should be resorted to. Small to medium animals such as chicken, sheep, and goats are often sold to meet small cash requirements. Planned and/or unplanned dominant incidences such as serious sickness and/or death of a family member, marriage of children, religious holidays, unanticipated debt burden, big legal incriminations, etc. necessitate sales of bigger animals. Percentage of households that sold various numbers of animals (cattle and equines) in the three AEZs is presented in Figure 7.3.

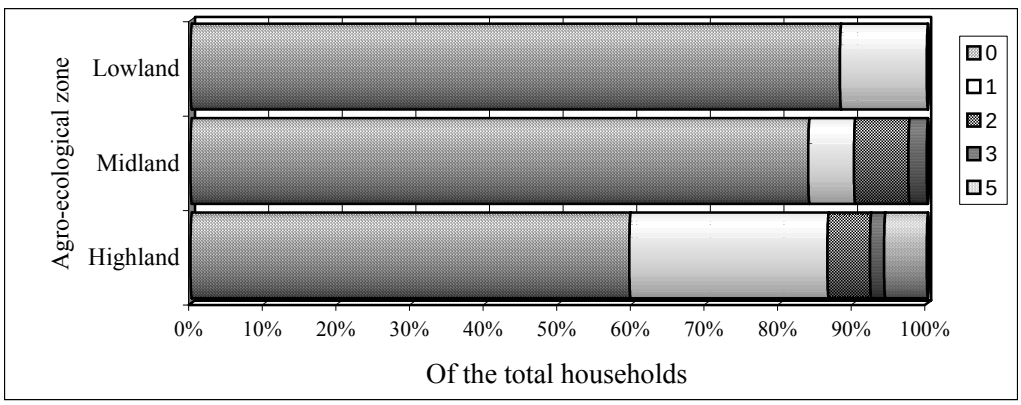


Figure 7.3 Percentage of households that sold various numbers of animals during 1998/99 and 1999/00 fiscal years

Household livestock resource endowment figures still prove the slightly better endowment status of highland households. From the above figure, some 40 % of the total highland farmers sold various animals during the two consecutive years, out of which about 33 % sold at least two animals. On the contrary, only 16 % and 12 % of the mid- and lowland households respectively sold various animals during the same period. Chi-square tests however, failed to reveal any significant association between the cash values of the total and own animals per household and the three AEZs. These tests also failed to reveal significant association between sex of household heads and the cash values of livestock resources (see section 4.3).

Statistical relationships between the number of households that sold various numbers of animals and AEZs were highly (χ^2 = 20.030; P≤0.010) significant. This finding further reinforces the meager contribution of animals to the overall household financial incomes in the low and middle altitudes. For reasons beyond justification, financial incomes from sales of animals declined to display significant associations with AEZs. Percentage of households in various AEZs that sold animals and range of accrued revenues are presented in Table 7.2. Both the number of animals sold and the size of revenue accrued from animal sales were not significantly related to the sex of household head.

Table 7.2 Mean revenues generated from sales of animals during 1998/99 and 99/00

Agro-ecological zone	Mean revenue (Birr)	Range (Birr)
Highland	769.43 (40.4)	60.00 – 2590.00
Midland	589.23 (16.0)	150.00 – 1450.00
Lowland	180.00 (11.8)	60.00 – 300.00

Figures in parenthesis indicate percentage of households that sold animals.

These empirical findings prove that both crop and animal productions do not represent important sources of cash revenue for the middle and lowland households. This clearly displays the substantial disparity between the natural endowment factors such as biophysical factors, landholding size, and family labor force, as well as production levels of both crop and animal sectors of the three AEZs. It also provides an important clue on the significance of the constraining factors on the sectors rather than less ingenuity of the farmers in the two lower AEZs.

7.2.1.3 Revenues from on-farm tree and shrub products

In the study area, farmers commonly plant various tree and shrub species both for household use and generating cash revenues. Farmers in the middle and low altitudes are the main beneficiaries of tree/shrub growing for the market. Although households in all AEZs are not significantly different in terms of the total number of eucalypts trees grown, accrued cash from sales of eucalypts in the middle altitude is about 2 times as much as that in the other two zones together. More tuned comparison reveals that households in Gardashie represent about 39 % of the total eucalypt sellers and drew about 33 % of the gross revenue in 1999/00. Table 7.3 depicts percentage of households in each AEZ that sold eucalypts, coffee, and t'chat during 1999/00 and the mean revenue generated.

By and large, most PAs in the middle altitude have potential to augment household cash incomes from sales of tree and/or shrub products. Accordingly, some 11 % and 17 % of the households

generated revenues from sales of eucalypts and t'chat respectively. Corresponding mean revenues amount to 12.50 USD and 19 USD respectively. Some 41 % of the household from the lowland reported selling coffee during the 1999/00-cropping season (Table 7.3). Although many (92.6 %) households in the middle altitude grow coffee, only 6 % of them generated cash from coffee sales during the same year, due mainly to the devastative berry disease. Guareba with 42 % of the households generating a mean of 8.50 USD from sales of t'chat represents the most beneficiary PA. Unlike that of coffee, financial incomes from t'chat and eucalypts are shared by households from six of the ten PAs each. Revenues from eucalypts are also more evenly distributed among these PAs with a coefficient of variation of 44.3 %. Corresponding coefficient of variation for cash income from t'chat is 159 %. Diamir with 29 % of the households generating mean revenue of 46.76 USD, Lanka Tore with 18 % of the households generating mean revenue of 10.59 USD, and Barewa with 14 % of the households generating mean revenue of 2.65 USD, are major t'chat marketers. None of the households in Doba, Gardashie, Merabicho, and Genet admitted commercializing t'chat. Financial incomes generated by households between 1995/96 and 1999/00 from sales of the three crops are reported in Negussie *et al*. (2003).

Table 7.3 Revenues generated from sales of eucalypts, coffee, and t'chat during 1999/00-cropping season

Ecological zone	Mean accrued revenue (Birr)		
	Eucalyptus spp.	Coffee	T'chat
Highland (n = 52)	145.00 (7.7)	0.00 (0.0)	75.00 (3.9)
Midland (n = 81)	106.44 (11.1)	83.00 (6.2)	90.17 (22.2)
Lowland (n = 17)	0.00 (0.0)	182.14 (41.2)	126.67 (17.6)
Total (n =150)	118.31 (8.7)	140.83 (8.00)	93.61 (15.3)

Figures in parenthesis represent percentage of households in each category.

Documented experiences prove that big farmers can be easily persuaded to convert their entire productive lands to profitable monocultural ventures. Smallholders, on the contrary, are rarely motivated to adopt on-farm tree growing unless some intermediate tangible products can be accrued (Arnold 1984). Reviews by Salam *et al*. (2000) indicate that small farmers are often reluctant to commit their scarce resources to tree planting when envisaged benefits are remote, perceived values are low, and access to markets is insecure. Results of fieldwork in northwestern India, nevertheless, failed to accommodate these assertions (see Saxena 1994).

A number of important exceptions to this assertion have been documented by various scholarly writers. Notable examples could be the Gujarat Forest Department project and the PICOP project in the Philippines (Arnold 1984; FAO 1985). As eucalypt plantations in Gujarat turned out to be extremely lucrative, many farm households replaced agricultural cash crops with eucalypt woodlots. On-farm growing of *Albizzia falcataria* in Mindanao, Philippines turned, on account of higher profitability, some 80 % of the participating smallholders into tree farmers (FAO 1985).

7.2.1.4 Revenues from off-farm activities

Household members of the study area generate off-farm revenues from various sources. Some household heads travel to other regional states in search of work, whereas others stay in the capital city for up to half a year during off-seasons. A considerable number of male members in certain PAs travel to the capital city and other major towns during major holidays, with the exception of *Meskel*. Nevertheless, the most popular means of generating cash revenues, as depicted in Table 7.4, are local trade and daily wage work. Local trade refers to buying and retailing of animals, crops, and their by-products. Daily wage labor is often set in neighbors' farms to prepare seedbed, cultivate the soil, and/or to harvest and process farm products.

Table 7.4 Percentage of households that generated off-farm revenues from various sources and mean annual revenues generated by agro-ecological zones

Type of off-farm work	Highland (n=52)		Middle altitude (n=81)		Lowland (n=17)	
	%	Income (Birr)	%	Income (Birr)	%	Income (Birr)
Daily wage work	19.2	501.60	21.0	224.12	23.5	293.75
House construction	7.7	1850.00	1.2	456.00	5.9	300.00
Local trade	3.9	832.00	21.0	359.94	11.8	145.50
Town work	1.9	1800.00	4.9	1848.25	5.9	270.00
Grain mill operator			1.2	1033.00		
Commodity trade			1.2	1260.00		
Grass sale			1.2	60.00		

It is evident from the above empirical data that households in the middle altitude generate by far the largest cash income from off-farm sources. Overall, participation of household members in the off-farm cash generation activities shows moderate variation between agro-ecological zones. In the highlands, male household heads performed the bulk (88 %) of off-farm works. Corresponding figures for the middle and low altitudes are 57 % and 63 % respectively. Women's share was highest (17 %) in the middle altitude and lowest in the lowland (0.0 %). Children's share in the low, middle, and high altitudes represents 38 %, 26 %, and 6 % respectively. Whereas only about one-third of the households in the highland generated cash income from off-farm activities, about half of the households in the middle and low altitudes raised cash revenues from off-farm works.

The statistical relationship between sex of household head and household member that participated in off-farm cash generating tasks was very significant ($\chi^2 = 19.055$; $P \leq 0.000$). Only 15 % of female-headed households participated in off-farm cash generating works. Cash generated by male and female household heads ranges from 3.50-529.50 USD and 0.70-18 USD respectively. Whereas 16 % of the male-headed households' children participated in off-farm work, none of the children in the female-headed households participated. This indicates that the latter are predominantly preoccupied with collective welfare rather than personal property building.

In addition to the data presented in Table 7.4, 11 % of the households in the middle altitude participated in second cash generating off-farm works. Amount of income generated ranges between 3.50 and 86 USD. Another type of work is weaving of bamboo stems into various household

utensils, local liquor brewing, and fuelwood sale. None of the female-headed households though participated in the second off-farm cash generating activity.

7.2.1.5 Revenue from remittance and credit

Some 24 % of the total households received remittance many and/or various consumable items from family members living in towns during 1999/00. Income from remittance and various gifts distributed almost evenly among the agro-ecological zones with the proportion of recipient households in the highland, midland, and lowland amounting to 21 %, 26 %, and 24 % respectively. Mean revenues from remittance and/or gift show much greater fluctuations between AEZs from 50 USD for the highland through 23 USD for the midland to 19 USD for the lowland households.

With regard to the PAs, all but Guareba received transfer money and/or gifts. Achawede and Genet, with some 38 % of the households receiving remittance money and/or gifts, represent the most beneficiary PAs. Lanka Tore and Diamir (36 % each) and Gardashie (32 %) are among the moderate beneficiaries. Merabicho, with only 9 % of the households receiving such revenue, is the least beneficiary. Some 26 % and 24 % of the female- and male-headed households received an average of 33 USD and 30 USD respectively during the 1999/00 year.

Relatively, less number of households (20 %) borrowed money than that received remittance money and/or gifts during 1999/00. Long-term borrowing of money from different sources is quite uncommon in the lowlands (Table 7.5). On the other hand, 24 % and 19 % of the households in the middle and high altitudes respectively borrowed money during the same year. Only 8 % of the entire households, 75 % of them from the middle altitude, borrowed during two consecutive years (1998-2000). Some 30 % and 18 % of female- and male-headed households respectively borrowed money during 1999/00. The low percentage of households that borrowed money indicates the scarcity of credit facilities with fair interest rate and the risk-averse nature of smallholder households. This analysis did not include the credit arrangements associated with extension packages.

Table 7.5 Mean amount of borrowed money by various categories

Revenue	Agro-ecological zone			Sex of household head	
	Highland	Midland	Lowland	Female	Male
Mean amount (Birr)	265.00 (19.2)	195.26 (23.5)	160.00 (5.9)	215.00 (29.6)	218.18 (17.9)

Figures in parenthesis portray percentage of households in respective categories.

Study households borrowed money from various sources. Households in the middle altitude had additional option of borrowing from an NGO. Interest-free borrowing is often possible only from relatives and/or friends and in rare cases from neighbors. Some 41 % of the total borrowers borrowed from similar interest-free sources. The highest interest rates were charged by *Idir* and some neighbors. An NGO that lent money to farmers charged the lowest interest rate of all lenders but accessibility was limited only to households of Diamir and Gardashie. Majority of the households borrowed from neighbors (41 %) and relatives/friends (38 %). Only 10 % of the borrowers secured access to the lending NGO.

None of the farmers borrowed money from governmental or private banks. Many of the farmers were bursting into laughs upon hearing the question whether they have borrowed money from any recognized bank. Two key elements are missing in this regard. On the one hand, farmers are totally unaware of this opportunity. On the other hand, they lack self-confidence of participating in entrepreneurial partnership with institutions.

7.2.2 Relative importance of various sources of incomes

From the present study, it is evident that off-farm activities represent the most important source of household income in all survey PAs but Kuneber, where revenue generated from animal sales predominates. Revenues from off-farm activities are of significant value particularly for households in Guareba that have quite limited opportunity to generate income from other sources. About 83 % of the total revenues in Guareba is generated from off-farm work. Sales of agricultural crops constitute substantial portions, 32 % and 30 % respectively, of the total household revenues in Doba and Merabicho. The data evinced that the share of agricultural crops to the overall household revenue in Lanka Tore and Guareba is inconsequential. The relative values of various sectors in generating cash revenues in the study PAs are summarized in Figure 7.4.

There is, nevertheless, a considerable variation in the total amount of cash incomes and the number of households that engaged in cash generating activities from various sources between the PAs. Each household in Genet and Diamir has participated on average, in 2.9 and 2.8 different cash generating activities respectively. Diamir also has the greatest potential to raise household revenue from all farm and off-farm activities followed by Achawede, Doba, and Gardashie, which lack one cash crop each. Households in Kuneber and Lanka Tore participated in the least number (1.1 and 1.2 respectively) of cash generating ventures. Maximum cash revenues from sales of eucalypts (59 USD), t'chat (105 USD), and coffee (150 USD) were generated in Gardashie, Diamir, and Doba respectively. It should be noted that 7 %, 18 %, 18 %, 17 %, 29 %, 36 %, and 18 % of all households in Diamir, Doba, Gardashie, Guareba, Kuneber, Lanka Tore, and Merabicho respectively did not raise any substantial revenue during the reference year.

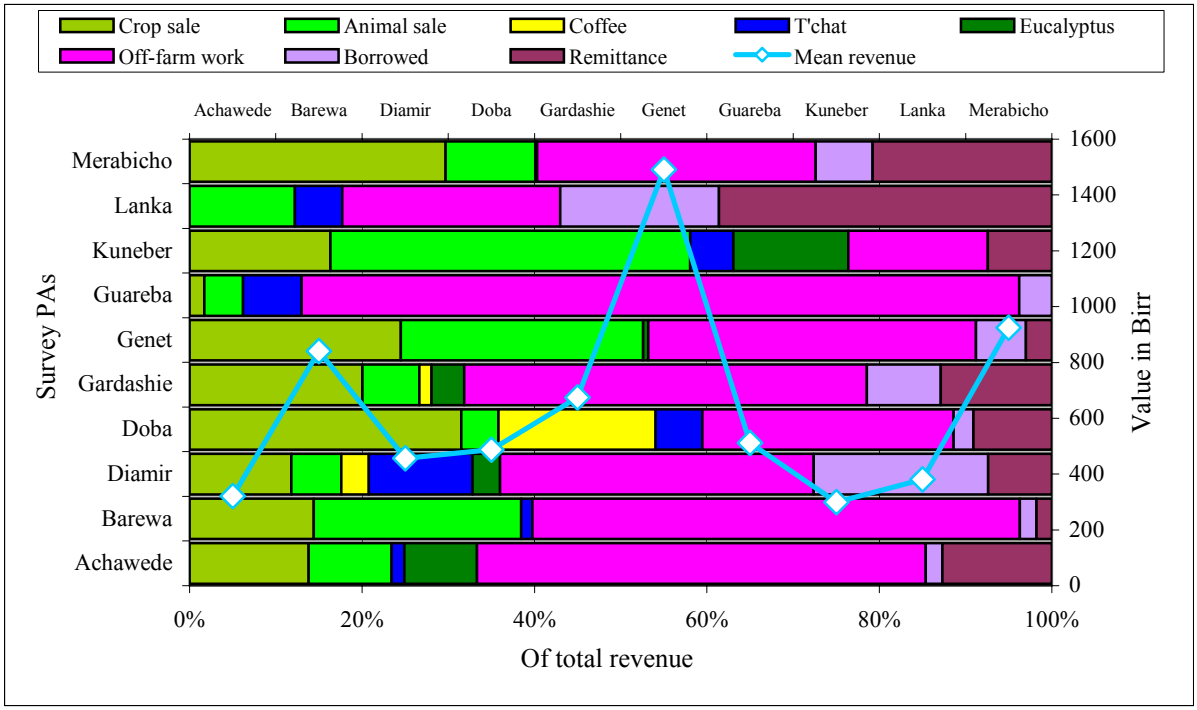


Figure 7.4 Relative value of various income sources for households of the study PAs
Mean revenues do not include households that did not participate in cash generating ventures and borrow money.

Mean cash revenues generated from various ventures considerably vary between PAs. As expected, households in Genet received the highest mean revenue (175.50 USD) followed by Merabicho (109 USD) and Barewa (99 USD). The least mean revenue was received by households in Achawede (37.50 USD) and Kuneber (35 USD).

This finding proves the presumption of the DAs (Pers. Comm.) that highland households, despite acute scarcity of farmland, are in a better financial position than the middle and low altitude households. The intermediate location of Kuneber between the mid- and highland, comparatively weakened rather than promoted, its financial position. It has limited opportunities to benefit from most cash generating crops such as coffee, t'chat, cereals, and fruit trees. The predominant portion (42 %) of household revenues in Kuneber draws from animal sales. It also represents a PA with the highest ratio of non-cash generating households.

7.2.3 Household expenditures

Compared to major household cash incomes that are predominantly generated at particular times of the year, household expenditures are often much more difficult to ascertain. As a result, only the major household expenditures along with estimated mean annual expenditures will be highlighted in this section. Major household expenses were elicited through detailed case study survey in which farmers were asked to willingly enumerate major household expenses.

Farmers often purchase various commodities including food and agricultural inputs for household use. Children clothing and educational materials, as well as adult clothing make part of indispensable annual expenditures. Farm households in the study area spend annually between about

5 and 25 USD for clothing alone depending on the size of the household and its wealth status. Households that use an agricultural extension package need to raise sufficient cash for repaying the debt of farm inputs. Others prefer to purchase smaller amount of modern inputs directly from the market against cash, in order to avert risks involved in credit schemes. The annual cost of all adopted farm inputs rises up to 35 USD per household.

Many of the households also purchased local seed and planting materials of various crops including enset, the annual cost of which may not exceed 7-10 USD. In good seasons, when above average revenues are generated, farm families resort to purchasing various animals mainly for household use and to a lesser extent for breeding or fattening purposes. The total value of animals purchased in any single year may not exceed 50 to 75 USD on average. Payments of annual taxes on land and various social obligations constitute part of the important expenditures. This may vary between 6 and 18 USD depending on the frequency of social expenses.

Cash incomes are also used for hiring wage labor for various agricultural operations or household construction works. A household that constructs a new house may need to purchase wood of specific quality or size. For some households, foodstuff bought from the market is the only means of diversifying nutritious diets. Nearly all households buy lamp oil, salt, and various spices at regular intervals. Mean annual expenditure for lamp oil amounts to about 9 USD. Purchasing of coffee constitutes an important expenditure particularly for highland households that do not grow coffee. The annual expenditure for coffee per household depends very much on the type of the coffee product used and the size of the coffee neighbors and varies between ca. 20 and 35 USD. Moreover, berry disease leaves many of the households in the coffee growing villages with little or no harvest and thus compels them to resort to purchased coffee.

Although local medicinal herbs are still the primary sources of treating various ailments, households also invest part of the cash revenue on medical treatments and for purchasing medical drugs. Health related expenditures are particularly high during the rainy season due to malaria infestations.

Expenses for religious and traditional holidays make up the largest and one of the most important household expenses in a year. A farmer who was interviewed in mid June expressed the importance of holiday expenditures by imparting that the vital annual expense involves slaughtering of a bull at *Meskel* holiday. He claimed that there is no other major expense up to September apart from striving to acquire a bull either in cash or in credit. Annual expenditure for holiday celebrations per household may ascend up to 75 USD or in few cases even more.

In general, quantification of household expenditures is much more difficult than that of incomes. Revenues that are obtained from marketing of farm products are spent throughout the year for meeting different needs. Short-term saving of accrued revenues and distribution of harvestable products over seasons serve as a security against seasonal contingencies and a failure of a particular crop.

7.3 Comparative financial advantages of eucalypts

7.3.1 Hitherto findings

In Ethiopia, a greater deal of attention has been paid to the economic feasibility of both private and state eucalypt plantations than to their social and ecological impacts. Some recent works on the topic, *inter alia,* include Pohjonen and Pukkala (1988; 1990); Teklay (1997); Wirtu and Gong (2000); and Asnake (2001). Attempts to carry out similar investigation in the study zone to reveal the comparative financial advantage of agricultural crops to the farmers have been thwarted by lucrative markets of eucalypt poles (Pers. Comm.). Furthermore, Wirtu and Gong (2000) exhibited that *E. globulus* plantations fetch ten times more financial returns than agricultural crops. Pohjonen and Pukkala (1988) confirm similar trends. Both assessments are, however, restricted to plantations within a radius of about 50 km from Addis Ababa.

Studies conducted further away from the capital city also claimed a substantially higher profitability of eucalypt poles (up to four or more times) than agricultural crops (Teklay 1997; Asnake 2001). Similar experiences were documented in India during the early 1980s. *Eucalyptus* plantations were aggressively promoted by private farm households during 1981-1986 in anticipation of higher returns (Saxena 1991). Tree planting, nonetheless, started to progressively slow down after 1986 (Saxena 1991) when farmers decided to revert to agricultural crops for better financial returns (Conroy 1993).

7.3.2 Eucalypt planting as a livelihood strategy

Personal experience and open discussions with the survey households strongly refute the claim that eucalypt woodlots accrue more financial profit than agricultural crops. In the first instance, irrigated cash crops (onion, tomato, etc.) production generates as much or even more financial returns in half a year than what otherwise could be expected from eucalypt sales in 6 to 8 years. Likewise, planting of cash crops like t'chat, sugar cane, coffee, and the like is being actively promoted by farmers in anticipation of not only easier transportation to demand centers but also better overall financial returns.

In the second instance, most (65 %) of the farmers sanction the claim that eucalypt woodlots do not represent the most profitable land use unit in their farming system (Table 7.6). Farm households in the study area plant eucalypts only as a means of generating subsidiary cash income rather than entirely replacing the existing land use units. This is mainly the main reason why eucalypt woodlots are often confined to strips furthest away from homegardens, valleys, and public trails.

Table 7.6 Farmers' conviction on the profitability of eucalypt woodlots as compared to agricultural crops

Farmers conviction level	Agro-ecological zone			Total
	Highland	Midland	Lowland	
	% of respondents			
Agree	26.9	23.5	43.2	35.3
It depends	26.9	47.1	12.3	21.3
Disagree	46.2	29.4	44.5	43.4
$\chi^2 = 20.13$; $P \leq 0.003$				

It is essential to draw a distinction between lack of access to market opportunities and actual non-profitability of eucalypt plantation in the various agro-ecological zones.

By many of the survey households in particular, and farm households of the region in general, eucalypt planting is viewed as one of the overall farm product diversification and risk reduction strategies. Under the prevailing demographic and marketing conditions, no farm household is willing to convert a substantial part of his farm and grazing lands into cash crop production. Farmers rather strive to maintain a certain carefully designed balance between all possible farm components in order to minimize risks. No other crop can be compromised for enset, a crop that has a carrying capacity of 7.5 times that of annual crops (Kanshie 2002). As Kanshie asserted, farmers attach higher overall importance to multiple cropping, despite its lower financial values. Its buffering effects against unforeseen fluctuations in market prices as well as biological and ecological hazards is more critical to smallholders.

Diversification of farm products for the objective of reducing risks, however, is often overemphasized by economic theories of farm studies. Farmers often diversify farm products to simply increase the number of alternative food and cash sources and to reduce risk. In other cases, some food products are best relished in complementary with one or more of other products. Farm crops also exhibit a considerable variation in productive potentials, the fact that makes the cultivation of some crops quite logical.

7.3.3 Costs of eucalypt poles and teff production

The following section presents financial viability of eucalypts from the central villages of the district, where relatively more number of households commercialize eucalypts poles. It is also found informative to compare the financial values of eucalypts with that of teff, a popular crop that fetches relatively high price in the market. This analysis provides some preliminary clues on the widely diverging farmers' views on the profitability of eucalypt poles. It also helps extension personnel develop better understanding of and take appropriate actions in promoting the financial positions of the smallholders.

A financial comparison between agricultural crop production and tree crops can be performed only if the former replaces the latter and vice versa on the same land unit. In situations where tree crops are confined to marginal and agriculturally unproductive land units, such comparison proves only trivial. An acceptable way of tracing the opportunity cost of the land would be to replace with the grazing value of the land (Pohjonen and Pukkala 1988). The values of grazing lands could be

calculated either from the total amount of hay that can be harvested or from an overall output of grass-browsing livestock. Economic values of livestock products include cash incomes from sales of stock, value of stock used for domestic consumption (payments in kind and gifts), value of the stock at the end of the accounting period, and value of stock produce (milk products, hides, meat, etc.) (Dillon and Hardaker 1993:85). Draught power of oxen and transportation values of equines should also be accounted. Moreover, the use of dung to manure crops and/or to meet fuel demands needs to be valued and accounted.

The price of eucalypt poles, the most commercialized eucalypt product, is rather uniform and less subjected to seasonal fluctuations in demands. Likewise, since it is sold at most once or twice in a year and only at infrequent intervals, it is much easier to remember the amount of cash revenue generated than that from crop and animal products. It was thus decided to carry out the relevant financial analysis under two appealing scenarios.

Scenario 1: Like conventional economic analysis, the following financial analysis is based on various hypothetical assumptions and price fixation, which otherwise is quite volatile.

There is a large variation in the value of land. Government land taxes represent a tiny fraction of what farmers actually pay for renting from one another. Whereas the former range mostly between 2 and 3 USD per holding size per annum, the rental price of about a quarter of a hectare of cultivable land reaches up to 12.5 USD per year. The current land opportunity costs (tax rate for grazing and cultivation uses) in the study district were thus given priority. On the basis of all relevant data, the opportunity cost of a hectare of typical land for eucalypt woodlots cultivation in the district was set to be 3 USD per year. Farmers generally, establish eucalypt woodlots at a spacing of between 0.5 and 1.0 m without any distinct alignment patterns. It is thus not uncommon to find up to 17 000 or more saplings per ha in young plantations. Other costs involved in eucalypt woodlot (1 ha) establishment and management are itemized in Table 7.7. The mean costs, although derived from Gardashie and Kuneber PAs, generally, apply to other PAs in the district with minor modifications.

Table 7.7 *Eucalyptus* woodlot (1 ha) establishment and management costs in two PAs

Operation	Cost in Gardashie Birr/ha	Cost in Kuneber Birr/ha	Mean cost Birr/ha
Land tax	175.00	175.00	175.00
Land cultivation	780.00	450.00	615.00
Pit digging	325.00	180.00	252.50
Seedlings cost (10,000)	250.00	500.00	375.00
Planting	52.00	36.00	44.00
Fencing	279.50	166.50	223.00
Weeding	396.50	198.00	297.25
Regular attendance	155.00	119.00	137.00
Total cost	2413.00	1824.50	2118.75

Source: Field survey (2001).

In estimating the costs, it was assumed that all operations are carried out manually by hand tools. Land tax, though uniform for certain size and quality of land, varies with the size of resources

available on it. Wage of an adult man for eight working hours per day is assumed, on the basis of survey results, to be 5 Birr in Gardashie and 3 Birr in Kuneber. Subsidiary costs for lunch and coffee (1.50 Birr/person) were also accounted. Weeding operation is not as systematically carried out in the highlands as it is in the middle altitudes.

Planting of eucalypts overlaps sowing of other crops such as barley, wheat, and teff. Although rise in wage rates may not be expected in the near future, temporary shortage of big wage labor can be anticipated at peak season. For visual comparison, costs that are involved in teff growing on communal land in Gardashie PA are presented in Table 7.8. As demonstrated in the table, seedbed preparation and loosening are done by a tractor, which during the peak season is highly demanded by households in the middle altitude. Use of communal lands for crop production also involves use of inputs from the agricultural extension package, fertilizer use being the most compulsory precondition. An average yield of 10 quintals[13] per ha has been adopted in this calculation. In addition to the costs indicated in the table, transporting and marketing costs of 10 quintals of teff are estimated to amounts to 70 Birr.

Table 7.8 Costs of growing one hectare of teff on communal land in Gardashie PA

Seed	First cultivation	Loosening	Leveling & sowing	Fertilizer	Weeding	Harvest	Transport	Threshing
96.00	250.00	125.00	156.00	390.00	100.00	205.00	100.00	100.00
Total cost including land tax, fencing and marketing = 1612.00 Birr								

Under the prevailing social and institutional arrangements, there is a limited possibility to compare the economic feasibility of eucalypt woodlots with that of agricultural crops. The only viable comparison could be, to compare eucalypt woodlots with the opportunity cost of marginal lands, on which eucalypts are often established, as the value of forgone animal fodder. The present comparison highlights the relative financial viability of the two crops under the prevailing management regimes, productive potential, and marketing opportunities.

Scenario 2: In the second and more realistic scenario, relevant financial analysis is made from farmers' own mode of calculation and with as few hypothetical assumptions as possible. In applying any of the economic tools to determine the economic feasibility of various land use options, care should be taken to pick items that are of particular importance to the farmers. Under normal conditions, farmers often do not include the cost of family labor in evaluating the value of different land use options open to them. In this line, Barlett (1980c) asserts that Chayanovian calculations[14] and qualitative assessments of agricultural options provide the most accurate tool for understanding agricultural decisions. Conventional economic calculations that are aggressively adopted in capitalist firms have little value, if at all, in discerning real smallholders' evaluation of farm operations. Once the decision to grow a crop is made, farmers are well prepared to bear the required material and human inputs for soil cultivation, sowing, weeding, harvesting, and threshing. What

[13] A quintal is a metric unit of 100 kilograms.
[14] Chayanovian calculation computes profitability by subtracting cash costs only from the revenues.

matters most to them at the end are costs that are incurred in the form of cash and the total yield and quality of the final harvest rather than its stringent financial viability. Table 7.9 presents financial costs of teff cultivation and eucalypt growing on 0.25 ha of cultivable marginal lands each as quantitatively assessed by farmers.

Table 7.9 Farmers' qualitative assessments of the financial costs of eucalypt woodlots and teff growing on 0.25 ha

Eucalypt woodlot (0.25 ha)		
Cost items	**Expense (Birr)**	**Year**
Seedlings (3906 x 2.5 cents)	97.66	1
Land tax	12.50	1-7
Teff growing (0.25 ha)		**Year**
Land tax	12.50	1
Land cultivation	62.50	1
Loosening the seedbed	31.25	1
Seed	24.00	1
Fertilizer	97.50	1
Weeding (chemical)	25.00	1

It is generally, impractical to assume a farm operation on a hectare basis, since majority of the farmers own less than one ha and judiciously allocate the available holding to all farm components of interest. Under the prevailing conditions, it is not wise to assume that smallholder farmers will convert most or all of their landholding to a monocultural cash crop in pursuit of high financial profits. This is mainly attributed to the higher priority accorded, unlike capitalist agricultural firms, to risk reduction than to profit maximization. The other significant departure is the exclusion of family labor from financial viability calculations. Farm households consider family labor not only as a privilege but also as an obligation to set into productive use.

In this analysis, the use of hired labor in tree planting has been totally excluded. This is attributed to the fact that only 17 % of the respondents, hired labor during the peak period and 92 % of the total hired labor was set into annual crops production and none has been used in tree planting. Although many of the respondents cite labor shortage as one of the major tree planting constraints, none dared to invest on it and risk the loss. Majority of the hired labor has been used instead for teff, wheat, and/or barley production with the intention not only to meet household subsistence food needs but also to generate cash revenues in order to compensate for the spent cash reserve.

7.3.4 Revenues from eucalypt woodlots and teff production

Scenario 1: It is important to note that this comparative analysis is meant only to reveal the disincentive of the farmers in promoting farm forestry for the market by the inequitable dispensation of the revenues between the participant stakeholders. Benefits accrued from eucalypt woodlots can be expressed in terms of the provision of basic wood requirements of the household and marketable poles. Precise quantification of the two product types is often not easy as households start to economically utilize the products as early as three years after establishment and whenever the demand arises thereafter. In contrary to Teklay's (1997:39) assertion, farmers in the study area start

receiving cash income from eucalypt woodlots three or four years after initial planting from sales of thin saplings for roof rafters (Table 7.10). A household that constructs a dwelling grass-thatched tukul demands all assortments of eucalypt poles from thin saplings to over-matured big trees (see Plate 11). Although every pieces of leaves, twigs, barks, and branches that remains *in situ* are collected for fuelwood and/or fencing uses, instances where medium sized trees were felled entirely for fuelwood use are not rare. Farmers in the highlands confirmed that eucalypt woods represent the major source of fuelwood especially during the rainy season when stocks of other external sources are at a minimum level or are hardly accessible. Eucalypt wood is also used by households as a gift or relief good to the needy households. It also serves as a material contribution towards achieving communal goals (construction of bridge, school, etc.).

Under these complex eucalypt wood utilization situations, it was found imperative to make judicious assumptions and attach values to each product according to the prevailing marketing situations. For practical simplicity, only pole production at a maximum seedling rotation of seven years was considered. Big sized trees of about 25-30 years age fetch up to 100 Birr each or more. Unless there are inadequate marketing opportunities, farmers often prefer to commercialize poles at much shorter rotation age (Table 7.10).

Table 7.10 Mean sizes and prices of major marketable eucalypt pole products

Pole product*	Under bark diameter (cm)			Height	Volume	Bundle	Bundle price
	Bottom	Middle	Top	(m)	(M^3)**	volume	(Birr)***
Atena, thin (14)	4.06	2.84	1.93	4.0	0.0025	0.0355	5.00
Atena, thin (9)	6.09	4.37	3.63	4.0	0.0060	0.0540	5.00
Atena, normal (8)	5.23	3.60	2.95	4.0	0.0041	0.0328	5.00
Atena, normal (8)	5.80	4.26	3.10	4.4	0.0063	0.0504	5.00
Atena, thick (6)	8.23	5.88	4.60	4.0	0.0109	0.0654	5.00
Atena, thick (6)	6.78	4.87	3.92	4.3	0.0080	0.0481	5.00
Atena, thick (6)	6.60	4,88	3.38	6.0	0.0112	0.0672	5.00
Woraj (3)	8.92	6.30	4.50	8.0	0.0249	0.0747	5.00
Woraj (2)	12.20	8.00	6.25	8,3	0.0417	0.0834	5.00
Quami (6)	9.38	7.52	6.54	4,1	0.0184	0.1104	5.00

*Local names for various size assortments of poles.
** Volumes were calculated according to Huber's formula (as suggested by Philip 1994:56-57)
***Real farm gate prices vary between 4 and 7 Birr depending on the quality of the poles and whether the farmer agrees to harvest himself.
Figures in parenthesis indicate the number of poles that make up a bundle.

Each of these pole assortments is sold in bundles of 2 to 14 depending on the size (diameter and length) of the poles. The usual price per bundle varies between 4 and 5 Birr (Pers. Comm.). Felling selected trees, debarking, cutting to appropriate sizes, and bundling the poles just outside the plantation cost 1.25-1.50 Birr per bundle. The second trader who comes often with trucks buys from either the intermediate brokers or directly from the farmers. If a farmer decides to perform the cutting and bundling operations, he would make an additional gain of 1.25-1.50 Birr from each bundle. Because of limited familiarity with and less frequent availability of the main buyers, farmers often prefer to sell to the intermediate brokers. Main buyers then collect the bundles from all the widely scattered small-scale woodlots to one loading center (Plate 14). The process of loading from

the original site, unloading at the loading center, and final loading to transport to Addis Ababa costs 0.90 Birr per bundle. In addition, the second buyer pays a tax of 5.50 Birr per bundle, which is shared between Finance Office, City Council, and DBO. Revenues generated from agricultural/forestry taxation in the district during the 1999/00 fiscal year are presented in Appendix 12. Transportation of the bundles is done in three main sizes 100 (small Isuzu truck), 280, and 300, bundles costing 1000, 2200, and 2400 Birr (118, 259, and 282 USD) respectively.

The second traders will then sell the whole load to one or more of the numerous wood traders that are densely dispersed throughout the city of Addis Ababa. The demand for construction poles is higher in certain parts of the city following major settlement expansion patterns, and so is the price. The profit of the second traders is highly dependent on the quality and seasonal supply patterns of the poles. During the months of July and August, gravel roads in the Guraghe region remain closed for heavy-duty trucks for protective measures. Moreover, temporary shortage of transport vehicles may sometimes extend for up to a month or more. It is thus very likely for the price in the city and profits of the second and third traders to increase during these months and shortly thereafter.

In this view, it is not an exaggeration to denote the highly imbalanced distribution of revenues from farm produce as one of the most ethically challenging question to the rural development agents. This plays a major role in yoking the decision-making process and the betterment of farmers' livelihoods as well as in undermining their efforts of getting out of the vicious circles of poverty. On the other hand, intermediate traders and city businessmen who directly or indirectly depend on smallholders' production are, in most cases, in better financial positions (Pers. Comm.). Table 7.11 exhibits approximate duration of time in growing and getting pole products to the final consumer, costs involved, and the distribution patterns of the returns from sales of the products[15].

Table 7.11 Time frame, cost, and revenue distribution in the production of '*woraj'* size poles on one ha of land

Stakeholder	Time	Cost	Revenue	Profit	Total profit (7 years)
Farmer	7 years	2 413.00	16 666.65	14 253.65	14 253.65
Second trader	1 month	68 333.28	74 999.94	6 666.66	559 999.44
Final trader	1 month	75 833.27	150 000.00	74 166.73	6 230 005.32

From the results, it is evident that farmers make only 2.5 % and 0.2 % of the profits made respectively by the second and third traders at the end of the rotation period. At the farm gate level, government taxes for a bundle of poles are more than the total revenue that a farmer receives from the sale after 7 years of management. The second trader receives about half (2 Birr) the profit that the farmer receives from every bundle, whereas the last trader receives a profit of about five and a half times (22 Birr) that of a farmer from each bundle (Table 7.11). Apart from the taxes collected from the second buyers, the state also levies annual charges on the traders for holding the trading license (minor intermediate costs of the second and third traders outside the district are not considered here).

[15] Details of the calculations and assumptions are presented in Appendix 13.

There is an additional wide gap between cash revenues that farmers in different regions receive for the same product. A farmer in Tigray, for instance, receives between 15 and 60 Birr for each pole of 8 to 12 years age (Teklay 1997; Jagger and Pender 2000), whereas a farmer in the Guraghe region receives only between 3 and 5 Birr.

Such an immense inequitable revenue distribution between earnings of farmers and intermediate traders as well as government fees is not confined to incomes from eucalypt poles alone. It equally applies to other cash crops such as coffee and t'chat. A kilo of t'chat, for instance, is taxed 5.25 Birr at the district town. Transportation cost adds up to further sink farmers' revenues. About half of the revenue from t'chat tax (3 Birr) goes to the Addis Ababa city council supposedly to cover the cost of cleaning the city from chat leftover. Only 0.25 Birr remains in the district mainly for various infrastructural works of the district town, Gunchire.

The net present value of the revenues received by various stakeholders obviously introduces further imbalances between their respective actual benefits. As presented in Table 7.11, the traders' rate of turnover is very short, in most cases less than a month. Farmers start investing in tree planting well ahead of setting the seedlings in the soil. Majority of the costs are incurred during the first year of planting the seedlings, and the financial proceeds (in the case of market-oriented woodlots) start to unfold only after about four years. Table 7.12 exhibits the net present values of the three major stakeholders at a discounting rate of 15 %.

Table 7.12 Interest compounded value (ICV) and net benefits from eucalypt poles ha^{-1}

Costs	Years							
	1	2	3	4	5	6	7	NCV (year 7)
Farmer	1878.00	193.00	90.50	77.50	64.50	64.50	45.00	5 987.03
Second trader	0.00	0.00	0.00	0.00	0.00	0.00	68 333.28	68 333.28
Third trader	0.00	0.00	0.00	0.00	0.00	0.00	75 833.27	75 833.27
Revenue								
Farmer	0.00	0.00	0.00	0.00	0.00	0.00	16 666.65	16 666.65
Second trader	0.00	0.00	0.00	0.00	0.00	0.00	74 999.94	74 999.94
Third trader	0.00	0.00	0.00	0.00	0.00	0.00	150 000.00	150 000.00
Interest (15 %) compounded profit								
Farmer	0.00	0.00	0.00	0.00	0.00	0.00	14 253.65	10 679.62
Second trader	0.00	0.00	0.00	0.00	0.00	0.00	6 666.66	6 666.66
Third trader	0.00	0.00	0.00	0.00	0.00	0.00	74 166.73	74 166.73

The interest-compounded value of alternative crop (teff) production has been summarized and presented in Table 7.13. The results of the present financial evaluations strongly confirmed that financial benefit of eucalypt woodlots is much more attractive than that of growing of the supposedly financially lucrative food crop. Care should be taken, however, in extrapolating financial viability of eucalypts to other perennial cash crops, since costs of land management and other intermediate inputs of the latter are much higher.

Table 7.13 ICV and net benefits of teff cultivation

	Year							
	1	2	3	4	5	6	7	NCV
Costs	1612.00	1612.00	1612.00	1612.00	1612.00	1612.00	1612.00	20262.84
Revenue	1800.00	1800.00	1800.00	1800.00	1800.00	1800.00	1800.00	22626.00
Profit	188.00	188.00	188.00	188.00	188.00	188.00	188.00	2363.16
NCV	500.08	434.28	377.88	329.00	285.76	248.16	188.00	2363.16

Mean yield and market price of teff were assumed to be 10 quintals/ha and 180 Birr/quintal respectively.

Comparison of financial benefits from one ha of eucalypt woodlot and teff crop each indicates a substantially higher profitability of the former. In this study, eucalypt pole production resulted in about 514 % compounded profit of teff production during the 7-year period. Moreover, it is necessary to note the considerable amount of biomass production from eucalypt woodlots, which fetches, as compared to teff straw, much more financial income. Evaluation of financial values of eucalypt and teff by-products would be done with more demands on research resources and would only inflate the net revenues from the woodlots. Most of the by-products from trees and food crops are often used to meet household demands for fuel, construction, and animal feed.

Scenario 2: The figures presented in Table 7.9 and 7.14 present the comparative financial advantages of eucalypt woodlots and teff growing. Farmers' qualitative evaluations of the cropping operations indicate that the repayment of input costs from revenues accrued from sales of crops is of primary concern. In most cases, farmers complained that incomes from sales of crop products did not cover the cash costs of inputs used and thus they were forced to sell other resources to repay the debt.

Table 7.14 Farmers' qualitative assessments of the financial benefits of eucalypt woodlots and teff growing on 0.25 ha

Eucalypt woodlot		
Products	**Revenue (Birr)**	**Year**
Rafters (400)	Household use	4
Small poles (406)	Household use	4-5
Intermediate poles and standards (390)	Household use	5-6
Intermediate poles (508)	508.00	7
Big poles (2202)	3670.00	7
Net cash revenue	3992.84	7

Teff growing		
Products		**Year**
Teff (0.5 quintal)	Household use	1
Teff (1.5 quintal)	270.00	1
Net cash revenue	17.25	1
Net cash revenue (in 7 years)	120.75	1-7

The above results revealed that despite the marginality of the land plots allocated to eucalypt woodlot, it still stands to be financially superior. The long gestation period, as compared to teff, nevertheless, represents a major intervening risk factor for smallholder farmers. Current marketing

arrangements, revenue sharing patterns, and attitudes of local authorities also diminish the potential benefit of eucalypt planting to the households in the foreseeable future. Likewise, smallholders cannot afford to wait long-term higher financial benefits by relinquishing all other short-term products to a monocultural crop. Genuine and carefully planned long-term credit facilities and guaranteed marketing opportunities for the ensuing products are possibly among the most appropriate incentive mechanisms in shifting the balance between annual food and perennial cash crops. The net compounded values of the revenues generated from the two crops are presented in Table 7.15.

Table 7.15 Interest compounded value and net benefits of eucalypt woodlots and teff cultivation on 0.25 ha

Eucalypt	Year							
	1	2	3	4	5	6	7	NCV
Costs	137.50	0.00	0.00	0.00	0.00	0.00	0.00	365.75
Revenue	0.00	0.00	0.00	0.00	0.00	0.00	4178.00	4178.00
NCV	-365.75	0.00	0.00	0.00	0.00	0.00	4178.00	**3812.25**
Teff								
Costs	252.75	252.75	252.75	252.75	252.75	252.75	252.75	3177.07
Revenue	270.00	270.00	270.00	270.00	270.00	270.00	270.00	3393.90
NCV	17.25	17.25	17.25	17.25	17.25	17.25	17.25	**216.84**

From the result, differences in purchased input requirements between the two crops stand quite conspicuous. Any serious woodlot management work is restricted to plantation establishment, one weeding operation during the first year, and erecting and maintenance of light fencing throughout the rotation age. The extremely high planting density of the woodlots makes sequential weeding operations uncalled for. Farmers with conducive soil and climatic conditions can also raise seedlings at least for their own use. Under most conditions, farm households establish and manage medium sized woodlots with family labor, leaving land tax as the only perceptible cost.

CHAPTER 8

REFLECTIONS, CONCLUSIONS, AND RECOMMENDATIONS

8.1 Reflections

8.1.1 Limitations

Lack of coherent and well-systematized approaches of decision-making studies has caused great setbacks at the preliminary phase of the study. Among the two major decision-making study approaches, the positive or behavioral approach was favored for its accurate and more pragmatic elicitation of smallholder households' decision criteria. This approach tries to carefully pinpoint farmers' real life decision criteria rather than pondering over highly unrealistic models and attempting to suggest hypothetical decision rules to the farmers.

This study was carried out in the western aspects of the Guraghe Highlands. As compared to other farm households, the Guraghe households posses unique farm units in which compact private plots are laid in a more or less symmetrical fashion adjacent to each other. Whereas highland households face severe land shortages for efficient resource use, lowland households, although relish excess and better quality land, are exposed to the threats of wild animals, diseases, and pests.

The three agro-ecological zones (AEZs) display distinct farm forestry features and thus results obtained from one zone cannot be entirely applicable to the other. In general, farm forestry decision-making strategies greatly vary with the level of household resource endowments and access to information. Although the general decision-making framework ascertained in this study can be applied to a wider scale, it is prudent to cautiously adapt to specific local conditions. It is thus quite hard to predict the extent to which the findings of the present study can be applied to other regions of peculiar farming systems. Only further research can reveal the extent of diversity in households' farm forestry decision-making strategies.

The other challenge faced during the process of decision criteria elicitation was farmers' low level of comprehension of numerical questions. Some farmers could not even differentiate their own age and that of their children. Questions pertaining to farm practices, cash incomes and expenditures, species and number of seedlings planted in the past years often tested the memory of the respondents. Moreover, some farmers found the questionnaire unbearably too long to sit and answer the questions for two to three continuous hours. The high rate of mobility of the Guraghe farmers hampered planned execution of the survey. Farmers' deliberate or unintentional nonattendance of the interview programs, despite preset appointments, interrupted some interview schedules.

Farmers' tendencies to provide 'conditioned' responses to familiar questionnaires in attempting to impress the researchers and possible dereliction of important farm forestry practices have been substantiated through participatory observation and detailed discussions. Each interview was followed by visual observations of the farm units in which farmers were allowed to give detailed accounts of their farm forestry practices. Moreover, specific questions of interest were addressed. This practice gave an opportunity to triangulate the information obtained via formal interviews. It

greatly minimized possible biases in the survey results that could have substantially reduced the validity of the data.

Findings of the decision-making study receive high significance only when the actual choice data is employed in testing the model. The very nature of the present study and shortage of time and financial resources hindered testing of the decision models. This would represent one of the topics for further research.

8.1.2 Relationships between theories and the findings

The behavioral decision-making study approach was found more appropriate to elicit and synthesize the real world decision-making process at micro level. As clearly demonstrated in Chapter 2, the advocates of this theory (Gladwin, 1980; Huijsman 1986; Senkondo 2000), generally, identify two stages of agricultural decision-making: the elimination-by-aspects and the hard-core decision process. The elimination-by-aspects phase is valid in farmers' decisions to narrow down the list of crops they consider to grow. The hard-core decision process involves detailed analysis of the possible alternatives and making of the actual decision. The decision analysis model of Clemen (1996) was adopted in analyzing and systematizing the decisions to plant various tree/shrub species on the farm.

The topic of agricultural/forestry decision-making study, however, is often so intricate since farmers' actual choices of farm practices are closely related to the strength of their conviction in obtaining viable harvest. Adoption of a particular cropping system or new technology is judged either individually or in a small group by discussing among neighboring households. Accordingly, farmers under a similar decision environment within the same AEZ practice more uniform cropping patterns than those in different regions and thus make more uniform decisions.

The application of the decision analysis model was not easy since many of these models were based on studies from commercial farmers whose primary target is maximization of profit. Unlike commercial farmers, smallholder farmers operate with quite small farm capital to meet diverse objectives: meeting subsistence food demands, reducing risks, and securing short-term savings, rather than maximizing capital resources for long-term use. Very poor farmers cannot even meet subsistence food demands and thus every effort is directed at guaranteeing subsistence food needs and sustenance of survival.

The theory of attentive and pre-attentive decision-making has been presented by Gladwin and Murtaugh (1980). The pre-attentive decision-making refers to the decisions made in the past and inculcated in our minds to become routine and thus such decisions are made in an unconscious manner. The decision that claims a considerable amount of scarce resources and involves nonreversible risks i.e., strategic decision is often made attentively by seriously comparing the various aspects of the alternatives with the available resources. Although many of the farm forestry decisions are taken attentively, pre-attentive decisions are also not uncommon. The straightening up and reinforcement work by a circumnavigating household member of a loose farm fence, for

instance, represents a pre-attentive decision. Experienced farmers, thus employ considerable part of farm experiences in making faster farm forestry decisions with fewer resources.

8.1. 3 Reflections on research questions

The following inferences are drawn from the research questions.

- Chapter four demonstrated the general biophysical and socio-economic features of the Guraghe region with a particular reference to the study district. Factors that have strong relation with farm forestry decision-making were emphasized. Chapter five, predominantly counting on the results of the present field study, elaborated major farm and off-farm activities and resource endowment status of the households.
- Chapter six highlights farm forestry decision-making strategies of the study households. Major objectives, available alternatives, and major risk and uncertainties that hinder farmers from planting tree/shrubs for enhancing sustainable livelihoods are identified.
- Some preliminary means of overcoming farm forestry constraints are given in this chapter along with possible future research areas.
- Lack of professional forestry personnel in the DBA, agriculture-focused training of the DAs, as well as farmers' complaints on the lack of effective technologies prove the incapacity of the current agricultural/forestry institutions to help farmers utilize the potentials of farm forestry.
- Eucalypt woodlots represent the major source of wood products particularly for construction, fuelwood, and cash generation. Despite its acknowledged high competition with food crops for soil nutrients and moisture, no other tree/shrub species replaces the use values and ease of management of eucalypts, and thus farmers will continue growing the species.
- AEZ, sex and age of household head, and number of eucalypt trees owned represent the most important variables that reveal whether a household continues expanding eucalypt woodlots. This has been verified in Chapter six.
- Farmers' capacities to take risks vary considerably with household wealth status and geographic locations. The propensity of wealthier highland farmers to adopt the agricultural extension package, for instance, is much higher.
- Higher financial profitability of eucalypt pole production as compared to selected food crop production is ascertained in Chapter seven. The extreme inequitable distribution of total cash revenues from sales of eucalypt poles between various stakeholders is also revealed.

8.1.4 Recapitulations on results

This section outlines whether the objectives of the research have been satisfactorily achieved as well as whether the research questions are well addressed. With respect to the main objective of the research in developing methodological approaches of farm households' decision-making studies

pertaining to farm forestry, this study adopted the most economically and socially acceptable and practically appropriate study approach that helps elicit smallholders' choice problems in the real world. The research questions were designed to address the specific objectives of the study.

The first research question pertains to the socio-economic and biophysical attributes under which the target households are operating. Biophysical conditions in the highlands are much better than that of the lower altitudes for crop and animal farming. Lowland and some middle altitude households have access to extensive land sizes, but lack basic inputs to make productive use. Damages from wild animals and animal and crop disease are more prevalent in the low and middle altitudes. Marketing infrastructure is better for midland households.

Questions two through five deal specifically with farm forestry decision-making strategies including decision criteria, constraints, and opportunities. These questions are addressed with particular reference to the three major on-farm plantation species, i.e., eucalypts, coffee, and t'chat. Some questions were addressed with specific data on eucalypt woodlots, since eucalypts represent the only species that are grown in all AEZs. Decision-making data on coffee and t'chat could not be employed in comparative analysis of the households in different AEZs. The effectiveness of rural development projects and government extension agents in promoting integrated tree and/or shrub management practices were assessed and summarized in Chapters 6 and 7.

Planting of eucalypt species is largely constrained by lack of land and labor as well as poor rainfall conditions. Government policy and low market prices reduce farmers' motivations to plant eucalypt species for the market. Coffee and t'chat planting, on the other hand, is constrained by lack of coffee seedlings, diseases, poor soil conditions, shortage of labor, and small landholding sizes.

The relationship between eucalypt planting and various household characteristics was ascertained through logistic and linear regression analyses. The models exhibit adequate levels of representation of the population. They can be employed in future projections of the woodlot expansion trends in the various AEZs. It is, however, beyond the scope of this study to accurately prognosticate the time frame within which the results remain valid.

Possible means of promoting farm forestry practices were suggested and more coherently summarized in this chapter. Possible policy recommendations that help promote farm forestry practices and thus contribute to guaranteeing of food self-sufficiency and poverty alleviation targets are also suggested.

8.2 Conclusions

The long history (more than 5000 years) of agricultural operations in Ethiopia has deprived the highland soils of basic nutrients. Unabated emaciation of the highlands soils led to complete dereliction and withdrawal of large areas of land from any productive use. Extreme highland soil degradation was the keynote of several scholars and is coined as the most critical environmental problem (cf. EFAP 1994a; Bishaw 2001; Dubale, 2001; Teketay 2001). The fact that most parts of

the highlands in the study area are still under cultivation hints the relatively more recent history of conversion into continuous agricultural use.

Unlike those in the highlands, low- and part of midland households often cultivate only a fraction of the total holding size owing mainly to lack of draught power and animal manure. The crops that are grown in such small homegardens are subjected to multitudes of damaging agents. Recent recurrent upsets in climatic conditions have worsened the impact of massive land degradations on agricultural production. For lowland and midland households, the high level of damage by wild animals adds up to significant yield reduction.

This research represents the first attempt under the Ethiopian condition to elicit farmers' decision criteria in integrating trees and shrubs in their farm units. Efforts were made to carefully and exhaustively draw key decision criteria and uncertain chance events that affect farmers' decision-making in planting tree/shrub species. Farmers make farm forestry decisions by cautiously considering the resources they have and subjectively predicting the likelihood of various chance events that influence their decisions and the outcomes. In addition, farmers' decisions are much influenced by the production objectives pursued and household characteristics.

Some farmers also carry out their own small-scale on-farm trials to cope with changes in the external or internal circumstances. For instance, some farmers were selectively regenerating coffee plants that are resistant to berry diseases and at the same time have good branching characteristics. Some farmers with no access to dry season irrigation water supply also raise seedlings with various moisture harvesting or conserving techniques. Others experiment by growing various crops outside their natural ecological ranges. Experimenting farmers mainly represent creative and advanced thinkers rather than those of higher wealth status.

Accordingly, the following conclusions pertaining to the objectives of the present study were drawn.

- Trees and shrubs play an important role in the daily lives and livelihoods of the Guraghe farm households. They provide valuable products and services like food, construction wood, fuelwood, materials for household utensils, farm implements, etc. Vital environmental functions of trees and shrubs include, *inter alia*, shade for humans, animals, and crops; erosion control, amelioration of soil fertility, etc. Trees and shrubs are also exclusively planted for amenity purposes in alleys around the homegarden.

- Farmers are generally, subjected to numerous risks and uncertainties in making various farm forestry decisions. Within the household entity, the stochastic climatic uncertainties, biological risks, poor soil conditions, weak marketing infrastructure, limited marketing channels, and lack of know-how on agroforestry innovations are the major predicaments. Shortages of land that can be entirely set aside for woodlot management and limited labor supply are important external factors.

- Compared to agricultural crops, government taxes on tree crops are extremely high to the extent of curbing farmers' motivation to grow more trees. In addition, current increasing pressure from regional and district authorities to gradually abandon eucalypt and t'chat planting may diminish product diversity and income sources in the future (i.e., a lower degree of risk distribution).
- Farm inputs are either very expensive or are not available on time to those who can afford. There appears perverse coercion of farmers to purchase inputs from specific sources at high prices. Current credit arrangements in connection with the agricultural extension package proved counter-productive in seasons of both good and bad harvests. Farm product price fluctuations are not in favor of farmers.
- Current extension programs failed to accommodate the integration of trees and shrubs in the existing land use units by focusing solely on food crop production. The field staff does not have a better know-how in farm forestry innovations than the farmers. This had a major impact on the utilization of agroforestry potentials and the performance of farm forestry practices.
- Both agricultural and farm forestry planning processes are largely done at higher levels and channeled down for implementation (i.e., top-down approach). This resulted often in rejection or unenthusiastic adoption of agricultural and farm forestry innovations. Lack of well-designed on-farm trials and demonstration plots compounded the impact of the top-down approach. In general, there is a failure to value and understand farmers' decision-making strategies in planning and implementing the intervention technologies.

8.3 Recommendations

Since the thrilling and partially successful efforts of Emperor Menelik to promote farm forestry practices during the last part of the 19th Century, there was no time when farmers were genuinely encouraged to integrate trees into their farm units and reap the rewards of various agroforestry techniques. Many 'short-sighted' still dwell on blaming the introduction and planting of eucalypt species with no regard to its dramatic role in narrowing the yawning gap between demand and supply for wood products and in the rural land management systems. Eucalypts played a very significant role in the daily life of both the rural and urban populations by providing the basic need for shelter and fuel. Eucalypt wood not only makes up the structural frame of residence houses for the majority of households but also constitutes the dominant sources of fuelwood and other structural constructions. Using eucalypt wood for timber, pulp, and charcoal production is currently attracting major interests.

Neither a single sector nor haphazardly composed recommendations solve the intricate and deep-rooted problems of the Ethiopian farmers. There is an urgent need for a paradigm shift in addressing the ever-worsening problems of the smallholders.

Accordingly the following recommendations are suggested.

Decision-making study approach

- Studies on smallholders' decision-making processes are bewildered by lack of empirically grounded and plain study approaches. Most of the decision analysis procedures converge on highly hypothetical elicitation techniques. Studies on decision-making processes are often conducted on small number of respondents, the fact that reduces the validity and reliability of the procedures. There is thus a need to develop an uncompromising and robust decision-making study approach specifically designed to elicit decision criteria of resource-poor farm households.
- Decision-making studies need to begin with elicitation of pertinent decision criteria from the decision-makers. In the case of smallholder households, the combination of carefully and exhaustively prepared survey questionnaire and careful triangulation between the various data sources produce robust and reliable data sets. The highly dynamic decision-making mechanisms of different individuals can be acceptably captured only through a combination of quantitative research methods and detailed case study approaches. Only ethnographic field study methods of long-term data collection can fully capture smallholders' decision-making processes.

Policy frameworks: the way forward

- Sustainable development and livelihoods of rural households cannot be guaranteed through agricultural crop production alone. There is thus a need to restructure and strengthen the extension division of the DBA both with human expertise and material resources. Forestry extension services need to be established and integrated with the existing agricultural extension programs.
- Promotion of agroforestry is crucial for the sustenance of farmland productivity and meeting the increasing demands for tree products. This holds a great promise particularly in the highlands where land scarcity and soil erosion problems are acute. Creation of a responsive and an enabling farm forestry policy and marketing infrastructure could pave a way for fuller exploitation of the potentials.
- The target of rehabilitating degraded forest resources needs to be initiated on farmlands with extensive adoption of agroforestry innovations and should create an incentive for private forestry entrepreneurs. Conferring full land ownership title and security upon farmers is expected to motivate them in taking management decisions, initiating investments, and using the land sustainably. Some farmers see the current tree use rights as discouraging in advancing on-farm tree/shrub integrations, and thus they need to be amended in the relevant policy.

Implication for future research

- The findings of this study should serve as a base for future farm forestry promotion works. Smallholders' research agenda need to start with full understanding of the prevailing decision-

making strategies, in order to guarantee the acceptability and adoptability of the ensuing recommendations.

- Smallerholders' decision-making process is extremely dynamic and very much dependent on the socio-economic position of the households and personal characteristics of the heads. It is thus essential to base decision-making data sets on as small homogenous group of households as possible.
- There is a need to carry out stringent economic evaluations on the fairness of the current distribution patterns of farm incomes between various stakeholders and to devise a means for more equitable dispensations.

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PLATES

Plate 1: Land use patterns in the highlands

Plate 2: Land use patterns in the middle altitude

Plate 2: (Contd.)

Plate 3: Land use patterns in the lowlands

Plate 4: Very steep slopes like this one are used for crop cultivation in the highlands

Plate 5: Rain water conservation technique for raising seedlings

Plates (Contd.)

Plate 6: Coffee seedlings heavily shaded during the dry season

Plate 7: Manual land cultivation through labor exchange

Plate 8: Distancing eucalypt woodlots from the Homegardens

Plate 9: Plantation densities of community woodlots

Plate 10: Typical female-headed household farm fields

Plate 10: (Contd.)

Plates (Contd.)

Plate 11: Tukul construction requires extensive amount of wood

Plate 12: Protective roles of eucalypt species

Plate 13:Coffee disease that dries up the entire bush

Plate 14: One of the many pole-loading centers in the middle altitude

APPENDICES

Appendix 1: General Survey Questionnaires

Identification:

Name of interviewer _____ Date _____
Peasant Association _____
Village _____
Head of household _____Sex: (M/F) _____ Marriage status:_____
Name of respondent (if different from above) _____(Wife/Daughter/Son...)
Total farm size: _____Zjeng/ha. Length of time in farming:_____ years

1. Which household members are currently residing and eating together? (List nuclear family members). Members who are entirely dependent on household for food and clothing but living elsewhere (e.g. high school students living in towns) should also be listed.

No.	Name	Age	Sex M/F	Level of education	Main role	Relations to hh head	Participate in fieldwork?	
							Y/N	How often?
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								

Key to main role: 1=Crop cultivation, 2=Animal rearing, 3=Household cooking, 4=Trader (specify!), 5=Handcrafts (pottery, baskets, weaving, wood work, blacksmith, builder, etc.) (Please, specify!), 6=Off farm work, 7= Marketing, 8=Student (A: Live with family, B: Live mostly in town), 9=Too old /disabled to work, 8=Others (please, specify!)

Key to education: 1=Illiterate, 2=Can read only, 3=Can read and write, 4=Primary school, 5=Middle school (7-9), 6=High school, 7= College year 1, 8=Vocational school, 9=Others (specify)

Key to how often: 1=Always, 2=Rarely, 3=Very rarely, 4=During land preparation and planting, 5=During weeding and harvesting

2. How many of the household members have migrated to urban centers? _____

3. Does any member of the household assume any social responsibility?
Name: _____ _____ _____
1=Caste occupation 2=PA council member 3=Religious server
4=Leader of traditional institution 5=Others (specify!) 6=Not at all

General farm activity and resource endowments

4. What are the major economic activity (source of livelihood) and respective objectives of the household? From where do you generate household income? Please, prioritize both!

	Farm activity	Priority of activity	Priority of income generation	Objective(s)
1.	Agricultural crop cultivation			
2.	Animal rearing			

3.	Tree crop growing			
4.	Trade			
5.	Handicrafts			
6.	Off farm wage employment			
7.	Lending money			
8.	Selling fuelwood			

Key for objective: 1=To secure food self-sufficiency, 2=To generate cash income, 3=For respect/prestige, 4=To imitate other villagers, 5=For insurance against risks, 6=For long-term savings, 7=Others (Specify!)

Specify here the type of trade and/or handicraft: _____

5. How are the currently cultivated/grazed land units qualitatively categorized?

Plot No.	Land quality	Walking time from home hr./min.	slope	Total area	Ownership/ Price if bought/ rented		Major land use type
					1,2,3,4,5,6,7	Price (Birr)	
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Key for land quality: 1=Very fertile, 2=Fertile, 3=Intermediate, 4=Poor, 5=Very poor

Key for Slope: 1=Flat, 2=Moderately sloppy, 3=Steep slope, 4= Very steep slope

Key for land ownership: 1=Allocated by PA councils, 2=Rented in, 3=Contractual agreement to share the yield with the owner, 4=Inherited, 5=Bought, 6=Given (gift), 7=Others (Specify).

Key for major land use type: 1=Enset, 2=Annual crops, 3=Chat, 4=Coffee, 5=Potato, 6=Grazing land, 7=Tree/shrub plantations, 8=Others (Please, specify)

6. Which food and cash crops (coffee, chat, etc.) did you grow during the previous cropping season? Prioritize according to importance and indicate the yield and problems encountered.

No	Crop grown	Total area	Major objective(s)	Total yield				Problems
				Unit	Consumed	Sold	Stored	
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
13.								

Key for crops grown: 1=Enset, 2=Chat, 3=Coffee, 4=Potato, 5=Sweet potato, 6=Godere, 7=Maize 8=Wheat, 9=Barley, 10=Teff, 11=Horse bean, 12=Field peas,

Vegetables: 13=Local cabbage, 14=Garlic, 15=Onion, 16=Cabbage, 17=Tomato, 18=Carrot, 19=Beet root, 20=Swiss chard, 21=Lettuce, 22=Pepper,

Fruits: 23=Orange, 24=Banana, 25=Mango, 26=Avocado, 27=Lemon, 28=Guava, 29=Citron, 30=Hop, 31=Papaye, 32=Peach, 33=Gishta, 34=Sugar cane,

Trees/shrubs: 35=Red eucalypt, 36=White eucalypt, 37=Wanza, 38=Birbira, 39=Zigba, 40=Sesbania, 41=Decurrens, 42=Gesho, 43=Yeabesha tid, 44=Kosso, 45=Yeferenj tid, 46=Schinus,

Appendix 1: (Contd.)

47=Tree lucern, 48=Bamboo, 49=Pegeon pea, 50=Medicinal plants, 51=Grazing land, 52=Others (Please, specify!)

Key for major objectives: 1=Subsistence food, 2=Cash income, 3=Reputation, 4=Animal fodder

Key for problems 1=Drought, 2= Wild animals, 3=Diseases, 4=Lack of seed, 5=Lack of cow dung, 6= Lack of fertilizer, 7=Lack of labor, 8=Lack of draught power/tractor, 9=Lack of tools, 10=Others (Specify)

7. Which farm inputs and quantities have you used in growing these crops during the previous cropping season?

	Farm inputs	Quantity (If quantifiable)	For which crops	Means of acquiring	If bought price (Birr)
1.	Irrigation				
2.	Cow dung				
3.	Fertilizer				
4.	Herbicide				
5.	Pesticide				
6.	Draught power				
7.	Seeds				
8.	Seedlings/stumps				
9.	Hired labor				
10.					

Key for means of acquiring: 1=Own, 2=Bought, 3=Provided by MoA, 4=From NGO, 5=Others

8. If you have used neither fertilizer nor chemicals, explain the reason.

_____

9. How many heads of the following livestock does your household own?

No.	Type	Number		Uses	Variety	Feeding system	Value (Birr)		Owner-ship
		Own	Others'				Own	Others'	
1.	Oxen								
2.	Cows								
3.	Bulls								
4.	Heifers								
5.	Calves (<1 yr)								
6.	Sheep								
7.	Goats								
8.	Chicken								
9.	Donkeys								
10.	Horses								
11.	Mules								
12.	Beehives								

Key for uses: 1= Plowing, 2=Milk for household use, 3=Fattening for sale, 4= Byproduct for sale, 5=Savings, 6=Social prestige, 7=Transportation, 8=Manure for crops, 9=Slaughtering for holiday, 10=Others (Specify)

Key for feeding system: 1=Zero grazing, 2=Tethering, 3=Paddocks, 4=Grazing on communal land, 5=Others

Key for variety: 1=Local, 2=Exotic, 3=Hybreed, 4=Others (Specify)

Key for ownership: 1=Relatives, 2=Neighbors, 3=Distant rich farmers, 4=Urban dwellers, 5=Others (Specify)

10. What are the critical problems in animal production? During which months of the year?

Appendix 1: (Contd.) _____

_____ ( ) _____ ( )

_____ ( ) _____ ( )

11. Which tree/shrub species have adequate palatability and nutritive value and for which animals? Underline the species that are grown by the farmer.

	Tree/shrub species	*Fodder value*		Months of feeding	For which animals	Side effects on animals
		Palatable	Nutritive value			
1.						
2.						
3.						

Key for palatable/nutritive value: 1=Very good, 2=Good, 3=Fair
Key for animals: 1=Cattle, 2=Equines, 3=Goats/sheep, 4=Chicken, 5=Others (Specify)

12. What are the problems in growing fodder trees? _____
_____

13. Do you collect fodder from forest trees/shrubs? Yes No
From which species? _____

14. Are you allowed to cut grasses from communal plantation? Yes No

15. How much grass did you collect or bought last year? _____ Price?_____

16. Which of the following assets does your household own?

No	Asset	Quantity	Year bought/ constructed	Present/ Value	Use life (years)
1.	Corrugated iron sheet roofed house				
2.	Grass-thatched house				
3.	Solar power				
4.	Semi-permanent house				
5.	Oxen plows (set)				
6.	Hoes/spades				
7.	Axes (all sizes)				
8.	Sprayer				
9.	Radio				
10.	Cassette player				
11.	Spongy mattress				
12.	Sofa				
13.	Chairs				
14.	Tables				
15.	Wrist watch				
16.	Hurricane lamp 'Masho'				
17.	Charcoal stove				
18.	Kerosene stove				
19.	Torch				

External support and awareness

17. Please, describe the level of awareness you have to the following information as:
1=well informed, 2=barely informed, and 3=not informed at all.

Appendix 1: (Contd.)

	Situations	Level of awareness	Sources of information
1.	Farm technologies (fertilizer, chemicals, modern bee hives)		
2.	Improved crop varieties		
3.	Improved animal breeds		
4.	Multipurpose trees & shrubs (with several use values)		
5.	Sources of MPTS seeds and/or seedlings		
6.	Soil erosion control measures		
7.	Role of trees in soil fertility improvement & erosion control		
8.	Role of trees in improving fodder supply during the dry season		
9.	Tree planting to stabilize gullies		
10.	Role of agroforestry in reducing risk of crop failure		
11.	Demonstration plots; farmers training services		
12.	Tree planting to protect wind damage		
13.	Tree nursery establishment and management		
14.	Effects of deforestation on local ecology and economy		
15.	Water harvesting system		
15.	Biogass energy generating system		
16.	Solar energy system		
17.	Improved fallow system		
18.	Possibility of acquiring bank credit		
19.	Energy saving mechanisms		
20.	Contacting development agents for useful information		

Key for sources of information: 1=Forefathers, 2=Neighbors, 3=Relatives, 4=Own school children, 5=Development Agents, 6=Radio, 7=Television, 8=Papers/Brochures, 9=Others (Specify)

18. What is your overall assessment on the strength and value of the current agricultural extension program?

a. Is very strong and very useful _____ b. Is strong and useful _____
c. Is modest and fairly useful _____ d. Is weak and of limited value _____
e. Is very weak and has no value _____ f. I have no idea _____
g. Other combination that is mentioned by the farmer _____

Appendix 1: (Contd.)

Tree management practices and objectives

Which of the following tree/shrub species did, do, and will you grow and which ones have you considered to grow but not done so?

1. Start by asking the farmer if he has grown, is growing or intending to grow a particular species.
2. If the answer is No, proceed to the next species.
3 If answer is Yes, ask strictly according to the flowchart (see below) and mark in the appropriate box. If the answer to any of the question is Yes, write the name of the species and proceed.

4 Mark ✔, x, or Ø, for objectives that are freely mentioned by the farmers, mentioned after being prompted, or if the objective is not applicable respectively. Then ask for the value of the species for respective objective under consideration.

Form of questions:

4.1. Would you grow species X for objective Y? If No, proceed to the next objective. If Yes, ask how good is the species for the objective on a scale of 5 (very good, good, fair, …).

5 After marking the constraints that are freely mentioned by farmers and ascertaining the relevance of the rest, ask their likelihood to influence the yield of the species or her/his decision to grow the species.

Forms of questions:

5.1. How likely is constraint X (constraint mentioned freely by farmers) to occur?

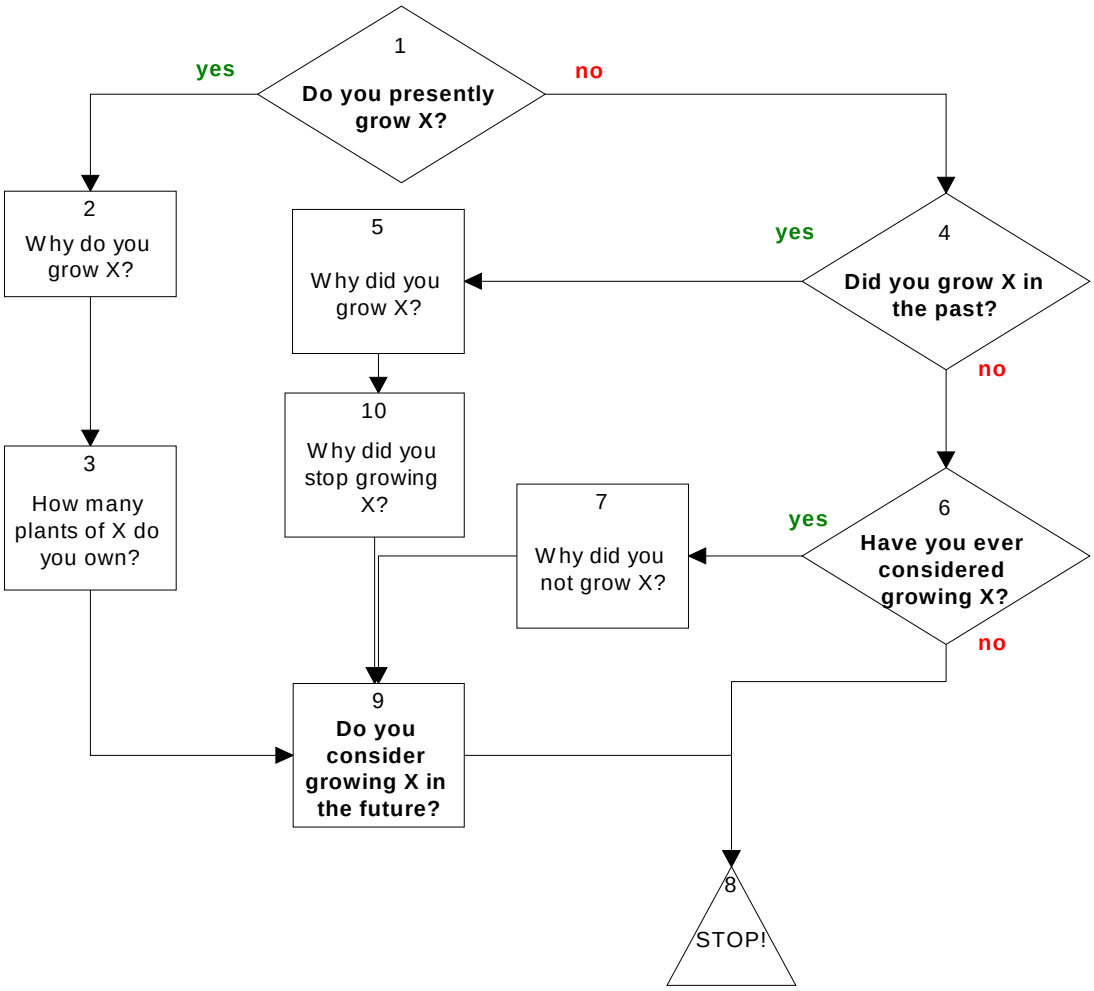
5.2. Does constraint X influence your decision to grow species Y? If No, proceed to the next constraint. If Yes, how likely is constraint X (0=certainly not; 25=unlikely; 50=as unlikely as likely; 75=very likely and 100=absolutely certain) to occur?

Appendix 1: (Contd.)

1. Species list

1. *Eucalyptus camaldulensis (Key Behrzaf)*
2. *Eucalyptus globulus (Nech Bahrzaf)*
3. *Juniperus excelsa (Yeabesha tid)*
4. *Cupressus lusitanica (Yeferenj tid)*
5. *Cordia africana (Wanza)*
6. *Arundinaria alpina (Kerkeha)*
7. *Coffea arabica (Buna)*
8. *Catha edulis (Chat)*
9. *Sesbania sesban (Sesbania)*
10. *Chamaecytisus proliferus (Lucern)*
11. *Rhamnus prenoides (Gesho)*
12. *Schinus molle*
13. *Citrus sinensis (Orange)*
14. *Citrus limon (Lomi)*
15. *Mangifera indica (Mango)*
16. *Carica papaya (Papaye)*
17. *Humulus lupulus (Hop)*
18. *Persea americana (Avocado)*
19. *Psidium guajava (Guyava)*
20. *Citrus medica (Citron)*

2. Flowchart



3. Likelihood scale

0=Certainly not; 25=Unlikely; 50=As unlikely as likely , 75=Very likely, 100=Absolutely certain

19. _____ *Number*_____

A

Nature of growing		Objectives	✔ ; x; Ø	How valuable is it for the objective				
				Very good	Good	Fair	Bad	Very bad
Present (1)	Y	Cash income						
		Construction						
	N	Fencing						
Past (4)	Y	Fuelwood						
		Household utensils						
	N	Reputation						
Considered (6)	Y	Saving						
		Aesthetic value						
	N	Erosion control						
Future (9)	Y	Food						
		Household use						
		Soil improvement						
	N	Coffee shade						
		Animal fodder						

B

Constraints	Influence crop yield/ decision-making	How likely
Competition effect		
Disease incidence		
Lack of know-how		
Lack of seedlings		
Low market demand		
Poor rainfall		
Poor soil quality		
Prohibitive government policy		
Shortage of draught power		
Shortage of labor		
Small holding size		
Wild animals' damage		

20. _____ *Number*_____

A

Nature of growing		Objectives	✔ ; x; Ø	How valuable is it for the objective				
				Very good	Good	Fair	Bad	Very bad
Present (1)	Y	Cash income						
		Construction						
	N	Fencing						
Past (4)	Y	Fuelwood						
		Household utensils						
	N	Reputation						
Considered (6)	Y	Saving						
		Aesthetic value						
	N	Erosion control						
Future (9)	Y	Food						
		Household use						
		Soil improvement						
	N	Coffee shade						
		Animal fodder						

B

Constraints	Influence crop yield/ decision-making	How likely
Competition effect		
Disease incidence		
Lack of know-how		
Lack of seedlings		
Low market demand		
Poor rainfall		
Poor soil quality		
Prohibitive government policy		
Shortage of draught power		
Shortage of labor		
Small holding size		
Wild animals' damage		

21. _____ *Number*_____

A

Nature of growing		**Objectives**	**✔ ; x; Ø**	**How valuable is it for the objective**				
				Very good	Good	**Fair**	**Bad**	**Very bad**
Present (1)	Y	Cash income						
		Construction						
	N	Fencing						
Past (4)	Y	Fuelwood						
		Household utensils						
	N	Reputation						
Consid ered (6)	Y	Saving						
		Aesthetic value						
	N	Erosion control						
Future (9)	Y	Food						
		Household use						
		Soil improvement						
	N	Coffee shade						
		Animal fodder						

B

Constraints	**Influence crop yield/ decision-making**	**How likely**
Competition effect		
Disease incidence		
Lack of know-how		
Lack of seedlings		
Low market demand		
Poor rainfall		
Poor soil quality		
Prohibitive government policy		
Shortage of draught power		
Shortage of labor		
Small holding size		
Wild animals' damage		

22. _____ *Number*_____

A

Nature of growing		**Objectives**	**✔ ; x; Ø**	**How valuable is it for the objective**				
				Very good	Good	**Fair**	**Bad**	**Very bad**
Present (1)	Y	Cash income						
		Construction						
	N	Fencing						
Past (4)	Y	Fuelwood						
		Household utensils						
	N	Reputation						
Consid ered (6)	Y	Saving						
		Aesthetic value						
	N	Erosion control						
Future (9)	Y	Food						
		Household use						
		Soil improvement						
	N	Coffee shade						
		Animal fodder						

B

Constraints	**Influence crop yield/ decision-making**	**How likely**
Competition effect		
Disease incidence		
Lack of know-how		
Lack of seedlings		
Low market demand		
Poor rainfall		
Poor soil quality		
Prohibitive government policy		
Shortage of draught power		
Shortage of labor		
Small holding size		
Wild animals' damage		

23. _____ *Number*_____

A

Nature of growing		**Objectives**	**✔ ; x; Ø**	**How valuable is it for the objective**				
				Very good	Good	**Fair**	**Bad**	**Very bad**
Present (1)	Y	Cash income						
		Construction						
	N	Fencing						
Past (4)	Y	Fuelwood						
		Household utensils						
	N	Reputation						
Consid ered (6)	Y	Saving						
		Aesthetic value						
	N	Erosion control						
Future (9)	Y	Food						
		Household use						
		Soil improvement						
	N	Coffee shade						
		Animal fodder						

B

Constraints	**Influence crop yield/ decision-making**	**How likely**
Competition effect		
Disease incidence		
Lack of know-how		
Lack of seedlings		
Low market demand		
Poor rainfall		
Poor soil quality		
Prohibitive government policy		
Shortage of draught power		
Shortage of labor		
Small holding size		
Wild animals' damage		

24. _____ *Number*_____

A

Nature of growing		**Objectives**	**✔ ; x; Ø**	**How valuable is it for the objective**				
				Very good	Good	**Fair**	**Bad**	**Very bad**
Present (1)	Y	Cash income						
		Construction						
	N	Fencing						
Past (4)	Y	Fuelwood						
		Household utensils						
	N	Reputation						
Consid ered (6)	Y	Saving						
		Aesthetic value						
	N	Erosion control						
Future (9)	Y	Food						
		Household use						
		Soil improvement						
	N	Coffee shade						
		Animal fodder						

B

Constraints	**Influence crop yield/ decision-making**	**How likely**
Competition effect		
Disease incidence		
Lack of know-how		
Lack of seedlings		
Low market demand		
Poor rainfall		
Poor soil quality		
Prohibitive government policy		
Shortage of draught power		
Shortage of labor		
Small holding size		
Wild animals' damage		

25. _____ *Number*_____

A

Nature of growing		**Objectives**	**✔ ; x; Ø**	**How valuable is it for the objective**				
				Very good	Good	**Fair**	**Bad**	**Very bad**
Present (1)	Y	Cash income						
		Construction						
	N	Fencing						
Past (4)	Y	Fuelwood						
		Household utensils						
	N	Reputation						
Consid ered (6)	Y	Saving						
		Aesthetic value						
	N	Erosion control						
Future (9)	Y	Food						
		Household use						
		Soil improvement						
	N	Coffee shade						
		Animal fodder						

B

Constraints	**Influence crop yield/ decision-making**	**How likely**
Competition effect		
Disease incidence		
Lack of know-how		
Lack of seedlings		
Low market demand		
Poor rainfall		
Poor soil quality		
Prohibitive government policy		
Shortage of draught power		
Shortage of labor		
Small holding size		
Wild animals' damage		

26. _____ *Number*_____

A

Nature of growing		**Objectives**	**✔ ; x; Ø**	**How valuable is it for the objective**				
				Very good	Good	**Fair**	**Bad**	**Very bad**
Present (1)	Y	Cash income						
		Construction						
	N	Fencing						
Past (4)	Y	Fuelwood						
		Household utensils						
	N	Reputation						
Consid ered (6)	Y	Saving						
		Aesthetic value						
	N	Erosion control						
Future (9)	Y	Food						
		Household use						
		Soil improvement						
	N	Coffee shade						
		Animal fodder						

B

Constraints	**Influence crop yield/ decision-making**	**How likely**
Competition effect		
Disease incidence		
Lack of know-how		
Lack of seedlings		
Low market demand		
Poor rainfall		
Poor soil quality		
Prohibitive government policy		
Shortage of draught power		
Shortage of labor		
Small holding size		
Wild animals' damage		

Appendix 1: (Contd.)

27. Have you ever participated in agricultural/ agroforestry training program of the MoA? Yes No

28. Which tree species have you planted and/or retained during the last two years?

Year (Eth.)	Tree species	Source of seedlings	Total number	Planting niches	Arrange-ment	Survival rate (%)
1991						
1992						

Key for sources of seedlings: 1=Self raised, 2=MoA nursery, 3=Bought from market, 4=Wildlings, 5=Others

Key for planting niches: 1=Around homestead, 2=Within farm/grazing land, 3=On contour bunds, 4=Along boundary, 5=Along roads, 6=Along/within gullies, 7=Block plantation, (a= on crop land, b= on uncultivated land, c= on grazing land), 8=Others (specify)

Key for arrangement: 1=Zonal, 2=Linear, 3=Scattered, 4=Mixed, 5=Others (Specify!)

29. If high proportion of the planted trees died explain the reasons. _____
_____ _____

30. Have you changed any of the previous tree plantations to agricultural use? Y N If yes,

	Land quality	Trees species abandoned	Area	Crop(s) grown	Reasons for replacement
1.					
2.					

Key for land quality: 1=Very productive/fertile, 2=Productive, 3=Intermediate, 4=Poor, 5=Very poor

Key for reasons: 1=Reduced holding size, 2=Restoration of fertility, 3=Falling prices of tree products , 4=Decline of yield from other plots, 5=Worsening negative effects of trees on crops, 6=Others

31. Which tree species do you avoid planting within and around farms? Why? Which ones do you prefer to grow within and around farms? (Please, prioritize each!)

	Tree species not preferred	Reason for not planting	Tree species preferred
1.			
2.			
3.			

Key for reasons: 1=Suppress crop growth, 2=Compete for crop growing space, 3=Harbor harmful vermins and birds, 4=Impede plowing by tractors, 5=Others (Specify!)

32. In cases of emergency and foreseen or unforeseen incidences which assets/possessions do you liquidate to get money? Please, prioritize in order of importance.

1. _____ 2. _____
3. _____ 4. _____

Key for assets: 1=Livestock, 2=Stored grains, 3=Wood from own plantation, 4=Fuelwood from communal/state forests, 5=Others (Specify!)

33. Which energy sources (both biomass and modern) do you use for household cooking, lighting, and heating; who is responsible for acquiring each? Please, prioritize!

Appendix 1: (Contd.)

	Fuel material	Decision-maker	Acquisition		Walking distance (one way, hr. min.)	Who collects
			Source	Frequency		
1.						
2.						
3.						

Key to fuel material: 1=Fuelwood, 2=Crop residue, 3=Cow dung, 4=LP gas, 5=Solar energy, 6=Electric energy
Key to acquisition source: 1=Own farm, 2=Neighbors' farms, 3=Communal plantations, 4=State forests, 5=Market, 6=Others (Specify!)

34. What are the major problems in acquiring and using fuel materials?
1=Decline in soil fertility, 2=Conflict with village leaders, 3=Conflict with forestry personnel, 4=Long walking distance, 5=High costs, 6=Health problem, 7=Others (Specify!)

35. Have you bought fuel material in the last 12 months? Y N If yes, how much was the price per bundle/liter and how much of it do you use for one month?

	Fuel type	Price per donkey bundle (Eth. Birr)	Price per women's back bundle (Birr)	Price per lit. (Birr)	Quantity for one month
1.					
2.					
3.					

36. Which energy saving mechanisms do you use? From where did you get /hear about them?

No.	**Type of energy saving mechanisms**	**Source of the mechanism**
1.		
2.		

37. How far is the drinking water point from your house and who is responsible for fetching?
Responsible (Name) _____ Distance (rainy season) _____km
Walking time (rainy season): _____hrs/mins. Distance (dry season) _____km
Walking time (dry season) _____hrs/mins.

38. Is/are there communal and/or state forest(s) from where you can freely harvest wood products? Yes No If yes,

39. How far is the nearest communal/state forest from here? _____km _____hr. / min. walking distance

40. Which wood products do you harvest from these forests? _____ _____
_____ _____ _____

41. Which **other** tree species could have been grown? Give reasons/objectives for each of them.

No	Tree species	Objectives
1.		
2.		
3.		

42. Mention the constraints that prohibited you from planting these species.

Appendix 1: (Contd.) _____

Species 1. _____ Species 2. _____ Species 3. _____
_____ _____ _____
_____ _____ _____

Farm and off-farm cash generating activities

43. In which off-farm activities was your household involved during the last 12 months and how much did they contribute?

Off-farm activity	Who was involved? (Name)	Total days worked	Income/item earned per day			
			Cash (Birr)	In kind[1]		
				Item	Unit	Amount
Farm wage work						
Food-for-work						
Town work						
Sales of fuelwood						
Local trade[2]						
Lending money						
**						

** Add other activities as mentioned by the interviewee.
[1] Mention here non-cash earnings such as grain, oil, farm inputs, etc.
[2] For income indicate trade profit: Sales price minus purchase price of a traded item.
[2] List here the type of commodities. _____ _____ _____

44. Did your household receive remittance money or gifts in kind from outside last year? Y N If yes,

No.	From whom (relationship)	Cash (Birr)	Used for	Item	Value (Birr)	How critical
1.						
2.						
3.						

Key for used for: 1=Purchase of food, 2=Purchase of clothing, 3=Purchase of farm inputs, 4=Purchase of commodities, 5=Savings, 6=Purchase of animals, 7=Others (Specify!)
Key for how critical: 1=Very indispensable, 2=Indispensable, 3=Necessary, 4=Just important, 5=Not important

45. How many heads of animals (cattle and equines) have you sold during the last two years? How much cash was generated?

No.	Year	Animal sold	Cash generated (Birr)
1.			
2.			
3.			
4.			

46. How much cash income have you generated from sales of agricultural crops during the last cropping season?

Crop sold	**Amount**	**Marketing channel**	**Total revenue**

Appendix 1: (Contd.) _____

47. Which tree products have you sold during the last five years and how much cash is generated?

	Year sold	Tree species	Type of product	Marketing channels	Cash gene-rated (Birr)
1.					
2.					
3.					
4.					

Key for type of product: 1=Construction pole, 2=Standing trees, 3=Fuelwood, 4=Others (Specify)
Key for marketing channels: 1=Local markets, 2=Neighbours, 3=Intermediate brokers, 4=National market (Addis Ababa), 5=Others (Specify)

48. Have you borrowed money during the last 2 years? YesNo
If yes, from whom/where and for what purpose?

	Year	Amount (Birr)	Lender	Interest rate	Purpose	Liquida-tion time	Decision -maker	Limits to borrow	
								Minimum	Maximum
1.									
2.									
3.									

Key for purpose: 1=Purchase of food, 2=Purchase of animals, 3=Purchase of farm input, 4=Marketing of products, 5=Others (Specify!)
Key for decision-maker: 1=Husband, 2=Wife (Wives), 3=Joint decision, 4=Son(s), 4=Daughter(s), 5=Hired labor (M=male; F=female) 6=Others (Specify)

49. Are you required to prove with a possession of fixed asset to borrow money? YesNo
If yes, which assets are considered as insurance? _____

Level of conviction to various farm ideas

50. Please, tell me weather you strongly agree = 1, agree = 2, it depends = 3, disagree = 4 or strongly disagree = 5 to each of the following statement.

	Statement	Response
1.	Improved crop varieties are more productive and risk tolerant	
2.	I worry that the productivity of land is continuously declining	
3.	I should adopt a cropping system that enhances soil and water conservation	
4.	If I plough with oxen, I can substantially increase my yield	
5	I concentrate on sustaining the life of my family rather than sacrificing for sustainable future production	
6.	I regard on-farm tree planting as insurance against risks, providing variety of food and cash in cases of emergency	
7.	On-farm tree planting generally improves household livelihood	
8.	*Eucalyptus* planting is and will continue to be more profitable per unit area than agricultural crops	
9.	Marketing cooperatives help us overcome tree marketing problems and increase our earnings	
10.	Highly degraded lands can be brought into productive use by integrating soil enriching trees/shrubs	
11.	Forests are essential for wildlife habitat	
12.	Forests/trees maintain ecological balance (less drought)	
13.	On-farm trees management is less labor intensive than other crops	

14.	On-farm trees greatly reduce soil erosion and crop damage	
15.	Agroforestry secures dry-season fodder production	
16.	Trees increase honey production and quality	
17.	Long-term gestation period of trees impede heavy reliance on them	
18.	Trees harbor harmful animals and disease organisms	
19.	In tree planting I take decisions by my own	
20.	The seedlings that I get from DBA nurseries meet my priorities	
21.	If I get better information and MPTS seeds I will plant more trees on my farm	
22.	Development projects address our felt needs and priorities	
23.	It is very difficult for me to contact the extension agent	
24.	I am interested in trying new farm technologies on my farm	

Intrahousehold decision-making in farm and forestry operations

51. Who is responsible for the following decision-makings and farm operations? If it is a hired labor how much wage do you pay per person per day?

	Farm activity	Decision-maker	Operator	Wage (Birr/day)
1.	Land preparation			
2.	Crop sowing/planting			
3.	Fertilizer requirement/purchase			
4.	Fertilizer application			
5.	Weeding			
6.	Harvesting/threshing			
7.	Marketing of crops			
8.	Storage of agricultural produce			
9.	Purchase/sales of animals			
10.	Feeding schedule, herding			
11.	Selection of tree planting niches			
12.	Selection of tree species			
13.	Raising and/or purchasing seedlings			
14.	Planting of trees			
15.	Pruning/Pollarding/Lopping/ Thinning			
16.	Rotation age/Harvesting			
17.	Sales of tree products			
18.	Investment of financial income			
19.	Saving of financial income			
20.				

Key for decision-maker and operator: 1=Husband, 2=Wife (Wives), 3=Joint decision, 4=Son(s), 4=Daughter(s), 5=Hired labor (M=male; F=female) 6=Others (Specify)

Soil management systems

52. Which traditional soil fertility maintenance and/or restoration, apart from tree planting do you employ?

a. Crop rotation (Please, indicate cropping sequence!)

	First order crops	Second order crops	Third order crops
1.			
2.			
3.			

b. Fallowing No. of fallowing years _____

Appendix 1: (Contd.) _____

c. Manuering (with dung and crop residues) d. Burning of crop residue
e. Burning of soil (gay) f. Others (Specify!)

53. Which soil conservation measures do you apply on your farm plots?

	Land use type	Area	Slope	Soil conservation		Man-days required	Effects of the structure
				Type	Length		
1.							
2.							
3.							

Key for land use type: 1=Enset, 2=Annual crops, 3=Chat, 4=Coffee, 5=Potato, 6=Grazing land, 7=Tree/shrub plantations, 8=Others (Please, specify)
Key for slope: 1=Flat, 2=Moderate slope, 3=Steep slope, 4=Very steep slope
Key to conservation types: 1=Bench terraces, 2=Soil/stone bunding, 3=Cut-off drains, 4=Check dams, 5=Contour planting of trees/grasses, 6= Others (Specify)
Key for effects: 1=Lower soil erosion, 2=Higher crop yields, 3=Lower crop yields, 4=More crop damaging vermins, 5=More maintenance work, 6=Others (Specify!)

54. How did soil fertility in your area change over the past 50 years?

a) Decreased much b) Decreased a little c) Not changed
d) Increased a little e) Substantially increased f). No idea

55. Reasons for change in soil fertility: _____

56. Can you please, tell me how the vegetation cover of your area has changed during the last 50 years?

a) Significantly reduced b) Slightly reduced c) Remained the same d) Slightly improved e) Significantly improved

Food security situations

57. How many enset plants do you own? _____

58. How long does enset take to mature? _____ years.

59. What are the major problems in enset growing? _____
_____

60. Can you meet the annual food needs of the household? Yes No
If no, since when? _____

61. What are the main reasons? _____

62. How do you compare the present decade with the previous ones in terms of food security and living standards?

a) Much better b) Slightly better c) Same d) Worse e) Much worse

63. What are the main reasons? _____
_____

64. What were your short- and long-term strategies to tackle the food shortage problems?

Appendix 1: (Contd.) _____

Short-term strategies Long-term strategies

a)_____ _____

b)_____ _____

Coping with risks and uncertainties

65. Which of the following land use type is more vulnerable to risk of annual crop loss? Assess according to the following criteria: 1=Risky, 2= Moderately risky, 3= Not risky

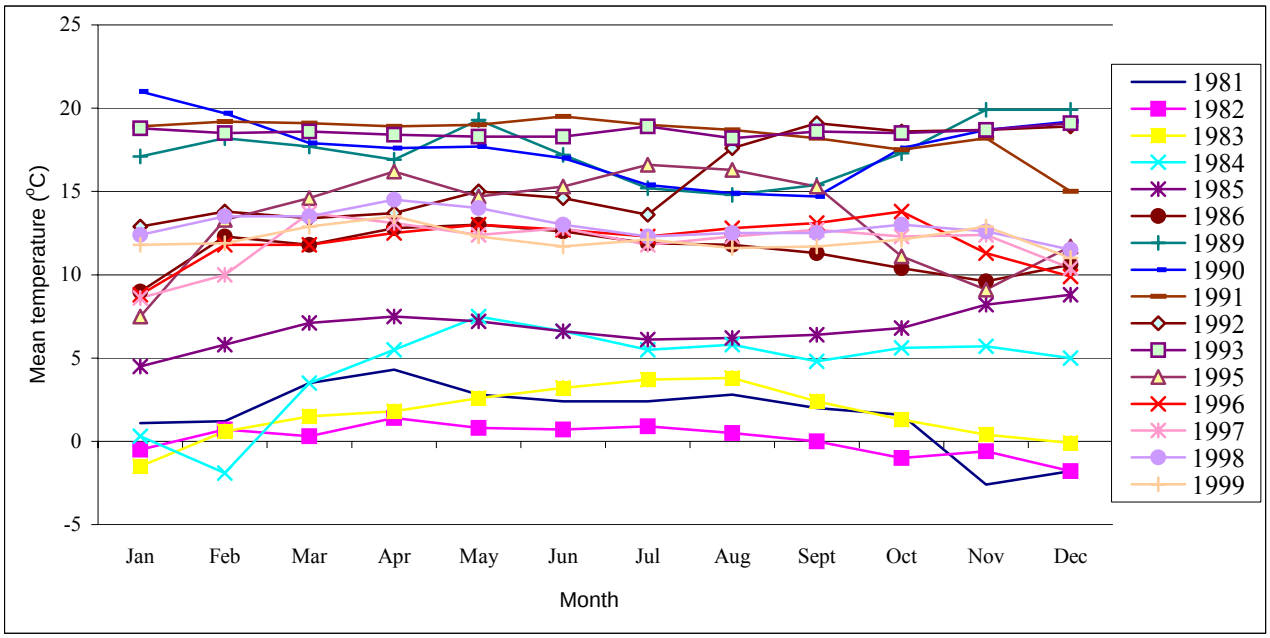
	Land use type	**Risk level**
1.	Enset crop	
2.	Annual food crops	
3.	Fruit trees	
4.	Vegetables	
5.	Cash crops (chat and coffee)	
6.	Mixed cropping	
7.	Agroforestry	
8.	Pure tree stands	

66. Please, describe the type of farm constraints that hinder the progress of your farm practices and possible solutions to overcome the problem. How critical is this constraint?

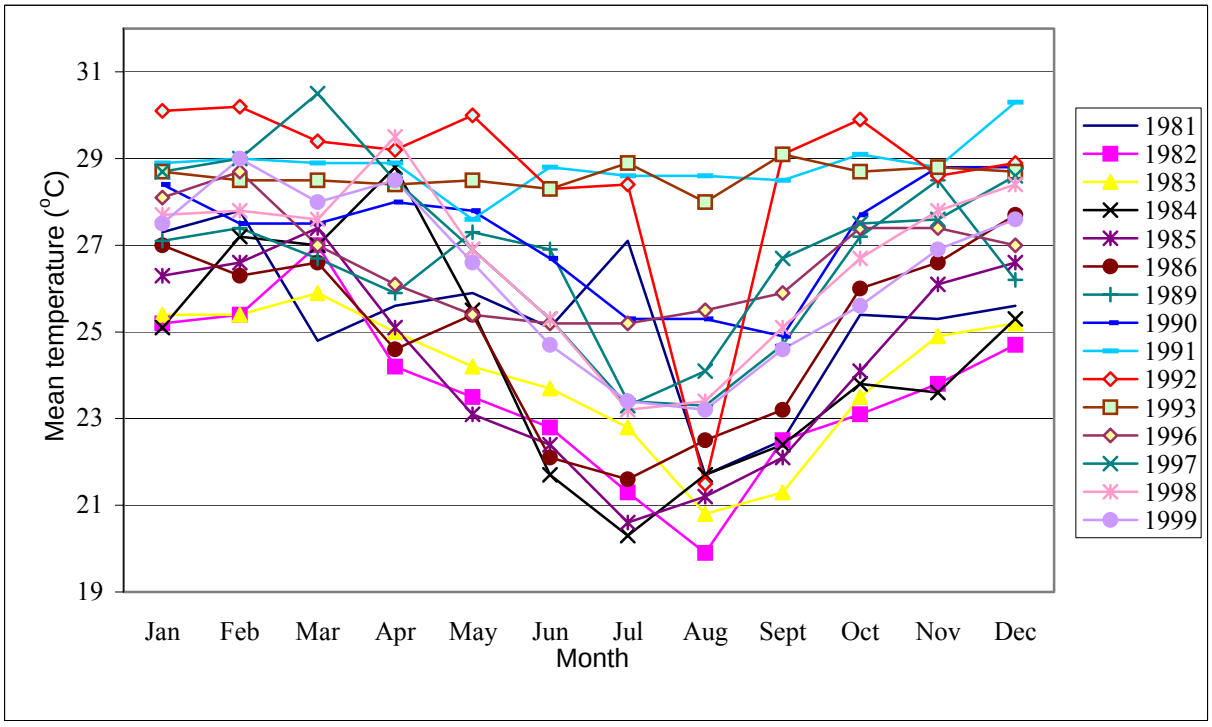
	Farm constraints	**Severity**	**Solution**
1.	Land tenure problems		
2.	Shortage of land		
3.	Tree use rights		
4.	Poor soil fertility		
5.	High soil erosion		
6.	Weak extension services		
7.	Shortage of farm labor		
8.	Lack of credit services		
9.	Low product prices		
10.	Poor transport facilities		
11.	High commodity price		
12.	Post-harvest losses		
13.	Backward farm implements		
14.	Low rainfall		
15.	Excessive rainfall		
16.	Frost damage		
17.	Hail damage		
18.	Pest outbreak		
19.	Lack of off-farm works		
20.	High cost of fertilizers		
21.	Lack of improved varieties		
22.	Lack of pesti-/weedicides		
23.	Lack of oxen for plowing		
24.	Lack of irrigation water		
25.	Wild animals' damage		
26.	Crop diseases		
27.	Lack of animal fodder		
28.	Animal disease		
29.			

Key for severity: 1=Very critical, 2=Critical, 3=Moderate, 4=Minor, 5=Not felt at all.

Appendix 2: Mean minimum and maximum monthly temperature in the study area[16]



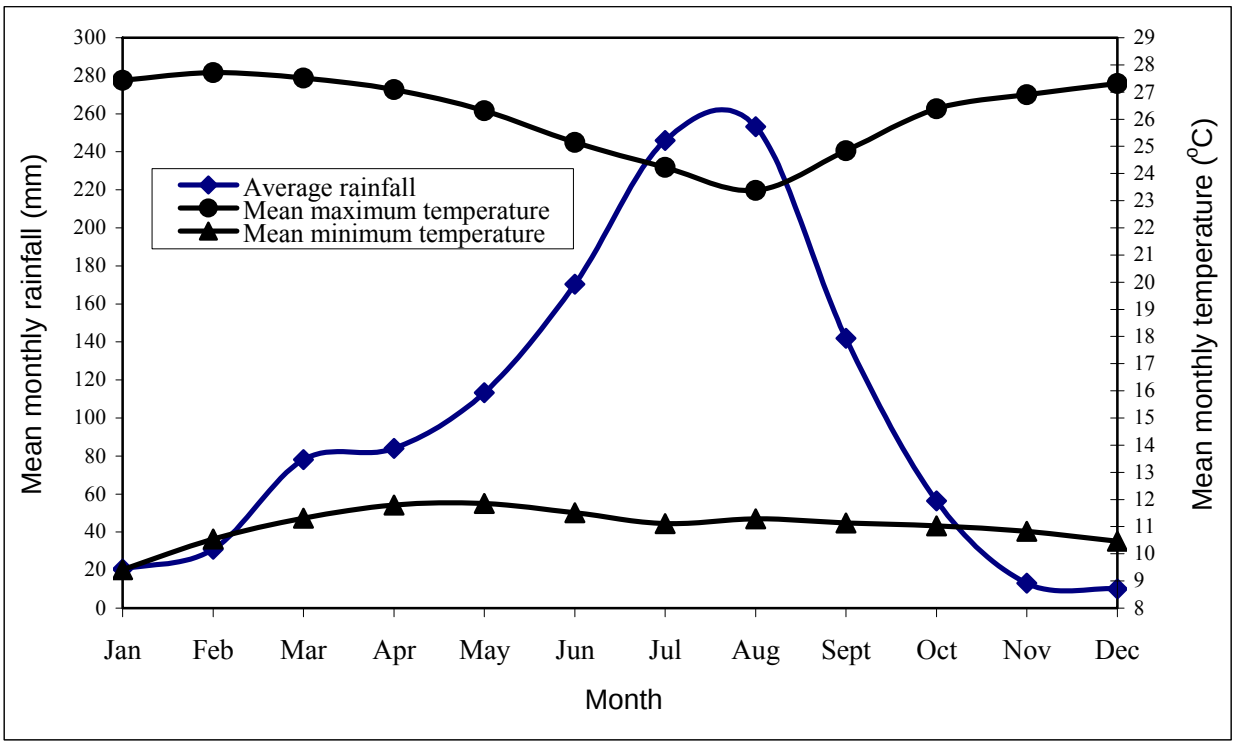
Monthly mean minimum temperature of Imdebir (2480 masl), Guraghe Zone between 1981 and 1999



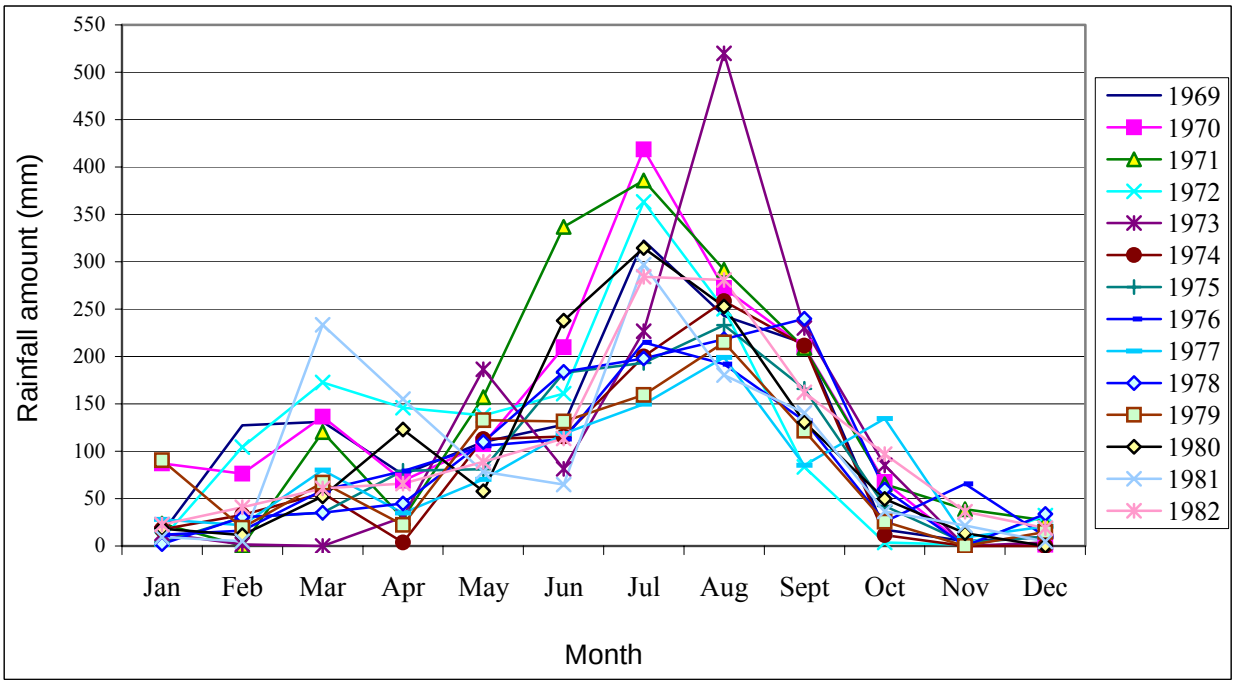
Monthly mean maximum temperature of Imdebir (2480 masl), Guraghe Zone between 1981 and 1999

[16] All climatic data were recorded at Imdebir metrological center (2480 masl).

Appendix 3: Monthly distribution of rainfall as well as maximum and minimum temperatures

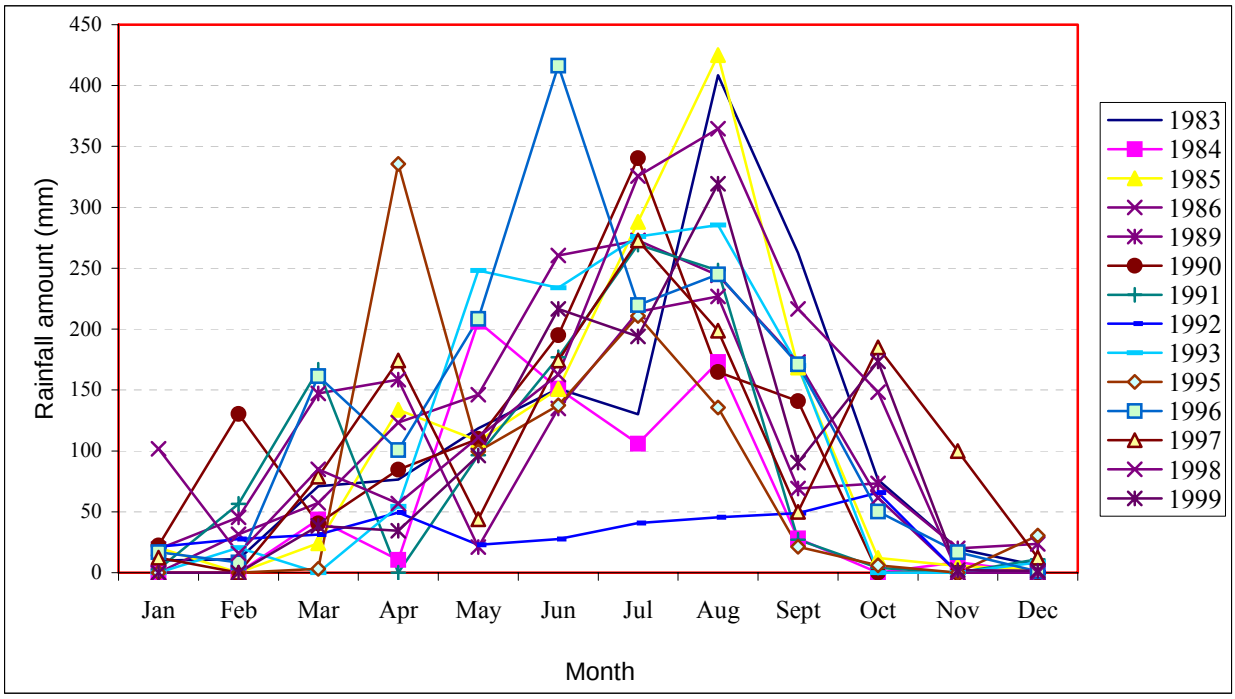


a) Mean values for the period 1969-1999



b) Monthly rainfall distribution of the study area between 1969 and 1982

Appendix 3: (Contd.)



c) Monthly rainfall distribution of the study area between 1983 and 1999

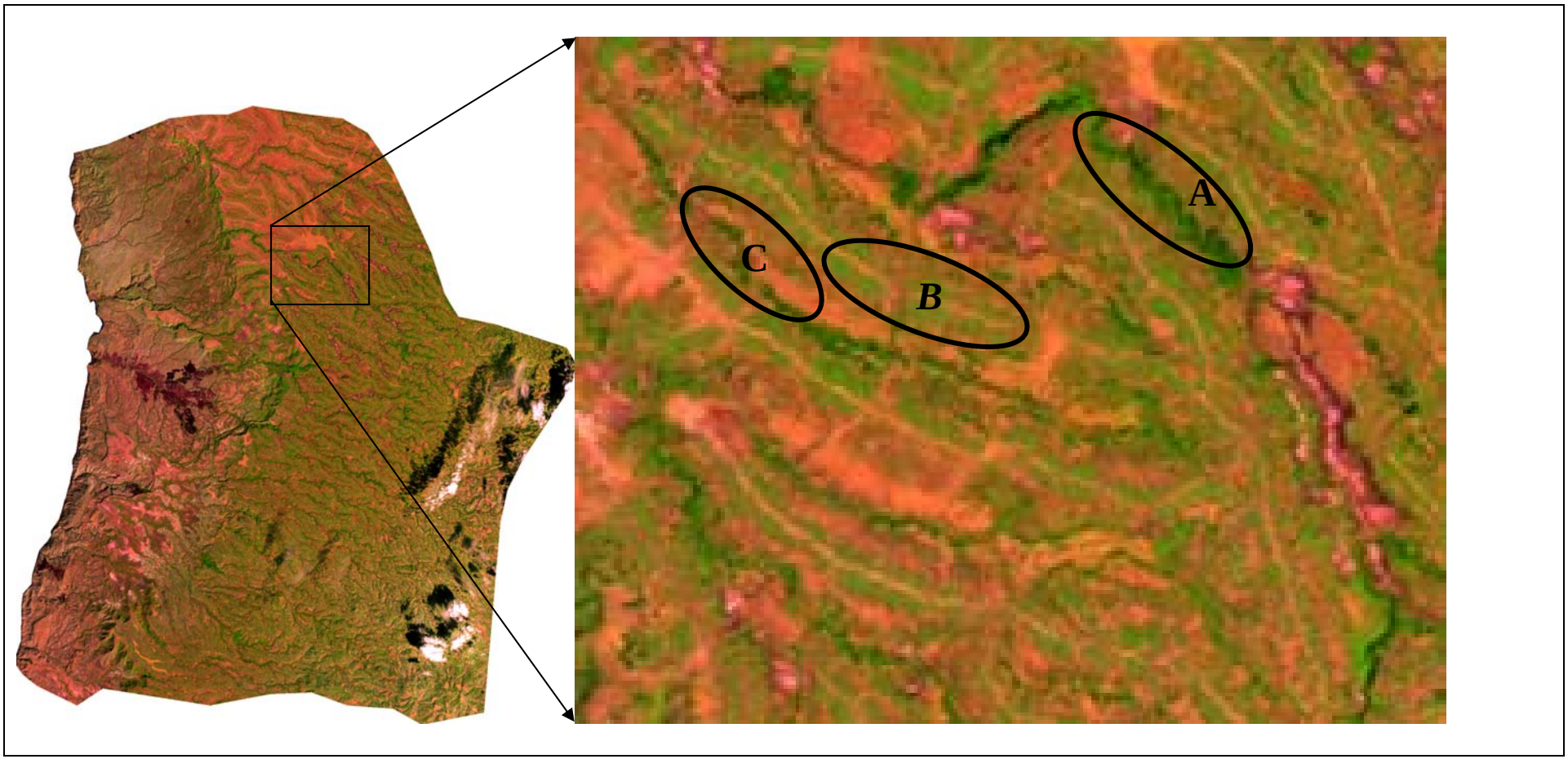
Appendix 4: The agro-ecological zones of Ethiopia

Altitude >3700m above sea level		**HIGH WURCH** A: None (Frost limit) C: None S: Black soils, little T: *Hypericum quartinanum, H. reoperianum*	**Legend** A: Main crop C: Traditional conservation S: Soil on slopes T: Natural trees/shrubs
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, higly degraded T: *Erica arborea, Hypericum reoperianum,H. 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, *E. teff* C: Water retention terraces S: Yellow sandy soils T: *Balanites aegyptiaca, Baswellia papyrifera, B. 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, Erythrina 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*
>500m 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 900mm	900-1400 mm	More than 1400 mm

Source: Adapted from Bekele-Tesemma (1997).

Appendix 5: Partial view of land use patterns of the Enemor and Ener district (based on the digital elevation model of the district)

A: Deep green color represents streamline vegetation
B: Light green color depicts enset plantations in the homegarden separated by Joforos
C: Eucalypt woodlots at the furthest extreme part of the homegardens



Appendix 6: Household labor force - man equivalent (ME) conversion ratios adopted in the study

Labor force		Man equivalent value
Age group (years)	Sex	
Below 8	Male	0.0
	Female	0.0
8-13	Male	0.2
	Female	0.2
14-17	Male	0.6
	Female	0.5
18-48	Male	1.0
	Female	0.8
49-58	Male	0.7
	Female	0.5
59-65	Male	0.4
	Female	0.3
Over 65	Male	0.1
	Female	0.1

Appendix 7: Levels and sources of perceived risks towards various cropping systems in various agro-ecological zones

Major crop	Major sources [1)]	Risk level	Highland	Middle altitude	Lowland	P [2)]
			% of respondents			
Enset crop	1, 2, 3	High	21.2	42.0	64.7	***
		Medium	19.2	50.6	29.4	
		Risk free	59.6	7.4	5.9	
Annual crops	6, 4, 7, 1, 8	Don't know	1.9	0.0	0.0	***
		High	28.8	70.4	17.6	
		Medium	65.4	22.2	70.6	
		Risk free	3.8	7.4	11.8	
Fruit trees	2, 1	Don't know	76.9	8.6	5.9	***
		High	7.7	39.5	11.8	
		Medium	7.7	39.5	76.5	
		Risk free	7.7	12.3	5.9	
Vegetables		Don't know	30.8	4.9	11.8	***
		High	11.5	44.4	17.6	
		Medium	26.9	39.5	58.8	
		Risk free	30.8	11.1	11.8	
Coffee	1, 3, 4	Don't know	73.1	0.0	0.0	***
		High	17.3	84.0	58.8	
		Medium	9.6	14.8	41.2	
		Risk free	0.0	1.2	0.0	
T'chat	1, 5, 4	Don't know	69.2	0.0	0.0	***
		High	3.8	6.2	17.6	
		Medium	23.1	72.8	82.4	
		Risk free	3.8	0.0	0.0	
Mixed cropping		Don't know	75.0	0.0	0.0	***
		High	5.8	16.0	5.9	
		Medium	13.5	72.8	82.4	
		Risk free	5.8	11.1	11.8	
Agroforestry		Don't know	61.5	2.5	0.0	***
		High	9.6	12.3	11.8	
		Medium	17.3	64.2	70.6	
		Risk free	11.5	21.0	17.6	
Pure tree stands		Don't know	3.8	1.2	0.0	*
		High	5.8	1.2	0.0	
		Medium	11.5	39.5	41.2	
		Risk free	78.8	58.0	58.8	
			n=52	n=81	n=17	

[1)] Major sources of risk in order of importance: 1 = Diseases; 2 = Wild animals' damage; 3 = Lack of animal manure; 4 = Drought; 5 = Low market price; 6 = shortage/high price of fertilizer; 7 = shortage of land; 8 = shortage of labor.

[2)] Significance levels (* at 0.05 & *** at 0.001).

Source: Field survey (2001).

Appendix 8: Species and number of seedlings raised by forestry and agroforestry section of the DBA

No.	Species	1996/97	1997/98	1998/99	1999/00	2000/01
1.	*Juniperus procera*	-	1015	-	1681	3833
2.	*Podocarpus falcatus*	2725	1353	-	3050	1709
3.	*Cupressus lusitanica*	11 000	52 694	140 488	11712	32160
4.	*Schinus molle*	2983	2304	-	3152	13940
5.	*Pinus patula*	-	4745	-	-	24902
6.	*Moringa oliefera*	-	1654	-	930	-
7.	*Jacaranda mimosifolia*	25 000	20 000	-	20 800	4960
8.	*Dodonea sp.*	-	3248	-	-	-
9.	*Acacia decurrens*	185 000	48 276	33 000	36 905	77 112
10.	*Delonix regia*	3000	488	-	-	-
11.	*Dovyalis abyssinica*	-	3886	12 000	34 988	-
12.	*Grevillea robusta*	14 845	15 650	8600	-	9554
13.	*Acacia albida*	-	1725	-	350	3248
14.	*Cordia african*	1000	3720	2000	15 000	12 350
15.	*Acacia abyssinica*	-	552	-	-	-
16.	*Albizia gummifera*	15 201	600	-	-	-
17.	*Millettia ferruginea*	8897	716	-	-	1500
18.	*Sesbania sesban*	14 531	33 399	35 000	86 056	50 900
19.	*Casuarina equisetifolia*	21 128	1896	10 000	16 690	15 840
20.	*Acacia saligna*	-	7997	-	20 730	17 990
21.	*Phoenix reclinata*	-	831	-	-	-
22.	*Olea europaea*	1144	774	-	4750	-
23.	*Hagenia abyssinica*	7246	-	-	-	10 500
24.	*Acacia melanoxylon*	50 000	-	6412	19 956	5890
25.	*Leucaena leucocephala*	8340	-	15 000	-	1024
26.	*Chamaecyticus palmensis*	9843	-	1500	-	-
27.	*Azadirachta indica*	1000	-	-	-	300
28.	*Cajanus cajan*	2000	-	-	-	-
29.	*Spathodea campanulata*	-	-	-	-	7588
	Total	(384883)	(207527)			(300000)

Source: DBA (2002).

Appendix 9: Use values of major tree/shrub species growing in the study district

No.	Species	Local name	Uses*											
			ST	FD	FW	C	HC	CS	LF	F	S/A	MH	MA	HU	MS
1.	*Podocarpus gracilior*	Zigva	x				x							x	
2.	*Juniperus procera*	Devat	x				x							x	
3.	*Cordia africana*	Koffe						x							
4.	*Croton macrostachys*	Woshehina													
5.	*Polyscias fulva*														
6.	*Phoenix reclinata*	Zenbe'a					x							x	2,5
7.	*Vernonia amygdalina*	Gora'a													
8.	*Calpurnia aurea*	Zenge'a							x						
9.	*Erythrina brucei*	Burat	x	x					x						
10.	*Maesa lanceolata*	Aguaj		x	x				x			x			1
11.	*Dombeya torrida*	Zewutere	x	x									x		
12.	*Êkebergia capensis*	Urer	x				x							x	
13.	*Bersama abyssinica*	Hurad			x									x	
14.	*Olea europaea*	Woira													3
15.	*Buddleja polystachya*	Anfuar					x		x	x					
16.	*Arundinaria alpina*	Enid					x								2,4,5
17.	*Brucea antidysenterica*	Aweriad						x					x		
18.	*Ficus sur*	Shebra	x				x							x	
19.	*Prunus africana*	Gereb					x				x			x	
20.		Gefe												x	
21.	*Hagenia abyssinica*	Tiwa	x		x									x	
22.	*Olea europaea*	Woira		x										x	
23.	*Acacia abyssinica*	Girar			x	x								x	
24.		Wura'e		x	x					x					
25.	*Combretum* spp.	Seyiba		x	x										

* Key for uses: ST = sown timber; FD = fodder; FW = fuelwood; HC = house construction; CS = coffee shade; LF = live fence; S/A = shade/aesthetic value, F = fencing; C = charcoal; MH = medicine for humans; MA = medicine for animals; HU = household utensils; MS = miscellaneous (1 = greasing the baking plate of injera, 2 = for carpet, 3 = the leaves and twigs are used for smoking pots to give a pleasant odor and flavor to milk and local beer, tella, 4 = for beehives, 5 = for house sweeping);
Source: Field survey (2001).

Appendix 10: Household attributes used in wealth status determination

The wealth categories were developed by working through several wealth-indicators. Each wealth indicator and corresponding values were carefully selected and introduced into the wealth analysis matrix. The values of each wealth indicator was then calculated for each household according to the number and/or size of the corresponding asset it possesses. This was followed by summing up the values of all wealth indicators for each household. Adopted wealth indicators are described in the following Table.

Cash income from trees/ shrubs	**Households that sold tree/shrub species over the 5-year period allocated1 point for every 100 birr revenue.**
Transfer money received	Households that received remittance money during the previous year allocated 1 point for every 100 birr received.
Number of oxen	Households were allotted 5 points for every ox they possess.
Number of cows	Households were allotted 4 points for every cow they possess.
Number of bulls/heifers	Households were allotted 3 points for every bull/heifer they possess.
Number of calves/sheep/goats	Households were allotted 1 point for every calf, sheep or goat they possess.
Number of donkeys	Households were allotted 3 points for every donkey they possess.
Number of horses	Households were allotted 4 points for every horse they possess.
Number of mules	Households were allotted 5 points for every mule they posses.
Number of hired laborers	Households were allotted 1 if hired 1-25 laborers; 2 if hired 26-50 laborers; etc.
Value of houses	Households were allotted 1 if total value of houses is between 1 and 1000 birr; 2 if total value is between 1001 and 2000 birr; etc.
Value of utensils	Households earned 1 point if value of utensils is between 1 and 100 birr; 2 if value is between 101 and 200 birr; etc.
Number of enset	Households earned 1 point if number of enset plants is between 1 and 100; 2 if the number is between 101 and 200; etc.
Food security	Households earned 1 point if they meet annual food demand of the family; 0 otherwise.

Revenues generated from sales of agricultural were intentionally excluded from the wealth status figures due to the fact that this was mainly practiced largely by highland households and thus has little value in measuring the likelihood of expanding eucalypt woodlots.

The total points of household wealth indicators ranged from 2 for the poorest household to 95 for the most better off household. The continuous and overlapping distribution of the points make delineation of households into various wealth groups a difficult task.

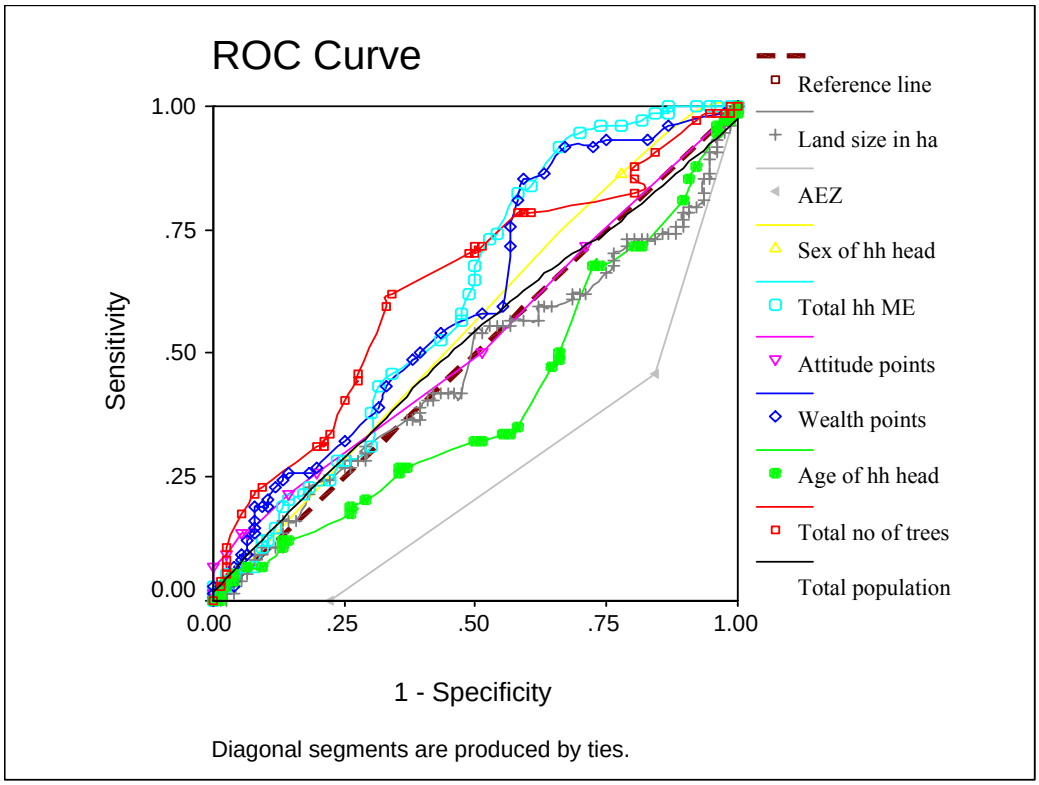
Appendix 10: (Contd.)

The attitude towards eucalypt planting was derived from three attributes that were selected for their better indicator quality. The attributes and respective values in the overall attitude points are presented in the following table.

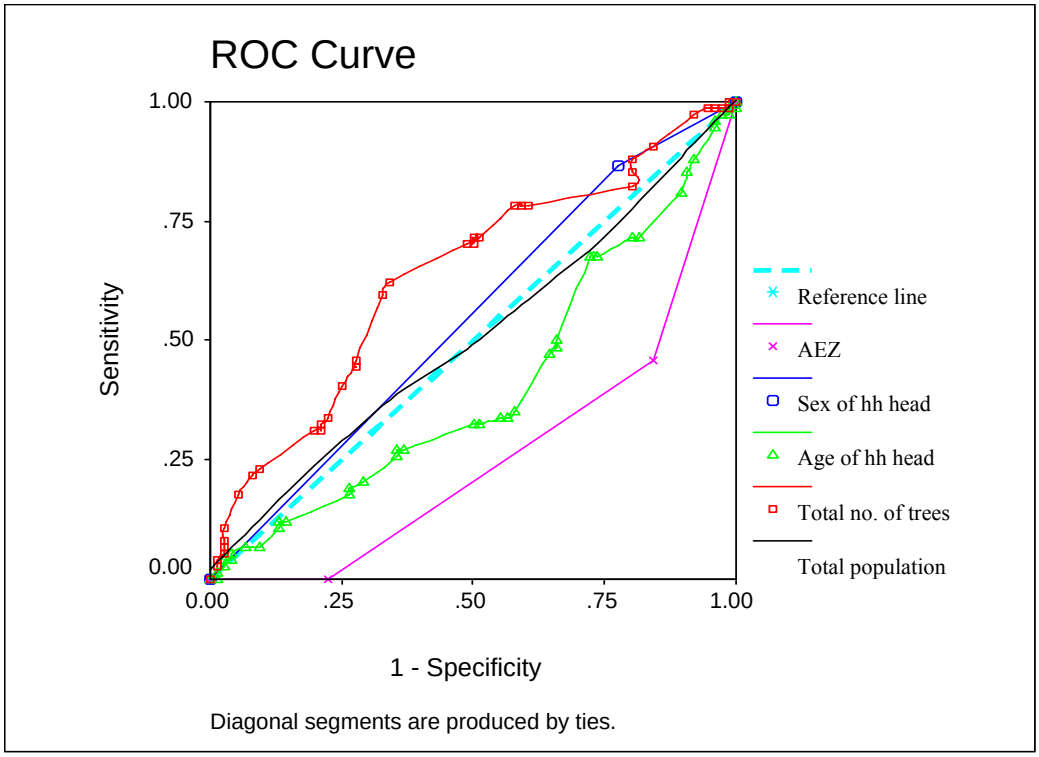
Attributes	**Original values**	**Corresponding values in the overall attitude points**
Liquidation rank during emergencies	Not Liquidated	0
	Third and Fourth	0.5
	First and Second	1
Amount of revenue generated from sales of eucalypts (Birr)	0-25	0
	26-100	1
	101-500	2
	More than 500	3
Profitability evaluation of eucalypts as compared other crops	Strongly agree	1
	Agree	1
	It depends	0.5
	Disagree	0
	Strongly disagree	0

The total attitude points for the survey household ranged between 0 for the households with strongest negative attitude towards the financial benefits of eucalypt woodlots and 5 for households with the strongest conviction on the positive financial values of eucalypt woodlots. About half of the survey households scored a total attitude point of 0.5 or less.

Appendix 11: Roc curves of correct predictions for the logistic regression model



a) with all eight explanatory variables.



b) with the four variables of significant influence.

Appendix 12: Amount of revenue generated from taxation of eucalypt pole and t'chat products by the DBF

Year	Tax revenue generated (Birr)	
	Eucalypt poles	T'chat
1995/96	250.00*	n.a.
1996/97	84326.67	n.a
1997/98	163278.00	7030825.00
1998/99	117778.00	4153137.00
1999/00	436123.00	467915.00

*A major part of the data is missing.
The data is kindly summarized and provided by a staff of the DBF.

Appendix 13: Details of assumptions in calculating the cost and benefit of Eucalypt pole ('woraj' size) production on 1 ha of marginal land

Stakeholder	Time	Cost (Birr)	Revenue (Birr)	Profit (Birr)
Farmer	7 years	2 413.00	16 666.65	14 253.65
Second trader	1 month	68 333.28	74 999.94	6 666.66
Third trader	1 month	75 833.27	150 000.00	74 166.73

Assumptions!

Farmer's costs (Birr):	Year1 :	Land tax	25.00
		Land cultivation (6.5 x 120)	780.00
		Pit digging (6.5 x 50)	325.00
		Seedling (10 000 x 2.5 cents)	250.00
		Planting (6.5 x 8)	52.00
		Fencing (6.5 x 24)	156.00
		Weeding (6.5 x 40)	260.00
		Regular attendance	30.00
	Year 2:	Land tax	25.00
		Fencing (6.5 x 7)	45.50
		Weeding (6.5 x 15)	97.50
		Regular attendance	25.00
	Year 3:	Land tax	25.00
		Fencing (6.5 x 3)	19.50
		Weeding (6.5 x 4)	26.00
		Regular attendance	20.00
	Year 4:	Land tax	25.00
		Fencing (6.5 x 3)	19.50
		Weeding (6.5 x 2)	13.00
		Regular attendance	20.00
	Year 5:	Land tax	25.00
		Fencing (6.5 x 3)	19.50

		Regular attendance	20.00
	Year 6:	Land tax	25.00
		Fencing (6.5 x 3)	19.50
		Regular attendance	20.00
	Year 7:	Land tax	25.00
		Regular attendance	20.00
Total cost			**2413.00**

Cost and revenue of second trader	Buying 10,000 poles (3333,33 bundles) (Bundle price = 6.50 Birr)	21666.65
	Tax (5.50 Birr per bundle)	18333.32
	Loading/unloading (0.50 Birr per bundle)	1666.67
	Transport cost (2400 for 300 bundles)	26666.64
	Sum of costs	**68333.28**
	Profit (2 Birr/bundle)	6666.66
	Total revenue	74999.94
Cost and revenue of final trader	Buying each bundle making a profit of 2 Birr/bundle for the second trader	74999.94
	Unloading (0.25 Birr/bundle)	833.33
	Total of costs	**75833.27**
	Total revenue	150 000.00
	Profit (sell each woraj at 15 Birr)	74 166.73

The entire calculation is based on the assumption that the farmer grows eucalypt poles for woraj (three of which make a bundle after 7 years rotation) at a spacing of 1 x 1 m and all 10,000 trees will survive to the final rotation.