International Centre for development
oriented Research in Agriculture (ICRA)

Ethiopian Agricultural Research
Organisation (EARO)
Melkassa Agricultural Research Centre (MARC)

"FOOD INSECURITY IN A BREAD BASKET"

Food security among households in the different agro-ecological zones in Arsi Negele Woreda, Ethiopia

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Setegn Gebeyehu

Khafiz Muminjanov

Angello Mwilawa

Kailash Rijal

Sidhakaran Subramaniam

Liang Weili

This report is a product of teamwork with equal contribution from the authors whose names are listed in alphabetical order

International Centre for development oriented Research in Agriculture (ICRA) P.O. Box 88, 6700 AB, Wageningen The Netherlands	Ethiopian Agricultural Research Organisation (EARO) Melkassa Agricultural Research Centre (MARC) P.O. Box 436 Nazareth Ethiopia

THE ICRA 2002 ETHIOPIA TEAM 1

Setegn Gebeyehu obtained his B.Sc. degree (in Plant Sciences) and M.Sc. degree (in Agronomy) in 1991 and 1997, respectively, from the Alemaya University of Agriculture, Ethiopia. He has worked at various positions on crop breeding and genetics research at Sinana (South-eastern Ethiopia) and Bako Agricultural Research Centres located in the Western parts of the country. He has also served as a teaching and research staff at Ambo College of Agriculture for two and half years. Currently, he is an associate researcher of breeding and genetics in the National Lowland Pulses Research Project based at Melkassa Agricultural Research Centre.

Address: P. O. Box 436, Melkassa Agricultural Reseach Center, Nazareth, Ethiopia, Tel. (251-2) 112186; Fax: (251-2) 114623;
E-mail: setegng@yahoo.co.uk or narc@telecom.net.et

Khafiz Abduvakhobovich Muminjanov was born in 1964 in Istaravshan City in the north of Tajikistan. After graduating from Tajik Agrarian University in 1987 up to now he is working at his alma mater. He obtained his MSc on Crop management (1987), PhD on Plant Physiology (1991) and DSc on Plant Breeding and Seed Multiplication (2000). He is as a Professor, Head, Department of Plant Physiology and Biotechnology, supervising the research work of MSc and PhD students, lecturing on plant physiology, biotechnology and plant breeding. In 2001 he attended CIMMYT Wheat Improvement Training Programme. Khafiz happily married, has 2 sons and 2 daughters and lives with his family in Dushanbe.

Address: 146, Rudaki av., Dushanbe 734017 Republic of Tajikistan, Tajik Agrarian University, Tel. (992-372) 33-19-60
E-mail: mha@cada.tajik.net mhafiz01@yahoo.com

Angello Joseph Mwilawa, Works with the Livestock Production Research Institute (LPRI), Mpwapwa, Tanzania. He attained his Bachelor of Science in Agriculture with specialisation in Animal Science and Production at Sokoine University of Agriculture, Tanzania. He received his Masters in Science in Range Ecology and Range Animal Nutrition, at the Univeristy of Nairobi, Kenya, 1996. He has been trained on Biophysical Modelling at Texas A & M University and in Savanna Modelling at Natural resource ecology laboratory, Colorado State University in US. He has experience of 12 years in research, particularly, on pastures and forages, range management, pastoral ecosystems integration and application of GIS and satellite images in Natural Resource Management. Angello is married to Fanikio and they have been blessed with two sons, Andrew and Amos.

Address: LPRI, P. O. Box 202, Mpwapwa, TANZANIA.
E-mail: Mwilawa@hotmail.com; Amwilawa@maf.or.tz

Kailash Rijal, born in Kathmandu, Nepal, in 1973, completed his Masters Degree on Finance in 1996 from the Tribhuvan University of Nepal. He is a development professional involved in the integrated rural development programmes in his own country for the last 10 years. Unmarried, Mr. Rijal is currently working at the capacity of Micro-credit Specialist in a NGO (Development Project Service Centre, DEPROSC-NEPAL).

Address: DEPROSC-NEPAL, P.O.Box. No.10953, Thapathali, Kathmandu, Nepal Tel: 009771-262396, (Off.) 009771-270799 (Res.)Email: info@deprosc.wlink.com.np

V. S. Sidhakaran is from Sri Lanka graduated in Agriculture from University of Peradeniya in Sri Lanka. He attained his Masters degree in Agricultural Extension from the same university in 1998 and a Postgraduate Diploma in Plantation Management from KAMC, Nilgiris in India. Presently, he is working for the Tea Research Institute of Sri Lanka as an Advisory Officer. Sidhakaran is married and has two daughters.

Address: Advisory and Extension Division, Tea Research Institute of Sri Lanka, Talawakelle, Sri Lanka. Tel. 0094 51 22601, 0094 5234945
E-mail: sidha@yahoo.com

Liang Weili, Ph.D, Professor of cropping systems and agroecology with 16 years experience in teaching and research on these topics; Resent 5-year research experiences on wheat-maize double cropping system modelling, management for high-yielding and nutrient-water efficient wheat-maize cropping system, structure adjustment in agricultural development.

Address: Department of agronomy, Hebei Agricultural University, Baoding, Hebei 071001, People's Republic of China.
Email: lwl@bdinfo.net; Wayleel@hotmail.com.

TEAM REVIEWER

Richard Hawkins Ph.D. (Nottingham, U.K.). Independent Development and Training Consultant, England. Twenty-five years experience in tropical agriculture, crop science and training for agricultural research in Africa, Latin America and Asia. From 1990-1998 staff member with ICRA and now ICRA associate staff. Married with 2 children.

Address: 5, Church Close, Wymington, Rushden NN10 9FG, UK
Email: richhawk@btinternet.com, richardlisbeth@hotmail.com

ABSTRACT

The study was conducted with the aim of analysing food security at household level and the impact of research technologies disseminated by MARC in Arsi Negele Woreda. Based on the output of this study, potential research & development options that can address the problem were identified.

The study revealed that 75%, 60% and 70% of the households in the highland, midland and lowland respectively, are not food self-sufficient for more than 6 months during a year, mainly because they sell grains after harvest to repay credit and to meet family expenses. Ownership of oxen, family size and land area has significant influence on food self-sufficiency and food security status. According to the calculation on food balance at woreda level, there is enough food potentially available for households. The calculation at household level however indicates that 40% and 75% of the households in midland and lowland respectively are food insecure, and other 60% and 25% are relatively secure in food after conducting some coping strategies, such as selling labour, charcoal, firewood, brewing, etc.

The problematique was studied in three dimensions — climatic risks (especially in the lowland), changes in economic environment and population pressure. Grain production especially in the lowland is inherently risky. Grain prices, declining soil fertility (especially in the midland) and the risk of drought shows that the benefits of fertiliser application are marginal. The continuing increase in population implies less cropping land per capita.

The scenario for future development of the woreda is likely to face four main driving forces: population pressure, input (fertiliser) prices, grain (maize & wheat) prices and alternative income generating opportunities. Two major strategies are identified for future development: (1) Breadbasket strategy and (2) Income generating strategy.

Assessment of technologies disseminated by MARC sub-centre shows that the adoption of most of the technologies is satisfactory. Suggestions are given for the urgent need of re-aligning the priorities of the activities of MARC sub-centre in order to create a greater positive impact on the problem situation.

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Our sincere appreciation is extended to Mr Girma Metaferiya the Head, Arsi Negele Woreda Agriculture Development Department and his entire staff who worked constantly with the team in different stages of the study. The Department provided most of the data required during the study. Development agents and chairmen of Peasant Associations are thanked for arranging meetings and providing relevant data during the field study.

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E-mail: mha@cada.tajik.net mhafiz01@yahoo.com

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Address: Advisory and Extension Division, Tea Research Institute of Sri Lanka, Talawakelle, Sri Lanka. Tel. 0094 51 22601, 0094 5234945 E-mail: sidha@yahoo.com

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Address: Department of agronomy, Hebei Agricultural University, Baoding, Hebei 071001, People's Republic of China.
Email: lwl@bdinfo.net; Wayleel@hotmail.com.

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Address: 5, Church Close, Wymington, Rushden NN10 9FG, UK
Email: richhawk@btinternet.com, richardlisbeth@hotmail.com

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ACRONYMS

AAU	Addis Ababa University
AARC	Awassa Agricultural Research Centre
AADA	African Aid Development Association
AEZ	Agro-Ecological Zone
AHA	African Humanitarian Action
AISCO/AISE	Agricultural Input Supply Corporation/Enterprise
AKIS	Agricultural Knowledge and Information System
AMC	Agricultural Marketing Corporation
ARD	Agricultural Research for Development
ATHPRC	Ambassel Trading House Private Limited Company
CBR	Cost Benefit Ratio
CBSCO	Community Based Savings and Credit Organisation
CDB	Co-operative Development Bank
CGIAR	Consultative Group on International Agricultural Research
CPD	Co-operative Promotion Department
CRV	Central Rift Valley
DA	Development Agent
DAP	Diammonium phosphate
DOA	Department of Agriculture
EARO	Ethiopian Agricultural Research Organisation
EAL	Ethiopian Amalgamated Limited
ECSA	Ethiopian Central Statistic Authority
EGTE	Ethiopian Grain Trade Enterprise
EPID	Extension Programme for Implementation Development
ESE	Ethiopian Seed Enterprise
HH	Household
GDP	Gross Domestic Product
FAO	Food and Agriculture Organisation of the United Nations
FRG	Farmer Research Group
FY	Financial Year
HQ	Headquarter
ICRA	International Centre for development oriented Research in Agriculture
KARC	Kulumsa Agricultural Research Centre
MARC	Melkassa Agricultural Research Centre
masl	Meter above sea level
MOA	Ministry of Agriculture
MOU	Memorandum of Understanding
MT	Metric tons
NGO	Non-governmental Organisation
PA	Peasant Association
R&D	Research and Development
SFI	Shashamene Forest Industry
SMS	Subject Matter Specialist
SSI	Semi-Structured Interview
TOR	Terms of References
USD	Dollar of United States of America
WADD	Woreda Agriculture Development Department
WIDS	Woreda Integrated Development Service

GLOSSARY

AKIS	The interlinked system of institutions and individuals involved in the generation, transfer and utilisation of knowledge and information for agricultural improvement
Agro-ecological zone	A major area of land broadly homogenous with regard to climatic and edaphic factors
Bole soil	Soil from lowland used as a mineral lick for cattle
Birr	Ethiopian unit of currency, 1 USD = 8.56 Birr in July 2002
Checklist	A list of criteria for questions to be used as a guide in informal surveys
Cropping pattern	The yearly sequence and spatial arrangement of crops on a given area
Crop rotation	Growing of two or more different crop types on a piece of land on rotation
Cropping system	The cropping patterns used on a farm and their interactions with farm resources, other farm enterprises and the technology, which determines their make-up
Enset	Indigenous food crop, false banana
Farming system	A collection of distinct functional units such as crops, livestock and marketing activities, which interact because of the joint use of inputs that they receive from the environment
Injerra	Local flat bread
Kebele	Village
Kotta	Land sharing practice
Livestock system	A group of techniques and practices carried out by the community to exploit the plant resources in a given space by the animals in conditions compatible with its objectives and the constraints of the environment
Off-farm activities	Activities performed by households not connected with agricultural production
Quintal (Q)	Unit of weight, 1 Q=100 kg
Reconnaissance survey	A survey based on informal interviews using a checklist aimed at describing farmers circumstances in a certain area and understanding what they do before in depth analysis of the farming systems
Sambusa	Food, prepared from dough and pulses
Shiro	Stew
Teff	Indigenous cereal crop
Typology	Model representing the structure and function of farming systems, which helps to categorise farms by "farm type" or "farm class" according to similarities as regards to development problems, like means of production or social relations
Woreda	Administrative unit equivalent to the district

EXECUTIVE SUMMARY

Introduction

Context and objectives of the study

The study reported represents a collaboration between the International Centre for development oriented Research in Agriculture (ICRA), based in The Netherlands, and Melkassa Agricultural Research Centre (MARC) of the Ethiopian Agricultural Research Organisation (EARO). Based on objectives developed by MARC, an ICRA team of 6 international scientists analysed the food security situation and rural livelihoods in Arsi Negele Woreda, and the impact of research results to date in the district, with the objective of identifying future research options for MARC and its subcentre located in the district.

Background

Arsi Negele Woreda (or District) of the East Shoa Zone, Oromiya Regional State, covers 1396 km^2, of which about 952 km^2 is land area. It is a major grain producing district, producing annually about 50,000 tons of maize, 35,000 tons of wheat, and some 25,000 tons of teff and sorghum. It is estimated that 30% of this production is exported from the Woreda. Arsi Negele also has a considerable livestock population (about 200,000 cattle and 70,000 goats and sheep).

For planning purposes, the Woreda Agricultural Development Department (WADD) groups peasant associations (PAs) into zones based on altitude. To further differentiate rural households for research and analysis, the team developed a typology based on land holding and livestock ownership for each zone:

Type	Description/magnitude of types		
	Highland (2000-2300 masl)	Midland (1800-2000 masl)	Lowland (1500-1800 masl)
1	≤ 1 ox, ≤1 ha land (15%)	no ox, with around 1 ha land (10%)	no cattle, ≤1 ha land (35%)
2	≤ 1 ox, >1 ha land (55%)	1 ox, ≤1ha land (20%)	<10 cattle and ≤1 ha land (15%)
3	>2 oxen, ≤1 ha land (15%)	1 ox, >1 ha land (40%)	10-20 cattle, ≤ 1 ha land (10%)
4	>2 oxen, > 1 ha land (25%)	≥2 oxen, >1 ha land (30%)	≤ 10 cattle, >1 ha land (40%)

Methodology

The main methods used to gather information were workshops and discussions with MARC and WADD staff, interviews with representatives of other stakeholders, and community, focus group interviews with farmers. The team selected one PA to represent each agro-ecological zone: Watera in the highland, Karsa in the midland and Keraru in the lowland. The team held 15 focus group interviews (5 in each PA), where about 20-25 farmers participated in each group. Six workshops were held with MARC, WADD staff and other stakeholders.

Food security and livelihoods

Definition of food security

The team defined household *food security* as access by all members at all times to enough food for an active, healthy life. Food security thus comprises both *food self-sufficiency*

(consumption of household food production), as well as *food purchase* (acquisition of food by exchange of labour, goods or cash).

Stakeholders' perceptions

MARC and the WADD regard Arsi Negele as food secure, based on its export of food grain. Calculation of food balance sheet for the district (based on population and food production minus exports plus imports), shows that inhabitants consume more than FAO minimum standards for protein and calorie requirements. However, farmers say they do not have enough food to cover requirements and food balance sheets based on household interviews showed considerably less consumption than the district level estimates. The most likely explanation for these discrepancies, the team believes, is unrecognised grain sales or possibly inaccurate district level production statistics.

Food self-sufficiency status

At the farm level, the team also investigated food calendars, what households consume during each month in the different zones, and farmers' perceptions of food sufficiency and shortages by month. These data showed that 75%, 50% and 70% of the households in the highland, midland and lowland, respectively, consider that they do not have enough food for 6 months of the year or more. Interestingly, this represents a severe deterioration of the situation 25 years ago in the midland, but an improvement of the past situation in the lowland (when the livelihood systems were almost entirely livestock based). All zones say that in the past diets were more based on dairy products than they are now, and that they sold less produce at that time.

Livelihoods and coping with food shortage

Farmers' main sources of income in the highland are sale of crop products (62% of the total), live animals (12.5%) and firewood (10%). In the midland income is mainly from sale of crops and livestock (22.5 and 17.5%, respectively), sale of local drinks (15%) and labour (12.5%); farmers here also indicate that 22.5% of their income is from borrowings. In the lowland, income sources were reported as sale of firewood and charcoal (25%), crop and livestock (15 and 12.5%, respectively), labour (10%), local drinks (10%) and livestock products (7.5%).

Farmers thus sell a considerable amount of their crops, mainly wheat and maize. To repay the seed and fertiliser credit to the WADD and moneylenders, these sales are usually at harvest time (December, January) when prices are low (40-50 Birr/quintal was reported for maize for the last 2 years). Later in the year (July, August), when households need to purchase food, the price has increased to around 100 Birr/quintal. To pay for such purchases, the relatively better-off farmers sell livestock and the poorer farmers sell their labour, firewood and charcoal. Borrowing from moneylenders (at 20% per annum), borrowing grain (usually no interest), sale of draft oxen, and renting out land are increasingly desperate measures that compromise the future ability of households to produce crops and put households deeper into poverty.

Dimensions of the problem

Based on the perceptions of farmers and other stakeholders of the factors that lead to food insecurity, the team identified three main dimensions of the problem: erratic rainfall (mainly in the lowland zone); the economic circumstances that have led to them buying inputs at high prices and selling grain at low prices; and the incessant increase in population pressure and its ramifications. The team used these three dimensions for more in-depth analysis.

Climatic uncertainty in the lowland zone

Farmers' perceptions

In the lowland, where the problem of erratic rainfall is more severe, farmers say that 3 out of the last 10 years have given very poor crop yields. In these years, livestock prices fall (as many are selling), grain prices increase, disease rates increase, and much time is spent in looking for water for household needs. Farmers feed tree fodder to their livestock or take them to the highland. To purchase food in drought years, the larger farmers sell livestock (when livestock prices of course fall), or rent out land to purchase food and smaller farmers sell labour, firewood/charcoal, sand and *bole* soil, or borrow. However, the intensification of farming systems in the lowland means that livestock numbers are decreasing, so this livelihood strategy is becoming less possible, increasing farmers vulnerability to shocks such as drought.

Risk of poor rainfall

The team attempted to evaluate the risks of crop farming by analysing rainfall data. Consideration of sixteen years data showed that only 2 years showed 4 consecutive 10-day periods with more than 15mm rain before the cut-off date for early maturing maize – minimum criteria as suggested in previous reports for Ethiopian Rift Valley conditions. In addition, 6 of the 16 years showed two consecutive dry 10-day periods after the rains had commenced, showing the risks of loosing crops after establishment.

Conclusions

Grain farming, especially maize, in the lowland zone is inherently risky, due to erratic rainfall. Even so, population pressure is leading to increased cropping (see below). Fewer livestock numbers, and the gradual disappearance of trees mean that the normal coping strategies of livestock, wood and charcoals sales are becoming less feasible (charcoal sale is in any case illegal and the cause of considerable environmental degradation). In the absence of alternative livelihood strategies, households in this zone are likely to become increasingly vulnerable in dry years.

The economic environment for grain production

Use of recommended technology

The main recommendations for grain crops in the Woreda are based on package of improved seed and fertiliser (100 kg of DAP plus 100kg of urea per hectare), with the fertiliser component dating back to blanket recommendations made in 1973. About 90% of farmers use these suggested rates on maize in the highland and midland, and about 50% in the lowland.

Changing prices of inputs and outputs

Data on price trends show that fertilisers (DAP and urea) more than doubled in price in the last 10 years, although there has been a decrease in the last 2 years. Over the same time, grain prices have remained stagnant or declined. The prices for 2001 were particularly low. Moreover, the seasonal variation in price (between planting and harvesting time) appears to be increasing with time.

Credit services

The study found that almost all farmers use credit to buy inputs, either in the form of the WADD package or from moneylenders. A consideration of cash flow shows that farmers also use credit for consumption needs. The proposed development of a new Cooperative Development Bank may provide the impetus for a variety of community based savings and credit organizations (CBSCOs) that are badly needed.

Profitability of maize production in lowland and midland

Analysis of the financial returns to the seed and fertiliser package shows that in the lowland, fertilisers are profitable in good years but not in drought years; users of fertilisers in this zone thus face a significant risk loosing their investment. Even in a good year, the profitability of fertilisers is marginal, if labour costs are included.

In the midland, there appears to be a financial loss when fertilisers are used, even if labour costs are totally discounted. This contrasts sharply with farmers' recollections of the situation some 5 years ago, when profitability was healthy. Part of this loss of profitability is due to the changing prices, but farmers also state that yields are declining significantly, even with fertiliser use.

Conclusions

Combinations of price changes, declining soil fertility (especially in the midland) and the risk of drought (particularly in the lowland) all show that the benefits of fertiliser are marginal or even absent. If current price and soil fertility trends continue, the situation is very bleak for continued use of recommended technology and grain production.

Population pressure and intensification

Population increase

The population of Arsi Negele Woreda has doubled in the last 15 years and farmers feel the resulting pressure on household food security. Proportionately, the increase has been greater in the midland and lowland.

Changes in livestock and crop farming

In the highland grazing land is about 15% of the total farmed (cropland plus grazing), and there has been little relative change over the last 6 years in the PA studied. In the midland, grazing land has declined from about 20% of the total to almost nothing. In the lowland, the area of grazing land was greater than the cropland area 6 years ago, but now is now about

40% of the total. Cattle numbers in both the upland and lowland have been declining, but apparently not in the midland: it appears that imported feeds from outside the zone are maintaining the numbers in spite of the decrease in grazing land.

Conclusions

Rapidly increasing population numbers imply less productive land per person. The increasing intensification of cropland and reduction of cattle numbers will have a negative impact on soil fertility levels. The decrease in cattle numbers also means that families have fewer assets to sell in times of need and hence their vulnerability to shocks are increasing.

Development strategies and research options

Development scenarios and strategies

The team also considered likely future development scenarios in the Woreda, based on trends in the main driving forces of population pressure, fertiliser and grain prices, and new income generating opportunities. If current trends continue, the outcome will be a continued deterioration in terms of poverty, food security and environmental degradation. Only if grain prices improve, if new income generating crops or activities are developed will the future situation improve.

The current policy of the national and local governments of emphasizing grain production (what the team calls the "breadbasket strategy") in the Woreda appears to offer little promise, unless prices improve. An alternative "income generating strategy" of introducing and promoting higher value cash crops and off-farm opportunities could make an important contribution to improving household incomes and food security at the household level, and offsetting some of the inevitable pressures associated with population pressure.

Identification and screening of research and development options

In workshops with MARC researchers and development agencies in the Woreda, the team identified a number of potential research and development options. These options were then screened with these stakeholders and with farmers, by scoring the potential interventions for sustainability (impact on soil conservation, forest and water resources), competitiveness (profitability, market potential and affordability), and equity (benefits to women, poorer social groups and social acceptability). From this screening, 8 research and development options were identified for further development.

From these research and development options, a number of more concrete research ideas were developed. These were then prioritised with MARC staff. As an example, one of these – the development of new fertiliser recommendations for maize in the midland and highland zones – was developed into a more detailed research proposal.

MARC technology and food security

Assessment of technology disseminated

The team assessed the adoption and impact of the research conducted to date by the MARC research sub-centre in Arsi Negele in the midland and highland zones.

Of the wheat varieties introduced, HAR1685 shows good adoption (45% of farmers using) and HAR710 less so (12%). The price of grain in the market, shorter growing season and taste are the most important factors considered by farmers when considering new wheat varieties.

The maize variety Awassa 511 has got the highest adoption in terms of number of farmers (50%) followed by PHH3253 (25%) and BH140 (22%). Yield, short growing duration, grain price in the market and resistant to storage weevil are the main determinants of adoption of maize varieties.

The sorghum varieties PGRC166 and IS9302 have been widely adopted (45% and 20%, respectively), although local varieties are still very popular. Farmers' major concerns here are better yield, shorter growing duration, taste, good quality straw for construction, and drought resistance.

The fingermillet variety *Taddesse,* disseminated during the last five years, is being rapidly adopted. Farmers appreciate the food quality (used for *injerra* as well as local drinks) value, the resistance to bird damage and weevils in storage, and the multipurpose uses of the stem (feed, thatching and fuel).

The *Roba* variety of haricot bean also shows promise, although introduction is too recent for assessment of adoption.

In general, the research conducted at the sub-centre appears to have been successful in terms of adoption. However, if the sub-centre is to make a greater impact on agriculture in the zone, MARC should consider a realignment of priorities along the lines suggested in this report.

GUDUUNFAA RAAW'ANNAA (EXECUTIVE SUMMARY IN OROMI FFA)

Kaayyoo fi toftaa qorannoo kanaa

Gabaasni kun firii qorannoo wal-ta'iinsa dhaabbata ICRA (kan biyya Neezerlaanditti argamu) fi Giddu-galeessa Qorannoo Qonnaa Malkassa (GQQM) taasifamee ti. Haala kaayyoo GQQM tiin kaawametti, hojiin qorannoo kun ogeessota qonnaa 6 biyyoota adda addaa adunyaa kana irraa dhufaniin gaggeefameera. Kayyoon qorannoo kanaa gad-fageenyaan tuuta ogeessota kanan qoratamaniis: haala wabii midhaan nyaataa fi sadarkaa jiruuf-jireenya ummata baadiyya aanaa Arsii-Negeellee hubachuu, faaydaan teeknoolojii qonnaa adda addaa GQQM tiin hanga ammaa naannoo kanatti tamsa'an maal akka tahe ilaalu, akkasumas rakkina qonnaa GQQM fi dameen isaa aanaa kana keessatti argamu qixa qorrannoo tiin gara fulduraatti irratti hirmaachu qabu addaan baasanii baru kan jedhan turan.

Aanaan Arsii-Negele bal'ina lafa isaa km^2 1396 ni ta'a. Aanaan kun bal'inaan oomisha midhaan nyaataan kan bekkame yoo ta'u, wagga waggaatti boqqoollo kuntaala 50 000, qamadiin kuntaalli 35 000, akkasumas xaafii fi misingaan kuntaalli 25 000 gahu ni omishama. Kana keessas midhaan dhibbeenta 30 ta'u aanaa kanan ala bahee ni gurgurama. Lakkoofsi loon 200 000, akkasumas hoolaa fi re'ee 70 000 tilmaamamu, aanaan kun qabeenya beeylada tiin kan badhaate ta'u mirkaneessa. Aanaa kana keessa ganda qotaa-bulaa 33 kan jiran yoo ta'u, qorannoon kun kan gaggeeffame ganda 3 (Waatara, Qarsaa fi Qaraaru) qilleensa aanicha (baddaa, badda-daree fi gammoojjii) bakka bu'an irratti ture. Sadarka gandattis, bal'ina lafa qonnaa fi baay'ina beeyladaa irratti hunda'udhaan abban-warraa qotee-bulaa sadarkaa qabeenya adda addaa bakka bu'an hojii qorannoo kanaaf filatamaniiru. Fiixaan ba'iinsa qorannoo kanaaf, odeffannoon barbaachiisaa ta'an haala adda addaan guramaniiru. Isaan keessas kanneen tuqamu qaban: walgahii fi maree sadarka sadarkaan qorattoota GQQM fi hojjattota Waajjira Qonnaa Aanaa A/Negeellee (WQAA) waliin taasifaame, gafii-fi-deebii bakka-buutota waajjiiraale Mootummaa fi Miti-Motummaa anaa kana kessa socho'an, akkasumas maree fi gaafii-fi-deebii tuuta qotee-bulaa ganda filataman bakka bu'an wajjin godhaman turan.

Wabii midhaan nyaata fi jiruu-fi-jireenya qotee bulaa

Akka garee qorannoo kana adeemsisaniitti, *wabii midhaan nyaataa* jechuun, matii tokko keessa namootni jiran hundi jireenya fayya-qabeessa mirkaneessuuf yeroo barbaadametti midhaan gaha ta'e argachu yoo danda'an qofa. Kanaafu, wabiin midhaan nyaata, midhaan qotee-bulaan ofii qotatee itti fayadamu akkasumas haala adda addaan bitaate nyaachuu danda'u ta'u ni mala.

Akka qorannoon kun mul'isutti, ilaalchi wabii midhaan nyaataa aanaa kanaa, qamawwan adda addaa giddutti gara-garummaan hedduu akka jiru ibsa. Fakkeenyaaf, ogeesotni qonnaa GQQM fi WQAA baay'ina midhaan oomishamee gara naannoo biraatti fe'amu ilaaluun, aanaan kun wabiin nyaata isaa kan ragga'e jedhanii amanu. Haaluma wal fakkaatuun, tuutni qorannoo kanaa, odeeffanno barreeffamaa bay'ina omiisha midhaanii argateen xiinxalli sadarka aanaatti godhame, jiraattotni aanichaa sadarkaa *pirootiin* fi *kaaloorii* FAOn namni tokko argachuu qaba jedhee baseen ol fudhachaa jiru. Haa ta'u malee, irri-jireessi qota bulaa akka dubbatanittis tahe gabateen nyaataa (food calander) yeroo qorannoo marii isaan wajjin gaggeeffame hojjatame kan mul'isu, midhaan waggaa gutuu matii qote bulaa gahu danda'u hin jiru. Akka amantaa garee qorannoo kanaatti, gara-garummaa kan fiduu kan danda'e,

bay'inni gurgurtaa midhaanii tilmaama keessa hin seennen ykn rakkina bay'ina callaa omishamuu sirri ta'e argachuu dhabuu ni ta'a.

Ragaan ganda qotee bulaa gosa qilleensa adda addaa bakka bu'an irraa argame akka mul'isutti, sadarkkaa abbaa-warraatti badda ti (% 75), badda-dareetti (% 50), akkasumas gammoojjiitti (% 70) ji'a 6 ykn isaan olitti midhaan nyaatan gahaa hin qaban. Ragaan kun akka dabalee mul'isutti, midhaan nyaataa sadarka mana-manaatti yeroo ammaa argamu kan waggaa 25 dura ture waliin yoo madalame, naannoo badda-dareetii yaratаа, gammoojjiitti ammoo fooyya'aa akka ta'e hubatameera. Nyaata dur ture keessatti bu'aa loonii (aannan, baaduu fi dhadhaa) heddumminaan waan seenuuf, guddina qamaa fi fayya namaa eegutti kan har'aa jiru fagoo akka caalu jiraattonni ni dubbatu.

Galii qotee-bulaa ilaalchisee, maddi ol aantummaan gumaachaa jiran, naannoo **baddaatti** gurgurtaa midhaanii (%62), gurgurtaa beylaadaa (%12.5) fi qoraan (%10) yoo ta'u, naannoo **badda-dareetti** ammoo gurgurtaan midhaanii (% 22.5) fi loon (%17.5) galii qotee-bulaa kan guddinaan deggeeran. Naannoo **gammoojjii** aanichaa kessatti, gurgurtaan cilee fi qoraanii (%25), midhaan (%15) fi loon (%12.5) madda galii gurguddoo tuqaman. Dirqama liqii mootummaa fi namoota dhuunfaa irraa fudhatan deebisuuf, irri-jireessi oomshi midhaan qotee-bulaa (boqqoolloo fi qamadiin) ji'a Muddee fi Amajjiitti gurgurama. Yeroo kana hunduu waan gabaatti baasuuf, gatiin midhaanii akka malee kufaa dha. Kara biraa garuu, waytii gannaa (Adoolessaa fi Hagayya) yeroo qallaba alaa bituun dirqama ta'u, gatiin midhaan nyaataa dachaa ol ni dabala. Maddi qarshii bittaa midhaan kanaaf oolu kan argamu gurgurtaa loonii, cilee fi qoraan, hojii humna hojjachuu, qarshii liqeeffachuu (dhala % 20 gahu ni qaba), midhaan liqeeffachuu, akkasumas akka furmaata dhumaatti qotiyyoo gurguruu fi lafa kiraa kennuudhaan ta'a. Toftaawwan kunis yeroo gabaabaaf raakkina haa oolchan malee, qotee-bulaa hiyyuummaa ol aanaa tiif kan saxil baasan jedhamanii amanamu.

Bal'ina rakkina wabii nyaataa

Gareen qorrannoo kanaa qaamotni (stakeholder) adda addaa hojii kana irratti qooda fudhatan rakkinicha ilaalchisee hubatnoo qaban xinxaluudhaan, sababni wabii nyaataa mirkanaa'u dhabuu bakka 3 ti qoodamanii ilaalamuu akka malan ni amana. Isaan kunis, 1) hanqina roobaa (keessumaa naannoo gammoojjiitti kan bal'inaan mul'atu), 2) rakkina dinagdee kan ol ka'iinsa gatii callaa guddistuu fi kufaatii gurgurtaa oomishaa wajjin wal qabate, fi 3) guddina baay'ina uummataa ti.

Hanqina roobaa naannoo gammoojjii

Naannoo gammoojjii aanichaa keessatti, waggaa 10 keessaa 3 yeroo oomishinni midhaanii hanqina roobaan (gogiinsaan) kan ka'e akka malee itti hir'atu ta'uu jiraattonni naannichaa ni dubbatu. Kan irraa kan ka'een, gaatiin gurgurtaa loonii ni kufa (qotee-bulaa hunduu waan gabaa basuuf), gatiin midhaan nyaataa ni dabala, dhukkubni ni hamaata, bishaan dhugaatii fi faayidaa manaa kessaaf barbadamu argachuun yeroo dheeraa fudhata. Bara akkana, qotee-bulaan loon isaa damee fi baalaa mukaa cabsaa soorrata ykn loon isaa ooffatee gara baddaatti ni godaana. Toftaan qotee-bulaan bara rakkinaa akkasi jala bahuuf, gatii xiqaan (gad-cabsee) loon gurguree, lafa isaa kiraa kennuudhaan, hojii humnaa hojjachuun, qoraanii fi cilee gurguruun, akkasumas biyyee boolee gurguruun qarshii argatuun midhaan matii isaaf oolu bita. Haa ta'u malee, midhaan qabanyaa uumamaa fi beeyladaa irratti waytii ammaa qaqqabaa jiruu irraan kan ka'e, toftaa armaan olitti tuqamanii fi qotee-bulaan hordoofaa jiru, furmaata yeroo dheeraa ta'uu hin danda'an.

Xinxalli ragaa roobaa kan waggaa 16 Laangaanoo irraa argame akka mul'isutti, carraan oomisha gaha boqqoolloo Waxabajjii 15 dura faca'e argachuu muraasa yoo ta'u, caamsaan guyyaa 15 – 30 gahu waggaa hedduu keessatti argamuun ammoo midhaan biqile akka badu ykn oomishinni isaa akka hir'atu ni taasisa. Guddina baay'ina uummataa fi badiinsa bosonaa amma mul'atuun, naannoon kun gara fuulduraatti hanqina midhaan nyaataaf daran saxil kan bahu ni fakkaata.

Rakkina dinagdee gatii callaa-guddistuu fi oomishaa

Qotee-bulaan aanaa Arsii Negelee, paakeejii sanyii filatamaa fi xaa'oo (gorsa teeknooloojii waggaa 30 dura guutuu-biyyaaf bahetti) bal'inaan fayyadamaa jira. Waggaa 10 darban keessatti gatiin xaa'oo dachaan kan dabale yoo ta'u, gatiin gurgurtaa midhaanii garuu bakkuma dur ture irra dhaabbachaa ykn kufaa jira. Haalli liqiis yoo ilaalame, irri jireessi qotee-bulaa liqii mootummaa (bittaa sanyii fi xaa'oo tiif) fi namoota dhuunfaa (rakkina adda addaa salphisuuf) irraa fudhatanii itti fayyadama jiru. Rakkina qixa kanaan jiru salphisuuf, Baankiin Misooma Waldaa amma karooran gara mootummaan qabamee jiru hedduu gargaara jedhamee ni amanama. Xinxalli baasii-fi-galii itti fayyadama xaa'oo ilaalchisee hojjatame akka mul'isutti, haala gabaa ammaatti qotee-bulaan bu'aa argachaa hin jiru. Gara fulduraatti haalli kun yoo kan itti fufu ta'e, itti-fayyadamni teeknooloojii ammayyaa kun gaaffi keessa kan seenu ni ta'a.

Rakkina baay'ina uummataa

Baaj'inni lakkoofsa uummata aanna Arsi Negele waggaa 15 keessatti dachaan dabalee jira. Kunis akka sababa rakkina wabii nyaataa dhabuuf gumaache jiraattonni deddeebisani ragaa ni bahu. Nyaata uummata kana gahu oomishuuf lafa gonna bal'isuun, lakkoofsa beeylada kan xiqqeesse yoo ta'u, gabbinni lafa xuuxamee akka dhumu godhee jira. Kunis, qotee-bulaan qotiyyoo gahaa tu'ee fi loon guuyyaa rakkinaa gurguree ittu fayyadamu dhabsiisaa jira.

Toftaa misoomaa fi xiyyeeffannoo qorannoo

Milkaa'uu hojii misoomaa fi qorannoo gara fuulduraatti irratti xiyyeffatamu qaban gareen qorannoo kanaa adaan baasanii osoo hin kaa'iin dura, ragaa argame irraa, haala yeroo kan Itoophiyaa fi adunyaa gad-fageenyaan xinxaaluun, garri fuulduraa maal fakkaachuu akka danda'u tilmaamamee ture. Tilmaamni kunis kan hundaa'e, murteesiitootni wabii nyaataa mirkaneessu danda'an 4 (baay'ina uummataa, gatii xaa'oo, gatii midhaanii fi carraa madda galii qonnaan alaa jiran) maal akka fakkaachuu danda'an hubachuun ture. Akka amantaa garee qorattoota kanaatti, haalli qonna oomisha midhaanii irratti qofa hundaa'e kun yoo itti fufe, qabeenyi uumamaa daran ni manca'a, beelli fi jireenyi gidiraa uummata baadiyyaa ni bal'ata. Kanaafu, galii qotee-bulaa foyyessuuf, wabii nyaataa sadarka mana-manaatti mirkaneessuuf, akkasumas dhiibbaa baay'inni uummataa qaqqabsiisu danda'u xiqqeesuuf, toftaan misooma midhaanii qofa irratti bu'urame kun gara toftaa misooma babal'isuu midhaan galii ol aanaatti jijjiiramuu ykn halli taftaan lamaan itti wal-simanii deeman barbaadamu qaba. Hojiiwwan misoomaa fi qorannoo toftaa misooma armaan olitti tuqaman mirkaneessuu danda'an, qaama adda addaa (stakeholders) kan akka GQQM, WQAA fi qotee-bulaa hirmaachisuun akka barbaachisummaa isaaniitti yeroo gabaa fi dheeraa keessatti raaw'atamuu qaban tartiiban gabaasa kana keessatti kaawamanii jiru.

Bu'aa teeknooloojii qonnaa GQQM tamsa'an

Bu'aan fi faayidaan teeknooloojii GQQM karaa damee isaa buufata qorannoo Arsii-Negeellee (ganda qote bulaa Qarsaatti argama) argamuun tamsaase, garee kanaan qoratame ture. Haaluma kanaan, gosa sanyii filatamaa midhaan adda addaa kan akka qamadii, boqqoolloo, misingaa,daagusaa fi boloqqee karaa giddu-galeesichaan tamsa'an irratti qotee-bulaan naanoo baddaa fi badda-daree jiraatan, faayidaa irraa argatanii fi hanqina (rakkina) teeknooloojiiwwan kana muudatan bal'inaan ibsamee jira. Waluumaa-galatti, raaw'iin teeknooloojii tamsaasuu GQQM hojjatame kan diqsifatamu yoo ta'e illee, gara fuulduraatti hojiin gara buufata qorannoo Arsii-Negelee jiruun irratti ciminaan xiyyeeffatamuu qabu, rakkina qonnaa naannichaa muudatanii fi gabaasa kana keessatti tuqaman kan hiikanii fi haala qabatamaa aanichaa kan bu'uura godhatan ta'u qabu.

CHAPTER 1 INTRODUCTION

1.1 Context of the study

1.1.1 Institutional framework

This field study was carried out as a joint activity among Melkassa Agricultural Research Centre (MARC) of the Ethiopian Agricultural Research Organisation (EARO) and the International Centre for development oriented Research in Agriculture (ICRA). MARC hosted the field study.

Melkassa Agricultural Research Centre (MARC)

MARC was founded in 1969 initially as a national horticulture research centre. The centre was soon expanded to deal with other commodities and over time MARC has become the leading research centre for the dryland areas of the country. The centre co-ordinates national programmes for sorghum, lowland pulses, agricultural mechanisation and horticulture. Research is organised through different divisions namely maize, crop management, crop protection, food science, agricultural economics and research and extension.

MARC executes its research activities with two broad objectives:

- To generate appropriate technologies, through interdisciplinary research, for the lowland moisture stress and irrigated areas
- To popularise and disseminate technologies to users in collaboration with other actors such as Ministry of Agriculture and non-government organisations (NGOs).

Arsi Negele is one of the two sub-centres of MARC, and was established mainly for developing suitable technologies for food crops grown at relatively higher altitude in the MARC mandate area (higher midland and the lower highland). Currently, the sub-centre has three technical assistants who are collaborating with different crop research programs.

International Centre for development oriented Research in Agriculture (ICRA)

The International Centre for development oriented Research in Agriculture (ICRA) is an international organisation founded on the initiative of European members of the Consultative Group on International Agricultural Research (CGIAR). The goal of ICRA is to strengthen the capacity of institutions in developing countries to conduct "agricultural research for development" (ARD), or, in other words, to improve the application of agricultural research to a broader development agenda. ICRA pursues this goal through the organisation of post academic courses, the provision of training materials and assistance to training institutions concerned with agricultural research in developing countries.

This study was part of ongoing collaborative programme of ICRA and EARO. ICRA teams have conducted field studies on different problems of agricultural development in Ethiopia, where EARO Centres are active.

Terms of reference (TOR)

ARD is based on a partnership between ICRA and the host institute. A task force, established by the host institute, MARC, in collaboration with ICRA prepared the terms of reference

(TOR) for this study (Appendix 1). The problem (problem situation) to be addressed by the study, objectives of the study, and main guiding questions were defined in the TOR. The TOR also included guidelines and suggestions to the team on the site selection and target group selection. In addition, the task force prepared a Memorandum of Understanding (MOU) specifying the roles of each stakeholders/partners towards the successful execution of the field study, and the implementation and follow-up of the study.

1.1.2 Justification of the study

Despite the fact that Arsi Negele district has been considered as one of the areas with good agricultural resource endowment, the contribution of the sector has remained low. As a result, fluctuating food security for most people in the area is a fact of life. In addition, farmers face problems in obtaining the tools and inputs (seeds, fertiliser, pesticides, etc) and in gaining access to sources of credit and other financial means, as well as in marketing of their produce.

Small farmers, in particular, are often unable to afford inputs when they need them, resulting in negative effects on their food production and food security. Variable climate and other ecological variables are also among the main factors contributing to the fluctuating food security situation in the district. Nevertheless, research and development workers have not demonstrated the nature and interaction of these factors with respect to the prevailing social and farming conditions in the area. The communities have adapted to these uncertainties by adopting a suite of coping strategies. Although these strategies may have a beneficial effect on the household food security situation, their relation with appropriate policy measures that enhance the sustainable development of the agriculture sector have not been analyzed. Vulnerability assessment studies are scarce.

The importance of agricultural technology generation and transfer in the district has been long recognized with the establishment of a research testing site at Arsi Negele (later upgraded to the sub-centre level). However, feedback on the level and status of technologies disseminated so far are lacking. Therefore, MARC wished the ICRA study to use participatory tools to analyze (together with the farming community) how useful the recommended technology packages have been for the different identified household categories in the different agro-ecological zones of the target area. As past research at Arsi Negele mainly focused on the midland areas the lessons that can be drawn from the team's participatory adoption study in the midland zone may assist the future development of research and development efforts in the highland and lowland zones.

In addition to the establishment of the Arsi Negele research sub-centre, several extension programs have been initiated since the early 1980s. However, activities in the research and extension sectors appear to have been fragmented: the sector and sub-centre oriented programs have lacked the holistic and integrated approach to improve the livelihoods of the rural community. Moreover, farmers' perspectives were not adequately considered in the development and dissemination of technologies to alleviate their problems.

1.1.3 Objectives of the study

The topic of the study as originally defined was "Food security strategies among households in the different farming systems along the toposequence in Arsi Negele: Opportunities for Research and Development". This study will contribute towards the goal of MARC to identify constraints to agricultural development in the semi-arid environment and to generate improved agricultural technologies in order to alleviate these constraints. The purpose of the

study is to assist research to have a better understanding of the coping strategies among households in the different farming systems, through the use of zonation, and to assist and identify approaches for improved research efficiency and effectiveness.

In summary, according to the TOR the key objectives are:

- to analyse food security strategies at village and household level in different farming systems along the toposequence in Arsi Negele district;
- to investigate if differences in resource endowments affect management options of household categories in relation to the production of sufficient food and its vulnerability, and, if so, to develop a relevant farm typology to better target future ARD efforts.
- to identify constraints and prioritise opportunities for future research and development and to formulate proposals for future collaborative ARD efforts;
- to assess in a joint effort with the local farming community the usefulness of the technologies so far disseminated by Arsi Negele/MARC for the different identified agro-ecological zones and farm types.

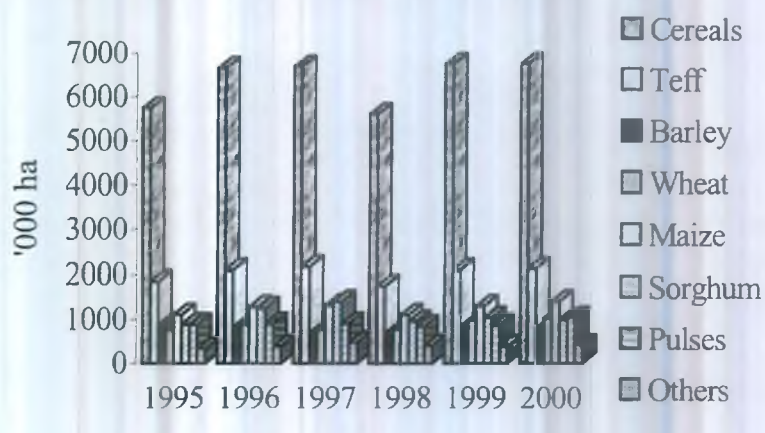
1.2 Background

1.2.1 The food security situation in Ethiopia

Ethiopia is located in the Horn of Africa, between $3^0$24' and $14^0$53' Northern latitude and $32^0$42' and $48^0$12' Eastern longitude. It is the second largest country in sub-Saharan Africa, covering an area of 1.223 million km^2, with an estimated population of 67 million people (projection by Ethiopian Central Statistics Authority for 2000). It is a diverse country, both culturally and agro-ecologically. Altitudes vary from 100masl in the Danakli depression to 4600masl on the Simien Mountain Massif. It has climatic conditions that range from desert to afro-alpine. The widely varied habitat, that includes mountains, lakes, deserts, savannahs and everything in between, hosts an astonishing richness in biodiversity. According to N.I.Vavilov's theory, Ethiopia is one of the centres of origin and diversity of crops.

Agriculture is the backbone of the country, and today 88% of the population is engaged in this industry. Agriculture produces 48% of Ethiopian gross domestic product (GDP) and 94% of its export earnings. It also supplies raw materials for the limited agro industries. Of the agricultural gross domestic product about one-fifth comes from livestock. The rest comes from crops, with roughly one-half of the crop value added coming from coffee (cropping area 295 000 ha in 1995), that accounts for two-thirds of all export earnings. Of the total land area of Ethiopia an estimated 7% is cropped, i.e. 8.22 million ha in 1999-2000. More than 80% of crop area is under cereals (Figure 1.1).

Figure 1.1 Crop areas in Ethiopia, 1995-2000

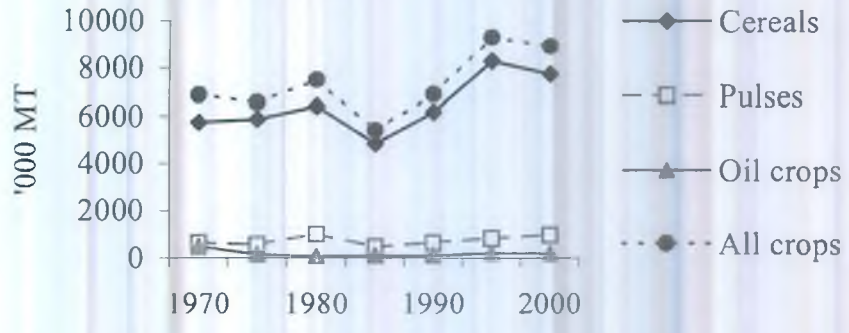


Source: Ethiopian Central Statistics Authority, 2001

The most important food crop is teff – an indigenous cereal - followed by maize and sorghum. Wheat is the fourth most important cereal crop, both in area and production. Smallholders cultivate 80% of the total grain production area, producing 70% of the cereals harvested in the country. The remaining 30% are produced on state farms and producer co-operatives. In recent years, the proportion of smallholder production has increased, due to the demise of co-operatives and privatisation of state farms.

The 1999-2000 season saw a bumper harvest, slightly above normal production quantities, with domestic production of cereals, pulses and oilseeds estimated at 8,987,650 metric tons (Figure 1.2). Statistics for the same type of outputs for the year 2000-2001 indicate that production was estimated at 10,702,018 metric tons or 19.3% higher than the previous year figures.

Figure 1.2 Crop production in Ethiopia, 1970-2000



Source: Ethiopian Central Statistics Authority, 2001

Data on incoming food aid shows that in 1999-2000 the direct food aid cereal equivalent was 1,079,550 metric tons, which is equivalent to 12% of total domestic production. This figure decreased to 653,220 tons in 2000-2001, which is 6% of the estimated domestic output for the same year. In the 2000-2001 season the volume of commercial imports of food increased to 313,760 tons, from 219,650 tons in 1999-2000.

Ethiopia has a large livestock population comprised of cattle (29,450,000 heads), sheep 21,700,000), goats (16,700,000), equines (9,580,000) and an estimated 54,000,000 chickens (FAO, 1996).

It is estimated that over 60% of the population are food insecure[1] or live below the absolute poverty line in Ethiopia[2]. About 13 million people in the rural area and 4 million in the urban areas are chronically poor. Another 3 million are among the transitory poor and millions of people are affected by drought each year (Food security, Nutrition and Poverty Alleviation in Ethiopia: Problems and Perspectives, 1995).

Endowed with considerable agricultural potential, Ethiopia had been self-sufficient in staple food and was classified as a net exporter of food grains till the late 1950s.It was reported that the annual export of grain to world market amounted to 150,000 tons in 1947/48. However, since early 1960s, domestic food supply failed to meet the food requirements of the people. Even though sufficient food has been produced in good years, the average food production during the last decades has remained almost stagnant.

Since the beginning of the mid-1980s, food production has exhibited very little growth. Domestic food production between 1979/80 – 1993/94 increased by only 0.5% per annum. The level of per capita food production in the same period dropped by 2.5% owing to the rapid population growth. Particularly, post years were 1984/85 (116 kg per person), 1985/86 (124 kg per person) and 1991/92 (123 kg per person). The maximum of 204 kg per person was recorded in 1979/80 (Zegeye, Habtewold, 1995).

Based on a food intake of 2100 cal per person per day (the minimum average calorie requirement per day for an average individual as recommended by FAO and the Ethiopian Medical Association), the annual deficit in the last decades was estimated at 0.6 to 4.0 million tons of food grain equivalent. The gap has been covered both by food aid and commercial imports. As a result, the volume of food import increased from 177 thousand tons in 1979/80 to more than 1 million tons in 1991/92. The per capita food import rose from 5 kg in the early 1980s to 24 kg during the famine period of the mid 1980s and 19 kg in the early 1990s (Zegeye, Habtewold, 1995).

Due to differences in agro-ecological conditions and utilisation of productive inputs, food crops are mainly produced in central (Arsi and Shoa) zones and north-west Ethiopia (Gojjam). These three zones alone account for more than half of the country's grain production. Apart from these zones, Wollega, Bale, Gondar and Keffa are considered as areas of food self-sufficient while the remaining are categorised as chronically food deficit areas.

1.2.2 Overview of Arsi Negele Woreda

The study was conducted in the Arsi Negele Woreda (or district) of the East Shoa Zone, Oromiya Regional State (Figure1.3). Arsi Negele is situated between $7^{0}09'$ and $7^{0}41'$ Northern latitude and $38^{0}25'$-$38^{0}54'$ Eastern longitude. It is one of the southern districts of the zone bordered by Southern Peoples' Regional State in the west, Adami Tulu-Judo in the north, Shashamene and Siraro in the south, and Arsi zone in the east and south-east (Figure 1.3). It

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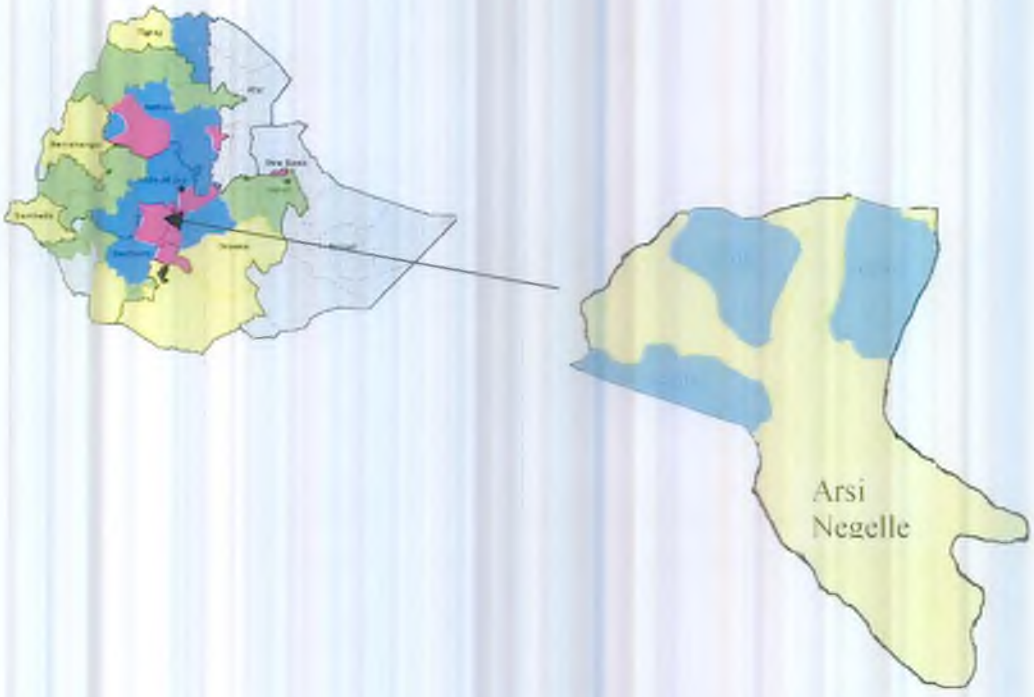
[1] A food insecure household is one that cannot produce or purchase sufficient food for a healthy and productive life of its members. A more complete discussion is given in Chapter 2

[2] Using a World Bank definition, absolute poverty is considered to occur when income is less than 1 USD per day

Negele is the 6th largest district in the zone. Arsi Negele town is located about 180 km away from Nazareth town, the capital of Oromiya Regional State.

Figure 1.3. The map of Arsi Negele Woreda



Conventionally, the Arsi Negele district is divided into 3 major climatic zones based on altitude (low, mid and high altitude). The cultivated part of the district, except its southern section has elevation between 1500-2300 masl. Forests exist to over 3000 masl. The northern and western part of the district is covered by coniferous forests of *Podocarpus* variety and by woodland and Savannah of *Juniferous* species. Broadleaf forests of *Arundinaria* and *Aningeria* cover the southeastern highland.

The major Rift Valley lakes of Abijata, Langano and Shalla are partly situated in Arsi Negele. There are also several hot springs and the highest number of rivers in the zone. About 80% of the district come under the category of sub-tropical agro-climatic zone and 20% (south-eastern highland) of cool temperate zone. Average annual temperature varies between 10-15^{0}C in the temperate and 15-20^{0}C in the sub-tropical agro-climatic zones respectively. Average annual rainfall ranges between 800-1400mm. Most of the district has an Andosol soil type. Nitosols are soils of high rainfall areas and thus constitute the south-eastern part of the district. They are clayey, reddish brown to red, deep, and have well developed and stable porous structure with high moisture storage capacity and deep rooting volume. This gives them high potential for cultivation with the addition of phosphate fertilisers (Socio-Economic profile of Arsi Negele Sub-district, 1998).

The district consists 3 urban *kebeles* (villages) and 33 Peasant Associations (PAs) and its total population is estimated to be 169,603, out of which more than 80% is rural. The population growth rate is very high and in the last 15 years the population has doubled. Arsi Negele is considered to have reasonable agricultural potential, as reflected in the diversity of crops and

animal resources. Agricultural activity in the district is based on crop and livestock farming systems.

The total cultivated area in the district (average for the last 3 years, 1999-2001) was 46,253 ha. Of the total cultivated land, over 89% was under cereals, 9% was under pulses and 2% was under vegetables (see Table 1.1).

Table 1.1 Crop area and yield, Arsi Negele Woreda, 1999-2001

Crop	1999		2000		2001	
	Area ha	Yield t/ha	Area ha	Yield t/ha	Area ha	Yield t/ha
Cereals, total	**41225**		**41274**		**41109**	
Wheat	15300	2,90	16413	2,40	15428	2,30
Maize	15700	4,15	17005	3,20	15860	3,20
Barley	2150	1,87	2075	1,20	2465	1,90
Teff	6000	0,86	4061	0,80	5047	0,90
Sorghum	2050	2,10	1545	2,13	2024	1,90
Fingermillet	25	1,00	175	1,20	285	1,20
Pulses, total	**1420**		**4564**		**6475**	
Bean	670	1,00	814	0,90	1125	1,00
Haricotbean	750	1,30	3750	0,70	5350	1,10
Vegetables, total	**880**		**893**		**904**	
Potatoes	521	5,32	516	8,80	523	5,22
Tomatoes	18	12,00	20	12,00	20,5	9,37
Onion	316	4,41	330	8,70	334	3,13
Pepper	9	4,67	10	7,50	9,5	5,16
Beetroot	6,5	14,77	7	12,00	7,5	16,40
Carrot	9,5	7,11	10	7,50	10	7,88
Annual crops, total	**43525**		**46731**		**48488**	
Fruits	4,75		5,375		4,87	
Oranges	0,65	3,08	0,875	2,19	0,51	3,14
Mango	1,15	13,91	1,2	16,67	1,21	12,40
Avocado	1,9	12,63	2,2	14,55	1,95	13,13
Banana	0,6	10,00	0,7	7,14	0,72	9,72
Papaya	0,45	64,00	0,4	74,70	0,48	30,00
Grand total	**43530**		**46736**		**48493**	

Source: Woreda Agriculture Development Department, 2002

Arsi Negele is one of the biggest grain producing and trading districts in Ethiopia. Annually the PAs of the district produce 110.000-120.000 tons of grain, 50-53% of which is maize and 30-32% is wheat. Every year about of 30% of produced cereals, 70% of pulses, 75% of vegetables and more than 80% of fruits are exported to other parts of the country. On average for the last 3 years, 39% of produced teff, 32% of wheat, 28% of sorghum, 25% of maize, 20% of barley, 20% of fingermillet, 63% of beans and 70% of haricot bean have been sold to other districts (Table 1.2). Simultaneously, during 1999 and 2000 respectively 675 and 1104 tons of wheat and maize were provided to the district's inhabitants in the form of humanitarian aid by European countries.

Table 1.2 Production and export of crop products, Arsi Negele Woreda, 1999-2001

Crops	Production, MT			Export, MT		
	1999	2000	2001	1999	2000	2001
Cereals, total	**123027**	**103033**	**99650**	**32806**	**29612**	**28849**
Wheat	44370	39391	35484	14195	12605	11355
Maize	65155	54416	50752	16289	13604	12688
Barley	4012	2490	4684	802	498	937
Teff	5160	3237	4542	310	1942	2724
Sorghum	4305	3289	3846	1205	921	1077
Fingermillet	25	210	342	5	42	68
Pulses, total	**1645**	**3358**	**6988**	**1085**	**2227**	**4839**
Bean	670	733	1125	402	440	735
Haricot bean	975	2625	5863	683	1838	4104
Vegetables, total	**4586**	**7886**	**4213**	**3458**	**5938**	**3181**
Potatoes	2772	4541	2728	2079	3406	2046
Tomatoes	216	240	192	173	192	154
Onion	1392	2871	1044	1044	2153	783
Pepper	42	75	49	32	60	37
Beetroot	96	84	123	77	67	98
Carrot	68	75	79	54	60	63
Fruits, total	**77**	**89**	**64**	**69**	**60**	**57**
Oranges	2	2	2	2	2	1
Mango	16	20	15	14	18	14
Avocado	24	32	26	22	29	23
Banana	6	5	7	5	4	6
Papaya	29	30	14	26	7	13

Source: Woreda Agriculture Development Department, 2002

Arsi Negele is among the livestock-rich districts of the zone. Its western and northern sections are mainly areas of livestock rearing. Until year 2000 cattle accounted for 60-62% of the livestock population, followed by poultry 18-19%, goats 7-8% and sheep 6-7% (Table 1.3). Due to decreasing grazing land and disease the number of cattle slightly decreased in 2001 (to 54% of total livestock population) and the number of goats and sheep increased (respectively to 10 and 12% of total livestock population).

Among the three lakes (Langano, Abijata ana Shalla) Langano has a high fish potential. The other two because of their alkaline nature have little fish. Lake Abijata until recently used to have fish, but, due to the growing degree of salinity as a result of the establishment of the Soda Ash Plant, it has lost this status. Lake Langano is estimated to have about 250 tons fish potential per annum, and production during 1996 and 1997 was 210 and 265 tons respectively (Socio-Economic profile of Arsi Negele Sub-district, 1998).

Table 1.3 Changes in livestock population, 1999-2001

No	Livestock	1999	2000	2001
1	Cattle - Oxen	278,920	291,038	186,493
2	Sheep	28,340	31,454	34,004
3	Goats	33,890	36,970	41,439
4	Horses	10,571	13,571	4,489
5	Mules	737	785	457
6	Donkey	15,545	18,654	14,136
7	Poultry	82,906	85,892	63,712

Source: Woreda Agriculture Development Department, 2002

1.2.3 Zonation of Arsi Negele Woreda

As per the TOR and the local map available at the Woreda Agriculture Development Department (WADD), there are three agro-ecological zones in Arsi Negele Woreda (Figure 1.4). These are:

- highland (2000 – 2300 masl),
- midland (1800 – 2000 masl),
- lowland (1500 – 1800 masl).

On the other hand, according to the national agro-ecological zonation map, Arsi Negele Woreda is divided in to five agro-ecological zones (Figure 1.4):

- H2-7 (tepid to cool humid highland mountains) ,
- M2-7 (tepid to cool mountains),
- SM2-7 (tepid to cool sub-moist mountains),
- SM2-2 (tepid to cool sub-moist lakes and Rift Valley),
- SA2-2 (tepid to cool semi-arid lakes and Rift Valley).

By comparing the two maps it is evident that the local map does not exactly overlap with the national map (Figure 1.4). According to the local map, the highland agro-ecological zone falls in M2-7, H2-7, SM2-7 and part of SM2-2, the midland AEZ consists of SM2-2 and particularly SA2-2, and the lowland AEZ consists of SA2-2 and SM2-2 of national classification. The team decided to use the local map due to two reasons; a) The activities of local authorities (both government and others) activities are based on the local map, and b) One of the important sampling units for the study was PA-based and the PAs are demarcated only on the local map.

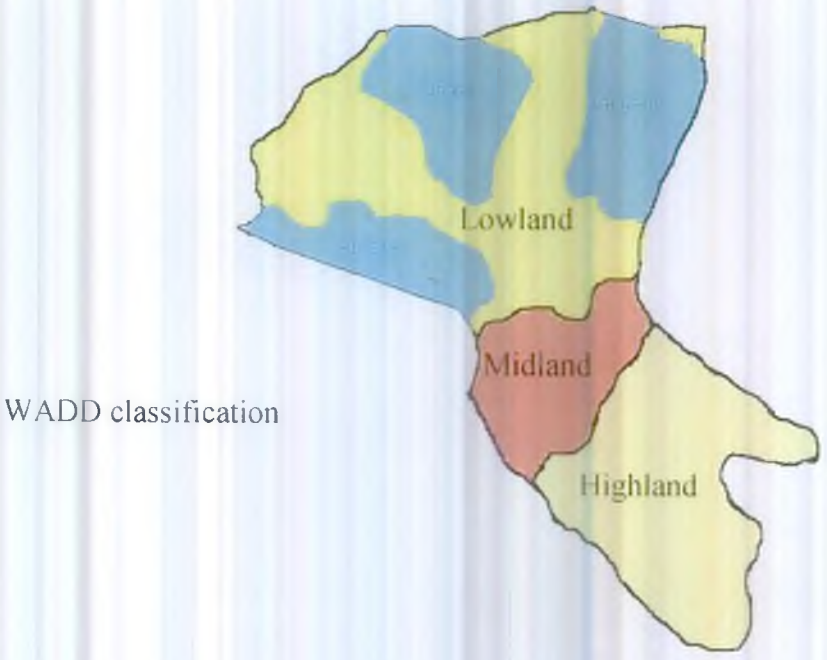
1.3 Methodology used in the study

This section describes the approach of agricultural research for development (ARD) in brief and how the team used this approach with some necessary modifications to suit the context of the study, and the tools and techniques used by the team in different steps of the ARD procedure. A more complete methodology is given in Appendix 2.

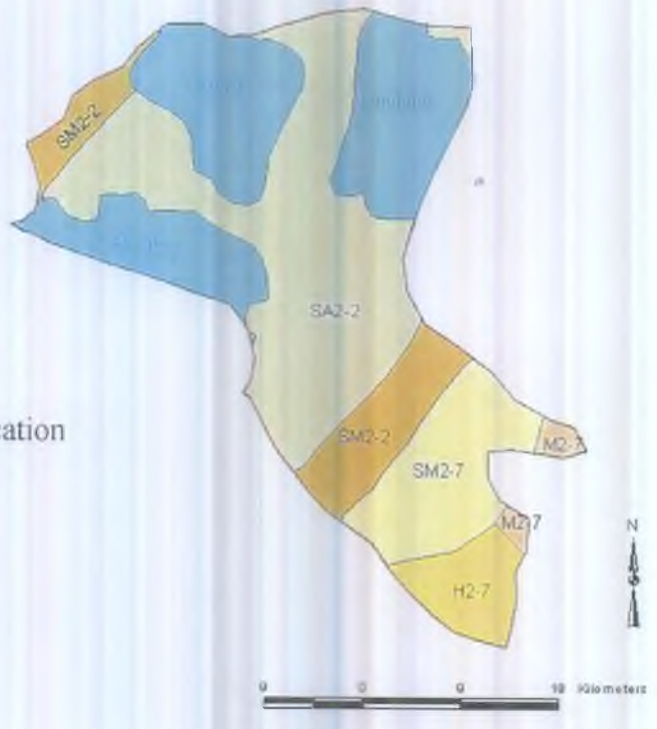
1.3.1 ARD Procedure

ARD (Figure 1.5) is a generalised procedure intended to orient research responds to the needs of clients and beneficiaries. ARD aims at research and development options (R&D options) that contribute towards poverty alleviation, food security, social equity, competitiveness of farming enterprises and sustainable resource use. ARD is conducted by interdisciplinary team, through systems thinking. ARD is demand driven and participatory in order to integrate the diverse perspectives of various stakeholder of the context. The iterative nature of the ARD procedure makes it more system oriented.

Figure 1.4. Agro-ecological zones of Arsi Negele Woreda



WADD classification



National classification

The key questions that guide the team through the ARD procedure are:

- How to organise the team to address the problem defined in the Terms of Reference?
- What are the wider factors that affect the problem situation (e.g. policy, environmental, social and economic factors)?
- Who are the stakeholders and what are their interests regarding the problem situation and solutions?
- Which system (related elements) should be analysed in detail in order to address the problem?
- How does the problem affect different stakeholders or target groups and what 'solutions' do they require?
- What are the likely and preferred development strategies, and what are the implications of these in terms of sustainability, competitiveness and equity?
- What research is needed to realise these strategies?
- What are the elements of a convincing research proposal to get funding for implementing these research activities?

The present field study was taken up as a part of the 2002 ICRA training programme. Before going to Ethiopia, the team spent 13 weeks in Wageningen, the Netherlands. This period was split into two. There were 10 weeks on knowledge acquisition that consisted of a series of workshops exposing the team to the ARD procedure, various methods and tools. The acquired knowledge, tools and methods were put into practice in the field exercises in Overijssel, the Netherlands.

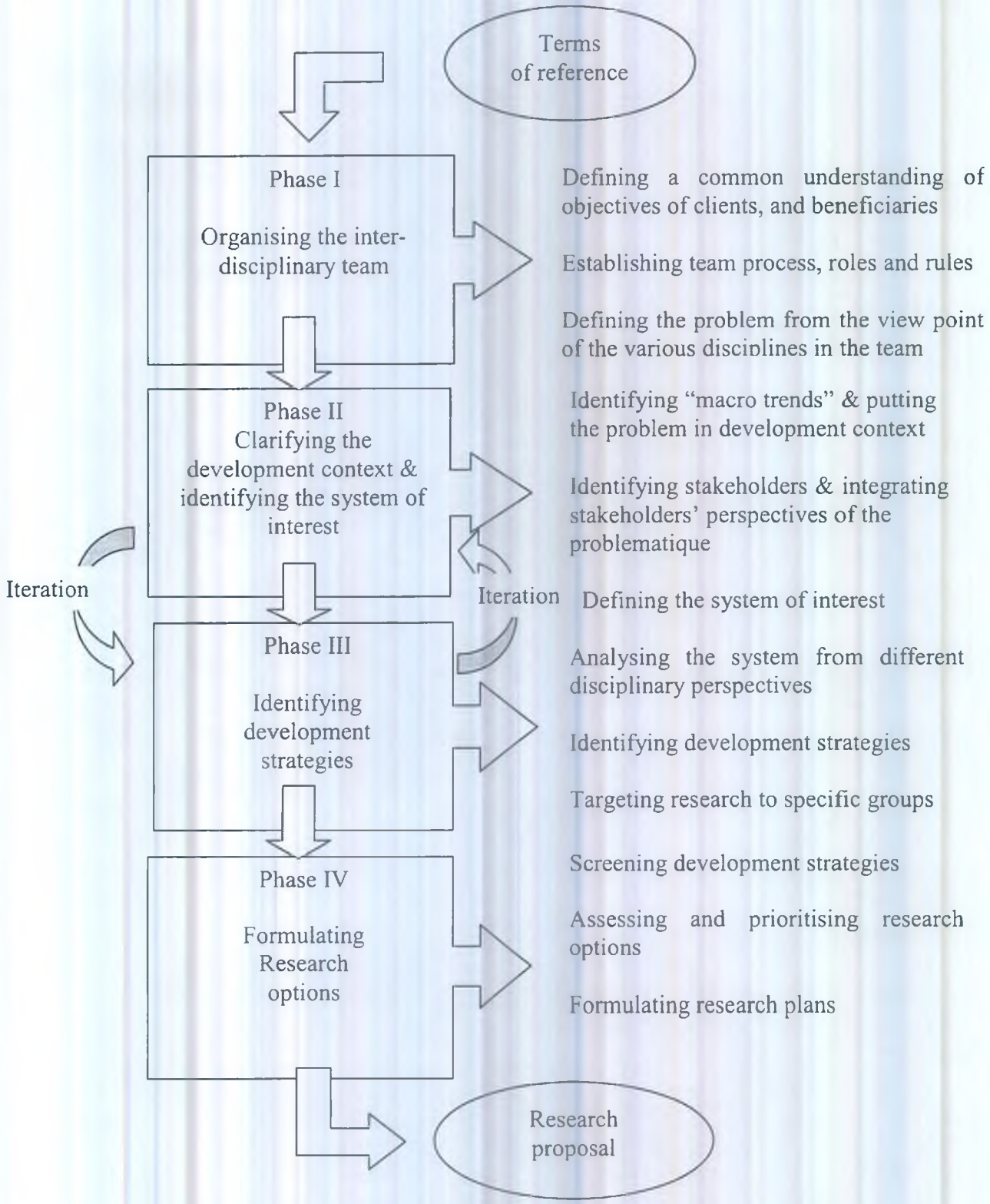
An interdisciplinary team of six members (one Ethiopian and five expatriates) was composed based on the disciplinary competence needed in order to address the problem situation defined in the terms of reference. The disciplinary backgrounds of the members were agronomy, plant breeding, cropping system, agricultural extension, livestock production and financial management.

The *knowledge acquisition phase* was followed by a *field study preparation phase,* of three weeks. During this phase, the TOR was given to the team, along with available secondary material. Based on the TOR, and secondary information available the team planned the field study, defining activities, expected outputs, research questions to be answered, and appropriate tools that could be used to gather information.

1.3.2 Data gathering

The team conducted 6 workshops (2 introductory, 2 intermediate and 2 final) for the scientific staff of MARC in Nazareth and for the key stakeholders – WDAD staff, DAs, and chairmen of PAs in Arsi Negele town. During the field study the team interviewed with other local stakeholders by visiting their offices. For in depth study the team selected one PA to represent each agro-ecological zone: Watera – for highland, Karsa – for midland and Keraru – for lowland. For information gathering and sharing of the results the team held 15 focus group discussions (5 in each PA), where about 20-25 farmers participated in each group.

Figure 1.5 The phases of ARD-procedure used in the study



1.3.3 Typology

To better target R & D options, a system of farm/household typology was defined and applied in this field study. A hypothetical typology system considered the criteria of land and oxen ownership was established based on secondary information at the planning stage of the study. WADD officers, DAs and Pas, verified these criteria after the team arrived at Arsi Negele, and they were further discussed among with selected DAs and PA chairmen from the 3 AEZs during the introductory workshop. At the beginning of the in-depth field study, the typology for all the 3 AEZs were checked and verified with farmers, and some of the magnitude of the criteria were changed. The typology system was finalized after checking with the farmers. The final typology is listed in Table 1.4.

Table 1.4 Typology defined and applied in different AEZs

Type	Description/magnitude of types		
	Highland	**Midland**	**Lowland**
1	≤ 1 ox, ≤1 ha land (15%)	no ox, with around 1 ha land (10%)	no cattle, ≤1 ha land (35%)
2	≤ 1 ox, >1 ha land (45%)	1 ox, ≤1ha land (20%)	<10 cattle and ≤1 ha land (15%)
3	>2 oxen, ≤1 ha land (15%)	1ox, >1 ha land (40%)	10-20 cattle, ≤1 ha land (10%)
4	>2 oxen, > 1 ha land (25%)	≥2 oxen, >1 ha land (30%)	<10 cattle, >1 ha land (40%)

CHAPTER 2 FOOD SECURITY AND LIVELIHOOD

2.1 Definition of food security

In this report, we adopt the following definition of ***food security*** at household level:

Food security for a household means access by all members at all times to enough food for an active, healthy life.

There are two main ways for a household to achieve food security following this definition: either a household can consume its own food production (what we call in this report "***food self-sufficiency***"), or a household can acquire food from outside by exchange of labour, goods or cash (what we call in this report "***food purchase***"). For the purposes of this report, at least, we do not consider receiving food aid, scavenging, stealing or other illegal ways as valid means of achieving food security.

The production of sufficient food by a household does not by itself guarantee food security for that household. If the household sells the food produced and is then left with insufficient food for its consumption needs, or with insufficient means to purchase the food needed, the household becomes food insecure.

As we have seen in the previous chapter, Arsi Negele Woreda exports food. However, and as we shall attempt to show in this chapter, this does not mean that the households in Arsi Negele are food secure. The evidence provided here shows that, for various economic reasons, farmers sell much of their produce and then are left with insufficient food or the means to buy food to satisfy their food security needs.

2.2 Stakeholders' perceptions

Stakeholders' perceptions on the situation of food security in Arsi Negele vary. Many researchers in MARC view Arsi Negele as a food secure district because of its relatively high production. A senior researcher said during the mid-term workshop that they had made their all efforts to increase crop yields. Researchers also believe that the lack of access to market and market information, and the lack of adoption of new technology by farmers both negatively influence food security status.

Other stakeholders, such as the WADD and the Co-operative Promotion Department (CPD), perceive that the only problem is to manage the resources properly, and this can be achieved by teaching the farmers. Along with MARC researchers, the staff of the WADD consider on-farm food storage to be an importance factor. They believe that farmers sell grain to meet family expenses such as school fees, weddings and other ceremonial events after harvesting. MARC, the WADD and CPD staff consider that the limited storage ability and the lack of farmers' knowledge of storage techniques is at least one of the major reasons that farmers sell their grains soon after harvesting and hence food insufficiency. They believe that good storage facilities would help farmers store food until the time of year when prices improve.

MARC and the WADD perceive another reason for food insecurity as a lack of alternative income sources, poor roads and other infrastructure. Staff of the WADD and some NGOs such as the African Aid Development Association (AADA) also believe that poor household budgeting and bad family planning are significant problems. Finally, MARC, AADA and

staff of African Humanitarian Action (AHA) mentioned that farmers have no knowledge on alternative ways of utilising food.

The Shashamene Forestry Enterprise mentioned that cutting trees illegally is a problem. Deforestation causes soil erosion and the resulting degradation results in food insecurity. The vision of the SFE is to teach the farmers how to make a balance (between livelihood/ short-term living and natural conservation/ long-term living). However, the SFE sees its mandate as being responsible for forestry for timber and firewood; they do not see agroforestry development as being within their mandate (but rather that of the WADD).

For their part, farmers' reported during interviews that they did not have enough food during the year due to series of problems. These perceptions are described in detail in the following sections of this chapter.

2.3 Food self-sufficiency status, food calendars

To get a comprehensive understanding to the status of food self-sufficiency, the team interviewed farmers in groups to identify the general food calendars of households in the different agro-ecological zones.

2.3.1 Highland

Food items and self-sufficiency status by month during the year in highland areas is listed in Table 2.1. Starting in September, farmers consume green maize cobs until the end of December when they harvest the mature maize; therefore the food self-sufficiency score increases in the period. Farmers prefer maize most because they can eat the green cobs before harvest.

Maize, wheat, barley, potato, faba bean and sorghum are the major food items available in the highland. These food items except potato are available for four months starting from January after the harvesting in December. Potato is available from mid of March and lasts until August. They sell their products (mainly maize) during January and February and purchase it in August. Purchasing price of maize in August is around 100 Birr/Q. while that selling price of maize in January is only 40 Birr/Q. During the months through May to August, Enset is also consumed along with potato so that potato can be consumed for a longer period. When potato finishes in August, Enset is the only food available for next four months from September to December; however, green maize cobs accompany Enset during the last two months. Enset is considered as coping food for subsistence during this period.

In addition to the staple food items, vegetables, meat, milk and butter are also available and are consumed during the year as supplementary. Vegetables consist of mustard leaf, carrot, beetroot and cabbage. Mustard leaf is the only self-produced vegetable available throughout the year while the rests are purchased from the market occasionally. Meat consumption, mainly beef, is rare; Muslims consume beef most in a special fasting month once a year. 10 out of 20 interviewed farmers had cows. Milk and butter availability depends on milking status of cows, giving priority of these foods to children.

Table 2.1 Current food self-sufficiency and the situation of highland households by month, Watera PA

	Food Items	Food self-sufficiency by months during a year											
		Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
1	Maize												
2	Wheat												
3	Barley												
4	Potato												
5	Faba Bean												
6	Enset												
7	Sorghum												
	Oil	Flax oil is consumed in all meals											
	Milk	Available throughout the year if there is a milking cow at home.											
	Butter	Ditto											
	Mustard leaf												
	Carrot	Occasional, whenever they go to market and have some cash in hand											
	Beetroot												
	Cabbage												
	Beef												
	Eggs	Consume around 40 % of the eggs produced											
self-sufficiency score		1	2	3	4	5	5	4	3	2	2	2	1

Note: 1. Food items from 1- 7 are listed on the basis of importance as a staple food.
2. Scoring was done ranging 1-5 on the basis of food self-sufficiency at home. If there was enough food production at home, 5 was scored for that month, and if there was almost nothing, 1 was scored to the month. Pieces of tree branches were given to farmers to do the scoring.

Resource ownership influences the pattern of the household food self-sufficiency calendar. Factors affecting food self-sufficiency include:

- Family expenditure: with students in school, the family have to rent house and supply food to them, and pay for their tuition. It is a big expenditure to those families.
- Ownership of oxen: more oxen, higher grain production.
- Level of inputs: more fertiliser, more grain.

The difference the poor and the better-off is the amount of grain consumption. Families with more land and having more oxen produce larger quantities of grain. The difference of food consumption among different types of farmers is also discussed in section 2.2.3. The difference in food calendars between different types of farmer is slight: farmers producing less quantity of grain also distribute the food over a possible longer period with coping strategies, such as reducing the size and frequency of meals.

It can be concluded that there is an 8 months food shortfall period in the highland, during which there is a 2 months acute food shortage period, August and September.

For comparison, the food self-sufficiency in highland farmers' households some 25 years ago was also investigated. According to farmers' recollections, food during that time was mainly based on livestock products such as milk and butter. Food grain such as barley was consumed throughout year, although if barley stocks were reduced by June, Enset was also consumed until mid-December, the next barley harvest. Farmers remembered the quality of food at that

time with pride. They said that the quality of food was better than it is at present, because they used to take meals twice a day without feeling hungry, although they did not have any vegetables and fruits. Nowadays they take 3 meals a day and still often feel hungry. They did not sell their barley at that time. Farmers considered the past to be better than the present in terms of food self-sufficiency.

2.3.2 Midland

The self-sufficiency status of food items by month during the year in the midland is listed in Table 2.2. As in the highland, farmers consume green maize cobs from September until the end of November when they harvest their maize. They therefore feel more comfortable during the months of October and November than in the months of April, May, June, July and August, even though they have little except green maize cobs during these two months.

Table 2.2 Current food self-sufficiency situation of midland households by month, Karsa PA

		Food self-sufficiency by months during a year											
	Food Items	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
1	Maize												
	Maize (type 1)												
2	Wheat												
3	Sorghum												
4	Barley												
5	Teff												
	Haricot bean												
	Potato												
5	Faba bean												
	Field pea												
	Chickpea												
	Lentil												
	Milk	Available throughout the year if there is a milking cow at home.											
	Butter	Do											
	Meat	Occasionally											
	Mustard leaf												
	Eggs	Once in a while											
Self-sufficiency score		2	3	3	5	5	5	4	2	2	1	1	1

Note: 1. Food items from 1- 5 are listed on the basis of importance as staple food.
2. The second row of maize applies to type 1 farmers in the typology (refer to section 1.3), while the first row of maize applies to the rest.

There are some differences in food self-sufficiency status between different types of household, but the major differences exist only in the 3 months after harvesting. The score of 5 for the months of December, January and February do not apply to those farmers with no ox and with less than 1 ha of land; these farmers have less food, and they take smaller and less frequent meals during period after harvesting. During the remainder of the year, all farmers are in the same situation.

The common main menu of the midland farmers and their families is maize plus side food (cabbage, bean/ lentil, potato etc.). Maize is thus the most important staple food followed by wheat, sorghum, barley and teff. Farmers keep 60% of the maize production for self-consumption and sell 40%, preferring to sell wheat first, then maize, and teff last because teff

can be kept in the field for a long time without decaying. Barley is consumed in small amounts combined with other food items. Potato is mainly for self-consumption and is available in July and August. Milk consumption is the similar to that in the highland, but the majority of midland farmers do not have cow. Meat consumption is only 4-5 chickens a year, with preference given to the household head. Children are given preference for milk and butter consumption, then to the household head (mainly the male) and then to the female. Typically, a milking cow yields around 1 litre a day. Cooking oil (mainly flax oil, some olive oil) is bought from the market.

Farmers in midland also have to sell their product mainly the maize during the months of January and February to repay the credit and have to purchase it again in August. There is a 8 months food shortfall period in the midland, during which there is a 3 months acute food shortage period starting from June and last to August (see Table 2.2).

Some 25 years ago, according to the farmers, food was mainly based on livestock products such as milk and butter. All households used to have at least 2-3 milking cow. Maize was the major staple food followed by wheat, faba bean, sorghum, barley and teff. Faba bean was consumed as a side food through out the year. A local long growing period maize variety was used. They did not sell maize at that time. Consumption of green maize cobs was also popular at that time; therefore they were more food sufficient in the months of September, October, November and December. The most food sufficient months were September to January and the least sufficient months were July and August when there were only milk and butter ready at home.

2.3.3 Lowland

Self-sufficiency of food items by month in the lowland is listed in Table 2.3. Major food items are maize, wheat, sorghum, barley, teff, beans (farmers consume red bean and sell out all white bean), mustard leaf and potato. Maize is considered the most important crop and teff the most productive. Farmers try to grow maize, but if rainfall is insufficient for maize, they sow wheat. As in the highland and midland, farmers consume green maize cobs from September until the end of November; therefore they feel more food sufficient during the months of October and November. Wheat is available only for 2 months, because the production is not large and they sell most of it. Eighty percent production of teff is sold, as it fetches a high price.

The pattern/composition of food consumption is changing. Sorghum is grown in small plots, but production is increasing due to two reasons: it is easy to be mix with other cereals to make various foods, and it can be stored for a long time. After harvesting, farmers preserve sorghum for around 4 months before starting to consume it in May when maize is finished. Farmers sell around 25% to 50% of their maize production and 60% of wheat, but they do not sell sorghum.

Milk and milk products are becoming very scarce in the lowland. Farmers only consume meat on holidays (3 days a year). When they slaughter an animal, they sell some meat to their neighbours. Milk, butter and meat is mainly given to children, then to the family leader, (i.e. the male) and then to the female. Fifty percent of the interviewed farmers have a cow. Milk is consumed through out the year but the main season of milking is from April to October when there is some forage available for the cow. Forty percent of the eggs produced at home are for self-consumption, and 60% for sale.

Table 2.3 Current food self-sufficiency situation of lowland households by month, Keraru PA

	Food Items	Food self-sufficiency by months during a year											
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	Maize												
2	Sorghum					Preserve							
3	Wheat & barley												
4	Teff												
	Milk/butter/ cheese												
	Meat (Goat/beef)	Occasionally											
	Mustard leaf												
	Eggs	Once in a while											
	Other Vegetables	Once in a while											
	Honey												
Self-sufficiency score		2	3	3	4	5	4	3	3	2	1	1	Nil

Note: Food items from 1- 4 are listed on the basis of importance as staple food.

Mustard leaf is the only vegetable cultivated and consumed. Other kinds of vegetable are purchased from market occasionally. The fund for purchasing comes from selling firewood.

There are 9 months of food insufficiency period in the lowland, during which there is a 3 months acute food shortage period starting from June and last to August. In August, there is almost nothing available.

Kararu is a newly cultivated area. Farmers say that 25 ago this area was covered with natural forest and there were plenty of grazing lands. At the time of villagization, many newcomers settled in the PA by clearing the forest and cultivating grazing lands. Farmers reported that 10-15 years ago they depended on livestock. Food was mainly based on livestock products such as milk and butter. Maize was the most preferred crop staple food, which they used to by selling livestock. Consumption of green maize cobs was popular at that time too. They used to store the sorghum for four months to extend the period of maize consumption because children preferred maize.

2.3.4 Yearly duration of food self-sufficiency status by agro-ecological zone

From the food calendars we conclude that farmers are not food self-sufficient for most of the year, mainly because they sell grains after harvest. The estimated present and past status of food self-sufficiency in the different AEZs is summarised in Table 2.4.

Table 2.4 Yearly duration of food self-sufficiency, percentage of households

AEZ	Duration of food sufficiency in months						Total
	Time	< 3	3 – 6	6 – 9	9 – 12	>12	
Highland	Present	19	56	20	5	0	100
	Past	-	-	-	-	-	-
Midland	Present	20	40	20	15	5	100
	Past	0	0	30	70	0	100
Lowland	Present	40	30	15	10	5	100
	Past	55	40	4	1	0	100

Note: 1. The past situation was set as 25 year ago in highland and midland, and 10-15 years ago for lowland.
2. The result came from group interviews. Seeds were given and used by farmers to identify HH percentage in various groups.

Significant differences in food self-sufficiency occur between households according to the family size, land area and ownership of oxen.

In the **highland**, according to the farmers, the 20% of households that are food self-sufficient for less than three months are characterised by lack of oxen and large family size. Families of this type normally rent out their land (*kotta),* taking a share of the grain production from the renter. Families having food for nine to twelve months are characterised by having more than two hectares of land, more than 2 oxen and several cattle.

In the **midland**, the 20% of the households that are food self-sufficient for less than three months are characterised by lack of oxen, less than one hectare of land (even landless) and large family size (i.e. 16 to 20 people in a family). Households that are food self-sufficient for 3 to 6 months typically have 1 ox and a small area of land; this type of farmer ploughs the land of others to earn money, and sometimes they rent in land and share 40% of the harvest with the landowners. Households that are food self-sufficient for 6 to 9 months typically have a pair of oxen, 1.5 to 2 hectares of land and a family size of more than 10 persons. Households that are food self-sufficient for 9-12 months are characterised by a land size of 2-3 hectares, 2-3 pairs of oxen and large herd of livestock (sheep, goats, donkeys); farmers of this type do not usually obtain credit from the MOA for seeds and fertilisers. Farmers reported that the 5% of farmers that are food self-sufficient for more than 12 months have more than 3 hectares of land and a smaller family size (around 5-6 people in a family).

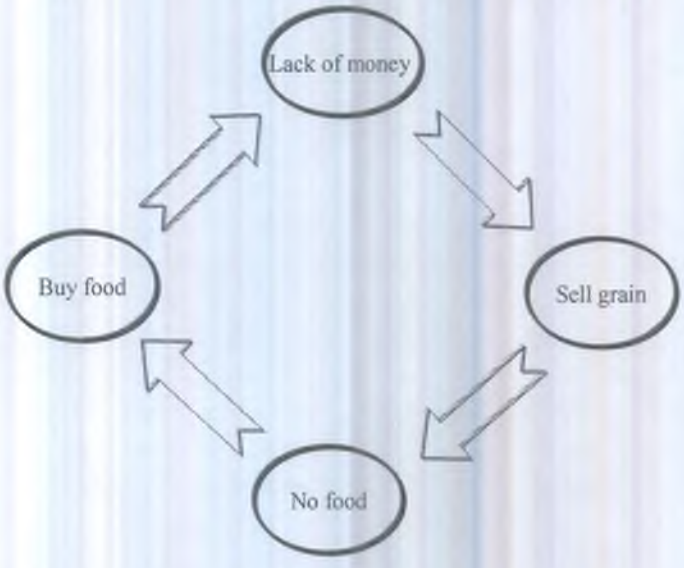
In the past, farmers were more food self-sufficient. Productivity was higher. They cultivated a smaller land area and the family size was also quite small. According to farmers' report, they used to use 30 kg of maize seed and harvest up-to 12 quintals while these days they have to use 1 quintals of seed to harvest 6-7 quintals of maize. Families that are food self-sufficient for less than 3 months used to borrow or received food from others.

The situation in the **lowland** is drastically different from the midland and was so even in the past. A large number of families (40%) are food self-sufficient for less than three months. In the past, this percentage was even higher (50%). The percentage of food self-sufficient households in the past was nil, while at present it is 5%. Farmers consider the reasons for these changes to include:

- Diversification of crops: only maize was grown in the past; many crops are grown at present.
- Expansion of the cropping area.
- Technology improvement, such as weeding.
- Application of fertilisers.
- Increase number of oxen.

To summarise this section, it seems that most farmers not self-sufficient in food. There is a vicious cycle that characterizes the food sufficiency situation (fig. 2.1):

Figure 2.1. The vicious cycle of food insecurity



2.4 Food balance calculations

2.4.1 Food balance at the district level

To obtain a more comprehensive understanding of the quantity of food potentially available for consumption in this area at district level, the food balance of this district was calculated using the FAO method and 3 years statistics on production, export and import. Food balance is presented in the amount of calories, protein and fat consumed per capita per year. The result of this calculation is listed in Table 2.5.

Table 2.5 Food balance at district level of Arsi Negele, 1999-2001

Year	Source of food	Daily available amount per capita		
		Calories	Protein, in gram	Fat, in gram
1999	Crop	3721	104	14
	Livestock	365	21	9
	Total	4087	126	24
2000	Crop	3114	88	13
	Livestock	305	18	9
	Total	3420	107	22
2001	Crop	2910	83	14
	Livestock	285	17	10
	Total	3196	101	25

Note: 1. The standard daily nutritional requirement per capita recommended by FAO (also by Ethiopian Medical Association) is 2100-2400 calorie, 65 gram protein and 20-25 gram fat.

2. Grain import and export via informal ways, and also some food items such as Enset, were not taken into consideration because of the unavailability of data.

According to the figures in Table 2.5, in recent years the district is more than food self-sufficient in terms of calories, protein and fat availability. It seems that, as many researchers have mentioned, there is enough food for people in the district. In fact, Arsi Negele has been considered a relatively productive district. Then why do farmers complain that they do not have enough food? To investigate further, the food balance at household level was also calculated and an in-depth study on farmers' livelihood conducted.

2.4.2 Food balance at the household level

The food balance of the different types of household in the lowland and midland were calculated using data obtained from farmers. In each of the 2 AEZs, 3 farmers from each type were selected and interviewed individually for detailed data on food consumption. The calculation used the average date of the 3 interviewed households. The detail procedure of the calculation is given in Appendix 3. The result of the calculations is shown in Tables 2.6 and 2.7.

Table 2.6 Food balance at household level in the lowland: Keraru PA, 2001

Household type	Average household data			Source of food	Daily consumption per capita		
	Size (persons)	Land area (ha)	Number of cattle		Calories	Protein (gram)	Fat (gram)
Type 1	8	0.83	0	Crop	600	15	7
				Livestock	162	4	15
				Total	762	19	22
Type 2	7	0.75	7	Crop	1744	46	15
				Livestock	434	17	36
				Total	2178	63	51
Type 3	8	0.70	15	Crop	1632	45	12
				Livestock	684	32	52
				Total	2316	77	64
Type 4	10	1.50	5	Crop	1031	29	11
				Livestock	239	14	17
				Total	1270	43	28

Since the household food balance is calculated using the estimated quantity of food consumed by the households, it can be considered as a measurement of the food security situation. Despite the inaccuracy of the survey methods and small sample size used here, we consider the results to reflect the approximate situation of the farmer households.

The result of the food balance calculation shows that food security status in midland is a little better than it is in lowland. This might be the reflection of higher productivity and more sources of income in the midland. Family size and oxen ownership has significant effect on household food balance. Type 1 farmers in both lowland and midland are the most food insecure group.

Taking into the consideration that type 1 farmers say they reduce their meal frequency up to once a day in some periods, together with the reduced meal size, and neglecting some amount of food might not be accounted in the calculation, we can conclude that this group of farmers are extremely hungry. Type 1 farmers in the midland take 83% of the standard calories, 92% of the standard protein and some amount more than the standard fat.

Table 2.7 Food balance at household level in the midland: Karsa PA, 2001

Household type	Average household data			Source of food	Daily consumption amount per capita		
	Size (persons)	Land area (ha)	Number of cattle		Calories	Protein (gram)	Fat (gram)
Type 1	8	0.83	0	Crop	1522	46	19
				Livestock	229	14	17
				Total	1751	60	36
Type 2	6	0.80	1	Crop	2079	56	14
				Livestock	194	11	14
				Total	2273	67	28
Type 3	7	1.44	1	Crop	2011	59	43
				Livestock	276	16	21
				Total	2287	75	64
Type 4	9	1.7	2	Crop	1513	43	13
				Livestock	241	9	21
				Total	1754	52	34

Type 4 farmers in both PAs suffer from food insecurity because of big family size, although they have better land and/or oxen ownership. Type 4 farmers in midland are supposed to be more food secure, but they are taking the same amount of calories (83% of the standard quantity) and less protein (80% of the standard) and fat compared with type 1 farmers, whom are supposed to be least food secure. The reason is that type 4 farmers have the biggest family size. Type 2 and type 3 farmers in both lowland and midland are food secure, which might be the result of some strategies for income generation and food purchases.

2.4.3 Comparison of woreda and household level data

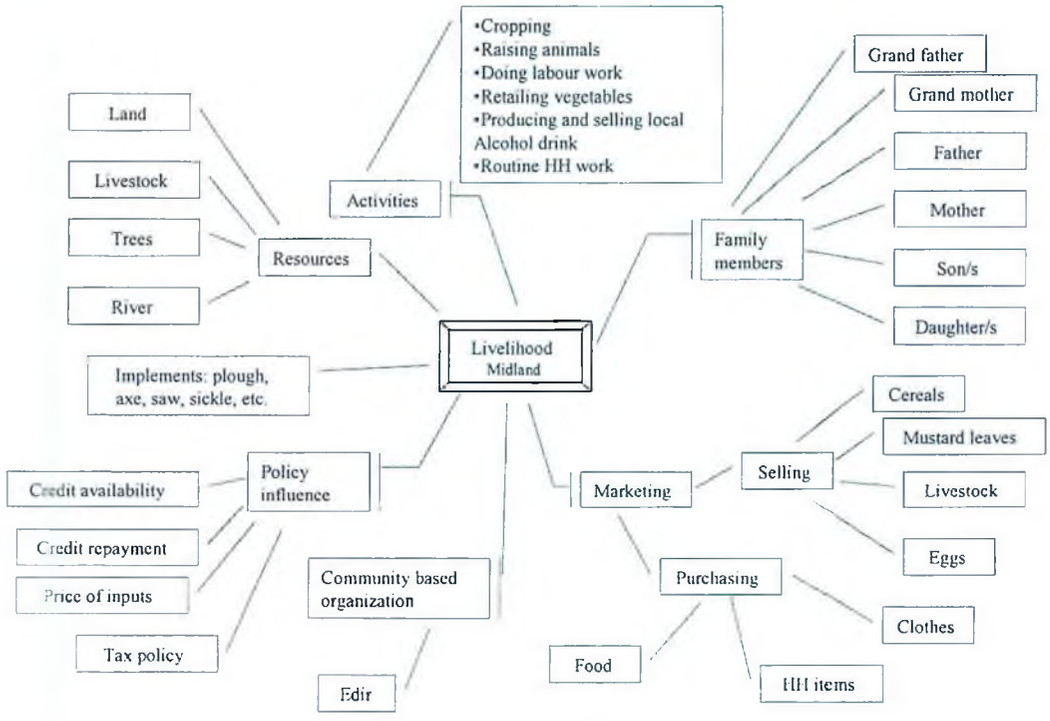
The food balances calculated from the household data show considerably less consumption than those calculated from the wlevel??? data. This can only mean that one or either of the data sources is inaccurate, or that the PAs analysed are very unrepresentative for the woreda. While it is possible that the food balance in the highland areas is better than the midland and lowland areas investigated, it seems that food sales reported by farmers are generally higher than suggested by the food export figures reported in Table 1.2. We suspect that there much grain sale by farmers goes through unofficial channels and hence the overall food export from the woreda is under reported, and that, consequently, the food balance situation among farmers in the woreda is worse than that indicated by woreda level crop production and export statistics.

2.5 Livelihoods

2.5.1 General description

A typical household in Arsi Negele is shown in Fig. 3.1. Family members' activities are generally distributed as follows: grandfather looks after the cattle; grandmother takes care of children; father works in the field; mother does most of the housework and takes care of children, cleaning, fetches water and prepares food; sons help their father with the work in the field when they are old enough, whereas daughters help with weeding, fetching water, and collecting firewood.

Figure 2.1 Livelihood spray diagram



Farmers sell a large proportion of their cereals immediately after harvesting. The price of maize at after harvest was reported to be 40 Birr /Q, rising to 100 Birr/Q when farmers buy it months later. In the highland, farmers sell about 40% of their cereals. Even they if do not sell their grain, they still do not have enough food for the year. Months later, they sell livestock for purchasing food grain. In the farmers' perception, livestock are easy to keep for extended periods compared to cereals such as wheat and maize. They said that the government requests or forces them to repay the credit after harvesting, and they themselves also like to repay the credit at the time when they still have enough food.

Women visit the market frequently whenever there is a fair. Men go to the market only occasionally; they sell their products at the nearest place, where retailers maintain the price at a very low level.

Women sell cereals in the market in small amounts to get money for daily family use such as for purchasing salt, oil etc. They know that the price of these inputs is lower in town, but they have difficulty going there. To be able to transport and sell cereals in another place one needs a license. Farmers do not usually have this license, which can be issued by the WADD.

Fuel for cooking consists of firewood, cattle dung, and maize cobs. Collecting firewood is a labourious and time-consuming work that is usually done by women and children. In the highland, they collect firewood every 3 days, setting off early in the morning at 8:00 a.m. and coming back in the afternoon at 2:00 p.m.. In the midland, they collect firewood once a week, taking 6 hours to fetch the load. In the lowland PA that was visited, the source of firewood was 6-7 km away and collecting took women and children two to three hours per day.

Women and children fetch water for family use from nearby springs or rivers. In the highland PA visited, there is a spring near the village from where women and children get drinking water. The frequency of water collection depends on family size, generally once every 2 days.

In the lowland PA Keraru, there are 42 ha of irrigated land, used to grow tomato, green pepper and sugar cane. However, only 15% of the households have access to irrigated land. Sand digging and sale of bole soil are sources of income in this PA. Around 20 percent of interviewed farmers had honeybees at the time of survey.

There used to be co-operatives in the socialist period; later these were disbanded. However, new efforts are being made to re-establish co-operatives. In the lowland, some 10 or 11 farmers have co-operated in groups since 1997. They collected 70 kg of maize from each household at harvesting, stored it at one of the farmers' houses until May, then sold it to help the members facing food shortage. The price of maize they collect is 40 Birr, and the price upon selling is 65-70 Birr per Q. They are starting to have some difficulties in operating this system, however, because if one member requests help and gets it immediately, it seems unfair to the other members. They consider that maybe better management is required in their co-operative system.

In the highland there was only one NGO that worked in the PA, in a single year, giving 70 Birr of credit to farmers to buy seedlings of Enset.

2.5.2 Income and expenditure

The sources of household income and their percentage of the total income as reported by the interviewed farmers from all 3 PAs are listed in Table 2.8.

Table 2.8 Sources of household income

Sources of income	Percentage of total income		
	Highland	Midland	Lowland
Sale of crop product (maize, wheat, faba bean, barley, potato, mustard leaf and Enset)	62.5	22.5	15.0
Sale of live animals (cattle and sheep)	12.5	17.5	12.5
Sale of animal product (butter and skins)	5.0	5.0	7.5
Sale of fire wood	10.0	-	15.0
Sale of poles (log wood)	2.5	5.0	-
Sale of honey	2.5	-	5.0
Sale of Enset leaf	5.0	-	-
Sale of local drinks and malt	-	15.0	10.0
Sale of labour	-	12.5	10.0
Sale of charcoal	-	-	12.5
Sale of bole soil*	-	-	2.5
Borrowings	-	22.5	10.0
Total	100.0	100.0	100.0

- Clay soil used for livestock as mineral supplement.

Sale of farm products is the most important source of income for households in all AEZs, as shown in Table 2.8, but their contribution to the total family income is different among AEZs. In the highland, selling crop products is the major income, followed by selling live animals and firewood as the second and third important income sources. In the midland, selling of crop products and loans accounts for half of the total income; sale of animals, production and

sale of local alcoholic drinks and labour are also significant. In the lowland, income from sale of crop products is much less significant than in the highland, and sale of firewood, charcoal, labour and local alcoholic beverages are all significant sources of income in addition to crop and livestock products.

Non-farm income (i.e. income not coming from crop and livestock products) consists of about 10% of the total income in the highland, 20% in the midland and 50% in the lowland.

Items of household expense and their percentage over the total expenditure as reported by interviewed farmers from all 3 PAs are listed in Table 2.9. As the table shows, the main part of household expenditure is composed by the cost of seed and fertiliser and repayment of credit. In the highland, food purchasing is the single biggest expenditure. In the midland and lowland, purchase of inputs (seed and fertiliser) is the largest expenditure item, at about 20% of the total.

Table 2.9 Expenditure composition of households

	Percentage of the expense in total expense		
Items of expense	**Highland**	**Midland**	**Lowland**
Kerosene for house illiminating	2.5	7.5	10
Medical expense	10.0	10.0	5.0
Seed and fertiliser procurement	12.5	20.0	17.5
Food purchase (grain, vegetable & oil)	25	5.0	12.5
Clothing	10.0	7.5	12.5
Cost house roof and poles	2.5	-	2.5
Repayment of credit	12.5	15.0	10.0
Grain sacks	2.5	-	-
Cart renting	2.5	-	-
School expenses	10.0	7.5	7.5
Renting combine harvester	5.0	-	-
Tax	5.0	5.0	7.5
Entertainment	-	2.5	-
Social events (wedding ceremony etc.)	-	2.5	5.0
Veterinary and livestock feed	-	5	-
Hiring oxen	-	7.5	-
Farm implements (carts etc.)	-	5.0	5.0
Transportation	-	-	5.0
Total	100.0	100.0	100.0

2.5.3 Coping with food insufficiency

Coping strategies by typology in and AEZ for the periods after farm-produced food is consumed are listed in table 2.10. Selling labour usually occur within the village by doing weeding, harvesting and ploughing for other farmers. Cash is usually borrowed for 3-4 months at an interest of 20%. Renting out 1 ox can get 150 Birr for 1 year. Renting out land is usually based on 120-140 Birr for 0.25 ha of land per cropping season. In the year 2000, lowland farmers asked for food aid from the Disaster Prevention Agency.

Food security is becoming worse. Sale of oxen is a last resort when there are no other possibilites to cope with the situation. If they would rent out land, then the land left may not be enough to produce sufficient food and the situation would get progressively worse.

Table 2.10 Coping strategies after on-farm produced goods have been consumed

Highland			
Type 1 (one or no ox, less than 1 ha land) • Reduce meal size & frequency; • Sell fire wood; • Rent out land.	Type 2 (one or no ox, more than 1 ha land) • Distribute food grain for a longer time period by: • Reducing the size of meal; • Reducing frequency of meal during a day; • Sell firewood;	Type 3 (more than 2 oxen and more than 1 ha land) • Plough for others; • Rent out land.	Type 4 (more than 2 oxen and more than 1 ha land) • Sell oxen.

Midland			
Type 1 (no ox, land size 1 - 1.5 ha) • Rent out land after harvesting maize. Keep ¼ of the land for their own maize growing (heir oxen to plough it). • Buy the cheapest cereal, maize; • Sell labour; • Retail of mustard leaves (mainly by women); • Make and sell local alcohol; • Move to highland to live with relatives and do some labour work for them; • Ask free assistance from relatives and friends, such as ploughing the land or planting, pure charity.	Type 2 (1 ox, less than 1 ha land) • Rent out land; • Sell labour; • Make a pair with another farmer of the same type; • Rent ox from another farmer; • Sell ox at critical occasion.	Type 3 (1 ox, more than 1 ha land) • Rent out land ; • Sell labour; • Make a pair with another farmer of the same type; • Make and sell local alcohol drinks.	Type 4 (more than 2 oxen and more than 1ha land) • Sell live animals (chicken, sheep, calf etc.); • Rent out land; • Sell oxen.

Lowland			
Type 1 (no cattle, less than 1 ha land) • Sell firewood (Mainly during May to August); • Sell sand for construction use; • Sell labour.	Type 2 (less than 10 cattle and less than 1 ha land) • Sell firewood; • Sell charcoal; • Sell cattle; • Sell labour; • Borrow money. • Rent in land • Making local alcohol; • Retailing sugar cane. • Migrate; • Ask for food aid; • Sell bole soil.	Type 3 (10-20 heads of cattle and less than 1 ha land) • Sell milk and milk products; • Sell cattle; • Rent out oxen.	Type 4 (less than 10 cattle and more than 1 ha land) • Rent out land; • Sell cattle.

2.6 General problematic and research themes

2.6.1 Problems reported by farmers

Problems reported by farmers during group interviews in each PA are listed in Table 2.11.

Table 2.11 Problems reported by interviewed farmers

Problems	AEZ affected
Shortage of grazing land	Highland
Decrease of livestock herd and hence amount of manure	Highland
High increase of fertilisers price	Highland, Midland
Fluctuation of fertilisers price	Lowland
Low and decreasing soil fertility	Highland, Midland
Decreasing of crops price	Lowland
Erratic rainfall	Highland, Lowland
Unemployment of school graduates	Highland
High dowry expense to female's	Highland
Difficulty in fetching drinking water	Highland
Shortage of oxen	Highland
Lack of capital and cash resources	Highland, Midland
Lack of other skills apart from farming	Highland
Too high of the interest and low ability of repaying the credit	Lowland

Because of the increasing population and hence the expansion of cultivated land, grazing land area is decreasing, which results in the decrease of livestock numbers. Some farmers perceive the reason of soil fertility decline as a result of decreases in amount of manure resulting from the decrease of livestock numbers. Because of soil degradation, farmers now have to plough their lands 3 to 5 times before sowing. Some farmers even consider that the decrease of soil fertility is a resulted from the application of urea.

Farmers reported that since the 1990s, the price of fertilisers has been too high. If they buy fertiliser on credit, they are not able to pay it back because the interest is too high for them. While the price of fertilisers are increasing (as farmers reported), the price of grains is decreasing in recent years, which puts them in a very difficult situation since grain sales are a main source of income.

Erratic rainfall (many farmers also think that rainfall has decreased in recent years) causes low crop productivity, and even complete crop failure in some years. Unemployment of school graduates is one of the reasons that farm size is becoming smaller. After marriage sons share the family lands.

Lack of cash is the main reason that farmers sell their grain immediately after harvesting. It is very difficult for farmers to replace their oxen or to rebuild their houses without reliable income sources. Farmers themselves also consider lack of other skills apart from farming a problem in income earning. High dowry expense (paid from the groom's family to the bride's family) affects the capital availability of the male's family for a long time.

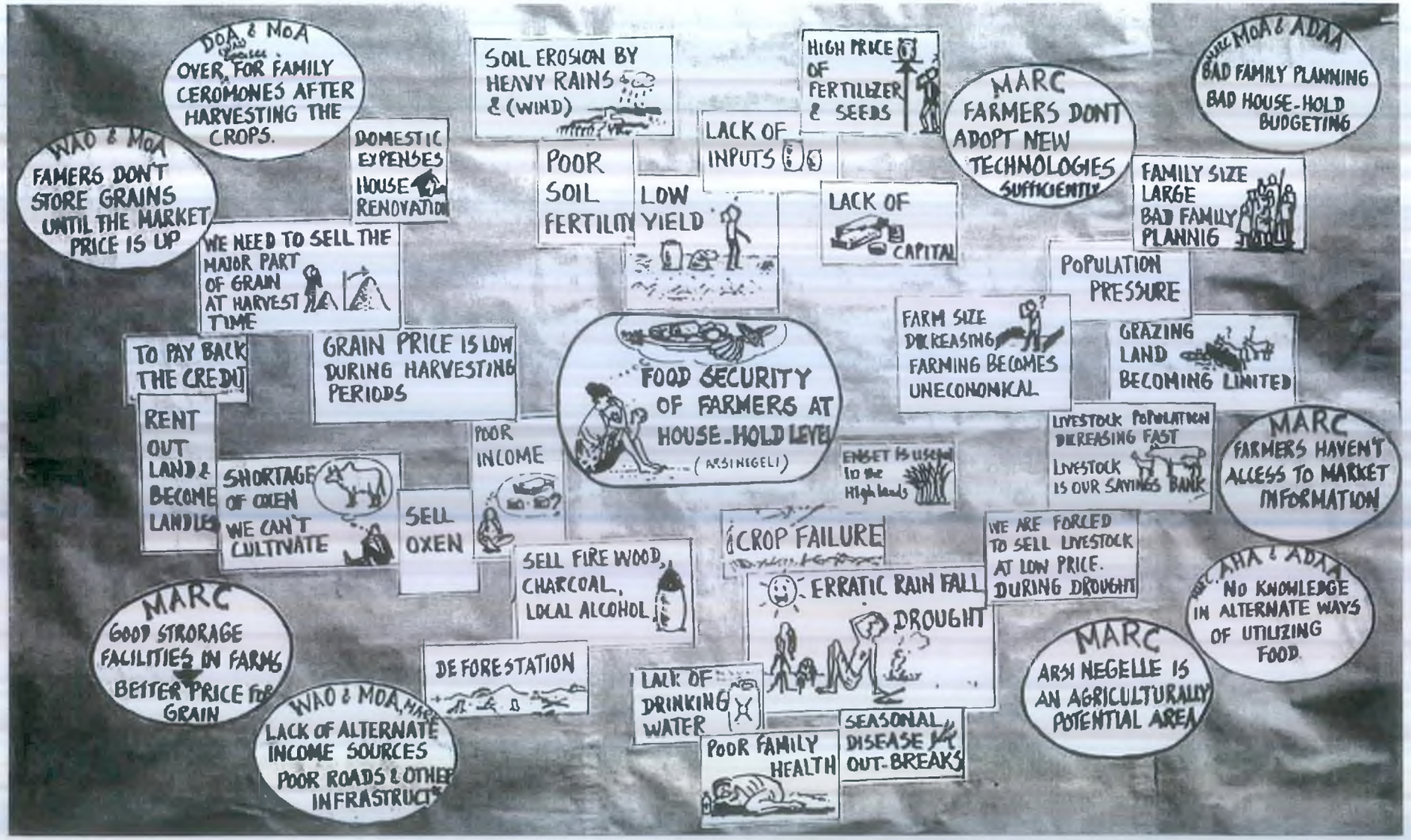


Fig. 2.2 Context of farmer household food security in Arsi Negele

Farmers consider oxen an important component of food security, even more important than land. For farmers, more oxen means more grain production. Shortage of oxen is the result of inadequate capital.

Difficulty in fetching drinking water is also perceived as a problem that affects food security. Women take a long time in fetching water for family use, which reduces the efficiency of family labour use. Lack of safe drinking water has an important negative impact on health of family numbers. Sickness of family members results in labour deficiency and increased family expenditure.

2.6.2 Context of food insecurity (rich picture) and research themes

Farmers' perceptions on the problem area of food security collected by the team during the whole field study period were visualised in Figure 2.2.

Based on the rich picture, 3 dimensions/themes relating to food security in the district and their importance in different AEZs were identified (Fig. 2.3) by the team, to focus the field study.

Changes in economic environment

According to farmers, the economic environment has been changing. The price of fertilisers has gone up while the price of grain has gone down. The present credit distribution system does not help the farmers much, and even sometimes makes the situation worse (as reported by the farmers). Meanwhile, the general fertiliser recommendation for all crops in all AEZs has not been modified for the last 30 years. Under this situation, the team identified the following research questions:

- On what information was the fertiliser recommendation made? Which stakeholders were involved in collecting/ supplying the information for the recommendation?
- How is the profitability of the recommended package on specific crops in the present economic environment? What is farmers' perception of the benefits of the package?
- Is it possible and/or necessary to de-package the recommendation? If so, what type of on-farm verification trial would give the best information?
- How have maize and wheat prices changed during the past years? What information on prices do farmers have? How have farmers adapted to price changes?
- How have fertiliser prices changed during the past years? Are there any alternatives to inorganic fertilisers? What is farmers' perception of soil fertility, fertiliser use, and alternatives? What research is being done on green manure, agro-forestry and crop rotation? How can cash flow be improved through a year? What are potential income generating activities? Can early cash crops (*bona* season) provide for fertiliser purchase?
- Who determines credit policy? How does WADD perceive this problem? Are there alternative credit resources? Can credit policy be changed?

Figure 2.3 Main dimensions of the food security problem

Importance of different dimensions in various agro-ecological zones

Dimensions	Lowland	Midland	Highland
Climatic risk due to bona season	+++	++	+
Changes in economic environment	++	++	++
Population pressure	+	++	++

Risk of crop loss in bona season

Under this dimension, the field study focused on the following relevant issues:

- Does food storage help in improving food security? What is the current situation and its potential?
- How has the climate changed? Is drought becoming more frequent?
- Is run-off of water a problem?
- What are the existing fodder resources in dry years?
- What is the impact of drought on livestock production?
- What is the impact of drought on food availability?
- What is the performance of the recommended seed-fertiliser package in dry years?
- How do farmers cope with drought? How could these strategies be improved?

Increasing population pressure

Land is becoming insufficient with population growth. To obtain a systematic and realistic understanding on how to improve food security in an environment of increasing population pressure, the following issues were identified for further analysis:

- How is population changing? How is land area per person changing? Is there a need for information on birth control?
- What other livelihoods are possible? Off-farm employment? Migration/resettlement?

- How are livestock numbers changing? How will role of livestock change? What alternative forms of saving are there (instead of livestock)? Such as trees, bank, farmer groups?
- What are farmers' perceptions on stall-feeding? What is the potential for fodder growing? What kinds of fodder is suitable: Grasses? Legumes? Trees?
- Can animal drawn implements be more efficient?
- Which is the best strategy to improve the current situation: food crops or cash crops?
- Is there any potential for intensification? How has the cropping index changed? What is the potential for double cropping and /or inter-cropping? Is soil fertility decreasing? Are yields declining?
- How has crop composition changed? What new crops have been introduced? How have they been introduced? What is the information flow? What is the profitability of the new crops and how are they profitable? What is the market size for new crops?

The field study was then focused on these 3 dimensions. The following chapters give a detailed analysis of these 3 dimensions.

CHAPTER 3 CLIMATIC UNCERTAINTY IN THE LOWLAND ZONE

The drought-prone, lowland part of Arsi Negele Woreda is of relatively low potential for crop production or is even marginal, yet thousands of people live in it as farmers. The incomes of these people are very low. This area has been the focus of attention as a disaster area when famine has occurred. Drought is still recognized as a major hazard to food production, and one that is likely to be even more important in the future as population pressure deplete the resource base and bring ever more marginal land into cultivation.

3.1 Farmers' perception on climatic risk

As indicated in section 2.4, farmers in Arsi Negele Woreda, particularly in the lowland zone, face erratic rainfall as one of the serious problems. Occurrence of drought due to erratic rainfall has a direct negative bearing on food security of farm households. According to farmers, as expressed during group discussions, they have experienced 3 years of very poor and 2 years of below average crop harvest in the last 10 years due to drought. Rainfall is highly variable in terms of quantity and distribution. The intensity of rains also varies; excessive run off due to high intensity rains has caused considerable soil erosion, which in turn leads to poor yields in the subsequent years. Farmers said that in the past they ploughed their lands once or twice before planting a crop, but that nowadays they need to plough 3 to 5 times because the soil physical properties have degraded. On many occasions, during early stages of crop growth, run-off water has destroyed a crop within hours.

The major negative impacts of recurrent drought on the livelihood of farm families as repeatedly mentioned by farmers in the lowland zone are briefly described as follows:

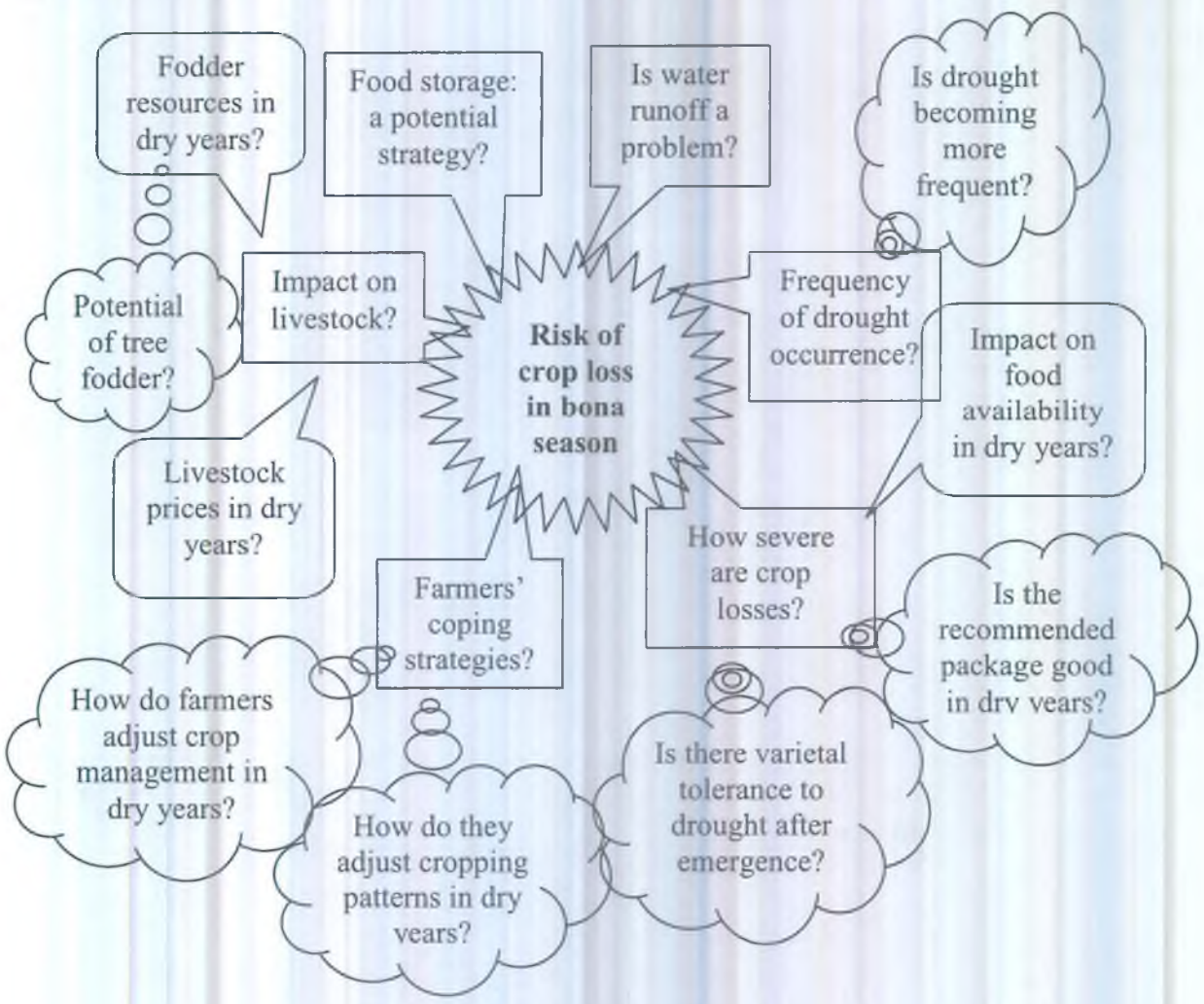
- **Crop and livestock failure** - When crops fail farmers cannot repay their credit and cannot buy food on credit either. They cannot pay school fees and children are kept without schooling. Livestock become weaker due to feed shortage and disease outbreaks. Food shortage becomes the issue and need to fight hunger. A common way to overcome the hunger is to sell livestock; as a last resort they sell even their oxen. Livestock price in the market drops drastically because all farmers want to sell their livestock.
- **Price increases of food in the market** - During a drought, food prices in the market increase, which is an added shock to farmers. Farmers cannot afford to buy sufficient food for the whole family.
- **Lack of drinking water and disease outbreak** - Drinking water becomes very scarce and women and children need to work hard to bring water. In some cases they need to spend more than seven hours a day to fetch water from far-away places. Seasonal disease outbreaks like malaria and water-born diseases become prevalent which in turn cause deterioration of family health. Shocks due to family health deterioration bring many other problems like inefficient labour.
- **Inefficient labour** - Labour force becomes weak in terms of efficiency due to poor family health and hunger. Poor labour limits other income generating activities like fire wood collection, charcoal making and mineral soil collection.
- **Shortage of oxen and renting out of land** - As mentioned previously, farmers have to sell their livestock and as a result they run short of oxen in subsequent years because they cannot afford to buy another ox. Without oxen they cannot continue farming successfully. If they cannot hire or share oxen, the only alternative is to rent out the land and effectively become landless. Also some farmers rent out their land because they lack capital to buy

inputs like seeds and fertiliser. Once the farmer becomes landless and without oxen it becomes very difficult to escape from the vicious cycle of poverty and then they have to rely on other income sources like labouring (working for others), charcoal making, migration etc.

3.2 Research questions

Erratic rainfall, both at the time of crop establishment and during the growing period are the two major forms of drought recognized as hazards to agricultural production in the lowland zone. In this drought-prone area, a prior effort should go to a thorough understanding of the farming system mainly through working with farmers and listening to them. To this end, several problems and research questions addressing the potentials and limitations of farming in the erratic rainfall environment were identified by the team for an in-depth study with farmers and other relevant stakeholders (Figure 3.1). These research questions were used as a basis for obtaining additional information and discussions with the stakeholders. The results and analyses resulting from this process are discussed in the following sections.

Figure 3.1 Farming in an erratic rainfall environment: problems and research questions



3.2 Effect of drought on agricultural production

The scarcity of water supplies directly used for agriculture in the lowland part of the woreda causes a consistently high soil moisture deficit throughout the growing season. Such an imbalance between moisture supply and demand causes frequent disruption of the rural economy, ultimately through adversely affecting crop and animal production.

3.2.1 Effect on crop production

Similar to many other drought-prone areas of the semi-arid tropics, drought affects the growth of crops through exerting a negative influence on the fertility and physical structure of the soil in which they are grown. In addition to the lack of the input, the resource poor farmers in the area do not take the risk of applying commercial fertiliser due to lack of crop response and possible damaging effect on the growing plant. Drought has enhanced both water and wind erosion often in an increasing rate, resulting in poor nutrient status of agricultural soil in the area. Consequently, general plant growth and dry matter accumulation is hindered due to the inhibition of large root system development. Low organic matter content of the sand dominated (coarse-textured) soil has made the soil prone to compaction. Compacted soil is difficult to start ploughing before the onset of rain, resists root growth and development, and the reduced infiltration rates causes significant loss of topsoil through runoff.

The low productivity of food crops in the area is mainly ascribed to the unpredictable interference of moisture stress once or repeatedly in any of their growth and developmental stages. The yield during drought years, compared to the relatively good growing seasons, for maize and beans is reduced from 30 to 10 q/ha and 20 to 6 q/ha, respectively. The commonest occurrence of moisture stress in the area being at the vegetative phase of maize, it reduces aerial vegetative growth in terms of height and spread. The combined effect of moisture stress and reduced uptake of nitrogen curtails the crop's ability to compete against weeds and other stresses. At flowering stage, moisture stress significantly depletes yield due to reduced seed number caused by failure of proper (effective) fertilization (both maize and beans) and considerable flower abscission (in beans). Insufficient water during the grain-filling stage results into reduced seed size and seed weight (maize and beans), and the sticking and subsequent rotting of the maize cob on the stalk. Onset of drought at one or more of these stages also indirectly contributes to grain yield reduction favouring the incidence and prevalence of insect pests mainly the stalk borer in maize and the pod borer in beans.

3.2.2 Effects of drought on livestock

Livestock production depends entirely on grazing on natural pastures and feeding on crop residues after harvesting crop fields. Drought has significant effect to availability of these feed resources. During Bona seasons, when there is lack of enough moisture for plant growth, forage and crop production is affected. During this time there is feed shortage and hence livestock loose weight and even when are sold in the market the fetch very low prices.

3.3 Farmers' coping strategies

3.3.1 Livestock husbandry changes during drought years

Migration of livestock to and from highland

Farmers in the lowland usually move their livestock to the highland for better pastures, through their relatives. When forage is available in the lowland again, the livestock are brought back. For the past years this temporary migration was possible. Wth the continued decline of grazing lands since more land is converted for crop cultivation, however, the practice might not be sustainable.

Feeding with tree branches

Livestock herders usually climb trees and lop the tender tree branches and feed to their livestock. In the lowland farmer feed mainly the branches from *Acacia* and *Albizia* spp.

Feeding crop residues and grazing on field margins

Farmers allow animals to graze on harvested fields and sometimes harvest the crop residues and store as hay. Similarly, livestock are taken to graze on the margin of the crop fields.

Selling livestock

Farmers sell their livestock for purchase of food grains and sometimes to earn cash so as to meet some other family needs. During this time the main driving force for livestock sales usually is get cash and buy food grains. Otherwise animals are sold because of their poor condition and they might loose the animal. Most of the animals during severe drought are emaciated and when are taken to the market they are sold by very low prices. However, on the other side farmers feel that selling livestock is becoming more and more difficult. Livestock numbers have decreased so much particularly livestock number per household. For example in the lowland a household with cattle had on average more than 10 cattle but now it is less than five heads per household. Some of the households have got only a pair of oxen, which is an important indirect contribution to food security.

3.3.2 Crop management response to climatic risk

Farmers in the drought-prone areas of the low altitude zone are well aware of the nature of risk in their production system. Because they typically have access to only a low level of technology factors and hence are unable to control environmental factors significantly, they tend to use a variety of tactics to spread risk. This is particularly true of planting which is not only high-risk operations as regards establishing the crop but also carry risks of adverse on later stages of growth and development.

The methods used by farmers of the lowland part to spread the risk of germination or crop growth failure:

- Ploughing before rains and dry seeding (planting before rains begin, in completely dry soil). This is mainly done by farmers who lack oxen
- Planting early maturing crops (beans, red grain teff, barley) as cash crops as a substitute for the failure of early planted maize
- Staggered planting of maize; *Secha*, planted usually in mid-May for green cob consumption and the one for its grain is planted in May to early June
- Community control of planting date; by interpreting meteorological and biological events how the season develops, elders in each village advise on the planting time (earlier or later), and type of crops to plant
- Spatial separation of the field; planting maize early usually in April with first shower for farms in the depressions and planting late in May in the other fields
- Although controversial, most farmers in the area perceive cultivation of young seedlings after several days of moisture stress also helps in fast recovery and growth of crops due to the improvement of moisture availability that infiltrates down through the loosened soil when rain recommences

3.3.3 Livelihood coping strategy for food shortage in the lowland zone

In addition to the several crop and livestock based risk spreading strategies discussed above, there also other community and individual household level coping mechanisms practised during periods of food shortage mainly caused by severe drought in the lowland. Although they share few mechanisms, there is a considerable difference among the households in terms of the diversity of coping strategies employed. In the first two farm types where they have no or less cattle and less than a hectare of land, the main coping options are to sell firewood and charcoal, mining and selling of sand and *bole soil,* sale of labour, migration and request for food aid. In the other two farm types, in which the livestock number owned is relatively higher, the main coping strategies are sale of cattle including oxen, and renting out of land and oxen.

3.4 Risk related to the erratic rainfall in the lowland zone

Agricultural production in the lowland zone of the district operates in an environment that is risky for farming. Risk is the single most important problem facing farming families. Risk avoidance is the underlying concern behind most of the day-to-day management decisions such families make. Risk is mainly related to rainfall/drought. Rainfall is highly variable both between and within seasons, which is manifested in the quantity, intensity, and distribution of precipitation in the growing season. The effectiveness of the rainfall also varies considerably depending on management of the land and the timing and intensity of the rainfall.

Several distinct types of risks related to moisture deficiency are experienced either alone or in combination at any given situation in the zone. Farmers try to combat the problem applying few crop and soil management practices. The two most common risks of drought are caused by insufficiency of early rain for crop establishment, and irregular or unpredictable distribution of rainfall distribution of rainfall throughout the season.

Farmers in the area are too familiar with early rains that peter out, resulting in the need to replant. Replanting, which is commonly done for early-planted crops, particularly for maize, not only increases seed and labour costs but also diminishes the prospect of an adequate harvest due to delayed establishment. Crop establishment is particularly a high-risk operation for subsistence farmers who usually lack the resources (mainly those borrowing or hiring oxen) for speedy cultivation and planting. In some of the seasons, the rainy period is too short (usually two months) so that the rain may be adequate to sustain early crop development when water demand is lower, or at the end of the season to mature grain. Farmers lack alternative fast maturing crops and varieties adapted to the typical effective and most reliable length of the rainy period.

As mentioned in the previous discussion, the average annual rainfall for the lowland part of Arsi Negele (724 mm) is not significantly lower when compared with both the midland and the high altitude areas that receive about 879 and 1169 mm, respectively. For farmers in this specific area, the distribution and reliability of the rain throughout the season and between years is more interesting than the mean annual rainfall *per se*. Their experiences show poor distribution throughout the growing season, often resulting in a highly damaging drought at critical periods of crop growth. Therefore, the two important aspects of the rainfall reliability were estimated from a sixteen-year rainfall observation period. Records were obtained from Langano weather station, which is located in the lowland part of the district.

With an annual rainfall range of 402 to 967 mm in the sixteen-year period, the coefficient of variability (cv) of the annual and the effective growing season (second decade of April to third decade of September) were about 21 and 23 percent respectively, indicating the variability of rainfall both from season to season and within a cropping season. Indeed, within-season variability increases with the increase in length of the growing period considered.

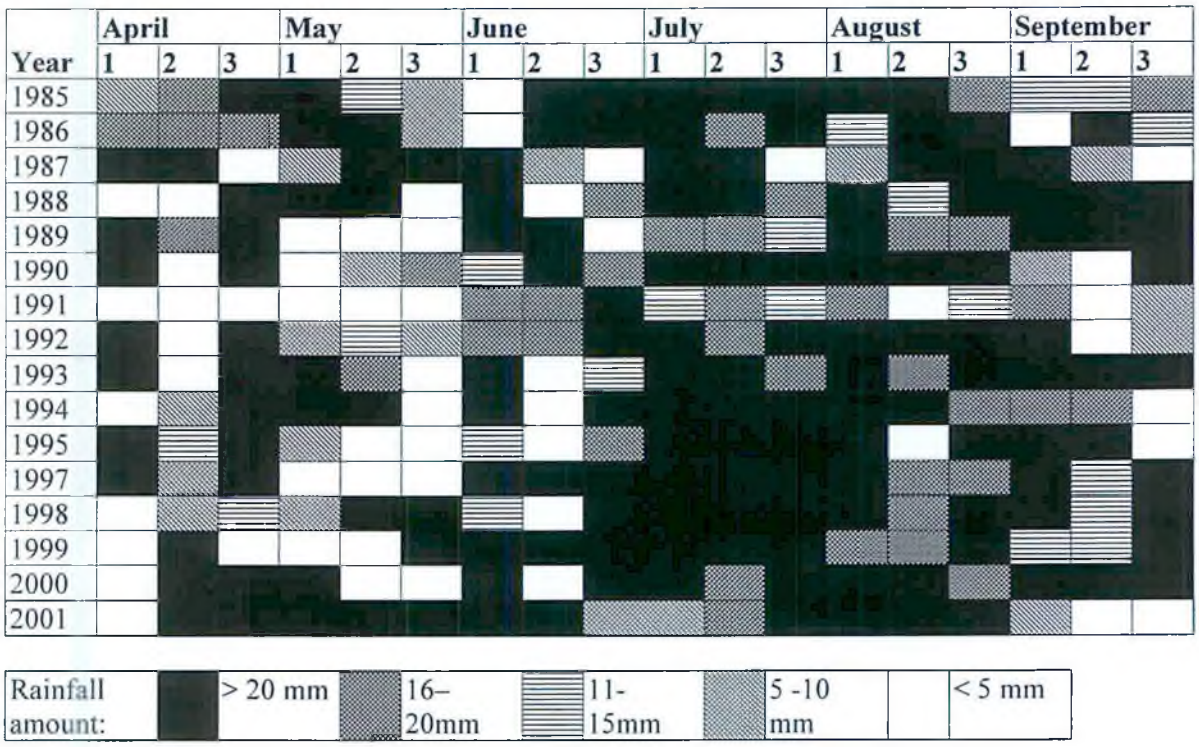
Since planting is the high-risk operation in the area, an attempt was made to see how farmers are managing the establishment of maize cultivars at the start of the season. The analysis on decade basis is related with farmers' decision of varieties to be grown. From the 1999 ICRA field study on drought-oping strategies in the upper part of the Ethiopian Central Rift Valley, the assumption that a threshold level of at least 15 - 20 mm rainfall per decade is required to meet the farmer's criterion of having a sufficient wet period was adapted. If four sequential wet periods did not occur before the cut-off planting date was reached for the specific maize varieties, it was assumed that the variety (ies) could not be planted anymore. In the case that the required wet periods are not available for planting maize before mid-June, farmers would shift their attention to planting of teff, beans, and barley.

The information presented in Table 3.1 regarding maize planting decisions was used in combination with rainfall analysis on a decade basis for Langano (Figure 3.2), to establish the pattern frequencies in the start of rains that are suitable for planting early maturing maize (farmers are abandoning the use of medium to late maturing maize cultivars as it is too risky).

In the period considered, only 2 of 16 years met the criterion of having 4 sequential wet periods of more than 15 mm rainfall, and hence favoured the planting and successful establishment of early maturing maize varieties before the cut-off day was reached. Moreover, in 6 out of the 16 years, there were at least two consecutive dry decades after the rain had commenced that would be likely to cause post-planting crop loss when the maize was planted before June. Although the length of the season appears to sustain growth and development of

early maturing maize varieties planted after mid June, such a late planting can result into an unacceptably low grain yield level due to the decline of yields with late planting.

Figure 3.2 Decadal rainfall analysis for a 15-year period (1985 – 2001) for Langano, located in the lowland of Arsi Negele Woreda



The occurrence of dry spells during the second and third decades of June can significantly affect the growth and productivity of the crop since it frequently overlaps with the sensitive early vegetative growth stages. If the drought stress is persistent and wilting continues for more than about five days, then all but very young plants suffer as the stomata experience permanent damage. They are unable to open fully thereafter, no matter how favourable the ensuring moisture conditions. Similarly, the frequent dry spells encountered in late July and early August can also substantially reduce the final grain yield. This period mostly overlaps with silking or shortly thereafter, which is the stage of maximum sensitivity of the crop: water deficits during silking and tasseling are known to reduce grain yield more than at any other period. In conclusion, maize appears to be a marginal crop for this environment, and alternative crops or management practices that spread the risk of crop failure or yield loss should be sought in the future.

Table 3.1 Planting dates of maize cultivars in the lowland part of Arsi Negele Woreda

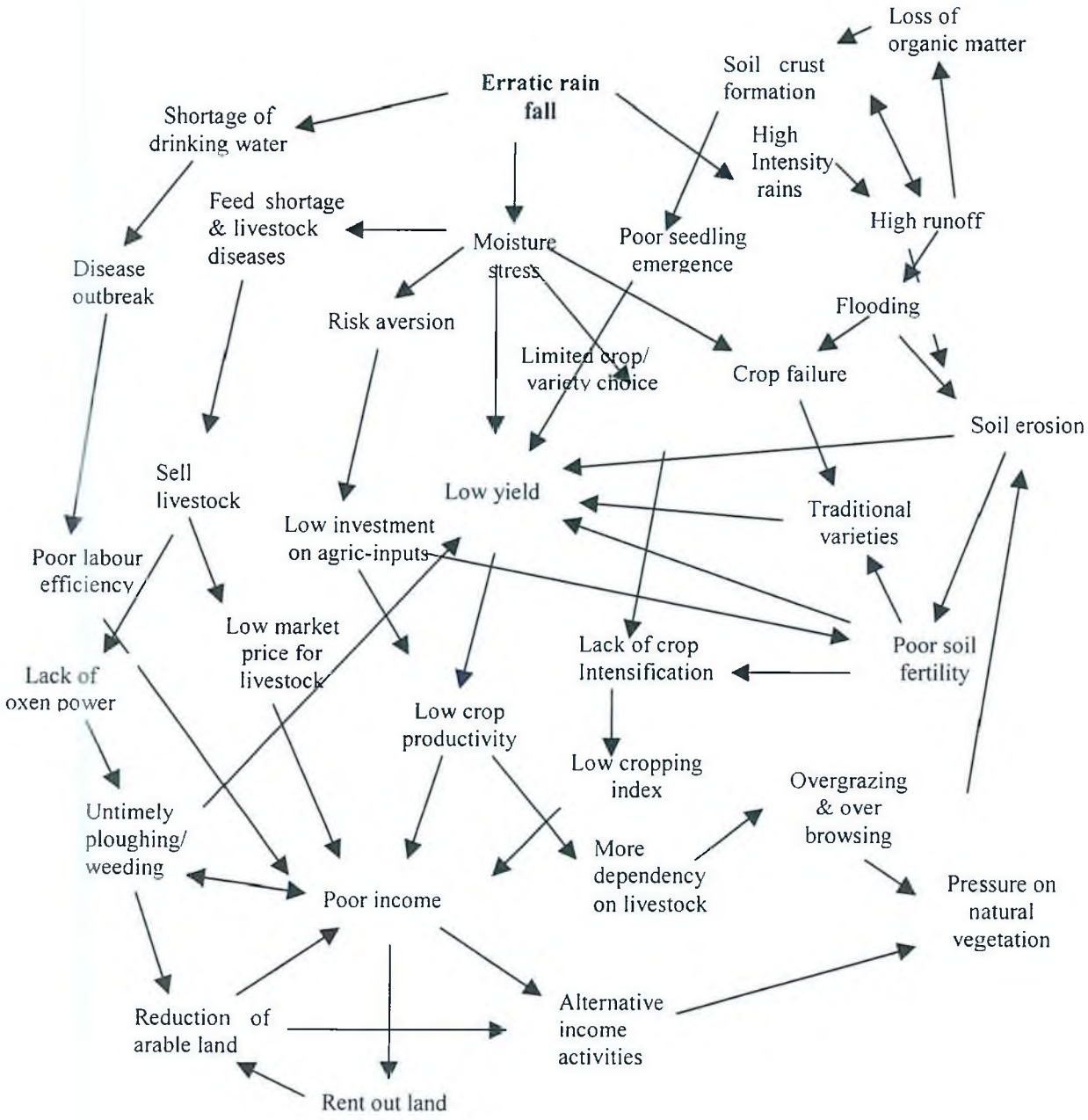
Maize cultivar	Preferred planting date	Cut-off date	Likely periods of tasseling/silking
Shaye (90 days)	April 22 – May 7	June 17	July 22 – August 7
A511 (90 days)	April 22 – May 7	June 17	July 22 – August 7
PHB 3253 (90 days)	April 22 – May 7	June 17	July 22 – August 7
Kenya (140 days)	April 8 – 23	May 7	July 8 - 23

3.5 The problem situation redefined

Farmers' problems in the woreda, and in particular in the lowland zone, are more complex than a simple list of priority constraints (Figure 3.3). The complexity of the production problems in this specific farming system can be seen from the environment-crop-livestock interaction scenario given in Figure 3.3.

For any intervention to be effective all possible interactions and its effects on overall systems sustainability should be evaluated critically. The first step then would be creation of awareness of the overall actor, the human component through education about the gravity of the problem. Secondly, technologies and inputs such as seed, water, and fertiliser, requiring moderate knowledge and capital that can be easily met with some extra efforts by the user, the agricultural service sector, and by credit facility rendering institutions should be emphasized. This can only help in stabilizing the system and fetch considerable confidence of the farming community in the drought-prone area of the lowland zone.

Figure 3.3 Problem-causal diagram of climatic risks in the lowland



CHAPTER 4 THE ECONOMIC ENVIRONMENT OF GRAIN PRODUCTION

4.1 Problem area and research questions

As we saw in chapter 2, the changing economic environment is one of the dimensions of food security identified in the preliminary analysis with stakeholders. Farmers are concerned that grain prices will be falling and that input prices will be rising. Similarly, the policy of repayment of the credit package is a limiting factor in food security, forcing farmers to sell at the time of year when grain prices are at their lowest. This chapter therefore focuses on the four sub-components under the changing economic environment: recommended technology, fertiliser price and grain prices, credit services, and profitability on fertiliser.

Firstly, we attempted to trace the historical background of the recommended technology package, and the current perceptions of the farmers regarding this package.

Secondly, we looked at the changes in price of seed and fertilisers and grain. We also looked at the past and current profitability of the recommended package, using data supplied by farmers.

Thirdly, we looked at credit availability under current programmes, including at issues such as policy determination, policy changes, possibilities of alternative credit services, future credit scenario, the perception of WADD on this problem, and the cash flow of farm households.

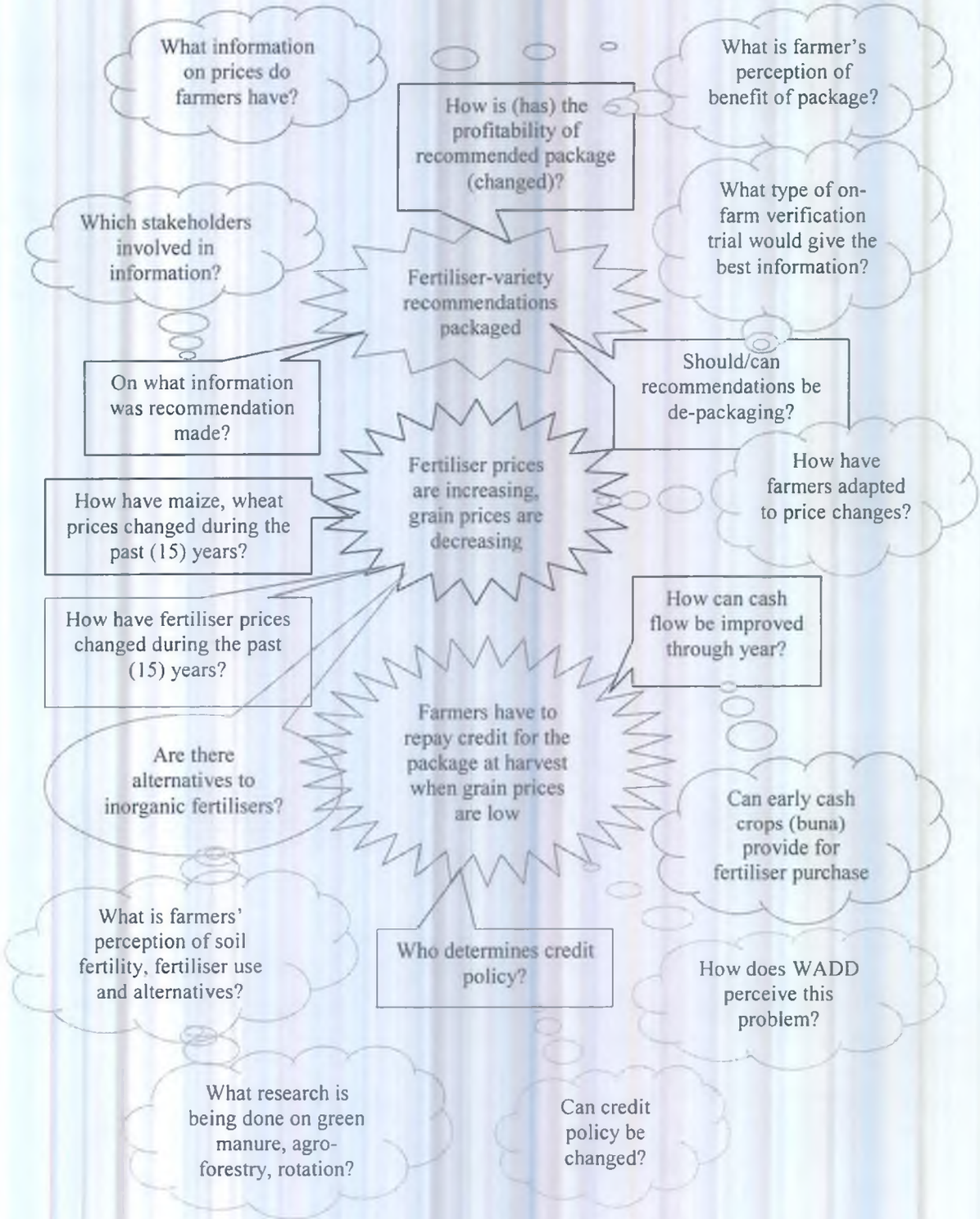
A more complete overview of the research questions that guided analysis of this theme is shown in Figure 4.1.

4.1.1 Stakeholders' perception of the problem

The WADD accepts that the price of major grains have declined mainly because of higher production and, to some extent, the role of traders. Whereas they do not recognise a significant increment of fertiliser price, it does accept that subsidies on fertilisers have been removed. This could be one of the reasons that farmers felt fertilisers have become more expensive. The WADD believes that farmers do not plan their crop selection, crop revenu, and cash requirement.

Regarding the farmers' complaint of being forced to sell the grain just after harvesting the product in order to be able to repay the credit, the WADD considers it as a serious problem but they do not see any solution at the moment, since this is a national package programme and a short-term loan which should be repaid within one year. Moreover, the WADD sees the social practices of celebrating feasts after the harvest as one of the determining factors to the administration to collect the loan just after harvest.

Figure 4.1 Changes in economic environment: problem area and research questions



Other stakeholders have a similar viewpoint. The Awassa Agriculture Research Centre (AARC) and African Humanitarian Action (AHA) see the higher production as the deciding factor in grain price reduction in recent years. In addition, the AARC mentioned this fall is due to government policy regarding credit and taxation. They further agreed that farmers have to repay the credit and pay the land tax just after the harvest, which leads inevitably to low prices at that time.

MARC understands that unavailability of market information to the farmers, insufficient infrastructure such as road, transportation and warehouse facilities, are factors leading to higher exploitation of farmers regarding prices.

Farmers themselves are mostly unaware of the reason behind grain price changes. Some farmers in the highland expressed that it could be due to the increased production because of improved seed and fertiliser. Exceptionally, one farmer in the highland expressed that this is the result of changed government policy of restricted grain export.

4.2 Recommended production technology

4.2.1 A brief history of fertiliser-variety recommendations package

The Extension Programme for Implementation Development (EPID) project, supported by the Swedish Government and FAO, developed the blanket recommendation for fertiliser application in Ethiopia in 1973. This was extended through the Ministry of Agriculture and its regional offices within a 5-km radius from the main roads. At that time, EARO and its research centres were newly established with limited resources, scientists, equipment, etc., and therefore they were unable to conduct fertiliser trials for different crops in the different zones.

EPID recommended a blanket rate for all agro-ecological zones and for all crops of 100 kg of DAP and 100 kg of urea. As DAP contains 18% of N and 46% of P_2O_5, and urea contains 46 % of N, the recommended nutrient rate per hectare is 64 kg of N and 46 kg of P_2O_5.

The recommended seed sowing rates of the package programme is 150 kg/ha for wheat, and 25 kg/ha for maize. The time of fertiliser application for maize is 100 kg of DAP at sowing, and 100 kg of urea at the vegetative stage, in the case of interrow cultivation . For wheat it is 100 kg of DAP and 100 kg of urea at sowing.

Initially, EPID provided fertilisers free of charge to promote their use, but later this policy was stopped. Since 1996, WADD has been implementing a package programme based on this recommendation to enhance grain production in the woreda. The package programme also recommends applying herbicides (2,4-D and U-46) at the rate of 0.5 l/ha of for weed control, especially on wheat fields.

The Agricultural Input Supply Corporation (AISCO) was established in 1985[3] and renamed as Agricultural Input Supply Enterprise (AISE) in 1994. Until 1992, distribution and marketing of fertiliser was fully under state control. Consistent with the new economic policy, the Government designed a new marketing system for fertiliser in 1992 with the main objective of liberalising the fertiliser market and creating a multi-channel distribution system. The liberalisation permitted the private sector to engage in the importation and distribution of fertiliser, thus ending the monopoly power of the state-owned AISE (Demeke, M. Said, Ali Jayne, T.S., 1997)

Crop variety trials and recommendations

Crop variety trials done by Awassa (maize), Kulumsa (wheat) and Melkassa (sorghum, fingermillet) agricultural research centres are recommended and applied for this district. These research centres have conducted various variety trials in different zones of similar agro-climatic conditions to Arsi Negele. These crop varieties are mainly obtained by EARO from international research centres. The recommended maize varieties for different agro-ecological zones include BH 660 for highland, BH 540 for highland and midland, PHB 3253 and A 511 for midland and lowland. Likewise, HAR 1685 wheat is recommended for all three agro-ecological zones, HAR 710, HAR 604 and Pavon 76 for midland and lowland. Other cultivated crop varieties were introduced from different parts of the country, which have similar climatic conditions.

Dissemination of recommendation and crop practices

EARO and its research centres conduct crop variety trials and recommend appropriate varieties for different agro-ecological zones. WADD has a mandate to disseminate the package programme and introduce new varieties and crop practices to farmers' fields. Development Agents (DAs) suggest to the farmers the rate and time of fertiliser application, crop varieties, weed and disease control methods. DAs are the bridge between farmers and WADD and have good linkages with PAs. The WADD also makes some recommendations based on information from literature, as in the case of. the pesticides Ridomil and Mancozel to control armyworms, Cypermetrin to control the late blight in potato and onion fields and Actellic for storage pests, weevils, and rodents.

Some farmers have introduced crop varieties and have adopted cropping practices from relatives who live in other parts of the country. The role of NGOs is also significant here. The African Aid Development Association (AADA), for example, has disseminated the technology of rapid multiplication and growing Enset in the highland.

Research conducted on fertiliser application

After introduction of recommendations by EPID, research organisations under EARO, in collaboration with the WADD, have conducted "farmers' demonstrations" and "special demonstration fields" to show the advantages of fertilisers. For the last 10

[3] Before the establishment of AISCO in 1985, (1978 – 1983), the Agriculture Marketing Corporation (AMC), a state-owned parastatal, was the sole importer and distributor of fertiliser.

years, however, such trials have been discontinued. WADD has continued to recommend 100 kg/ha of DAP and 100 kg/ha of urea for sorghum and barley, 50 kg/ha of DAP and 50 kg/ha of urea for teff and tomato, and 200 kg/ha of DAP for onion.

Awassa ARC has conducted fertiliser trials for maize which recommends 200 kg/ha of urea and 100 kg/ha of DAP. It suggests to apply the full amount of DAP and 1/3 of urea at sowing, and 2/3 at near-head stage. These recommendations are not further extended, however, because they have been done for specific ecological conditions. Recently, the agronomic section of Awassa ARC has started on-farm fertiliser trials for maize in Awassa zone.

According to WADD, some of the farmers were independently trying different fertiliser rates in their fields and suggesting an increased of rate of DAP application. Little research on alternatives to inorganic fertilisers (manure, green manure, compost, etc), rotation, crop management and agro-forestry has been conducted in the district Farmers adopted crop practices that are based on experiences in other parts of the country, and WADD's blanket recommendations.

Researchers at Arsi Negele sub-centre of MARC also apply 100 kg of DAP and 100 kg of urea per ha for maize and wheat variety trials and farmers' field demonstration plots. Some research has been conducted on fingermillet fertiliser application. Based on this they apply 50 kg of DAP on fingermillet fields

Recently, the National Fertiliser Agency started analysis of soils for determination of different soil types, their fertility and are developing district soil maps, which can be used for developing appropriate fertiliser recommendations for different agro-zones.

From the above information we can conclude that research organisations under EARO are mainly doing variety trials on different crops. Released varieties are also disseminated to the farmers and they have been adopted too, however, there is a high scope for doing trials on drought tolerant, early maturing and low nutrient responsive varieties. In the case of fertiliser there is a need to update recommendations. It is quite surprising that research organisations have done so little research for fertiliser recommendations for this area in the last two decades, with one or two exceptions.

Furthermore, i is equally important to conduct research considering the possibilities of alternative fertilisation in the light of changing prices as well as fertility so as to cater the need of farmers from an economic as well as environmental point of view.

4.2.2 Use of seed and fertiliser by farmers

Farmers' perceptions on soil fertility and possible alternatives to inorganic fertilisers

Analysis of farming system changes show that farmers have a clear perception of declining soil fertility. Farmers believe that during the last 10 years, soil fertility in all agro-ecological zones has decreased. The main causes of soil fertility decline are water and wind erosion and improper cultivation practices. One of the causes of wind and water erosion is deforestation, which has extended during the last decades. The

prevention of deforestation according to farmers can stop declining soil fertility and some farmers suggest planting of trees as windbreaks. Farmers perceive that it is impossible to obtain good crops without applying fertilisers

According to farmers, they were applying manure 20-25 years ago but after introduction of inorganic fertilisers they have stopped this practice. However, the increasing price of fertilisers is forcing farmers to think about possible alternatives. Farmers understand the role of manure and crop rotation for increasing of soil fertility, but traditional free grazing of livestock doesn't allow collection and application of manure. Recently some farmers apply manure collected from kraals for cash crops (potato, onion, and sugarcane) and in kitchen garden. However, livestock numbers are declining, particularly in the mid and lowland zones.

Distribution of fertiliser and seed by agro-zones

According to information obtained during farmers' focus group discussions, most of the farmers in all agro-ecological zones apply fertilisers for all crops, except for pulses (haricot and faba bean). The number of farmers who use fertilisers varies from one agro-ecological zone to another. For example, in highland and midland almost 90% of farmers apply fertilisers, while this is about 50 % in the lowland. Sources of fertiliser include the package programme provided by WADD and self-procurement. In the highland, farmers unable to purchase or obtain credit rent out the land to those who can afford to buy fertilisers.

Table 4.1 Distribution of inputs by package programme in 2001-2002

Type of input	Number of PAs received inputs	Estimated number of HHs received inputs*		Location of input receivers (agro-ecological zone)		
		HHs	%	HL	ML	LL
Fertilisers:						
DAP	30	11,603	50.44	+	+	+
Urea	24	8,257	35.9	+	+	-
Seeds of improved maize varieties:						
BH 660	12	2,719	11.8	+	-	-
BH 140	8	294	1.2	+	+	-
PHB 3253	10	617	2.7	-	+	+
A 511	12	971	4.2	-	+	+
Seeds of improved wheat varieties:						
HAR 1685	12	686	3	+	+	+
HAR 710	8	45	0.2	-	+	+
HAR 604	4	20	0.1	-	+	+
Pavon 76	8	64	0.3	-	+	+
Herbicide:						
U-46		5,286	23	+	+	+

Source: WADD, May 2002, unpublished data

* Farmers are counted for more than one type of input at a time.

The package programme has provided at least one type of fertiliser: DAP to 11603 HHs in the FY 2001/02 (Table 4.1). Other farmers purchase fertilisers from the regional store of AISE or from other suppliers. The price of fertilisers purchased directly from AISE is usually higher than the price of fertilisers provided by the WADD package programme. The difference in price is 9-10 Birr per 100 kg of fertiliser.

According to WADD and researchers, some farmers do not follow existing recommendations. They apply part of the fertilisers received from the package programme to the maize and wheat fields, and they apply the rest to other crops such as teff, barley, sorghum, or vegetables. Due to the increasing gap between grain and fertiliser prices, farmers can not afford therefore, decrease the rate of fertilisers in some cases.

Type of fertilisers

These days farmers are complaining about the quality of fertiliser, especially the urea. They perceive the impact of urea to the crop yield is negligible and it decreases the soil fertility: they therefore do not want to use it. Instead, they are interested in applying an increased rate of DAP up to 200 kg/ha. The WADD does not recommend fertiliser application to some PAs because of unsuitable ecological and economic environments, on lowland sandy soils for example.

Source of improved seeds

Farmers having access to the package programme mainly use improved seeds of maize and wheat. Improved seeds provided to farmers through the package programme are produced by the Ethiopian Seed Enterprise and Pioneer Seed Company. About 20-25% of farmers' purchase improved seeds of maize from regional dealers of Pioneer Seed Company and AISE.

Arsi Negele Research sub-centre of MARC provides improved seeds of sorghum and fingermillet in some PAs, mainly in the midland. For other crops, farmers use locally produced seeds or purchase seeds from different regions (Shashemene, Awassa, Wonde Ganet, etc). Due to the increment of fertiliser prices, farmers prefer to plant locally produced crop seeds. They use seeds of lower generations of improved varieties and "local varieties" that are less responsive to fertiliser application. Actually, by "local varieties" farmers understand varieties introduced to the region a long time ago popular with local names such as Kenya (maize) and Israel (wheat).

Herbicide and insecticide application

About 75% of farmers in the highland apply herbicides to control weed in wheat fields while in the midland only 15% of farmers uses herbicides. In the highland there is no disease control at all, but in the midland and the lowland 30% of farmers apply pesticides mainly on onion and potato fields. These pesticides are provided by the input supply company Amalgamet and other merchants.

Farmers are quite exposed to the varieties of different crops and they perceived fertiliser as an important ingredient to increased production. Therefore they opt to

apply fertiliser but due to lack of resources, not all of them can do so. Package provided seed and fertilisers are limited to major cereals such as maize and wheat. Dependency on the package program is quite high, however, this year there was no package programme. Farmers had to rely on the open market although it is expensive and sometimes not reliable. Some farmers who cannot afford improved seed even use the second and third generations of the hybrid seed. Seed and fertiliser markets should be more competitive and a market information system is necessary.

4.3 Changing input-output prices

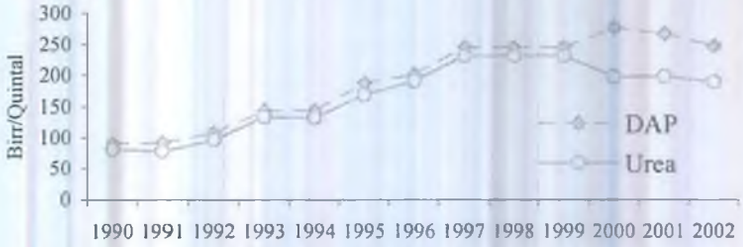
4.3.1 Farmers' perception on price changes

Farmers have perceived that fertiliser and seed prices are quite high for the last few years and they cannot afford them. Farmers are looking at the comparative price changes between the fertiliser and the grain mainly at harvest time. For example, one quintal of maize at harvest (referring the last years price) is 35 Birr. Farmers calculate if they need to get one quintal of fertiliser (DAP For example), they need to sell 7.6 quintals of maize, which they expressed very expensive.

4.3.2 Fertiliser prices

Information from the WADD shows that the prices of DAP and urea for the last 10 years have increased from 90 and 81 Birr/Quintal in 1990 to 247 and 188 Birr/Quintal in 2002 respectively (Figure 4.2). The maximum price of DAP, 266 Birr/Quintal, was recorded in the year 2001 and for urea 230 Birr/Quintal in 1997-1999. For the last 2 to 3 years the fertiliser price has been decreasing. This decrease, however, is insignificant as compared to constant increment over the last eight to nine years.

Figure 4.2 Fertiliser price trends, 1990 - 2002



Source: Arsi Negelle Woreda Department of Agriculture

The Government of Ethiopia was subsidising fertiliser until 1994 and the price seemed not too high to farmers. After introducing a free market economy, the subsidy on fertilisers was withdrawn. Moreover, the price of imported fertilisers depends on the world market, according to WADD and District Administration.

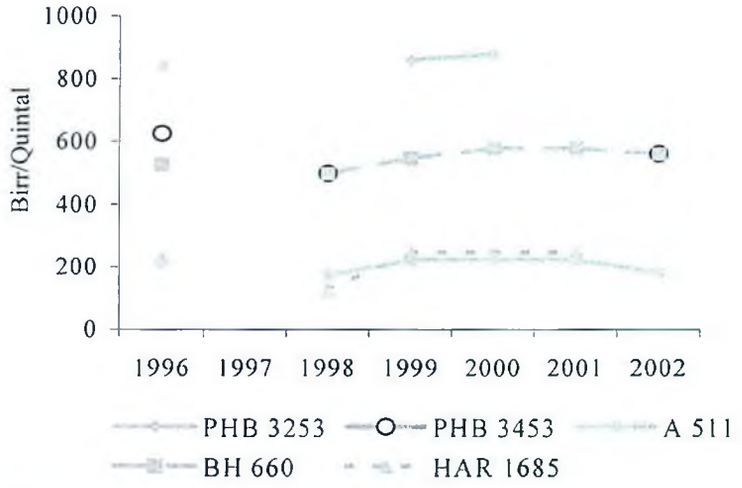
The price of fertilisers is not fixed and it differs from year to year and from region to region. There are several fertiliser suppliers who are always competing among themselves. East Shoa Zonal Department of Agriculture, for package programme,

selects Fertiliser Supply Company every year on the basis of price lists and results of auctions. In the region some small traders provide fertilisers to farmers and they increase the price adding other operational and capital cost.

4.3.3 Changes in seed prices

The prices of maize and wheat seeds provided by the package programme during the last 6 years have not been changed so much (Figure 4.3). There are differences only between hybrid (PHB 3253, PHB 3453, BH 660) and composite (A 511) maize varieties, while all wheat varieties (HAR 1685, HAR 710, ET 13, Pavon 76) seeds have the same price.

Figure 4.3 Changes in maize and wheat seed prices, 1996 – 2002



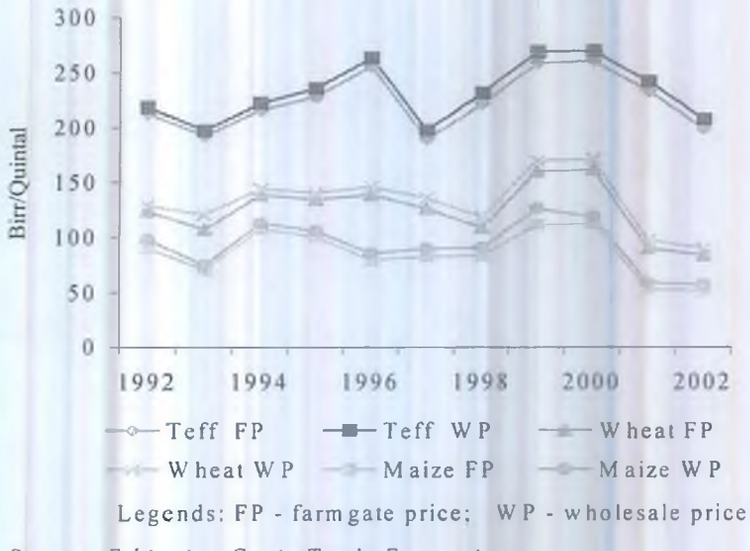
Source: Woreda Agriculture Development Department, 2002

4.3.4 Changes in grain prices

The Ethiopian Grain Trade Enterprise (EGTE) has a monopsony of grain marketing in the country (i.e. EGTE is the only buyer). This institution purchases grain from farmers and small grain traders, stores it and resells. According to information received from EGTE, the price of grain is changing year to year, depending on production level and environmental catastrophe. In the dry years when the grain production decreases the price goes up but with suitable climatic conditions grain production increases and the price comes down.

The average maize and wheat price for the last 10 years shows a decreasing trend with an exceptional increment in 1994 and 1999 (Figure 4.4). Although, prices in those two years increased, the gradual fall in the other years has brought the price even more down than it was ten years ago. There has been a marked decline in the last 2 years.

Figure 4.4 Grain price changes 1992 - 2002



Source: Ethiopian Grain Trade Enterprise

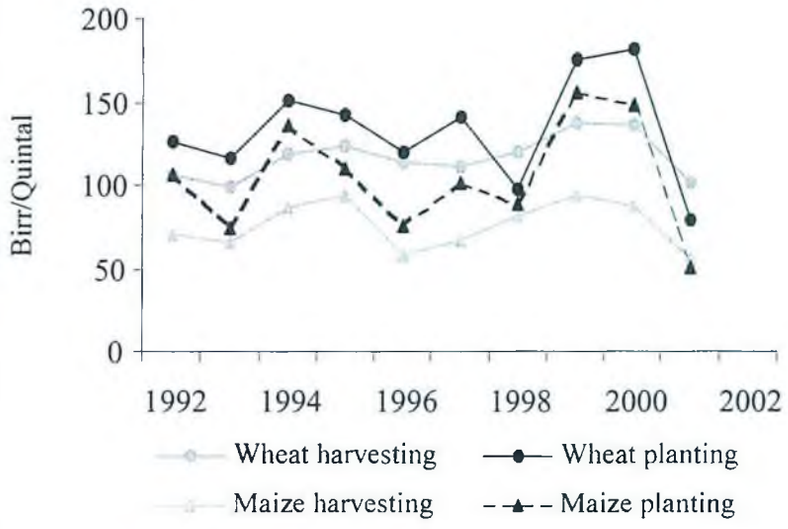
The price trend of teff is different than maize and wheat, as the price is not much lower than it was in 1992 and 1997. Teff has a higher market value compared to other grains. There are small differences between farm gate and wholesale grain prices, which vary from 7 to 10 Birr per Quintal.

The grain price also has a seasonal fluctuation (Figure 4.5). Usually, farmers market wheat and maize immediately after harvesting (November-January) which consequently decreases the grain price at this time. At sowing time, when demand for the sowing materials increases and the reserved grain is depleted, the price of grain increases. The highest grain price during the year is observed from June to September.

Analysis of grain price at planting and harvesting time for the last 10 years presented in Figure 4.5 shows that the price of wheat at harvesting has relatively less difference than at planting as compared to maize. The price of wheat at harvesting time has fluctuated from 98 to 136 Birr/Quintal, whereas at planting time it has varied from 97 to 182 Birr/Quintal. Compared to wheat, the price of maize has fluctuated in both seasons. It has varied at harvesting time from 70 to 88 Birr/Quintal and at planting from 50 to 155 Birr/Quintal.

The price of grain is highly volatile. If rainfall does not favouring maize planting maize, the price immediately goes up. In May and June 2002, the price of maize increased from 60-65 Birr/Quintal in May to100-130 Birr/Quintal in June. This year (2002) is a dry year and not all farmers are able to finish maize planting in time so the prices are already started to increase.

Figure 4.5 Seasonal fluctuation of grain prices

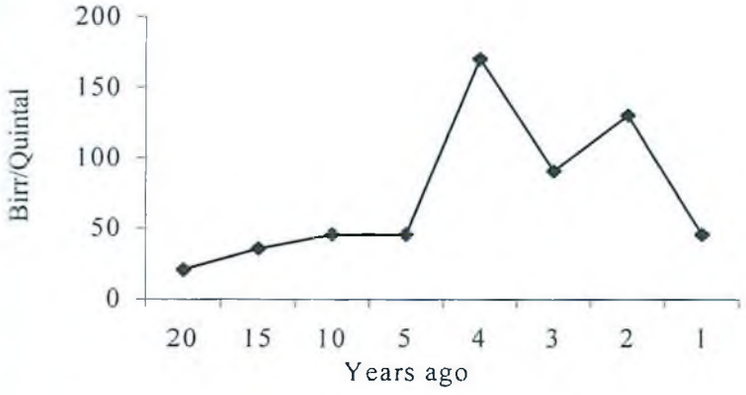


Source: Ethiopian Grain Trade Enterprise

Changing of grain price in the local market

Interviewing of grain traders in Arsi Negele town market showed that farmers bring mainly wheat and maize from different PAs located at 20 to 40 km distance. The amount of grain brought by farmers varies from 5-10 to 50-60 Quintals, which mainly depends on cropping season. Grain traders confirmed the decreasing of grain price for the last 2-3 years (Figure 4.6), the cause of which, on their perception is increasing the grain production in the region. According to grain traders, the difference between farm gate price and market price is not more than 5-10 Birr per Quintal, but farmers believed that differences sometimes reach 25-30 Birr per Quintal.

Figure 4.6 Changes in maize price in Arsi Negele



Source: Small grain traders' interview

Farmers are not aware of the price of fertilisers, seeds and grain in the different markets or in other parts of the country. Due to lack of market information, farmers cannot plan what to grow and when to sell. It is very important to establish a strong

market information system in order to recognise, predict and anticipate market conditions.

Usually farmers sell up to 70% of their products very cheaply immediately after harvesting and lateron they buy at higher prices. This is a very serious problem of household management and budgeting. In solving this problem the impact of co-operatives is significant. According to Arsi Negele Co-operative promotion Department, service co-operatives are buying grain from their members at harvesting, to store and resell it during the year. After recalculation of transportation, storage, and market expenditures, 30% of the received profit remains in co-operatives and 70% is distributed to the members. Strengthening of service co-operatives so as to provide support to farmers would be an effective measure.

4.4 Credit services

After the dissolution of the socialist regime and establishment of democracy in 1992, support and subsidies provided to the co-operatives were stopped; hence the co-operatives stopped providing inputs and credit services to the farmers. In addition the co-operatives were also affected by the internal war and management misappropriation during the transition period. Previously, WADD used to provide inputs and credit services particularly for oxen, tractors and implements through the farmers co-operatives in kind. The chemical fertilisers provided as a promotion, however, were in nominal quantity. Providing credit for the promotion of cereals and others was only started in 1996 under a national initiative intended to increase the production of cereals with the introduction of a package programme.

4.4.1 Cash holding and credit requirement

A knowledge of cash holdings and borrowings at the household level is crucial to design and deliver credit packages. The study tried to estimate these, using a score of 1 to 5, where 1 represents the least cash holding and borrowing and 5 the most. February in highland, January in midland and December in lowland are the months that farmers have the highest amounts of cash, because of the sale of grain, followed by March when cash is obtained from labouring (working for others). In the rest of the year, there are very small amounts of cash in the households.

The highest cash holding among farmers scored at 5 ranges from 200 to 300 Birr in the month of January, while the highest borrowing amount ranges from 300 to 600 Birr in the month of April and July. The smallest cash holding scored 1 ranges from 10-30 Birr.

Farmers borrowing sources are WADD and local moneylenders. In the months of April and June they borrow from WADD to buy seed and fertiliser of maize and wheat while the loans in July, August and September for food and household consumption come from local moneylenders. Borrowing in September for school fees ranges from 50 to 100 Birr. In the midland, farmers borrow money in March to purchase seed and fertilisers for onion and potato. The number of farmers cultivating onion is not high at present, but the trend is increasing.

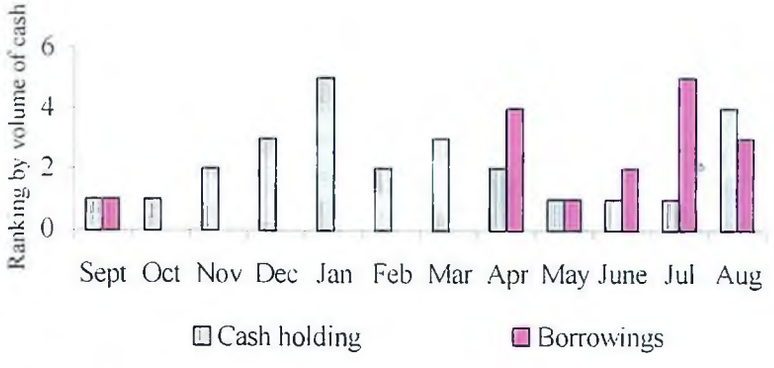
From the group interviews, we estimate that only around 5% of farmers in the highland and midland are able to afford fertilisers without any credit. If the package programme serves around 50%, this means an additional 35% of farmers use moneylenders. They do this at an interest of 20% per annum.

Figure 4.7 Cash borrowing and holdings in the highland

Source: Field survey, May 2002

Note: Cash holding ranking 1 represents 10-20 Birr and 5 represents 200-300 Birr
Borrowing ranking 1 represents 10-20 Birr and 5 represents 300-600 Birr

Figure 4.8 Cash borrowing and holdings in the midland



Source: Field survey, May 2002

Note: Cash holding ranking 1 represents 10-20 Birr and 5 represents 200-300 Birr
Borrowing ranking 1 represents 10-20 Birr and 5 represents 300-600 Birr

We conclude that farmers have limited opportunities for cash earning and face cash shortages throughout the year. Among the major cash requirements are for seed/fertilisers and household consumption. A formal, efficient credit for consumption and for micro investments is necessary. Likewise, small-scale income generating activities such as vegetables, fruits, poultry and beehives could be some sources of income to smoothen the cash flow.

4.4.2 *Package Programme*

The package programme delivered as a credit facility is designed at national level. The Zonal Agriculture Department decides the quota for each woreda and co-ordinates with the Commercial Bank of Ethiopia at regional level for the necessary resources at the district level. WADO is the leading institution at the district level. From next year onwards the woreda will be able to set its total quota for the loan number and amount because of additional decentralisation.

A district level committee is responsive for the effective implementation of the credit package programme within the district. The committee decides on the quota for each PA. It includes chiefs and representatives of the economic department, administrative office, WADD, finance department, police office, justice office, and co-operative promotion department, and. Generally, the quota increases around 20 per cent each year. Farmers are selected on a demand basis at each PA by DAs. The credit goes to the farmers in kind, after down payment of at least 15 per cent. However, 10 per cent of the total loan can be delivered without down payment, subject to the vulnerability of the farmers. Seed and fertiliser companies supply materials disbursed as credit upon the approval of WADD. The credit should be repaid in one to three instalments before starting of the second loan cycle for the following year. The interest rate is 10.5 per cent per annum. There is neither extra interest charge for overdue amounts nor any rebate for early repayments.

In principle, farmers can get credit upto two years under this program. After that they are considered to be graduated, and therefore they should manage their credit requirement by themselves. In practice, however, it is not so.

The credit package is mainly used for maize and wheat, but fertilisers are also distributed for other teff and barley. The number and volume of loans disbursed has increased significantly during the last six years, although at 5798 for the woreda and at 193 per PA it still only covers about 50 per cent of the total HHs.

Credit is provided on a group basis without collateral but there is no group liability. The average loan size is Birr 170.8 (approx. USD 20) and the repayment rate is about 67 per cent. Of the overdue amount, around 50 per cent is more than 1 year in arrears. The low repayment rate indicates the need for revision of the package. As indicated, the current credit package is designed at the national level. The Arsi Negele WADD did not disburse the credit package this year and they hope that it will be revised in future, which could happen with the proposed establishment of the new Co-operative Development Bank (CDB) at the Oromia regional level.

4.4.3 *Informal credit activities and possible alternatives*

The prevalence of various forms of informal credit activities was revealed during the field survey at the community level. These forms include grain and cash collection, individual borrowing, and primary staged savings and credit groups.

Collection of grain and cash is practised in the entire area. This is in a form of social cohesion. In the highland and lowland grain is collected, and in the midland cash is

collected on a monthly basis to provide support for those who are sick or have a death at home. There is no interest. Money or food given upon death is not returned whereas the money given for treatment is repaid in equal volume, after harvest, in December. In the midland, one association is handling these activities for the last 40 years. At the moment this association has a total fund of 1000 Birr, which is insufficient to revolve as credit, they think.

Borrowing money from the local moneylender has been practised for many years but it is not commercialised. Local moneylenders do not keep money, they arrange money on a need base, e.g. by selling their own livestock. These transactions are not legalised and usually require third party guarantee. Such borrowings are for household consumption (May to August) as well as for purchasing seed and fertilisers. Loan amounts are mostly equivalent to one quintal of maize or wheat at the time of borrowing, and should be repaid in December after harvest.

At the field level discussions, farmers did not acknowledge the existence of interest payment on informal credit, stating religious reasons; instead, they mentioned, only in the case of grain borrowing was repayment double the loan. But DAs revealed that interest rates for money loans from moneylenders are about 20 per cent.

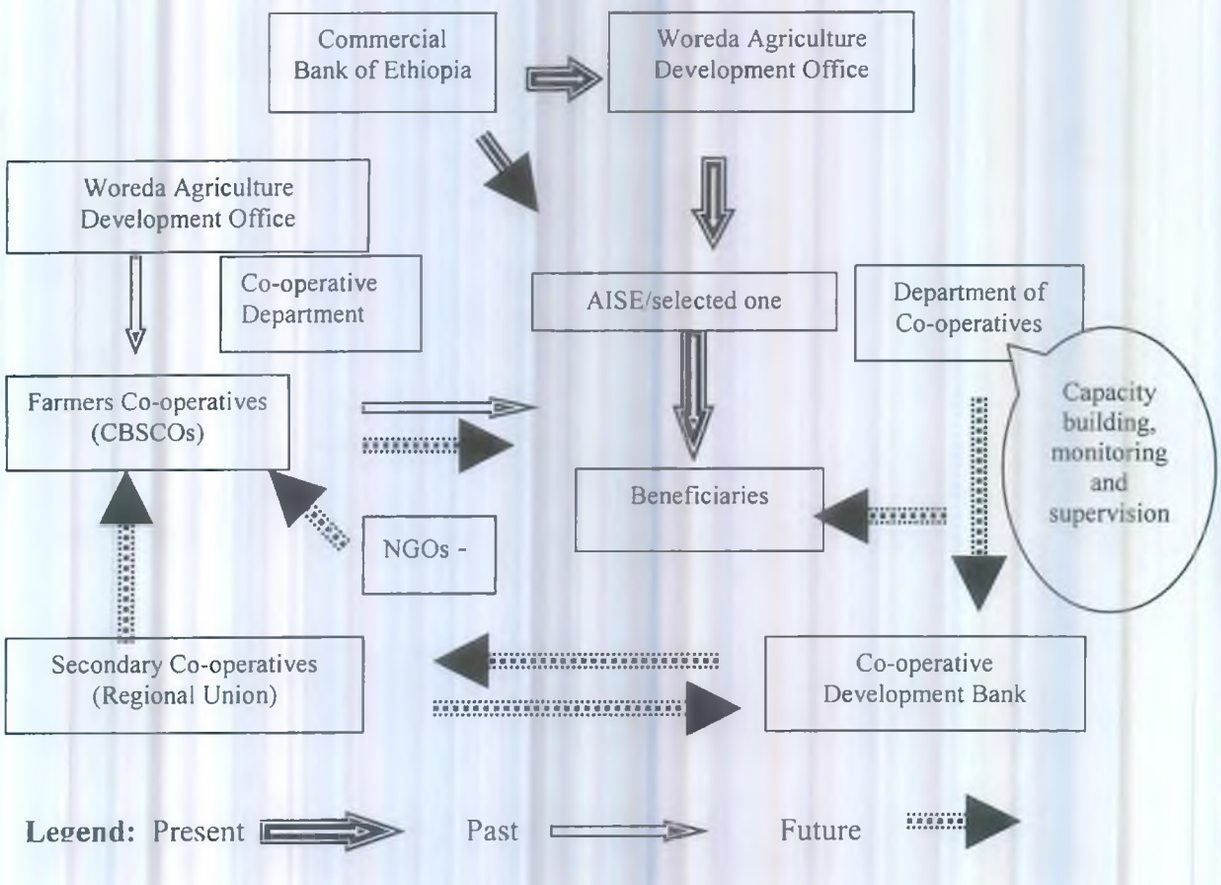
In the mid and lowland two NGOs are introducing and promoting community based savings and credit activities, organising mainly female farmers in groups. Farmers are very enthusiastic about these activities, but they are in an early stage and need full support to enhance their capacities. Woreda Integrated Development Service (WIDS) is also providing revolving credit to primary groups. With the establishment of the new Co-operative Bank, such initiatives could be an effective measure for efficient credit delivery at the grass root level.

NGOs and the CPD have formed, 40 community based savings and credit organizations (CBSCOs), including 712 members of whom women represent 92 per cent. Total resources of 255,105 Birr have been generated, where members' savings and external loan accounts represent 13 and 40 per cent respectively. Members organised in groups borrow individually and on a group basis. So far, most of internal resources generated have been deposited in the bank and in some cases they are revolving among beneficiaries. Interest rates on loans are 7.5 to 20 per cent. Interest on savings is 3 per cent. These CBSCOs register at the CPD, which monitors and provides the technical assistance.

4.4.4 Future scenario of credit services

Reviewing the current situation, it can be presumed that future credit market will flourish enough to cater for the credit need of the farmers. According to information received, CDB is being started from the 1st of January, 2003. Presumably, CDB provides the credit to the regional level co-operatives federation, which afterward gives credit to the primary CBSCOs at the grass-root level. Emerging CBSCOs should be able enough to get the resources and manage at their own.

Figure 4.9 Present, past, and future scenario of credit delivery



It is believed that CBSCOs will have equity participation in CDB thereby creating ownership, repayment of loan would be better, at the same time benefiting from the dividend. Figure 4.9 summarizes the credit delivery mechanism in the past at present and in future.

4.5 Financial benefit analysis

A large number of farmers (90% in the highland, 50% in lowland) are applying chemical fertilisers. In the context of changing grain and fertiliser prices, we attempted to review the profitability of these recommendations. We looked at two specific cases: firstly, the risk of improved seed and fertilisers in relation to drought; and secondly, changes in profitability with reference to price changes over the last five years. Both these analyses were done on maize, as this has the highest contribution to the food security (see Chapter 2).

For the analysis, we collected data from focus group discussions in Karsa (midland) and Keraru (lowland). Farmers were selected on the basis of number of years that they had applied the recommended package; we also ensured that women were represented in the focus groups. Five to six farmers representing each category of "high input" (improved seed plus fertiliser), and "low input" (local seed without fertiliser) gave data based on a group consensus. In the lowland PA, a third category, "intermediate

input" (local seed with fertiliser) was also included, as a significant group in the village practised this technology.

4.5.1 Analysis of drought risk on maize in the lowland

The lowland is more vulnerable to drought than the midland. Droughts occur once in every three years according to the farmers. Three years in ten years they get a poor harvest, two years a mediocre harvest, and 5 years the harvest is relatively good.

Information from the farmers was used to analyse the financial returns in good and poor years, combined with the "high input", "intermediate input" and "low input" technologies. The results of this analysis are presented in Table 4.2. More details of the calculation are given in Appendix 4.

The analysis shows that the labour costs are highest under the low input technology, whereas draught power costs are least under low inputs and highest under high inputs. Labour costs account for 83%, 61% and 53% of the total costs under the low, intermediate and high input technologies, respectively. Farmers applying high inputs use more draught power more for land preparation than human labour; although farmers with all input levels plough the land three times, the number of oxen days is higher with high input.

Farmers with low input use appear to use more labour resources than with high input. One of the reasons could be that low input farmers do not plough the land properly therefore they face high weed infestation. Furthermore, they do not use oxen for weeding hence they use more human labour. All weeding in both high and intermediate input is done by hired labour while with low inputs family labour is used. Among the whole labour work, women do planting, weeding and harvesting jobs.

The total cost increases from low input to high input from 1204 to 1997 Birr, respectively. Grain yield in high input is more than 3 times that of the low input technology in good years and more than twice in bad years. Nevertheless, in bad years the reduction in yield under high inputs is about 60 % whereas under low inputs there is a 39 % reduction. The highest reduction in yield in bad years, 78%, is under the intermediate input technology, indicating that chemical fertilisers have a more adverse effect on local seed than in improved seed in the dry years.

Net profit is positive only in good years, and under high inputs. In all other combinations a loss is made. In a bad year, all technologies give negative returns, but the low input technology is the least loss making. The overall profitability ranking is:

In good year	High input > Intermediate > low input
In bad year	Low input > High input > Intermediate input

Table 4.2 Comparative cost and benefit analysis of improved seed and chemical fertilisers on maize in the lowland

S.N	Particulars	Amount in Birr per hectare		
		High Input	Intermediate Input	Low Input
I	**Variable cost**			
A	**Non-cash expenses**			
	Human labour	630	544	730
	Draught labour	436	352	268
	Total labour	1066	896	998
	Financial opportunity cost of seed/fertiliser	0	23	3
B	**Cash expenses** (Seed, fertiliser and transport)	856	491	128
	Total variable costs	*1922*	*1410*	*1129*
II	**Fixed costs (cash expenses)**			
	Depreciation cost on tools and equipment	35	35	35
	Land tax	40	40	40
	Total fixed costs	*75*	*75*	*75*
III	**Total costs**	**1997**	**1485**	***1204***
IV	**Gross Income**			
a)	Yield in good year (Qt.)	60	36	18
	Value in good year (Birr)	**2100**	**1260**	**630**
b)	Yield in bad year (Qt.)	24	8	11
	Value in bad year (Birr)	**1248**	**416**	**572**
V	**Net Profit (NP)**			
a)	In good year	**103**	**-225**	**-574**
b)	In bad year	**-749**	**-1069**	**-632**
VI	**NP without considering human labour cost**			
a)	In good year	**733**	**319**	**156**
b)	In bad year	**-119**	**-525**	**98**
VII	**Cost Benefit Ratio (CBR)**			
a)	In good years	**1.05**	**0.85**	**0.52**
b)	In bad years	**0.62**	**0.28**	**0.48**

Data source: Field survey, May 2002

Notes

- Field survey is done organizing a group discussion of six farmers of different input type separately at the Kararu PA of Arsi Negele.
- Depreciation cost of tools and equipment is calculated dividing the total cost of each item by its lifetime. Depreciation on tools and equipment is charged for one year.
- Financial cost on seed is charged for 9 month @ 10,5 % per annum as an opportunity cost of fund.
- Land tax is not based on single variables and varies among farmers. Therefore modal cost is taken. By products of maize is not sold, therefore difficult to convert in monetary value hence not considered.
- Work done by men and women is considered equally as man-days, however rate is different.
- According to farmers' version, price of product goes up in the bad years; therefore price in bad year is 50 per cent higher than the normal year.
- For further details of the basis of the above calculation, see Appendix 4.

If net profit is calculated without considering labour costs, in a good year the return to labour is positive with all input types, and is highest under the high input technology. In bad years, the return to labour is only positive (although marginally so) under the low input technology. In drought years, the return to labour is most negative under the intermediate technology.

If we consider a reasonable Cost Benefit Ratio (CBR) to be two, then maize is generally not remunerative in the lowland under the current price trend whatever the rainfall or technology levels. But we should not forget that for farmers, the opportunity costs of labour are very low, making the cultivation of maize more attractive for them. If we discount the labour costs, using fertilisers and improved seed provides the highest net profit in good years; but a loss in a drought year, when local seed and no fertiliser still provides a marginal gain.

The improved package can therefore be considered to be more risky. For farmers who can carry gains or losses over the good and bad years, it makes sense to use inputs, as the return over the long term will be greater. But for farmers with little capital or savings, the risks of loosing the investment in inputs in a bad year are probably unacceptable. The worst technology seems to be when local seed is used with fertiliser, as the gains are much less in good years and the losses greatest in poor years: this combination makes no sense for any sort of farmer in any sort of year.

4.5.2 Analysis of changing profitability of maize in the midland

In the midland, an attempt was made to compare the current profitability of maize cultivation with the situation five years ago, at the two technology levels of "high input" (improved seed and chemical fertiliser) and "low input" (local seed without chemical fertiliser). Six farmers of each technology type were interviewed in a group for this exercise in Karsa PA.

The analysis revealed that farmers using high inputs use less human labour in comparison to the low input farmers, but more draught power. Cash expenditures for the high input package have risen significantly over the last 5 years, compared to the relative increase for the low input package (see Table 4.3). The fixed cost is same in both types but has also increased by more 130% over 5 years because of a significant increment in the cost of farm implements.

The yield in grain is three times higher under high inputs than low input at present, and was apparently even greater 5 years ago: farmers noting that the yield of maize with high input is decreasing year by year, presumably because of depleting soil fertility or exhaustion of other nutrients in the soil. Even at stable grain and fertiliser prices then, the profitability of the input package is decreasing with time.

With both types of technology farmers are making a net loss present, although the loss is less with input use. Even if the cost of labour is totally discounted, the returns are still negative, although marginally so if inputs are used. Five years ago, the situation was much more favourable, with quite healthy profits under high inputs and only a slightly negative return with no inputs when labour is costed at commercial rates. The profitability of maize has therefore declined sharply over the last 5 years. The fact that

farmers are still growing this crop indicates a marginal cost of labour of zero, the high preference for this crop, and a desperate lack of alternatives.

Table 4.3 Comparative cost and benefit analysis of with and without improved seed and chemical fertilisers on maize at present and in the past in the midland

S.N.	Particulars	Amount in Birr per hectare			
		Improved seed with chemical fertiliser (High input)		Local seed without chemical fertiliser (Low input)	
		At present	*5 years ago*	*At present*	*5 years ago*
I	Variable cost				
A	Non-cash expenses				
	Human labour	582	242	662	274
	Draught labour	404	138	368	128
	Total labour	986	380	1030	402
B	Cash expenses (Seed, fertiliser and transport)	816	400	136	92
	Financial opportunity cost of seed and fertiliser	0	0	8	6
	Total variable costs	*1802*	*780*	*1174*	*500*
II	Fixed costs (Cash expenses)				
	Depreciation cost on tools and equipment	39	4	39	4
	Land tax	40	30	40	30
	Total fixed costs	*79*	*34*	79	34
III	Total costs	1881	814	1253	534
IV	Gross Income				
	Yield (Qt.)	36	44	12	12
	Value	1260	1760	420	480
V	Net Profit (NP)	-621	946	-833	-54
VI	NP without considering human labour cost	-39	1188	-171	220
VII	Cost Benefit Ratio (CBR)	0,67	2,16	0,34	0,90

Data source: Field survey, May 2002

Notes

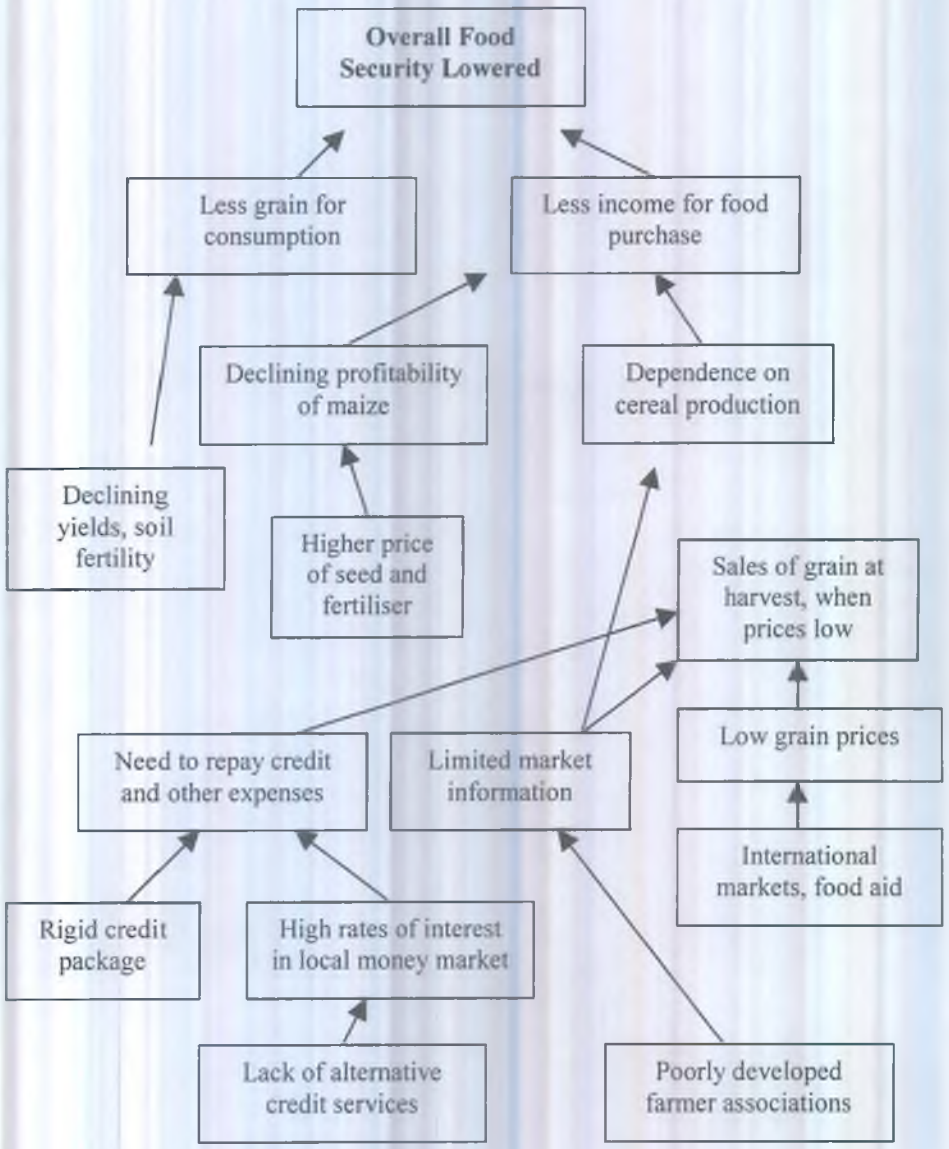
- Field survey is done organizing a group discussion of six farmers of different input type separately at the Karsa PA of Arsi Negele.
- Depreciation cost of tools and equipments is calculated dividing the total cost of each item by its lifetime. Depreciation on tools and equipment is charged for one year.
- Interest on loan is charged for 9 month @ 10,5 % per annum on the credit amount only for both times
- Financial cost on seed is charged for 9 month @ 10,5 % per annum as an opportunity cost of fund
- Land tax is not based on single variables and varies among farmers, therefore modal cost was used
- By products of maize are not sold. therefore difficult to convert in monetary value hence have not considered.
- Work done by men and women is considered equally as man-days, however the rate is different.
- For further details of the basis of the above calculation, see Appendix 4.

4.6 The problem situation revisited

The issue of food security is complex. This study has attempted to address the major dimensions of the problem situation according to their importance in the different agro-ecological zones. The change of economic environment surrounding the cultivation of major crops has been shown to play a significant role in food security. This environment includes issues related to prices, markets, infrastructure, institutions and information systems. Related factors include the lack of alternative job and income generating opportunities. At a more macro level national issues such as credit, trade policies food aid become relevant in terms of their effects on the local economic environment. However, the combined impact of all these factors appears to be one of deteriorating food security at the household level in Arsi Negele (Figure 4.10).

Farmers have few alternative sources of income to grain sales, and few credit facilities. Government policy is to increase cereal production, but the analysis of this chapter shows that maize cultivation is economically marginal in the midland and risky in the lowland. The pressure on farmers to sell their grain at harvest to meet cash requirements combined with the low prices at this time combine to cause food insufficiency, poor incomes and therefore compromised food security. The lack of credit programmes that are responsive to farmers' conditions exacerbates the problem of grain sales by food insufficient households. Farmers are caught in an increasingly vicious trap of having to sell precious food grains at ever-lower prices, thereby having less income to buy food or invest in production improvements.

Figure 4.10 The problem situation as related to economic dimension



CHAPTER 5 POPULATION PRESSURE AND AGRICULTURAL CHANGE

5.1 Problem area and Research Questions

Ethiopia is one of the most populous countries in Africa, with an annual growth rate of 2.9%. Of 62 million people, 86% is rural dwellers. The land area is about one million square kilometres, and population densities range from 2 to 627 persons per square km. In Ethiopia, past regimes have resisted formulating a population policy, due to cultural, religious and ideological grounds, and have rejected population as a determining factor in the socio-economic development of the country. However, cognizant of the fact that no economic reform can be successful without sound population policy, the present government has issued new policy. The new policy underscores the effects of high population growth rate, which significantly bear on the major socio-economic activities in the country. The policy itself seeks to harmonize the rate of population growth, with efforts to establish efficient social services that would effectively respond to people's needs and achieve tangible improvements in health standards. Efforts are being exerted to enhance people's awareness on population growth and the consequences of high fertility for the individual, the family and the country at large.

In Arsi Negele Woreda the population has almost doubled in the past fifteen years, implying a population growth rate of 4.6%. During the contextual analysis of the problem situation, the farmers and various stakeholders viewed this ever-increasing population pressure as one of the contributing factors of food insecurity. It was therefore considered as the third dimension of the food security problem situation analysed by the team.

With the aim of understanding the central theme in figure 5.1, population changes were analysed and related to the land holding per households. The team attempted to investigate the implications for land use, livelihood and farming systems (see Figure 5.1).

5.2 Population changes

According to the zonal Atlas of East Shewa 1999, Arsi Negele is categorized as intermediate in terms of population density with 100 – 200 persons / km2 . The total population of the woreda for the past six years is presented (Figure 5.2). It is evident that from 1984 to 2001 the population has tremendously increased, almost doubled. That means, more resources are necessary to meet the over increasing population.

On the basis of the population and housing census of 1994 the average household size of Arsi Negele was 5.2, with the highest dependency ratio among the woreda in the zone of 115.47% (i.e. the proportion of non-economically active to active members in a household where a number of persons reside in one house or several houses located close to each other and have a common cooking arrangements). The dependency ratio shows the proportion of the population that depends for its livelihood including food, clothing, health and education etc. on the active age group (14 – 59 years). (CSA 1994).

Figure 5.1 Increasing population pressure: Problem area and research questions

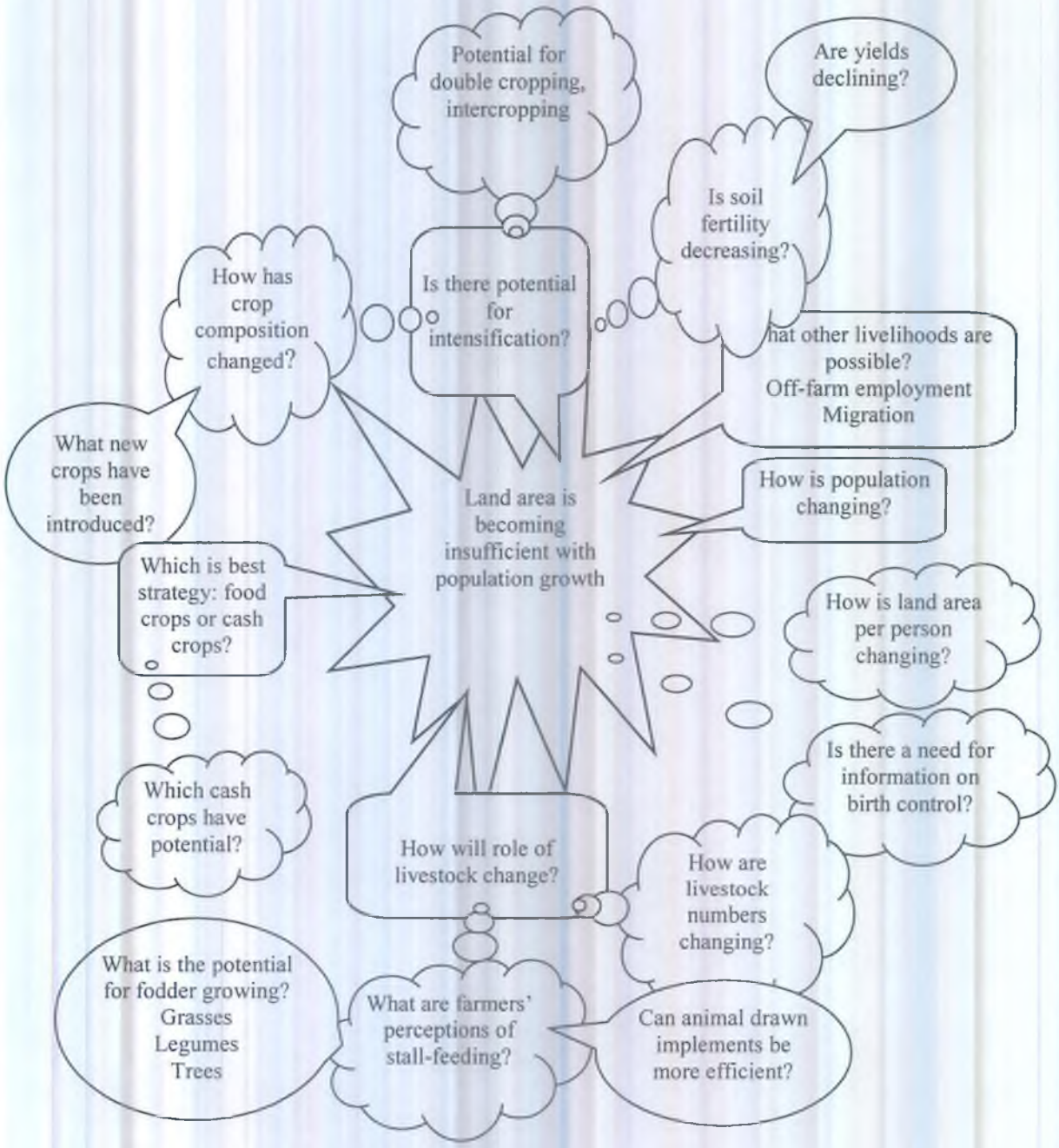
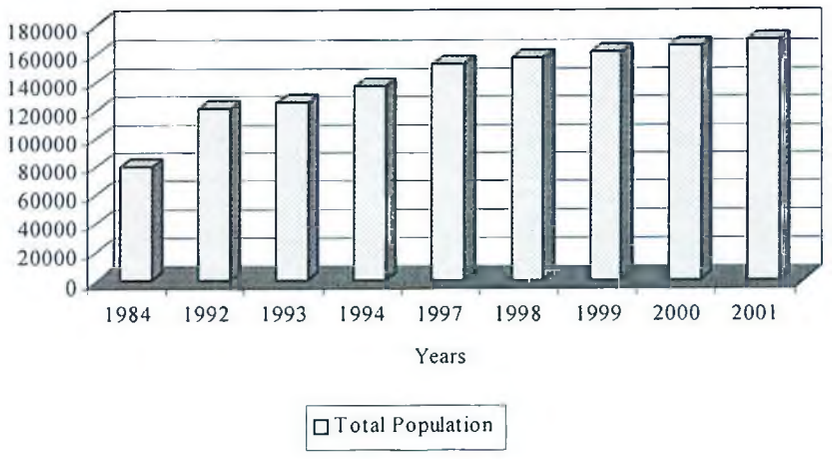


Figure 5.2 Population increase in Arsi Negele Woreda



From Figure 5.2, it is apparent that human population is increasing year after year. During the interview on food security problem, farmers and stakeholders perceived that food security is directly influenced by this increase in population pressure. There is more pressure on land and land-holding size per household is decreasing. It is evident that farmers see the land per household is becoming smaller and smaller due to sharing the same owned peace of land to their children. Farmers from all the three agro-ecological zones highland, midland and lowland reported that human population is increasing.

Figure 5.3 Population increase in the highland, midland and lowland zones

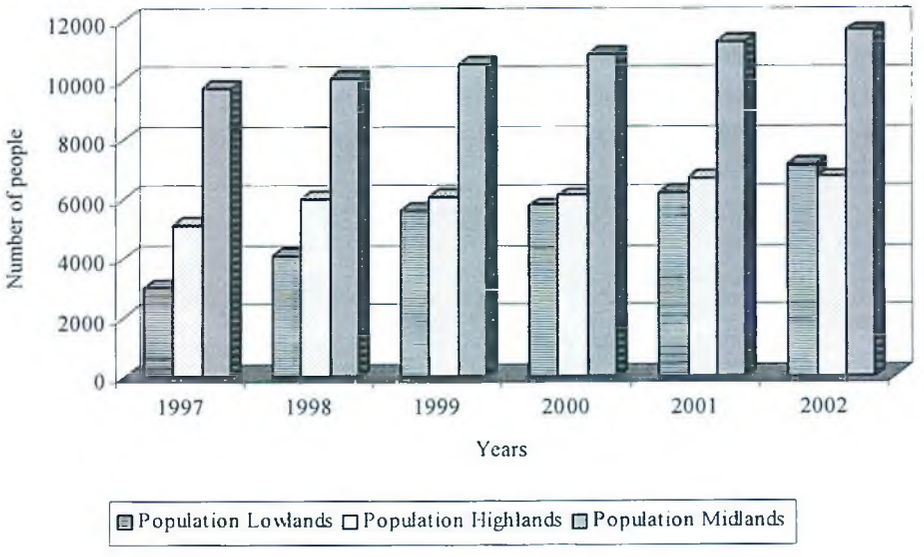


Figure 5.3 presents the population increase in the three agro-ecological zones. It is apparent that population growth has been increasing more in the midland and lowland, than in the highland

5.3 Change in farming systems

5.3.1 Livestock and crop changes

Livestock population from representative PAs in the three agro-ecological zones is presented (Figures 5.4, 5.5, and 5.6). The representative PAs were Watera and Lepis in the highland, Karsa, Ali Woyoo, Sanyoo and Malka Buta in the midland, and Keraru and Dole in the lowland. In the highland, the cattle population has been decreasing while the number of sheep has slightly increased. In the midland the number of cattle has slightly increased mainly due to increase in number of farmers purchasing more oxen for ploughing. In the lowland zone, the number of cattle has been declining while the number of goats has slightly increased. The overall trend on livestock population, especially cattle, is decreasing significantly in the highland and lowland. Farmers and other stakeholders gave the reason for the decrease as due to limited grazing land.

Figures 5.7, 5.8 and 5.9 show changes in land size for crop cultivation and grazing land for various agro-ecological zones for particular PAs.

In the highland, only about 12% of the total (grazing plus cropland) is now grazing land. The amount of grazing land that is left has declined by 15% over the last 6 years, with a corresponding increase in cropland of about 2%.

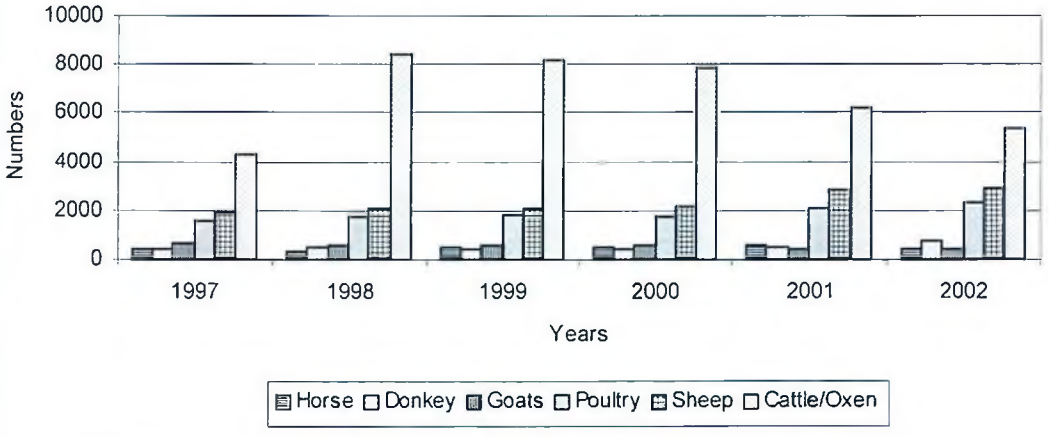
In the midland, there has been a drastic decline in grazing land. 86% of the grazing land of 6 years ago has now been converted into cropland, with a corresponding increase in cropland of 28% during the same period. There is now little grazing land left in the midland.

In the lowland there was more grazing land than cropland six years ago. The situation is now reversed, with grazing land having decreased by 30% and cropland increased by 40% over the same period. Twenty years ago, semi-nomadic livestock keeping dominated the lowland. Now, livelihood systems are much more crop-based.

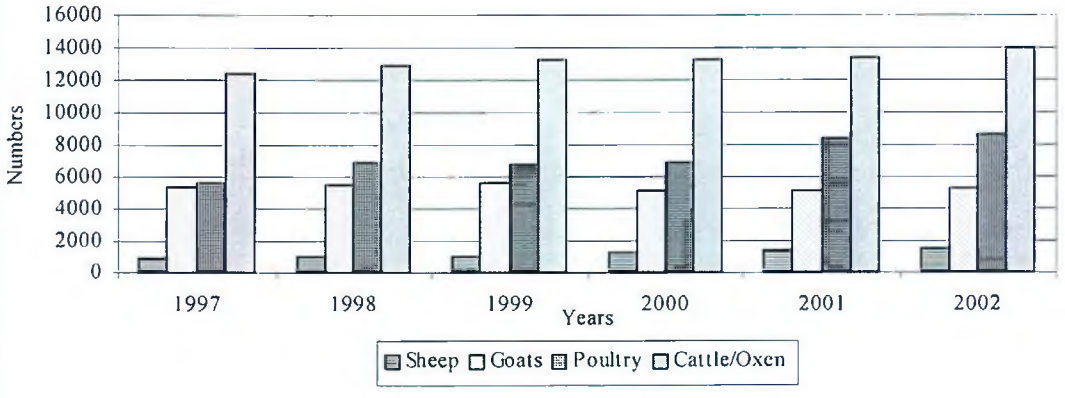
The decline in grazing land and in the number of cattle in the highland and lowland has implications for soil fertility and for capital accumulation (savings), and also therefore for food security. The loss of the ability to sell cattle in times of need makes farmers more vulnerable to shocks in times of drought or other need. In the midland, it seems that cattle numbers have been maintained even in the face of the disappearance of grazing land. If the figures for cattle numbers in the midland are correct, it implies a significant shift from grazing to more intensive feeding systems. Local officials claim that most of the cattle in the midland are oxen, with much feed being imported from the highland. The shift to intensive livestock rearing is one area where research and development can play a significant role, in helping farmers adjust to this process.

Figure 5.4 Livestock population changes in the 3 agro-ecological zones.

Highland



Midland



Lowland

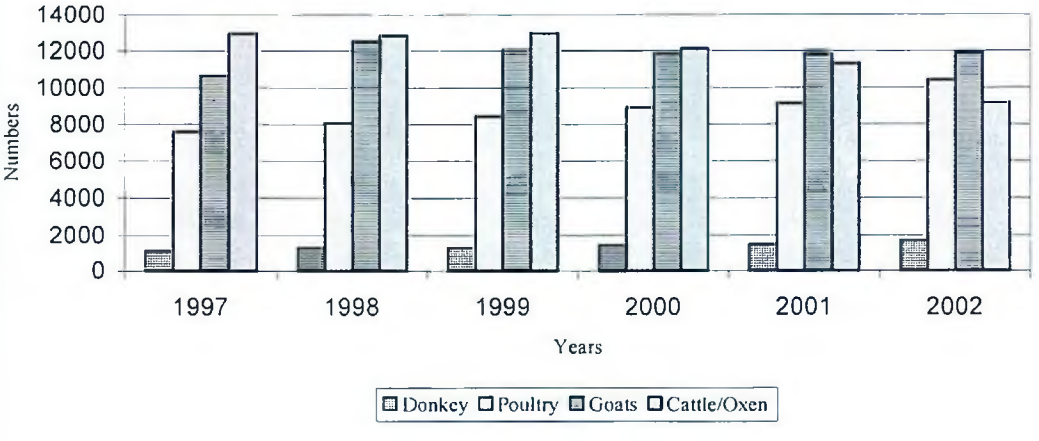
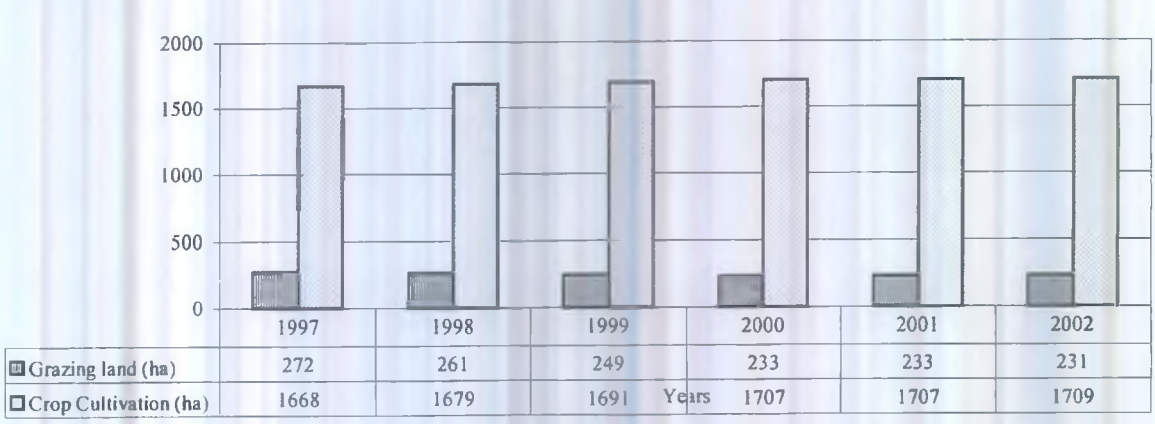
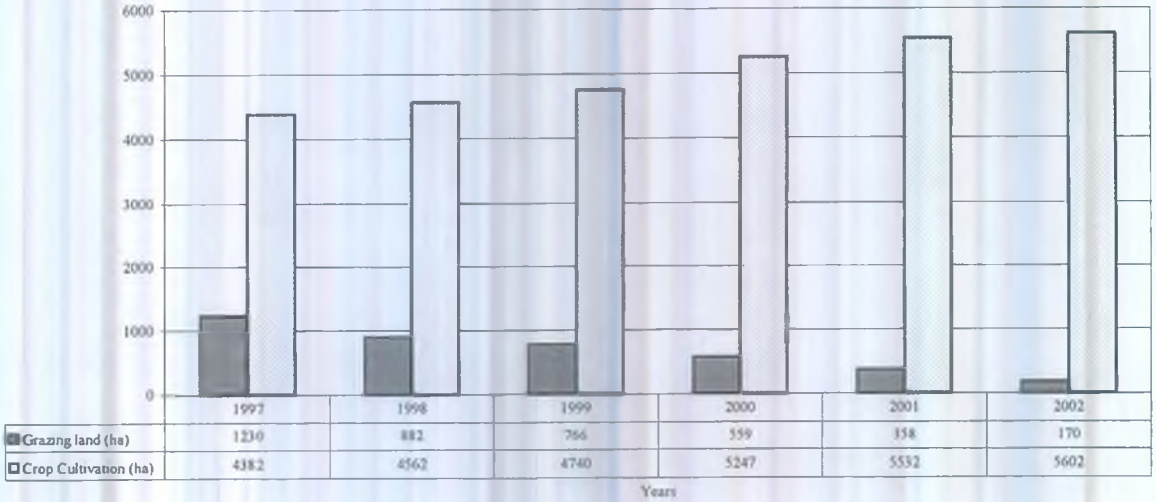


Figure 5.5 Changes in grazing and crop areas in the highland, midland, and lowland zones

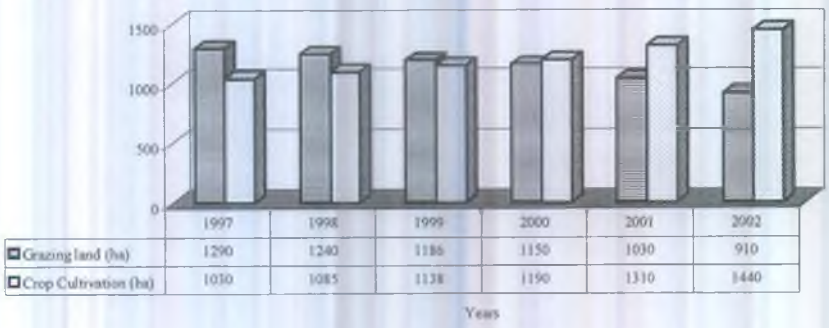
Highland



Midland



Lowland



5.3.2 Changes in cropping practices

Over time, cropping practices have been changing in all three agro-ecological zones in order to increase crop yields. Through the package program, improved varieties and fertilisers have been used in the highland and midland. Similarly, in the lowland where livestock was the main activity, crop cultivation has intensified with improved crop management practices such as planting in rows. Ploughing frequencies have changed over time: in the past farmers ploughed only twice but now they plough three to four times depending on the crop. Farmers perceive that soil fertility has significantly reduced. The main criteria they use to assessing the soil fertility are: soil colour, standing crop in the field and decrease in crop yields over years. According to farmers the causes of soil fertility decline are the removal of top soil by wind and runoff, also deforestation in the lowland and partly in the midland which has lead to decrease in vegetation cover and hence more erosion. Previously, there was no fertiliser application. There was enough grazing land and most of crop residues were left in the field. Moisture conservation was practised in the past 20 years using terracing, but this practice has ceased. Crop rotation is practised to some extent especially in the highland and midland. Maize is planted followed by wheat and then maize. However, in some cases it varies haricot bean followed by teff then sorghum or maize. In some cases double cropping is now practised: in the midland, for example, onions or are followed by wheat, and in the highland potatoes are followed by wheat.

5.4 Implications for food security

The team, farmers and other stakeholders perceive that the increase in population pressure is more serious in midland followed by the highland and lastly in the lowland. Probably this could be contributed due to migration and the potential of these areas in terms of agriculture resource endowment. Through inheritance and fractionation, land area per household is decreasing. Increasingly, crop production cannot meet household needs and there is thus a need to find alternative incomes sources. Farmers and stakeholders perceive that there is a need for birth control and family planning measures, although due to tradition not many farmers are able to speak out publicly on this issue.

With limited land available farmers cannot practice traditional soil management practices like fallowing the land as a means for soil fertility restoration. Farmers are forced to intensify agriculture. Farmers perceive that soil fertility and crop yields are in decline. Under limited land available per household and where moisture is not limiting, double cropping and inter cropping could be used to intensify land use. With intensification crop composition is likely to change. The introduction of new higher yielding food crops could increase food security, and also the promotion of cash crops that could increase cash income at household level. Although grazing land is disappearing, livestock can still play an important role in the farming system, but zero grazing and more intensive production systems will have to evolve. Improvements in implements and hence the more efficient utilization of draft power can also play a role in compensating for lower livestock number. Finally, to compensate for the decline in overall livestock numbers, alternative ways of saving will need to emerge to maintain food security.

CHAPTER 6 DEVELOPMENT STRATEGIES AND RESEARCH NEEDS

6.1 Identification and screening of R&D options

In previous chapters, the team has presented the analyses of the three dimensions of the study - climatic risks, changes in economic environment and demographic population pressure. These analyses were also presented at 2 workshops with MARC researchers and the WADD/Co-operative Promotion Department in Nazareth Arsi Negele, respectively. At the workshops, these stakeholders identified a number of potential research and development (R&D) interventions based on the analyses.

The team then consolidated the resulting initial 33 list of R&D interventions to 18 proposals to address and contribute to food security at household level directly or indirectly. The team then identified criteria and indicators for screening the R&D proposals. The criteria and indicators used are given in Table 6.1.

Table 6.1 Criteria and indicators used for screening R&D proposals

Criteria	Indicators and their description
Environmental sustainability	*Soil (5)**: Indicates whether the intervention will improve and conserve the soil. *Forestry/Bio-diversity (3)*: Indicates whether the intervention will improve forest conservation and not result to loss in plant or animal genetic resources *Water (2)*: Indicates whether it will have a more demand on water sources relative to other uses.
Economic competitiveness	*Profitability (4)*: Indicates whether the intervention will increase income of farmers and if is cost effective. *Market potential (2)*: Refers to the expected price and market potential of the output. *Affordability (4)*: Refers to labour and other input requirements by resource poor farmers.
Social equity	*Gender balance (3)*: Whether the intervention will benefit men and women equally, reducing the current workload of women. *Wealth group (5)*: Indicates whether smallholder farmers with minimum resources (types 1 and 2) will benefit. *Social acceptance (2)*: Refers to whether the intervention will culturally be acceptable considering local traditions and religion.

* Weighted value for indicators

The team then returned to the three stakeholder groups (farmers[4], researchers and developmental agencies) to screen the R&D proposals using the criteria and indicators developed. At these meetings the stakeholders were asked to consider if and how the activity might have positive or negative effects according to each indicator. Mild and strong positive effects were then noted using + or ++, respectively, mild and strongly negative effects with - and --, respectively. The total number of pluses and minuses was then calculated and an overall rank denoted using the weighting of the indicators developed by the team as shown in Table 6.1. A more complete scoring record for

[4] R&D interventions were screened in group meetings with farmers in the Highland and Lowland zones; it was not possible to arrange a meeting with farmers of the Midland zone.

each stakeholder group is given in Appendix 5.

It is interesting to compare the different results for the three stakeholder groups. Even though each group used the same criteria and indicators, the overall ranking varied considerably between the three groups. For example:

- Farmers rated the introduction of improved livestock breeds (R&D proposal 16 in Table 6.2) as having less potential, due mainly to their perception of this as being unaffordable and having few benefits for the poorer farmers. However, researchers and development agencies rated the affordability and benefits to small farmers higher.

- Farmers and development agencies rated alternative ways of using food crops (No 2 in Table 6.2), as having high potential, but researchers saw few environmental benefits and thought that social acceptance would be low.

- Development workers rated alternative ways of maintaining soil fertility (proposal 7 in Table 6.2) as low, because they did not see much benefit in terms of competitiveness, whereas farmers saw it as more affordable as well as competitive.

In retrospect, there were problems with this procedure. There were differences in the way the different stakeholder groups scored for environmental benefits: farmers tended to give pluses when there were no environmental costs, whereas researchers and development workers gave neither pluses nor minuses in such cases.

6.2 Development Scenarios

Setting research priorities is complex. Firstly, the farming and livelihood systems are complex, and changes in one component of these systems or activity will have knock-on effects on other components. Secondly, research is a long-term investment and livelihood and farming systems are dynamic: by the time research is conducted, evaluated and the resulting technologies disseminated to farmers, conditions may well have changed making this research less relevant.

To overcome these problems of research planning, the group attempted to identify a limited number of future scenarios, that could be used as a context to choose appropriate development strategies, and hence the R&D interventions that might best support such a strategy.

Based on the analyses in the previous chapters, the team identified 4 main "driving forces" that will most likely affect the evolution of livelihood and farming systems in Arsi Negele in the 10-20 years. These driving forces are:

- Population pressure
- Input (mainly fertiliser) prices
- Grain (mainly maize) prices
- Opportunities for off-farm employment

Table 6.2 Research and Development interventions proposed and screened by different stakeholder groups for Arsi Negele Woreda

	Developmental Strategy	Far. rank	Res. rank	Dev. rank	comb. rank
1.	• Awareness on household budgeting/ efficient use of family labour • Creation of awareness and promotion of family planning	3	6	7	11
2.	• Alternative ways of utilizing staple food crops	1	7	1	5
3.	• Introduction of high value crops like vegetables and oil crops (onion, garlic, coffee in the highland, linseed oil) • Diversification of package programme for food and cash crops	4	7	3	8
4.	• Promotion of multiple cropping system in the midland and highland (Inter cropping of fingermillet with other crops)Improve crop management practices: • Broadcasting to row planting; plant population; tie ridging; response farming (weather forecasting promotion); mulching; scooping;	3	5	3	4
5.	• Development and introduction of improved crop varieties suitable to each agro-ecological zones • Development and introduction of drought tolerance crop varieties and root varieties: Early maturing varieties; drought escaping type • Development of low input (fertiliser) responsive varieties	8	2	4	9
6.	• Development of appropriate fertiliser recommendation: Site specific recommendation for various crops • Determination of fertility status of different soil types	9	10	3	13
7.	• Introduction of integrated nutrition management • Development of alternative soil fertility (maintenance) management practices (manure, compost manure, green manure)	3	10	1	6
8.	• Water harvesting techniques for irrigation and livestock drinking: Roof water harvesting; Catchment harvesting • Development of small scale irrigation schemes	2	2	1	1
9.	• Establishment of informal seed systems: Seeds and or planting materials	8	11	1	12
10.	• Initiate and promote on farm and or off farm income generating micro-enterprises (sericulture; Carpentry; animal fattening) • Generation of off farm employment	5	7	1	6
11.	• Development of efficient credit delivery mechanism	1	4	2	1
12.	• Development of efficient storage structures • Awareness on post harvest management	7	12	8	14
13.	• Strengthening service co-operation that benefit individual members (farmers): • Establishing informal community based saving and credit groups	1	2	8	10
14.	• Development of kitchen garden	2	9	2	3
15.	• Promotion of agroforestry practices; Introduction and integration of fodder trees into cropping systems (e.g. Sesbania, Leucaena, Gliricidia, Calliandra)	3	1	5	2
16.	• Introduction of improved livestock breeds appropriate to different agro-ecological zones in Arsi Negele Woreda	9	2	1	7
17.	• Introduction of improved forage species into the farming system and utilization of Crop residues and agro-industry by products	6	8	5	12
18.	• Alternative sources of draft power, harnessing methods and improvement of agricultural implements	9	3	5	11

Based on combinations of these driving forces, 4 scenarios were chosen for further development. These were:

Table 6.3 Scenarios chosen for further development

Scenario	Population	Fertiliser Price	Grain Price	Off-farm opportunities
1	Increasing	Increasing	Low	Limited
2	Increasing	Stable	Increasing	Limited
3	Increasing	Increasing	Low	Increasing
4	Increasing	Stable	Increasing	Increasing

Based on the understanding of the team from the previous analysis, the implications of these 4 scenarios for food security, poverty and environmental degradation were sketched out. These expanded scenarios are shown in Figures 6.1 a,b,c, and d.

Under scenario 1 (population pressure increasing, fertiliser price increasing, grain sale prices at harvest remaining low, continued limited off-farm opportunities for cash income), the prognosis is bleak. The analysis presented in Chapter 3 indicates that in the midland, at least, the returns to fertiliser and the recommended package for maize are already negative. Worse still, it seems – from farmers recollection of yields and prices, at least – that yields obtained under the recommended package for maize have declined significantly over the last 5 years, showing soil fertility decline even when recommended fertilisers are used. Under these conditions, it is likely that uptake of the recommended technology will be lessened or even reversed, hence causing even faster decline in grain production. Population pressure will continue to mean less cropland per household, giving even less grain consumption or sale. Converting grazing resources into cropland (especially in the lowland, the process seems to be mostly complete in the midland) means that there will be less possibility to gain income from livestock sales to buy food. Pressure to obtain income from firewood (highland) or charcoal (lowland) will increase, and hence so will environmental degradation. Lower incomes mean increasing poverty, and less grain produced for consumption or sale (to repurchase food) means worsening food security.

If the relative prices of inputs and output prices improve, and hence the profitability of grain-growing returns to more favourable levels, then some of the negative effects noted in the previous paragraph will be lessened (e.g. scenario 2). However, the negative effects related to increasing population would continue. How these positive and negative forces balance out will determine the overall outcome for poverty, food security and environmental degradation.

Similarly, if new sources of income generation (other than from grain) are developed, then farmers' ability to buy food will be increased. Again, this will offset the negative effects of population pressure and the outcome will depend on the balance of these forces (scenario 3).

The most optimistic scenario is one where grain prices increase and new income generating activities are developed. These positive forces could overcome the negative force of the population pressure (scenario 4).

Figure 6.1a Scenario 1

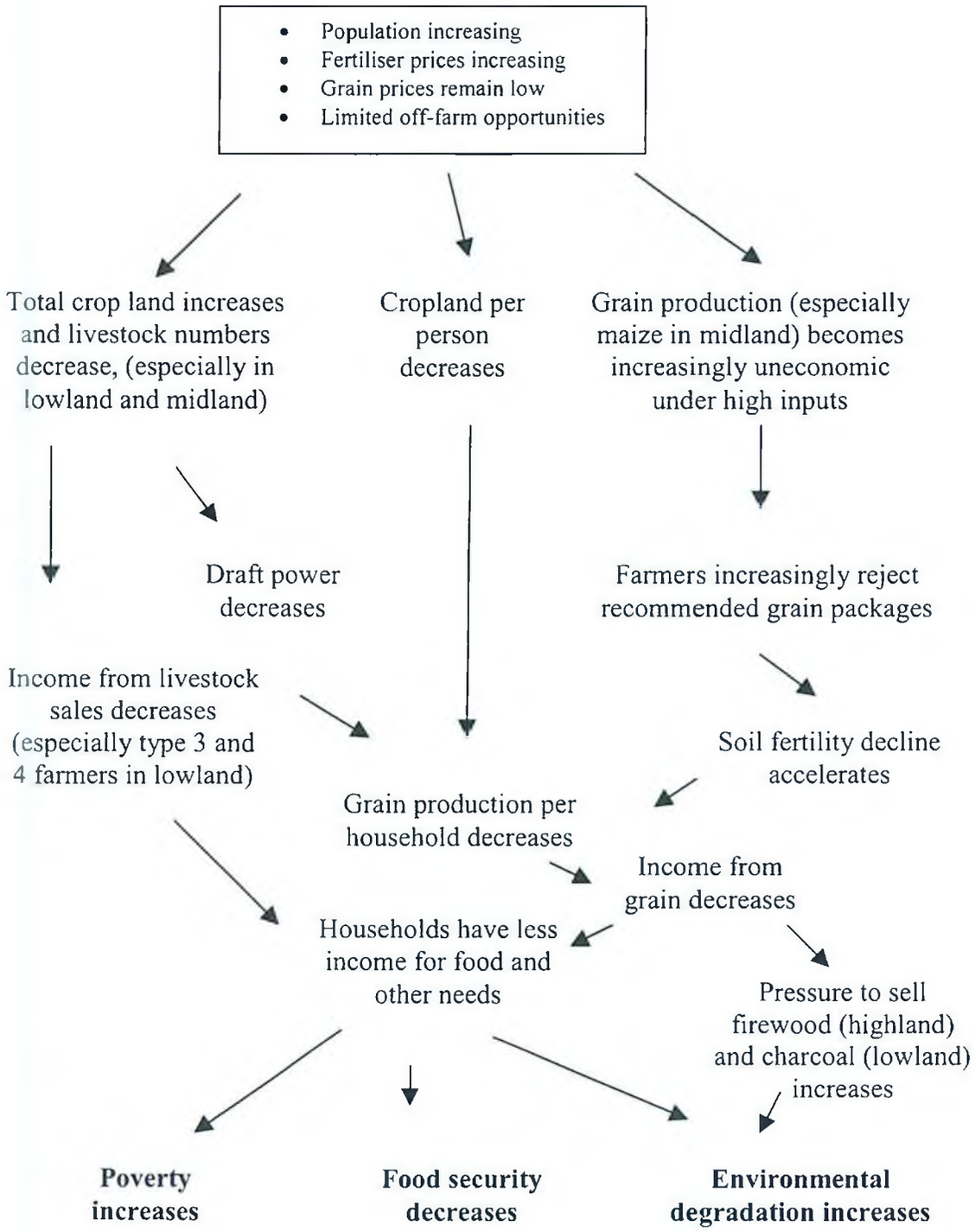


Figure 6.1b Scenario 2

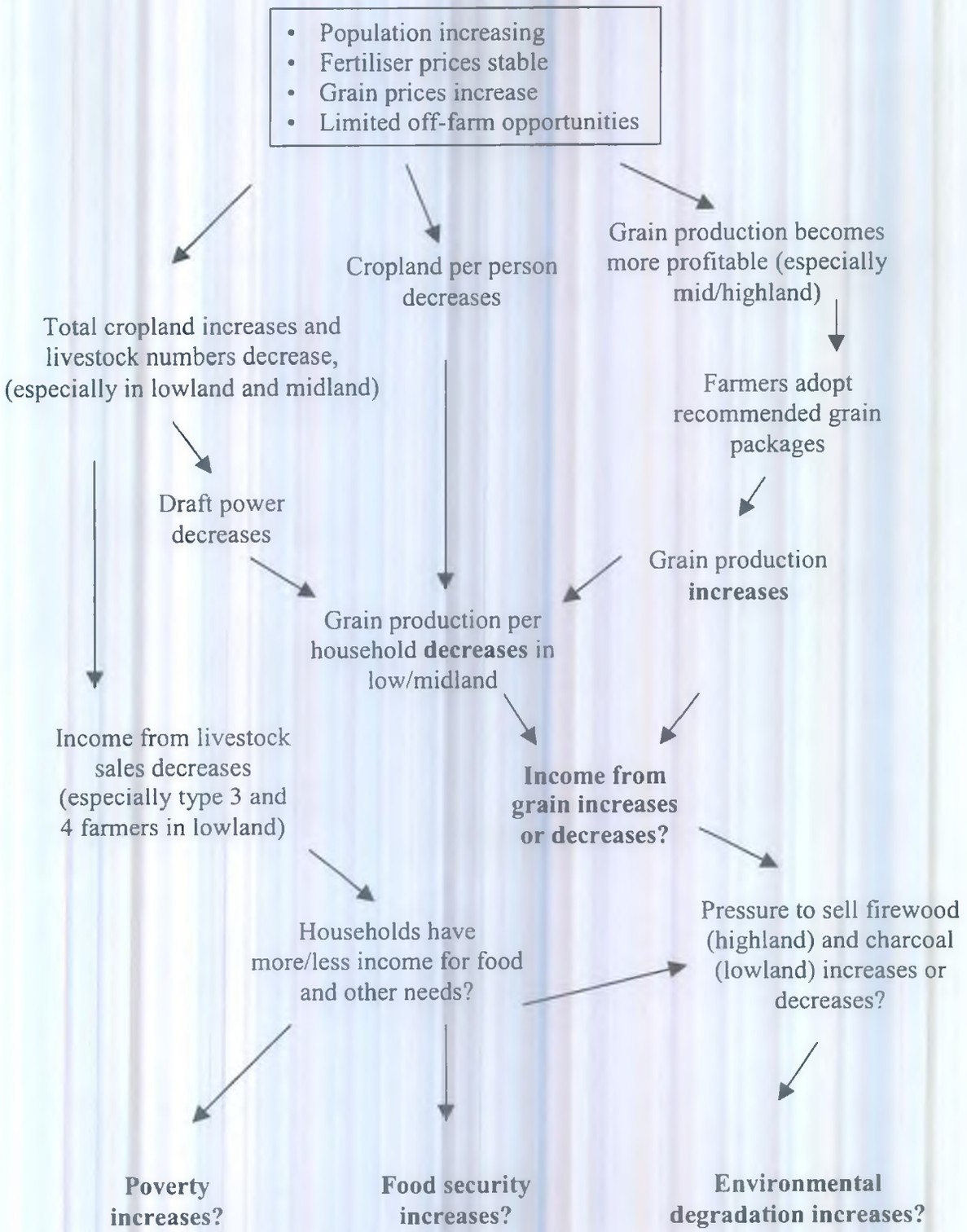


Figure 6.1c Scenario 3

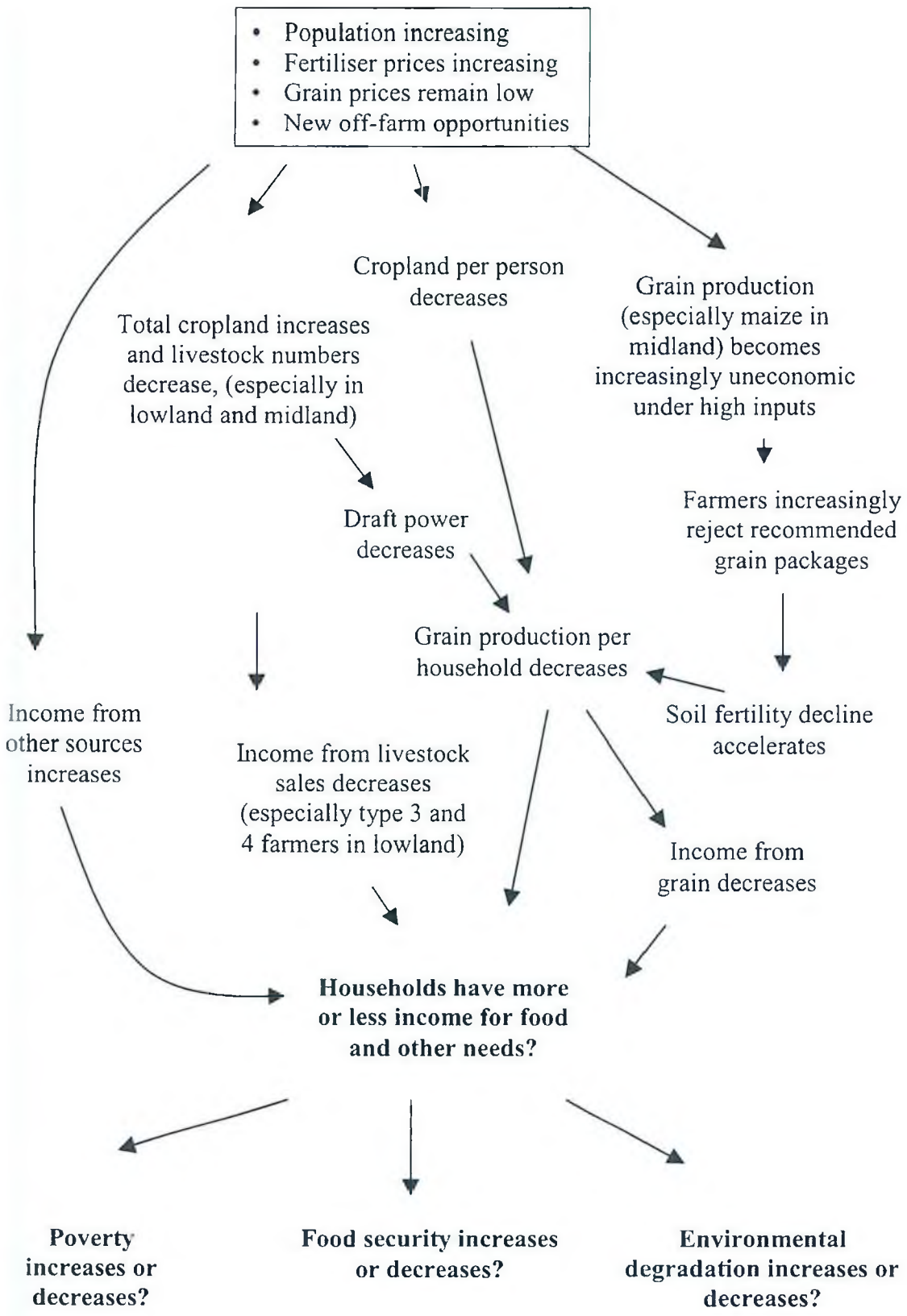
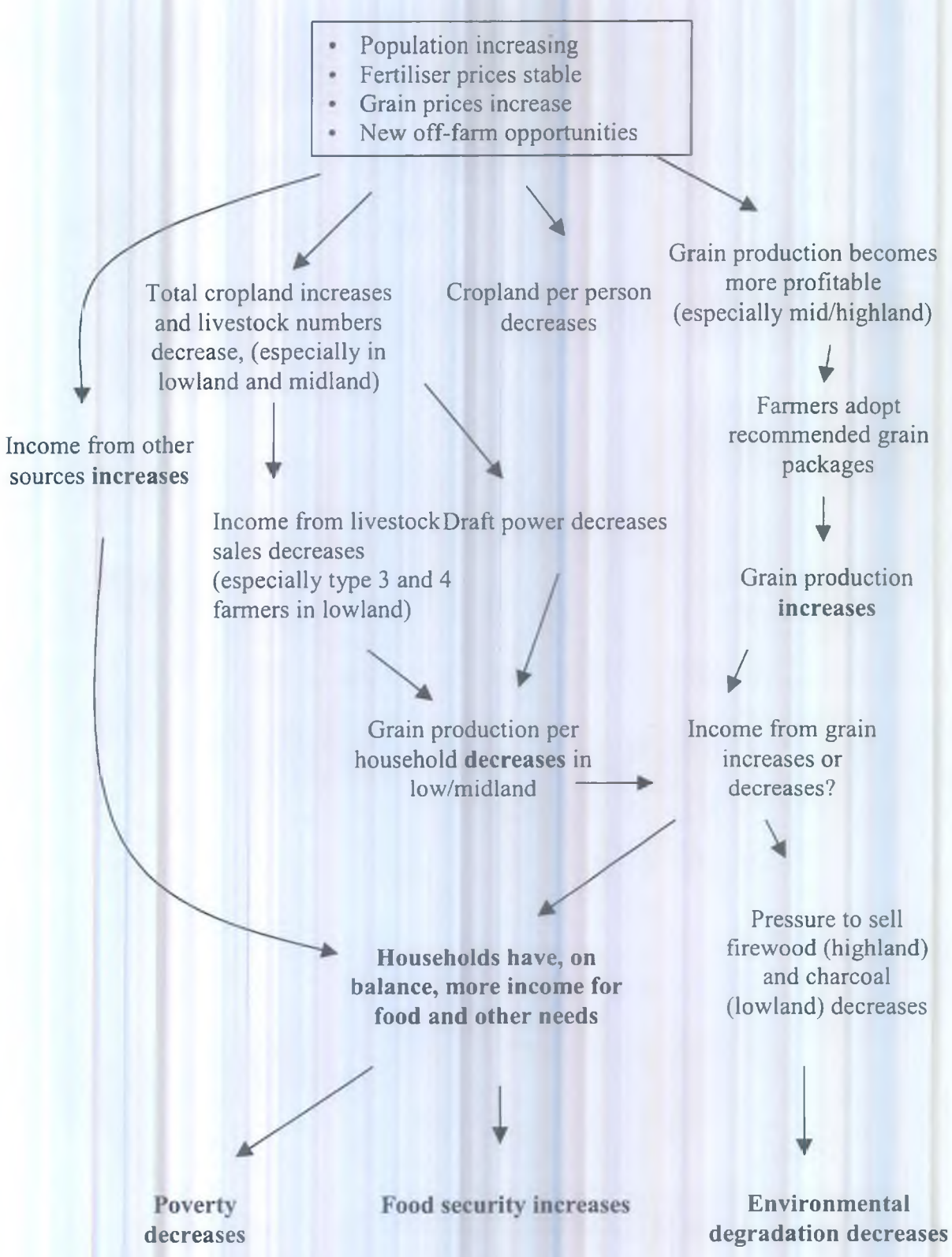


Figure 6.1d Scenario 4



Will grain prices improve? The general trend for the last 2 decades has not been encouraging for farmers. Increased liberalization of trade, the recent farm subsidies announced in North America, the disappointing progress in removing subsidies at world trade talks, and the continued effect of food aid to Ethiopia all point towards continued depressed prices. It is interesting that the prices of teff, which is not internationally traded, have held up better than maize or wheat.

6.3 Development Strategies for Arsi Negele

Based on the understanding of the team, the contextual analysis and the future scenarios, two contrasting strategies for the future development of the woreda are discussed here: the "breadbasket strategy" and the "income generating strategy".

6.3.1 The "Bread Basket" Strategy

The National and District level governments regard Arsi Negele as a grain producing area and most research and development activities are oriented towards this end. The agro-ecological conditions of the woreda are generally favourable for grain production (except in the lowland), and the woreda is a considerable exporter of grain (see Chapter 1). However, as we have attempted to show in this report, it is possible for farmers to experience food insecurity at the household level even in the midst of this apparent bountiful production – hence the title of this report "food insecurity in a bread basket".

Farmers sell much of their grain production at harvest, even though they are left with insufficient food to meet their own household consumption needs. The need for cash, to repay debts incurred by the production package itself, as well as service other debts to money lenders appears to overwhelm the need to store grain for future consumption. Because many farmers sell at this time, the price is low, and there is some evidence to suggest that the annual fluctuations of grain prices are increasing (see Chapter 4). When farmers' own stores are exhausted and they have to purchase food later in the season, grain prices have risen. They thus have to resort to a variety of coping strategies such as livestock sales (the larger farmers) or firewood or charcoal sales (the smaller farmers), or hiring out labour to survive. This explains the apparent paradox of food insecurity at the farm level, even though Arsi Negele is considered to be food secure at woreda level because of its food exporting status.

The scenarios presented in the previous section indicate that the strategy of continuing to emphasize grain production is not very promising for the farm households of the woreda, even if it favourable at a zonal or national level in the short or medium term. If grain prices remain depressed, this strategy is likely to continue to lead to poverty, food insecurity, and environmental degradation in the woreda.

6.3.2 The income generating strategy

If farmers have ways of generating income that are more remunerative than grain production, the future scenario might be more favourable. Such a strategy might include higher value cash crops (such as the onions which are increasingly being grown by farmers in the midland zone, although there is some indication that the local market is becoming saturated), farm level processing to add value (such as brewing that occurs in the midland zone, although a more socially acceptable alternative might be better), or some household industry.

If farmers' income generation is improved, they will be able to purchase food from the market and gradually overcome the food insecurity situation. This strategy could not only bring significant positive changes in food insecurity but, also in living standard such as better education, better housing. It could also divert the farmers from charcoal and firewood selling, which will help in protecting forest resources. As land pressure increased due to the increasing population, higher value products, which require higher labour input per unit land area, can provide local employment for the households with little or no land.

6.4 Prioritisation of research options

The R&D proposals described in section 6.1 were grouped according to which development strategy they support. This breakdown is shown in Table 6.4.

A total of 19 research options were identified by the team from a list of the top seven research and developmental interventions screened in previous Table 6.2. The researchers during the final workshop at MARC prioritised the research options. From the list of research options the researchers suggested three more research topics, which they thought, were equally relevant and fall in the two strategies outlined. Before prioritisation the researchers were asked to identify the critical criteria to be used. A total of five main criteria were suggested and according to their importance the weighting were given. These were as follows:

- Relevancy to food security (weighted 6)
- Immediate impact /adoption (weighted 5)
- Resource Capacity (human and financial) (weighted 4)
- Time frame /duration of research (weighted 3)
- Cost effective (weighted 2)

During the scoring, a scale of 1 to 4 was used. Scale of 1 represented the least feasible, 2 fairly feasible, 3 feasible and 4 represented the most feasible. Researchers were divided into two groups for prioritisation. The two groups were formed randomly, regardless of their disciplinary background. However, the intention before was to incorporate the other stakeholders during the prioritisation but unfortunately they were not represented. The

two groups did the scoring, and the total scores from the groups were combined and the mean was taken for ranking. The total mean score and the rankings are presented in Table 6.5. Research option number 20 got the highest value and was ranked first, followed by research number 15 as the second one,and research number 10 as the third.

6.5 Formulating the research proposal

The team consolidated the result of the prioritisation and decided to pick research option number 2 instead of number one for proposal writing. The major reason for not selecting number one was that, the research intervention that included this option was ranked very low during the initial screening phase. The research proposal is presented in Appendix 7.

Table 6.4 Research and Development Proposals grouped according to Strategy.

Breadbasket Strategy
2. Alternative ways of utilizing staple food crops 4. Promotion of multiple cropping system in the midland and highland (Inter cropping of fingermillet with other crops) Improve crop management practices. Broadcasting to row planting; plant population; tie ridging; response farming (weather forecasting promotion); mulching; scooping; 5. Development and introduction of improved crop varieties suitable to each agro-ecological zones. Development and introduction of drought tolerance crop varieties and root varieties: Early maturing varieties, drought escaping type. Development of low input responsive varieties with respect to nutrients 6. Development of appropriate fertiliser recommendation: Site specific recommendation for various crops Determination of fertility status of different soil types 7. Introduction of integrated nutrition management Development of alternative soil fertility (maintenance) management practices (manure, compost manure, green manure) 9. Establishment of informal seed systems: Seeds and or planting materials 11. Development of efficient credit delivery mechanism 12. Development of efficient storage structures and dissemination Awareness on post harvest management 18. Alternative sources of draft power, harnessing methods and improvement of agricultural implements
Income Generation Strategy
3. Introduction of high value crops like vegetables and oil crops (onion, garlic, coffee in the highland, and linseed oil). Diversification of package program for food and cash crops 7. Introduction of integrated nutrition management Development of alternative soil fertility (maintenance) management practices (manure, compost manure, green manure) 10. Initiate and promote on farm and or off farm income generating micro-enterprises (Seri-culture; Carpentry; animal fattening) Generation of off farm employment 11. Development of efficient credit delivery mechanism 15. Promotion of agroforestry practices; Introduction and integration of fodder trees into cropping systems (e.g. Sesbania, Leucaena, Gliricidia, Calliandra) 16. Introduction of improved livestock breeds appropriate to different agro-ecological zones in Arsi Negele Woreda) 17. Introduction of improved forage species into the farming system and utilization of Crop residues and agro-industry by products 18. Alternative sources of draft power, harnessing methods and improvement of agricultural implements
Neutral as to strategy
1. Awareness on household budgeting and efficient use of family labour. Creation of awareness and promotion of family planning 14. Improvement and promotion of home garden /Kitchen garden 13. Strengthening service co-operation that benefit individual members (farmers): Establishing informal community based saving and credit groups 8. Water harvesting techniques for irrigation and livestock drinking: Roof water harvesting; Catchment harvesting. Development of small scale irrigation schemes

Table 6.5 List of research options and their prioritisation

	RESEARCH OPTIONS	Score group A	Score group B	Total	Rank
1	Identification of compatible crops and varieties for double and inter cropping systems	67	63	65	5
2	Development of maize varieties adaptable to double cropping and late planting after potato/onion harvesting	67	52	59.5	9
3	Assessment of economic and agronomic feasibility of onion/potato based double cropping and maize based single crop rotations in Arsi Negele area	67	63	65	5
4	Development of nitrogen and phosphorous management in potato/onion-wheat/barley/teff double cropping systems	73	60	66.5	4
5	Development of appropriate agronomic management practices for sorghum-fingermillet, maize-fingermillet and maize-bean inter cropping systems	60	61	60.5	8
6	Development of agronomically optimum and economically feasible soil moisture conservation practices (tillage, mulching, scooping, etc.) for major crops grown in the drought-prone areas of Arsi Negele	53	64	58.5	10
7	Development of maize and bean crop management adjustments in response to specific rainfall indicators in the early part of the season in the lowland part of Arsi Negele	46	59	52.5	11
8	Comparison of different hydraulic methods on environmental impact, economical affordability and profitability for different purposes (net present value analysis/analysis on potential return of investment). Note: Water harvesting: underground cellar, pond, dam, collecting run-off to crop field. Well construction; River water utilisation: gravity irrigation by building small dams and channels; water lifting by electric powered pump, diesel powered pump, by windmills and by animal draft power.	55	64	59.5	9
9	Technical suitability of various hydraulic methods in different agro-ecological zones.	60	64	62	7
10	Studies on affordability and profitability of small scale irrigation system by co-operative activities Note: Resource is there, but only government or donors can do the construction, farmers can only afford the operational cost. If government would do it, it would be able to collect more tax from irrigated lands to compensate the investment.	69	67	68	3

Table 6.5 List of research options and their prioritisation (continued)

	RESEARCH OPTIONS	Score group A	Score group B	Total	Rank
11	Selection of tree species for combination with annuals (indigenous or introduced) suitable in different agro-ecological zones for various/specific purpose	67	54	60.5	8
12	Possible combination of tree and annual crops	-	48	48	-
13	Optimum growing pattern of the tree-crop community	-	48	48	-
14	Development of Woreda soil map	60	57	58.5	10
15	Development of appropriate fertiliser recommendation for major crops by AEZ and soil types	71	67	69	2
16	Development of integrated nutrient management, (using green manure)	66	64	65	5
17	Introduction and Evaluation of stall feeding/ zero grazing system appropriate to different agro-ecological zones in Arsi Negele Woreda	55	64	59.5	9
18	Introduction and Evaluation of dual purpose goats (lowland-midland) and dairy goats (highland-midland) under stall feeding system in Arsi Negele Woreda	65	59	62	7
19	On farm selection of improved forage species and fodder trees suitable to different agro-ecological zones in Arsi Negele Woreda Note: (grass e.g. *Chloris gayana*, *Cenchrus ciliaris*; legumes e.g. *Macroptilium* spp, *Stylosanthes* spp. *Lablab* spp, and *Clitoria* spp.; fodder crops e.g. *Sesbania* spp, *Leucaena* spp, *Gliricidia* spp, Mulberry spp, and local *Acacia* spp.)	70	59	64.5	6
20	Analysis of marketing constraints of input output related to agriculture	71	69	69.5	1
21	Development of soil conservation technique	62	59	60.5	8
22	Introduction and integration of high value cash crops	64	57	60.5	8

CHAPTER 7 MARC TECHNOLOGY AND FOOD SECURITY

This chapter considers how MARC technologies have addressed the problem situation related to food security in the study area. The team attempted to assess the usefulness of the innovations disseminated by MARC in the study area with the joint effort of the farming community in order to meet one of the objectives of the client institute.

7.1 The agricultural knowledge and information system

The agricultural knowledge and information system (AKIS) can be defined as 'a set of agricultural organisations and/or persons, and the links and interactions between them, in relation to the problem situation'. A consideration of the AKIS illustrates who are engaged in such process as generation, transformation, transmission, storage, retrieval, integration, diffusion, and utilisation of knowledge and information. The existence of a good AKIS ensures working together to support good decision making and problem solving in the farming community. Farmers need to know about new ways of doing things, information on prices and price fluctuation of agricultural products and environmental changes etc. On the other hand an analysis of the AKIS can help the agricultural service organisations such as research, extension, credit, co-operatives and various other agriculture related organizations to improve their interrelationships and efficiency. The team identified the existing AKIS with the involvement of farmers in the selected PAs (Karsa, Sayoomaja, Keraru and Watera) and the WADD. The information flow at the woreda level is shown in Figure 7.1

7.1.1 Formal sources of information to farmers

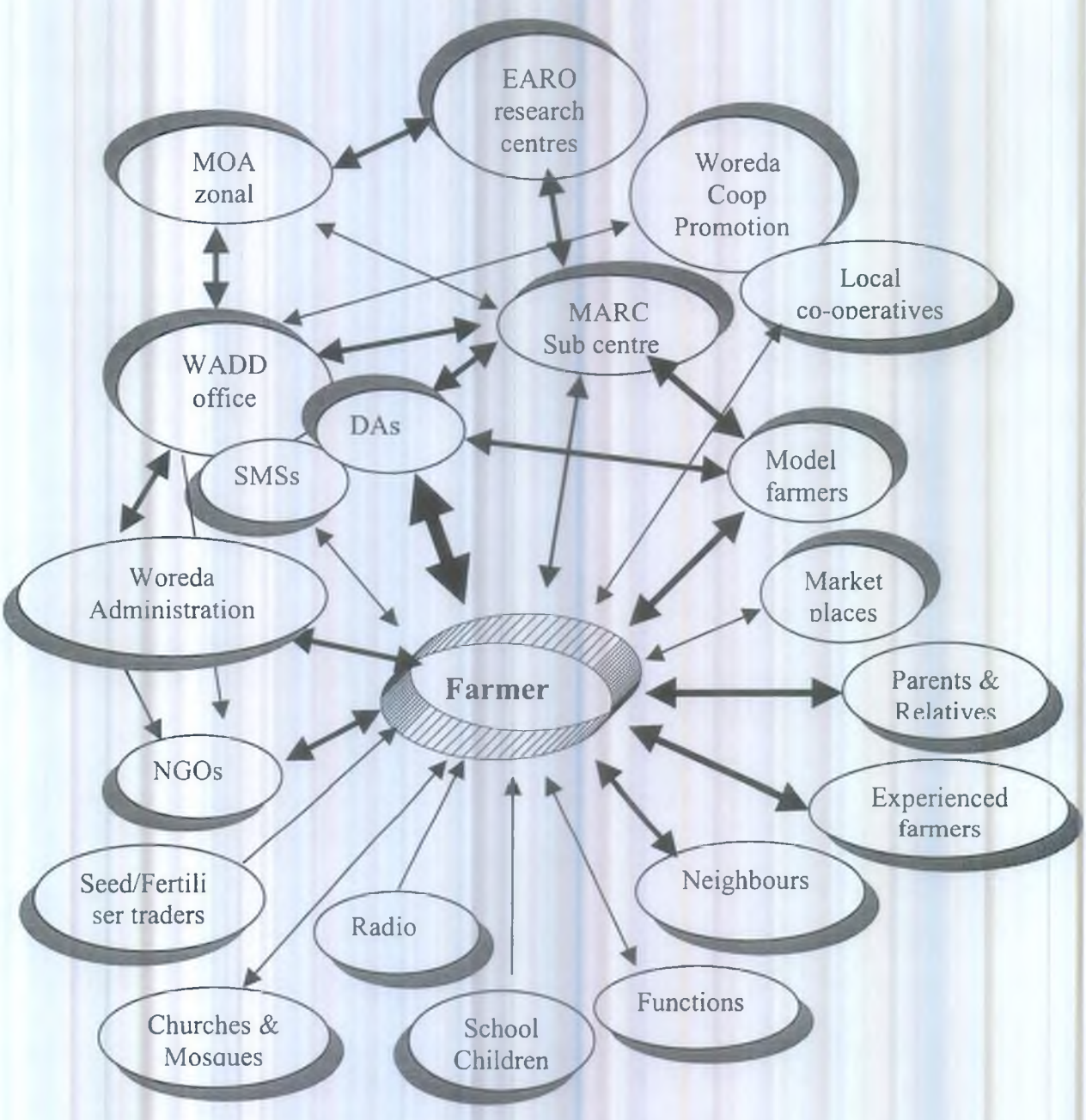
The strongest source of information to farmers is the DA of the peasant association who is an official of the WADD. The DA is the village level extension and administrative worker who has a very good relationship with the farming community. The DAs serve as a good informal source of information. DAs are trained through WADD by various institutes including research institutes like MARC.

NGOs, the MARC sub-centre and the WADD are other main sources of formal information. NGOs such as the African Aid Development Association (AADA), African Humanitarian Action (AHA) seem to have more direct contacts with farmers through various specified programmes. Model farmers of the Farmers Research Group (FRG), established by the WADD and MARC sub-centre receive good information mostly on new technologies from the MARC sub-centre. The MARC sub-centre provides regular information to the FRG through training programs, demonstrations and on-farm trials.

7.1.2 Informal sources of information to farmers

The relatives, model farmers and experienced farmers in the village are the strong informal sources of information. Traditionally much of the information is shared when

Figure 7.1 Agricultural Knowledge and Information System in the study area



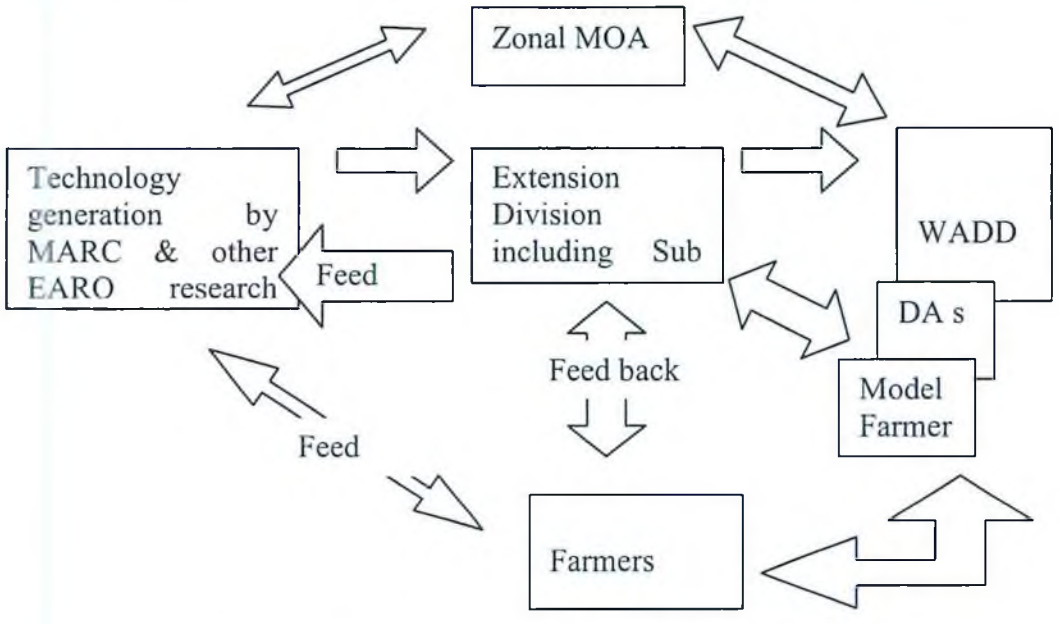
Note: The degree of thickness of the arrows shows the strength of the information flow

relatives visit each other and also from experienced farmers. Model farmers, farmers who have a high degree of willingness and interest towards new technologies, are also becoming an important source of information. There are about 25 model farmers in each PA who are selected by the DA. These model farmers receive new varieties and inputs like fertiliser along with information on improved cultural practices from the MARC sub-centre. Farmers who get training other than model farmers also becoming a good source of information. Gathering places like open markets, churches/mosques, family functions and traders are also serve as source of information. Media like newspaper and radio serve as an information source to a limited extent, but access to these is limited: around 25 percent of farmers have access to a radio.

7.1.3 The technology dissemination system in MARC

The extension division of MARC was established eight years ago with the main objective of transferring technologies generated by MARC and other relevant research institutes. The popularisation of existing technologies and creating a linkage between farmers and other stakeholders is also an objective of the extension division. Mainly, the division conducts demonstration programs on new technologies for DAs and model farmers, which is called ' Pre-Extension Demonstration'. It is expected that these technologies introduced will diffuse through the WADD i.e., through DAs and model farmers. Once a new technology is introduced to farmers, the extension staff make regular visits (mostly once a week) to farmer's fields for giving advice and getting feedback. After one or two years, feedback on technologies introduced is given to researchers by extension division. Usually, this feedback is given during review meetings and by regular reports (Figure 7.2).

Figure 7.2 Flow chart of technology dissemination system in the MARC



Note: the thickness of arrows indicates the degree of feedback

7.1.4 MARC technologies disseminated in Arsi Negele Woreda

The MARC sub-centre in Arsi Negele conducts extension activities since 1997. The major extension activities conducted so far are:

a) Training of model farmers and DAs (pre-extension demonstration) on new improved varieties such as:
   - Wheat: 'HAR 710'(*Wave*) and 'HAR 1685'(*Kubsa*)
   - Sorghum: 'IS 9302' with the row planting method
   - Fingermillet: *'Taddese'* with row planting method
   - Haricot bean: *'Roba'*

b) Training of women and food sellers on different ways of preparing food from haricot bean (*Roba* variety) such as
   - *Shiro* (stew) preparation
   - *Sambusa* preparation.
   - Soup preparation

c) Conducting field days for Farmers associations, Model farmers, Agricultural Experts of the woreda WADD, officials of NGOs and students.

d) Training of Agricultural Experts and DAs of the WADD on new technologies once in five years.

7.2 Assessment of MARC technologies disseminated in Arsi Negele

An attempt was made to assess the usefulness of the technologies that have been disseminated for the last five years by MARC. The assessment was mainly directed to the midland zone because the MARC's extension activities have been so far focussed to the midland. However, for comparison purpose some assessment was extended to the highland and lowland zones. The assessment was done for wheat, sorghum, fingermillet and haricot bean. In addition, assessment was done for several maize varieties although maize is not included in MARC's pre-extension demonstration programs at present. All assessment was based mainly on the perception of local farming communities. The farmer's perceptions on new technology were also verified with the WADD. The following proxy indicators were used for the assessment:

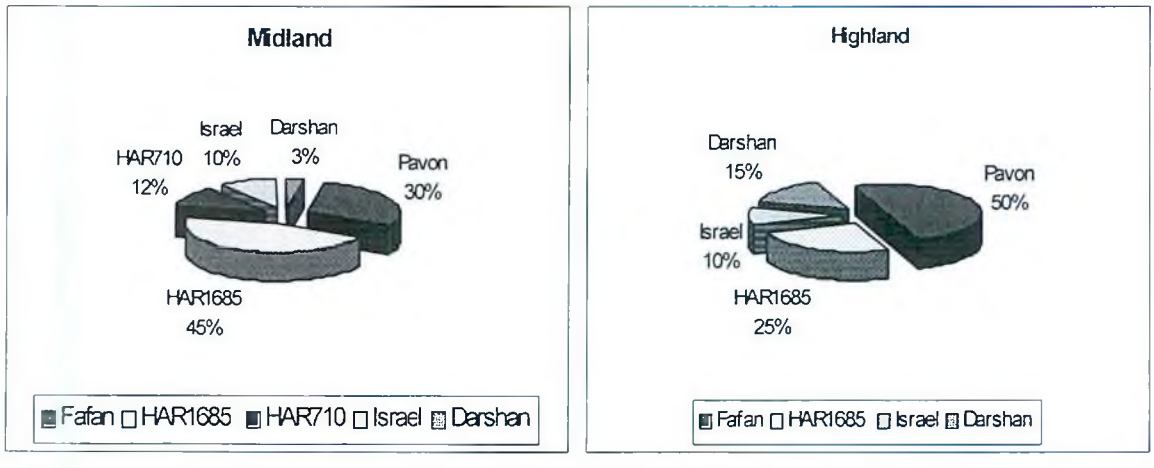
- **Percentage of the adopters of the technology:** The percentage of adopters is an indicator of behavioural change, which can be an evident of usefulness of the technology introduced. Focus groups from three PAs in the midland (Karsa, Sayoomaja, Ali Wayoo) estimated the number of farmers adopting a particular technology. Each focus group consisted of around 20 farmers, including model farmers, contact farmers and others.

- **Preference and scoring matrix for new varieties:** Farmers developed the matrices by listing their own criteria that they usually use when adopting a particular crop in the local condition. These criteria were mainly based on their livelihood. They also gave scores for the different varieties against the criteria they listed, using a fixed number of maize seeds (20 to 40 seeds depending on the number of crop varieties) for each criterion by placing the agreed numbers of maize seeds in relevant boxes on a flip chart on which varieties and criteria were listed. During scoring exercise, care was taken to make sure that all farmers in the group actively participated.
- **Assessment by suitability scoring:** Finally, based on the preference matrices developed by farmers the usefulness of the technologies were assessed by the team in relation to the three dimensions of the overall food security problem such as climatic risk, change in economic environment and population pressure. Livelihood pattern and the gender issues were also taken in to consideration in this assessment.

7.2.1 Assessment of wheat varieties

The percentage of farmers adopting different wheat varieties was assessed in three PAs of the midland zone (Karsa, Sayoomaja and Ali Wayoo) and one PA (Watera) in the highland zone. Farmers usually grow more than one variety in a season depending on resource availability and domestic needs. Therefore the percentages indicated in the Figure 7.3 do not mean that a farmer grows only that particular variety.

Figure 7.3 Percentages of farmers adopting different wheat varieties in the midland and highland zones



Farmer's comments regarding wheat varieties were:

- **Pavon 76:** Grain weight is high due to bigger size of grains. Straw is very much preferred by livestock due to its good taste and the soft nature. The straw breaks in to small pieces during threshing which makes more palatable to livestock. Although yield of Pavon 76 is not the best, farmers prefer this variety.
- **Kubsa:** The grain starts sprouting before harvesting if whether is moist. The colour is not attractive, so traders do not like it for bread making, and hence the market price is poor. Straw is short and not strong hence not suitable for thatching roof but suitable

for feed. Seeds are small hence weight of grain is low. Yield is satisfactory even in bad rainfall years.

- **Wave:** No idea about the taste. Straw is strong and long hence not preferred for livestock feed but it is suitable for thatching roof. Grain weight is less due to its smaller size. Long growing duration makes susceptible to drought.
- **Israel:** Texture and taste of its flour is most preferred for dough (bread) making hence market price of grains is high. Straw is long and strong hence preferred for thatching roof, but not suitable for livestock feed. Seed is big hence grain weight is high.

Table 7.1 Preference and scoring matrix developed by farmers of midland zone for wheat

Wheat varieties		Pavon 76	HAR 1685 (Kubsa)	HAR 710 (Wave)	Israel
FARMERS CRITERIA IN ORDER OF IMPORTANCE	Yield in good rain fall year	+ + + + + +	+ + + + + + + +	+ + + +	+ +
	Yield in bad rain fall year	+ + + + +	+ + + + + + +	+ + + + +	+ + +
	Grain price	+ + + + + + +	+	+ + + +	+ + + + + + + +
	Short growing duration	+ + + + +	+ + + + + + + +	+ + +	+ + + +
	Taste	+ + +	+ + + + + + + +	+ +	+ + + + + + + +
	Drought resistance	+ + + + +	+ + + + +	+ +	+ + + + + + + +
	Straw as livestock feed	+ + + + + + + +	+ + + + + +	+ + +	+ +
	Straw for roof thatching	+ + + +	+ + +	+ + + + + +	+ + + + + + + +
	Grain weight	+ + + + + +	+ + +	+ + + +	+ + + + + + + +
	Overall preference rank	**1**	**2**	**4**	**3**

Assessment shows that HAR1685 and Pavon 76 varieties are widely adopted. In the midland, the adoption of HAR1685 is greater than Pavon 76 whereas the situation is the reverse in the highland. HAR710 is only adopted in the midland to a certain extent. Main reasons for a greater adoption of HAR1685 as against HAR710 are better yield potential even in bad rain fall years, shorter growing period, drought resistance, good taste and better quality straw for livestock. However, the low grain market price for this variety is a main draw back because major portion of grain is sold.

Table 7.2 Suitability/usefulness scoring for wheat

	Pavon 76	HAR1685	HAR710	Israel
1. Climatic risk	+ + +	+ + +	+	+ + + +
2. Change in economic 3. environment	+ + + +	+ +	+ +	+ +
4. Population pressure	+ + +	+ + +	+ +	+ +
5. Utilization value as food	+ + +	+ + + +	+ + +	+ + + +
6. Livestock feed value	+ + + +	+ + +	+ +	+
7. Firewood value				
8. Contribution to 9. gender balance	+ + +	+ + + +	+ +	+ +
10. Overall suitability score	20	19	12	15

++++ Very good, +++ Good, ++ Moderately good, + Not much of use

According to the suitability scoring, Pavon 76 and HAR1685 varieties appear to be useful varieties for the midland zone.

7.2.2 Assessment of maize varieties

Figure 7.4 Percentages of farmers adopting different maize varieties

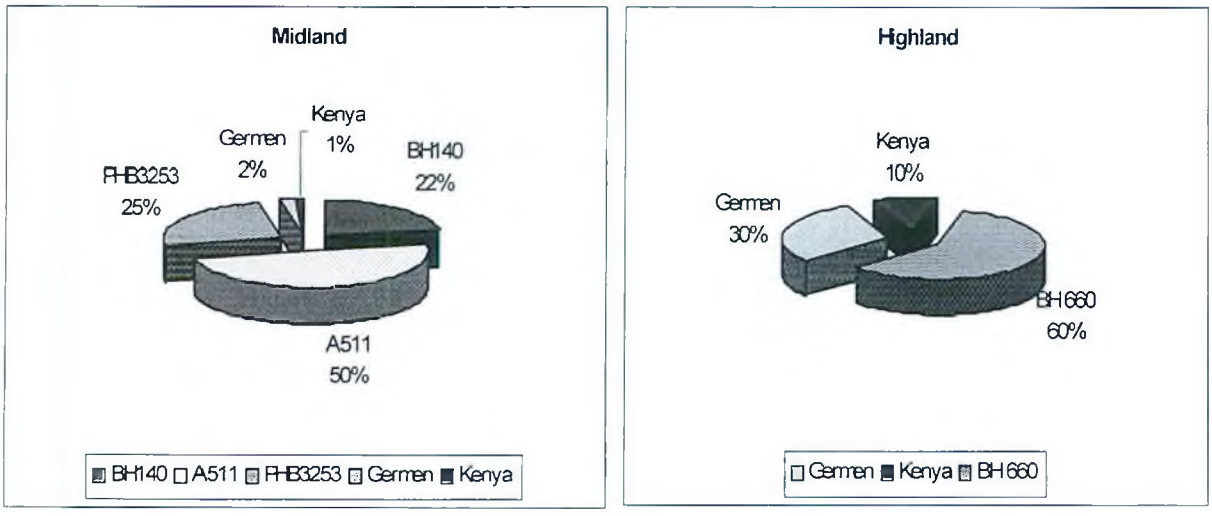


Table 7.3 Preference and scoring matrix developed by farmers of midland zone for maize

FARMERS CRITERIA IN ORDER OF IMPORTANCE	Maize varieties	PHB 3253	BH140	Awassa 511
	Yield in good rain fall year	+++++ 40q/ha	++++++ 50q/ha	++++ 32q/ha
	Yield in bad rain fall year	+++++ 30q/ha	++++ 20q/ha	++++++ 30q/ha
	Growing duration	4 months	4 ½ months	3 months
	Grain price	++++++	+++	++++++
	Weevil resistance	+++++	+++	+++++++
	Straw as livestock feed	+++++	+++++++	+++
	Stem for fuel & fencing	+++++	+++	+++++++
	Overall preference rank	**2**	**3**	**1**

Farmers' comments on maize varieties were:

- Variety Awassa 511 is delicious as green cob hence it helps as a food source during early maturing time of the crop. The weight of the grain is high due to its resistance to storage weevil, which in turn fetch a good price in the market.
- Variety BH 140 susceptible to rust attack during dry period and yield drop is very significant in bad rain fall years. Yield drop of Awassa 511 and PHB 3253 in bad rain fall years is not very much. PHB 3253 and BH 140 are suitable for 'injerra' making.

Table 7.4 Suitability/usefulness scoring for maize

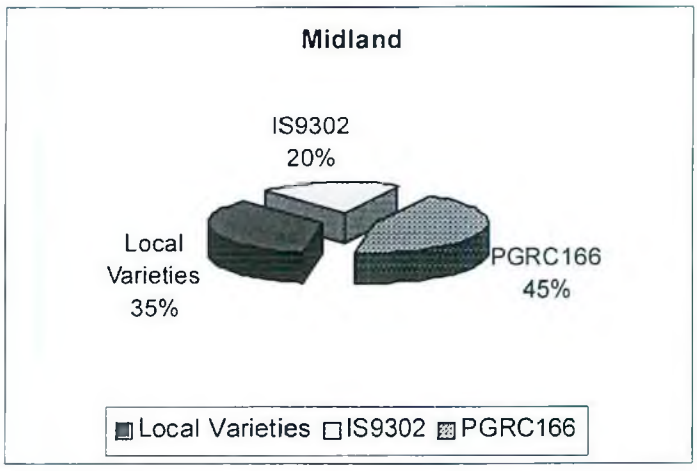
	PHB3253	BH140	A511
Climatic risk	+++	+	++++
Change in economic environment	+++	++	+++
Population pressure	++	++++	++
Utilization value as food	+++	+++	++++
Livestock feed value	++	+++	+
Firewood value	++	+	++++
Contribution to gender balance	++	++	+++
Overall suitability score	17	16	21

++++ Very good, +++ Good, ++ Moderately good, + Not much of use

The scoring shows that variety A511 appears to be more useful for the midland, followed by PHB3253.

7.2.3 Assessment of sorghum varieties

Figure 7.5 Percentages of the farmers adopting different sorghum varieties



Although farmers prefer IS9302, its adoption percentage is less than that of PGRC166 because of shortage of seeds and because it was only introduced recently.

Farmers' comments regarding sorghum varieties were:

- 'Tall local variety' (loose headed) is the most commonly grown variety. It is a dual-purpose variety that gives good stems for building construction and firewood. It is highly resistant to drought, bird damage and storage weevil.
- 'Zenda' short variety (loose headed) is also a common and high yielding local variety. The stem has little value for construction work but is useful for firewood. It is resistant to bird damage, drought and storage weevil.
- 'Arsi Negele' is short variety (semi compact headed) which is seldom grown. The stem has no value for building purposes. It is moderately resistant to bird damage, drought and storage weevil.
- The food value of these 3 local varieties is low due to bitterness and usually flour is mixed with other kinds of flour like wheat flour to prepare food. Bird damage to all local varieties is less because of the bitter taste and small size of the grain.
- PGRC 166 (Harcabas long variety). This variety is preferred next to the local varieties because of its high yield and good taste (suitable for 'injerra'). It also gives good stem for building purposes. However farmers are reluctant to grow this variety due to the high susceptibility to bird damage, storage weevil and drought.
- IS 9302 (Harcabas short variety). This gives the highest yield and has very high food value (suitable for 'injerra'). The stem is not useful at all for building purposes. Susceptibility to bird damage and storage weevil is less than PGRC 166 variety. However it is very susceptible to moisture stress.

Table 7.5 Preference and scoring matrix developed by farmers of midland zone for sorghum

FARMERS CRITERIA IN ORDER OF IMPORTANCE	Sorghum varieties	Local varieties	PGRC 166	IS 9302
	Yield	+ + +	+ + + + +	+ + + + + + +
	Growing duration	4 months	3 months	3 months
	Taste	+ + +	+ + + + +	+ + + + + + +
	Stem for construction	+ + + + + + + +	+ + + + +	
	Drought resistance	+ + + + + + + +	+ + + +	+ + +
	Less damage by birds	+ + + + + + + +	+ +	+ + + + +
	Weevil resistance	+ + + + + + + + + +	+ +	+ + + +
	Firewood	+ + + + + + +	+ + + +	+ + + +
	Overall preference rank	**1**	**3**	**2**

Table 7.6 Suitability/usefulness scoring for sorghum

	PGRC166	IS9302	Local varieties
Climatic risk	+ + +	+ +	+ + + +
Change in economic environment	+ + +	+ + + +	+
Population pressure	+ + +	+ + + +	+
Utilization value as food	+ + +	+ + + +	+
Livestock feed value			+
Firewood value	+ +	+ +	+ + + +
Contribution to gender balance	+ + +	+ + +	+ + + +
Overall suitability score	17	19	15

++++ Very good, +++ Good, ++ Moderately good, + Not much of use

The scoring shows that variety IS9302 appears to be more useful in the midland, followed by PGRC166.

7.2.4 Acceptance of the fingermillet crop by farmers

Assessment was done in midland and lowland zones. However in the low land this crop is not popular and few farmers are growing a local variety called "short red" variety. The yield in the lowland is 20 q/ha in good rainfall years and 8q/ha in bad rainfall years.

Fingermillet is a newly introduced crop to the midland zone by the MARC sub-centre some five years back. At present about 25 % of the farmers in Karsa PA are adopting the crop in the midland zone. Usually one farmer grows 1/4 to 1/8 ha by extent. Model farmers mostly cultivate the crop, although others are also gradually adopting the crop after realizing its value and benefit. About 80% of the farmers are getting seeds from the sub-centre while others obtain seeds from model farmers. Seed is broadcasted along the row, which is called row planting. Farmers, including the model farmers, do not know about varieties of fingermillet by name. They know by the seed-colour and they call it "brown variety" which is variety '*taddesse*'. It reveals that most farmers are willing to grow this crop but the major limitation is the unavailability of seeds. The following feed back has been given by farmers of the mid land zone;

According to farmers, the benefits of fingermillet include:

- The crop has a high food value. Good quality food such as *injerra,* bread, porridge and also malt can be prepared. Particularly the quality of *injerra* is very good and is similar to injerra made with teff, therefore the whole family is satisfied by consuming millet-injerra. Millet is mixed with other cereals or use alone to prepare various foods.
- Is very suitable for making malt and local alcohol hence this has a good market value especially in towns. Market price is in the range of 140 to 200 Birr per quintal. However due to its good food value and limited production, selling is not common.
- Yield is satisfactory: 7Q per 0.25 ha. A harvest of seven quintal is sufficient for an average family of eight members for 1.5 to 2 years. Normally it is consumed after mixing with other cereals.
- Millet can be stored for a longer duration for about two years without damage such as weevil damage.
- Livestock prefer millet straw hence is a good source of animal feed.
- Also the straw is useful for thatching roof.
- The stem (after harvesting the panicle) is used as a source of firewood because it is hard.
- Fingermillet is more resistant to drought than other cereal crops.
- Bird damage to the crop is slight.

Problems raised by farmers with regard to fingermillet include:

- Cultural practices, particularly weeding is very tedious and labourious. The work of 1.5 ha of maize is equal to work of 1/8 ha of millet. Farmers share labour with their colleagues to complete the work. The first weeding is done manually and the second weeding is by oxen.
- Harvesting is tedious because the heads are cut separately and put into a sack, unlike in other crops.
- Sometimes attack by some worm is noticed on the head, when young.

Table 7.7 Suitability/usefulness scoring for fingermillet

	Taddesse
Climatic risk	++++
Change in economic environment	+++
Population pressure	++ +
Utilization value as food	++++
Livestock feed value	+++
Firewood value	++
Contribution to gender balance	+++
Overall suitability score	22

++++: Very good, +++: Good, ++: Moderately good, +: Not much of use

Although fingermillet is a recently introduced crop, according to the farmers' comments and the usefulness scoring, the crop variety *Taddesse* is very suitable for the midland. The variety positively fulfils many of the farmers' criteria, as well as responding to the different dimensions of food security noted in this report. Fingermillet seems to be a good income generating grain as well. Availability of seeds and higher labour requirement for weeding are currently the determinants of further adoption and diffusion.

7.2.5 Acceptance of Haricot bean by farmers

Haricot bean was first introduced by the MARC sub-centre to the midland in 2001. The variety introduced was '*Roba*' along with food utilisation aspects of this variety. About 4 women in one PA in the midland were given training on the utilisation aspects of *Roba*. The sub-centre through the WADD distributed the seeds (6 kg per farmer) to the selected 4 model farmers in one PA free of charge. A two-day training was given last year to a group of women (4 from each PA) on the following food utilisation aspect of *Roba*:

- Soup preparation
- *Sambusa* preparation
- Stew (*shiro*) preparation

Although it is too early to assess the usefulness of *Roba* and its utilisation, the following feedback was obtained from the model farmers and women who underwent the training:

Benefits

- The stew is commonly prepared and eaten with *injerra*.
- The soup is preferred by all in the family including the children.
- *Sambusa* is seldom prepared because it needs more ingredients and more time.
- Haricot bean is a good substitute to faba bean. Haricot bean is cheaper than faba bean, hence it saves money.
- Children prefer food prepared with Roba, which is an added advantage.

Problems

- Seed shortage is the major problem
- Making *sambusa* is difficult, and it needs more ingredients like oil and more time.

7.3 Conclusions

7.3.1 Adoption of new technologies in the midland

MARC sub-centre started disseminating technologies five years back in the midland zone. Out of the new technologies disseminated, different levels of adoption among farmers have been taken place.

The sub-centre introduced two wheat varieties, HAR1685 and HAR710 during the last five years among which the HAR1685 shows very good adoption percentage (45%) among farmers, and HAR710 less so (12%). The variety Pavon 76, already existing at that time is also widely adopted (30%). In wheat, yield, the price of grain in the market, shorter growing season and taste are the most important factors considered by farmers when comparing/scoring varieties.

From last year, the sub-centre started popularising the maize variety A511 in the midland. This variety has been already quite popular in the area since several years back and it has got the highest adoption in terms of number of farmers (50%) followed by PHB3253 (25%) and BH140 (22%). Yield, short growing duration, grain price in the market and resistant to storage weevil are the main determinants of adoption of maize varieties.

Sorghum varieties such as PGRC166 and local varieties have been introduced before seven years in the midland even before MARC started its extension activities in the area. Variety IS9302 was introduced last year. Widely accepted varieties are PGRC166 (45%) followed by local varieties. Farmers' major concerns are better yield, shorter growing duration, taste, and good quality stem for construction, and drought resistance.

The haricot bean variety, *Roba,* was introduced last year. Although it is too early for making comments, it seems that, according to farmwomen, it is a useful variety in terms of food security and nutrition.

The fingermillet variety *Taddesse* has been disseminated during the last five years and the adoption among farmers seems to be quite satisfactory (about 25%). *Taddesse* fulfils many of the requirements of farmers and has a promising acceptance. Usually, the crop is grown at small scale ($^1/_8$ – ¼ ha per farmer) due to high labour requirement for weeding and limited availability of seeds. Farmers are not aware of the variety *Paddet* that was introduced last year. Based on the farmers' experience so far, fingermillet deserves more extension activity.

Among the technologies disseminated so far, the most useful and successful in the midland in terms of the problem situation analysed in this report (climatic risk, market risk and population pressure) and livelihood pattern of the farmers appear to be:

- Wheat varieties "Pavon 76" and "HAR1685"
- Maize variety "A511"
- Sorghum variety "IS9302"
- Fingermillet variety "Taddesse"
- Haricot bean "Roba"variety

Although, yield is one of the major criteria for farmers, other criteria, particularly grain price, taste, and weevil resistance are very important factors in determining the market price because farmers sell their major produce in the market.

7.3.2 Priority areas of sub-centre activities

The MARC sub-centre is actively collaborating with various national research programs. Research trials are more directed more towards cereal crops. For example, in the year 2001 more focus was on sorghum followed by maize and then wheat (see Appendix 6). Sorghum is not a priority crop for farmers in any of the zones of Arsi Negele. Among cereals, wheat and maize are the farmers' priority, followed by sorghum, teff and barley. Potatoes and peas in the highland, onions and potatoes in the midland are other priority crops for farmers. Farmers in the lowland have also been experimenting with onions in recent years. Based on the analysis of future scenarios and development strategies discussed in Chapter 6, income generating crops merit more attention from MARC and the sub-centre for alleviating food insecurity and poverty. Hence, there is an urgent need to re-align priority activities of the sub-centre in tune with future scenarios likely to exist in ten to twenty years. Presently, the sub-centre extension activities are emphasising major cereal crops, with the exception of haricot bean and fingermillet. Research and extension activities should be extended to the cash crops already existing in the area such as shallot and other kinds of beans that have good market potential. New high value crops suitable for the area (fruits, vegetables and others) should also receive more attention. Food security is not always best secured by growing the major food staples.

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APPENDICES

APPENDIX 1 TERMS OF REFERENCE

Institutional Framework

The field study will be carried out as a joint activity of the Ethiopia Agricultural Research Organization (EARO) (through its Melkassa Agricultural Research Centre, MARC); and International Centre for Development oriented Agricultural Research (ICRA).

MARC/AERO has a national mandate of co-ordinating and conducting agricultural research in the semi-arid environment s of Ethiopia including the Central Rift Valley. It has 18 research programs and a total number of research staff of 10 PhD, 24 MSc and 17 BSc holders. Research of MARC is mainly focused on:

- identification of constraints to agricultural development in the semi-arid environment;
- generation of improved agricultural technologies (such as drought tolerant varieties and suitable agricultural implements) in order to alleviate the constraints;
- popularization and dissemination of workable crop production technologies to users (e.g. the farming community) in collaboration with other actors such as the Ministry of Agriculture and non-government organizations (NGOs).

Arsi Negele is one of the three sub-centres of MARC that was established mainly for developing suitable technologies for food crops which are grown at relatively higher altitude in MARC mandate area (higher midland and the lower highland). Currently, the sub-center has three technical assistants who are collaborating with different crop research programs.

ICRA is an international organization founded on the initiative of European members of the Consultative Group on International Agricultural Research (CGIAR) to assist in strengthening the capacity of researchers and development professional working in Latin America, Africa and Asia to contribute effectively to agricultural development.

ICRA provides participating scientists with an opportunity to acquire new concepts and skills, and to apply them in a professional assignment with partner research institutes in the South. The core part of the ICRA Programme consists of three-month intensive field study in rural areas of the developing countries. The scope and dimension of this study are based on the terms of reference (TOR) that are subject of the present document.

Period

This study will be carried out from 13 April to 12 July 2002. Data collection will cover about 5-6 weeks. The rest of the period will be allocated to data processing and analysis, scaling up of the results, organisation of workshops (for presentation and getting feedback of stakeholders on prioritised research and development proposals) and the writing of draft and final reports.

Topic of the study

The topic of the study is:

> "Food security strategies among households in the different farming systems along the toposequence in Arsi Negele: Opportunities for Research and Development."

Justification

Despite the fact that Arsi Negele district has been considered as one of the areas with good agricultural resource endowment, the contribution of the sector has remained low. As a result, fluctuating food security for most people in the area is a fact of life. In addition, farmers face problems in obtaining the tools and inputs (seeds, fertiliser, pesticides, etc) and in gaining access to sources of credit and other financial means, as well as in marketing of their produce.

Small farmers, in particular, are often unable to afford inputs when they need them, resulting in negative effects on their food production and food security. Changing climate and other ecological variables are also among the main factors contributing to the fluctuating food security situation in the district. Nevertheless, research and development workers did not demonstrate the nature and interaction of these factors with respect to prevailing social and farming conditions in the area. The communities have adapted to these uncertainties by adopting a suite of coping options (coping strategies). Although these strategies may have a beneficial effect on the household food security situation, their relation with appropriate policy measures that enhance the sustainable development of the agriculture sector have not been analysed. Vulnerability assessment studies are scarce.

The importance of agricultural technology generation and transfer in the district has been long recognized with the establishment of a research-testing site at Arsi Negele (later upgraded to the sub-centre level). However, feedback on the level and status of technologies disseminated so far are lacking. Therefore, MARC wishes the ICRA study to use participatory tools to analyze (together with the farming community) how useful the recommended technology packages have been for the different identified household categories in the different agro-ecological zones of the target area. As past research at Arsi Negele mainly focused on the midland areas the lessons that can be drawn from the team's participatory adoption study in the midland zone may assist the future development of research and development efforts in the highland and lowland zones.

In addition to the establishment of Arsi Negele research sub-centre, several extension programs have been initiated since the early 1980s. However, activities in the research and extension sectors appear to have been too fragmented: the sector and sub-centre oriented programs lacked the holistic and integrated approach to improve the livelihoods of the rural community. Moreover, farmers' perspectives were not adequately considered in the development and dissemination of technologies to alleviate their problems.

Improving the food security situation, through rapid increase in food production and productivity by educing year-to-year variability in food production on economically and

environmentally sustainable basis, appears a critical development theme in Arsi Negele district. This theme could provide a potential basis for the integration of research, extension and development activities through designing joint strategies, which result in long-term productivity growth in the agriculture sector. Furthermore, the required research and development interventions should be based on the changing farming system. They should incorporate feedback on the acceptance and feasibility of previous technologies, address gender issues, and utilize indigenous knowledge and coping strategies of different household categories and their farm/field characteristics) in relation to the fluctuating food security situation in the study area.

Geographical area and target population

Geographical area

The study will be conducted in the Arsi Negele Woreda (or district) of the East Shoa Zone, Oromiya Regional State. The town Arsi Negele is located about 180 km away from Nazareth town, the capital of Oromiya Regional State. The Arsi Negele District is bounded by the Adamitulu Woreda in the north, in the east by the Kersa Woreda (Arsi Zone), in the south by the Shashamene Woreda and in the west by Siraro Woreda. It is characterized by crop-livestock based farming systems. The woreda consists of 35 peasant associations (PAs) and 3 urban *kebeles*. The total area of the woreda is about 1396 km^2 of which 52% is arable, 30% water bodies, 5% forest and 13% grazing and others. The total population of the woreda is estimated to be 161,000 people out of whom 81% are rural. Of its soils, 83% is classified as sandy loam, 9% as sand.

Conventionally, the Arsi Negele Woreda is divided into 3 major climatic zones based on altitude (low, mid and high altitude) ranging from 1500-2300 masl). The high altitude climatic zone occupies the largest area followed by mid and low altitude climatic zones. Average annual temperature varies from 10-25°C while rainfall varies between 500-1000 mm. The topography is slightly undulating in the highland and almost flat in the lowland.

The area has a reasonable agricultural potential, which is reflected in the diversity of crops and animal resources. Some of the area is still covered by natural forest and other types of vegetation. Some large water bodies are included as well. Crops and animals are the major sources of food and income. Forests and woodlands are used for income generation through timber, fuel-wood, construction material and charcoal. The water bodies (3 lakes and 3 rivers) are used for fishery and wildlife (especially birds) sanctuary.

In the highland, maize, wheat, barley and Irish potato are grown as single crops. The area under sorghum and teff is limited. The area under Faba bean and under vegetables (kale) seems to be on the increase. Crop rotation is practised between years as crops occupy the field for a full growing season. Enset (an important perennial starch crop looking like a false banana) is cultivated in the homestead gardens.
In the mid altitude areas, double cropping is practised with crops like maize, wheat, teff, shallot, potato and sorghum. Some fingermillet is produced as well. The growing season is long enough and rainfall and temperature are both high enough to allow two crops to be planted sequentially and mature on the same time field. So, before the planting of wheat or teff, potato or shallot may be planted and harvested. The area under sorghum and teff is substantial.

In the lowland areas maize, haricot bean, teff and sorghum are major crops cultivated. However, due to the low and erratic rainfall crop production is risky. The potential for double cropping practices is limited, as conditions are barely suitable for the growing of one crop. Livestock and other activities (charcoal production and marketing) are important enterprises supporting the households in sustaining their livelihoods.

As far as livestock is concerned cattle, sheep, pack animals and goats (in order of importance) are major animal resources in the high and mid altitude areas whereas cattle, goats and donkeys are the major ones in the low altitude area. Ox-ploughs are used to prepare the land before planting. Access to ox-plough teams is an important criteria to differentiate among household categories.

Site selection

The team will be based in a guesthouse in the town of Arsi Negele (1960 masl). The field study will focus on food security strategies of households in representative farming systems along the local toposequence. Within the diverse study area an agro-ecological zonation will be used and a farm typology will be developed to identify representative homogenous target groups of households.

The study will be conducted in three altitude-based agro-ecological zones: high, mid and low. In each agro-ecological zone two representatives Peasant Associations (PAs) will be selected. The suggestions and criteria for selection of representative PAs, which are presented by the Woreda Bureau of Agriculture (BoA), will be given due consideration.

The preliminary proposed PAs are:

- Watera/Gonda Gureti (2300-2200 masl) and Adaba Tita (2100 masl) for high altitude areas;
- Kersa/Arsi Negele (1960 masl and Ali Weyo (1940 masl) for mid altitude areas;
- Hadhaa Bossa (1740 masl) and Keraro (1700 masl) for low altitude areas.

The team will start with a transect trough the study area. Based on its results the team may wish to refine or change the preliminary selection of representative PAs. However, the number of PAs or sites in each agro-ecological zone should not become less than one.

Target group selection

The farming systems of the three agro-ecological zones differ greatly. Although at first glance crops grown appear to be similar; farmers use different varieties and seasons of crop production.

Households in the high altitude zone produce maize, wheat, barley, potato and Enset in the order of priority. Due to the low temperatures only one crop per year can be grown on each field. As rainfall conditions are favourable crop production may be reliable if weeds can be controlled.

In the mid altitude zone two seasons are available for crop production. Here maize, wheat, potato, sorghum and teff are produced as well as shallots. The risk of a complete crop failure in a particular year is low as two production seasons are available.

In the low altitude zone, households produce maize, haricot bean, sorghum and teff. Unfortunately, only one season is available for crop production. Due to the higher temperatures, lower rainfall and higher evapotranspiration rates crop production is risky. Although for instance maize is produced in all three zones, varieties differ in their maturity, plant height and yield.

With regard to livestock, in both high and mid altitude zones farmers raise cattle, sheep, pack animals and a small number of goats in the order of priority whereas in the low altitude zone they raise cattle, goats, donkeys and a small number of horses.

Sales of crop, cattle, fuel-wood, and timber are major sources of cash income to farmers in the high altitude area. In the mid altitude farmers generate cash income through sale of onion, wheat and cattle while farmers in the low altitude sell crop produce, cattle, charcoal and fuel-wood.

Priority production constraints of the high and mid altitude areas include poor farming practices, shortage of oxen, high weed infestation and shortage of agricultural land. In the low altitude shortage of rainfall, insect pest, poor harvest and shortage of agricultural land are the major constraints in that order. The fertility of the soil increases with the increase in altitude.

Depending on the team's assessment of the heterogeneity of the farming population in the selected agro-ecological zones, and based on the available secondary data and results of the field reconnaissance study, the team may decide to further subdivide the target population into more homogenous categories of households (farm typology) and concentrate its study on a limited number of categories of households and their farming systems.

Objectives of the study and expected results

1. To analyse food security strategies at village and household level in different farming systems along the toposequence in Arsi Negele District.
2. To investigate, if differences in resource endowments affect management options of household categories in relation to the production of sufficient food and its vulnerability. If so, a relevant farm typology must be developed to better target future ARD efforts.
3. To identify constraints and prioritise opportunities for future research and development and to formulate proposals for future collaborative ARD efforts.
4. To assess in a joint effort with the local farming community the usefulness of the technologies so far disseminated by Arsi Negele/MARC for the different identified agro-ecological zones and farm types.

Main guiding questions

Guiding questions
Clarifying development context, identifying stakeholders and defining system of interest
• What is the broader development context of the central theme? • Who are the stakeholders involved and what are their interventions and linkages in relation to the food security problem at district, village and household levels? • Within this broader context, what is the relevant system of interest that the team will study in detail? • How can it be demarcated?
Analysing the system of interest and identifying development strategies
• What smallholder farming systems are existing in the area? Are these differences systematically related to variation in agro-ecological conditions? • How have these farming systems changed? • What are the major factors influencing these changes? • How are these farming systems likely to change in the future? • What food security strategies exist within the current smallholders farming systems? Have there been any recent changes in these strategies? Are any of these changes related to changes in vulnerability? • Do additional differences (e.g. access to resources, oxen, and land) between farms within a particular farming system zone call for different ARD interventions? • What costs and benefits are involved in the current food production systems in the different identified farm types? Who "pay(s)" those costs and to whom do the benefits accrue? • How do these costs and benefits and their distribution within the household and between households influence the decision making process on securing sufficient food? • Which of the current food security strategies can be influenced or changed and can become leverage points for ARD interventions that contribute towards a more sustainable management of agricultural resources and a better food security situation? • How can the concept of field typology applied by farmers be used to better target R&D interventions? **Is the relationship between the zonation and the described farming systems strong enough to identify different farm typology types that require different ARD intervention?**
Screening development strategies, assessing research needs and prioritising research options
• What has research and extension to offer to households to cope with the changing conditions? Are their solutions targeted (zone and farm type specific)? • What are successful technologies introduced by extension agents or researchers that are adopted by households? In which zones/farming systems were these technologies successful? To what extent have the different household categories/farm types benefited from these technologies? • What are the development scenarios for a more sustainable management of agricultural production with increased food security in the identified farming systems and farm types? • What are their potential effects on social equity, environmental sustainability and economic competitiveness? What criteria should be used to determine the feasibility of these options? • Who are the stakeholders necessary for implementation of these strategies?
Formulating research proposals
• In order to increase the sustainability of the local agricultural production, taking into account the local food security strategies of households: How can the local administration and Offices of Agricultural Development, Planning and Economic Development and Co-operative Promotion of East Shoa Zone and Arsi Negele Woreda together, with the assistance of rural NGOs, start a collaborative effort to improve the contribution and effectiveness of their joint ARD efforts? • On what priority ARD issues should the collaboration focus? • How can the collaborative effort be best organised?

Team composition

The field study team will be composed of 6 research and development workers. The team will include 1 Ethiopian from MARC and 5 expatriates. The Ethiopian is a crop breeder. The expatriates in the team will preferably have a different disciplinary background complementary to the Ethiopian (e.g. extension, socio-economy, animal husbandry, and agronomy).

Form of the final product

Before leaving the country the team will produce a report with a main text of not more than 100 pages including tables and figures. This report will be submitted to the various stakeholders directly or indirectly involved in the field study and to the host institutions. It will analyze past and present research and development activities and focus on future agricultural research and development directions in Arsi Negele Woreda.

Other interested institutions

Other stakeholders who are likely to benefit from the field study and use the results include the Regional, Zonal and Woreda Departments of Agriculture (DOA), the Woreda Administration, Shashamene Forest Industry, Wildlife Conservation, Rift Valley Women and Children Development Agency, Adventist college, and the African Development Aid Association.

Field study process

The team will present the field study plan upon at meetings to be held at MARC and Arsi Negele involving East Shoa Zone and Arsi Negele Woreda DOAs, and other relevant stakeholders (e.g. local NGOs). The ICRA-EARO National Co-ordinator (Dr Aberra Deressa) will assist the team in organizing presentations and incorporating useful comments in their plan.
At the mid-term workshop in Arsi Negele, the team will present a brief report of its findings. Including the methodology, it has used and various options of issues on which the team could focus in the second phase of its study. The workshop will involve a selected group of researchers from Melkassa and Arsi Negele ARCs, the ICRA reviewer, and some selected representatives of the East Shoa zonal administration, ADO, PEDD, CPD, and NGOs active in the zone,
The team will conduct several meetings at PA-level for feedback and discussion of its findings with farmers.

Final results of the study will be discussed at a final workshop (at Melkassa ARC) involving a larger audience of the same stakeholders mentioned for the mid-term workshop and some other invited guests from the Oromia ADB, EARO HQ, and other relevant institutions or programmes. This workshop will be held about 7 days before the end of the field study to allow incorporation of useful comments into the final version of the report before the team leaves Ethiopia.

An international expert appointed by ICRA will review the field study in two visits of approximately 10 days each, including travel. The first visit will be after 4-5 weeks in the field

to participate in the fieldwork and in the analysis of first findings. The second visit will be scheduled to assist the team in organizing the report and conducting the final workshop.

Field study responsibility

The team is collectively responsible to MARC, EARO and ICRA for respecting the terms of reference (TOR). The team will maintain regular contacts with the ICRA-EARO National Co-ordinator who based at MARC. The Ethiopian participant in the team will be the liaison officer of the team. EARO/MARC will appoint a contact person for the interaction with the team.

The team is expected to manage its own affairs. Within the limits specified in the TOR and in the budget, the team is free to decide its own approach, methodology, tools and work program as well as the way how it makes use of resources provided for the field study. Important questions concerned the TOR arising during implementation will be immediately clarified in a discussion with ICRA-EARO National Co-ordinator and contact person in MARC/EARO.

Means

ICRA and EARO/MARC are responsible for providing the team with the means specified in the Memorandum of Understanding (MOU). In addition, these institutions will provide the team with secondary data, reference materials, rainfall data and long-term trial results upon request during the course of the field study.

APPENDIX 2 METHODOLOGY USED IN THE STUDY

This appendix describes how the team applied the ARD procedure throughout the field study process, and also gives the team's reflection on the use of the ARD procedure in this field study.

Phase I: Organising the interdisciplinary team

There were 10 weeks on knowledge acquisition that consisted of a series of workshops exposing the team to the ARD procedure, various methods and tools. The acquired knowledge, tools and methods were put into practice in field exercises in Overijssel, the Netherlands. This knowledge acquisition phase was followed by a field study preparation phase, of three weeks. During this phase, the TOR was given to the team, along with available secondary material. An interdisciplinary team of six members (one Ethiopian and five expatriates) was composed based on the disciplinary competence needed in order to address the problem situation defined in the terms of reference. The disciplinary backgrounds of the members were agronomy, plant breeding, cropping system, agricultural extension, livestock production and financial management. A team contract was developed and signed by the team members for an effective and efficient teamwork. This contract spelt out the roles and responsibilities of each member based on the individual strengths and preferences. A set of rules of conduct was also included in the contract by the team to maintain a smooth running of the team. These included decision-making and conflict resolution procedures based on the likes and dislikes of each team member.

Terms of Reference (TOR)

ARD is based on a partnership between ICRA and the host institute. The terms of reference (TOR) for this study was prepared by the task force established by the host institute, Melkassa Agricultural Research Centre (MARC) of the Ethiopian Agricultural Research Organisation (EARO) in collaboration with the International Centre for Development Oriented Research in Agriculture (ICRA). The problem (problem situation) to be addressed by the study, objectives of the study, and main guiding questions were defined in the TOR. The TOR also included guidelines and suggestions to the team on the site selection and target group selection. In addition, the task force prepared a Memorandum of Understanding (MOU) specifying the roles of each partner towards the successful execution of the field study, and the implementation and follow-up of the study.

Defining the common understanding

The team studied the TOR and available secondary information and video provided by team's counterpart, during the period of field study preparation phase in Wageningen. The team discussed on the broader context of the problematic "Food security strategies among households in the different farming systems along the toposequences in Arsi Negele: Opportunities for Research and Development" in the viewpoint of various disciplines in the team. Interviews also were conducted with the key informant Dr. Driek Enserink of ICRA during the preparatory phase in Wageningen. The team attempted to explore the policy issues, markets, institutional issues and other macro-developmental issues that may have an influence on the problematique. The team also identified

the possible stakeholders of the problematique during this period with the intention of finalising/verifying at the first workshop.

Logical framework, research questions and major outputs

After identifying the causes and effects of the problem the team converted those problems into a logical framework, which is the summary of the proposed field study with hierarchy objectives, indicators, means of verifications and critical assumptions. The research questions and major out puts were listed. The team planed the whole field study activities to be carried out each week and the expected outputs.

Planning the field study activities

The first step of planning was the listing of all the major activities required in order to achieve the objectives given in the TOR within the available time. Initially, the team prepared a weekly summary work plan indicating, the nature of work and expected outputs. Then, the details of activities to be accomplished were presented in the form of another table including details such as dates, responsible persons of the team for the particular activities, the places where the activities will be carried out and the interim outputs of each activity. This detailed activity table was used as monitoring tool through out the field study. However, the activities from the 5th week to 13th week were amended after the first visit of ICRA reviewer in order to fit with the changes that took place in the local situations.

Phase II: Clarifying the development context

Introductory workshops with the client institute and stakeholders

The team arrived in Ethiopia on 12th April. After arriving in Ethiopia the team commenced the activities by conducting the first introductory workshop for the scientific staff of MARC and Department of Agriculture in Nazareth on 16th April. Similarly, another workshop was held for representatives of relevant stakeholders in the study area. This was held at the MARC subcentre in Arsi Negele, on 19 April. The participants were the DAs and PA chairmen of the study area. The main objectives of these workshops were:

- Presenting the team's understanding of the problem
- Identifying/verifying the stakeholders
- Identifying the perceptions/interests of Development Agents and Chairmen of the area on the problematique
- Developing an initial farm typology.
- Getting suggestions on the field study activity plan
- Ensuring involvement and commitment of the key stakeholders during the process.

Secondary data analysis

The team collected relevant secondary information from various organizations such as ICRA, MARC, WADD, Woreda Administration Office, Input supply companies, NGOs, Adami Tulu Livestock Research centre, ECSA, Woreda Health Department, AARC and National Meteorological Service, AISCO and EGTE.

Reconnaissance survey

After the introductory workshops, the team made reconnaissance survey through the study area to expose themselves to the area, it's farmers, land use and livelihood patterns. Three days were spent in the field for this purpose, one across the high land, the second across the midland and the third across the low land. The manager of MARC sub centre of Arsi Negele guided the team. During the survey, team interacted with DAs, PA chairmen and farmers. The survey helped the team to:

Learn about existing farming systems, diversity of the agro-ecological situation of the area principally topography, soil types, vegetation, population, research, extension and developing activities in the study area.
Understand the researchable problems in the area.
Confirm the zonation of the area, which had been based on the secondary data and discussion with client institute and other stakeholders.
Obtain a better idea about the initial farm typology developed at the second introductory workshop.

Refining the contextual analysis with farmers

The team visited the three-selected PAs (Watera in the highland, Karsa in the midland and Keraru in the lowland) in three days, to capture the farmer's perception about the problem, for further refinement of the contextual analysis. This exercise was done by farmer focus groups (around 20 farmers in each group) by visualising on flip charts. Finally the team refined the context of the problem based on the results focussed group discussion, perception of the stakeholders.

Typology

The steps involved in defining the typology were:

- Defining the purpose of typology
- Identification of appropriate criteria and categories
- Developing a hypothetical typology
- Reality and distribution checks
- Finalizing the hypothetical typology

Defining the purpose of typology

A farm typology is to better target R & D options, considering the fact that different people are affected differently by the problem. This is because; farmers of a single zone can have different resource and skill endowment, which will have different response to the problem. Typology differentiates between farming households within the system of interest.

Identification of appropriate criteria and categories

During the field study preparatory phase, the team attempted to identify the difference among the target beneficiaries relevant to food security applying various criteria based on the information gathered from secondary materials and key informant. The criteria used were land holding size, cropping pattern, ownership of oxen.

Developing a hypothetical typology

Hypothetical typology was developed based on secondary information considering the major criteria such as availability of oxen and land size. These criteria were explained, verified and categories were developed at different levels. Verification was done with the WADD among DAs and PA chairmen followed by farmers during initial field visits. Finally it was verified and modified with the farmers during the field survey.

Reality and distribution check

In order to get the perception of the target groups and stakeholders, two methods were applied. First was to explain about the definition of typology and criteria and get their understanding towards the major differentiation among the target group in terms of food security. The second was to explain the hypothetical and modified typology for enrichment based on their feedback. In particular, first approach was applied in WADD and first introductory workshops while the later was applied with farmers.

Finalising the typology

Verified typology after reality distribution check was finalised during the field survey with farmers. Criteria used initially to build up the hypothetical typology remained similar even in the final typology. However, magnitude of the criteria differed and only significant difference was considered in finalising the typology.

Identification and analysis of the Stakeholders

Identification of stakeholders started during the field study preparatory phase in Wageningen through studying the secondary information. The list of identified stakeholders was clarified during the first introductory workshop conducted for DAs and PA chairmen at MARC sub centre in Arsi Negele. Then the list of stakeholders was further clarified and modified with the farmers during the contextual analysis. Thereafter, team prioritised the list as primary/ key stakeholders and secondary stakeholders on the basis of their role in solving the food security problem. The team decided to interview and to further analyse the stakeholders after completing

the in depth interviews with farmers. This decision was made based on the advise of MARC and local authorities in order to meet the farmers before the planting season commences (in mid May) during which time farmers are busy on their farm activities.

Stakeholder analysis was done in order to identify their levels, their objectives, interest and influences on the problematique. A stakeholder interest matrix, which is a listing of all the key stakeholders relevant to the context of the study and their objectives, was developed. SSI was used to interview the stakeholders and key informants. The following steps were followed to do this exercise:

- all actors who play a significant role towards the system of interest were listed
- the actors having common objectives and similar interests were clustered
- the relative importance of each stakeholder was identified for the functioning of the system and influencing forces.

Phase III: Identifying development strategies

Selection of PAs and villages for the in-depth study

The team selected the PAs based on the zonation as per the local agro-ecological map available in the WADD. According to the TOR (on the suggestion of WADD) two PAs representing each agro-ecological zone were proposed:

- Wattera/Gonda Gureti (2200-2300 masl) and Adaba Tita (2100 masl) representing highland zone
- Karsa/Arsi Negele (1960 masl) and Ali Weyo (1940 masl) representing midland zone
- Hadhaa Bossa (1740 masl) and Keraru (1700 masl) representing lowland zone.

However, the team understood that it was not possible to conduct the study in six PAs as proposed, owing to the limited time for the study. Therefore, three PAs were selected for in-depth study, each representing one of the three agro-ecological zones. The PAs selected finally were Watera, Karsa, and Keraru in respectively the highland, midland, and lowland. The selection was based on the representation of the PA to the particular agro-ecological zone, following the reconnaissance survey, recommendations by the TOR and verification done with the WADD and Woreda Administration Office. For the purpose of assessing the technology disseminated by MARC, additional two PAs (Sayomijaa and Ali Wayoo) from the midland were selected. In each PA, the team identified representative villages to participate in the study.

Data gathering in the field

In-depth analysis of the problem situation started in the field with farmers and other stakeholders. Participatory methods were applied throughout interviews in order to achieve the objectives of the study; the following tools were used

- Semi-structured interview (SSI)
- Mapping
- Matrix scoring and ranking
- Visualisation

Information was gathered from farmer focus group discussions and key informants. Individual respondents at household level were interviewed for specific issues such as food balance calculation. The following output were achieved by the in depth study with the farmers by using the above methods:

Farming system analysis

- Input/out put flow diagram of farm resources
- Changes in the farming systems (past, present and future)
- Labour calendar
- Rainfall calendar
- Cropping calendar, cropping pattern
- Daily activity calendar by gender
- Livestock feed calendar and livestock importance scoring

Livelihood analysis of farm households

- Food availability calendar
- Off farm/non farm activities
- Gender issues
- Food coping strategies
- Food balance sheet
- Livelihood spray diagram

Analysis of new technologies and AKIS

- Preference/scoring matrices for crop varieties
- Adoption of new technologies
- Benefits and constraints of new technologies.

Economic change analysis

- Input-output prices
- Cost-benefit analysis.
- Cash holding and borrowing at household level
- Package credit outreach
- Informal credit and alternatives
- Recommended production technology

Analysing the problem situation

Based on the refined context analysed, the team focused on the major issues related to the context and attempted to capture relevant elements that the team could focus on.

The following steps were followed in analysing the problem situation;

- By studying refined context, team attempted to look at the problem in different dimensions and as first level three dimensions of the food security problem was identified. The three dimensions were the climatic risk, the change in economic environment and population pressure.
- The different dimensions were elaborated separately and presented in the form of three spray diagrams. The relevant problem areas and possible research questions were also identified and presented in the spray diagrams.
- The problems and research questions identified through the above procedure were more focussed to the study than those identified during the field study preparatory phase in Wageningen. Accordingly, subsequent data gathering in the field were adjusted in relation to problem areas presented in the spray diagrams.

Identifying the development interventions

Identification of development interventions was done by MARC and other key stakeholders during the mid term workshops. Two mid-term workshops were conducted one in Arsi Negele for the key stakeholders from the regional offices and another in Nazereth for the MARC officials including few stakeholders of regional level. The workshops were conducted

presenting major findings, reviewing the objectives of the study and intended outputs followed by a poster presentation.

After the poster presentation, participants were divided into different working groups to discuss and identify possible development and research interventions.

The group work was handled in the following manner:

- The group work of the workshop conducted in Arsi Negele was done in two groups, one for DAs another for officials and other local stakeholders.
- In the group work conducted in Nazeret, the participants were divided in to three groups and worked on three different dimensions (climatic risk, changes in economic environment and population pressure) identified in the problematique. The three groups were formed on the basis of disciplinary background of the participants. Working groups were facilitated by one of the group members.
- In addition the team, based on the disciplinary competence also identified several developmental interventions.

Phase IV: Formulating research options

Screening the development interventions

The development interventions identified by MARC, other key stakeholders and by the team were subjected to screening. Based on the data analysis of in-depth study, team identified four driving forces of the development context in the area. Then team developed four scenarios likely to be existed in the future. The development interventions were then screened through the scenarios.

The developmental interventions which passed the different scenarios were further subjected to second stage of screening with MARC researchers, farmers and key stakeholders for;

- Environmental Sustainability
- Economic competitiveness and
- Social equity

After the second screening, development interventions were grouped in to two broad developmental strategies called "bread basket strategy" and "Income generating strategy".

Mainly the team identified possible relevant research options for different development interventions. The MARC researchers also identified research options during the final workshop held in MARC. Prioritising the research options was done during the final workshop by researchers. Five criteria along with weighing factors were identified. Finally, all research options were ranked according to the total scores of each option as against the criteria.

Reflections on the methodology

The ARD process is designed to address the core need of the farmers in an effective manner for poverty alleviation and social uplifting through the agricultural research in a participatory and iterative way. Participatory approaches putting the farmer first are not a new idea.The process of ARD with its different stages, however, helps to orient such a participating approach. The team's understanding and the application extent of the ARD process are described hereunder.

Organising the inter-disciplinary team

ICRA's approach of team development considered the requirement of the disciplinary background thereto address the complex problem explained in the TOR. The team realised that the presence of diverse disciplines could better dig out the problem. However, the possibility of over-focusing in some point because a dominating discipline always exists. During this phase the team tried to define problems from the viewpoint of various disciplines, but we felt that this part of the preparatory phase in Wageningen was not useful: it was only after arrival in Ethiopia that the team began to understand the situation.

Clarifying the development context & identifying the system of interest

Clarifying the development context and the system of interest was considered to be critical, especially when the study topic is as vague such as "food security". Further, this team felt the coverage of the study was also quite ambitious, although we recognise the tension between depth and breath of any such study.

The team tried to analyse the development context and develop the system of interest at the planning phase in Wageningen but did not succeed. The team defined the focus of the study (system of interest) only after the first round of interaction with the stakeholders, including farmers in the field.

According to the ARD procedure, zonation and typology are major tools to target the research. Zonation was quite clear in the TOR differentiated in three agro-ecological zones, while typology was difficult to apply. First of all, variables differentiating farm HHs were many: land size, access to oxen, number of cattle and average family size (the importance of which was not expressed at first). Moreover the issue of food security was not much different across the HHs type however, there was a difference on food self-sufficiency at the HHs. The team has addressed the issue of typology to the extent possible, for instance, food self-sufficiency, cooping strategy and food balance calculation.

The team conducted all the analytical activities of the study in a participatory way as was envisaged. Farmers to be interviewed were selected on a random basis, taking into account, though, the gender balance and age group. The possible biases of the DAs while collecting the farmers in the village cannot be ignored, however. It was not pragmatic to invite the same farmer for more than one time. If somebody participated voluntarily, that was accepted.

Identifying development interventions

Development interventions were identified in a participatory way by collecting ideas from stakeholders during the mid term workshops. Farmer's ideas were collected during the field survey and the team incorporated its own ideas during team discussions before screening these interventions against different scenarios. It was realised however, the team did not have clear idea about the development interventions and the revisited the strategies after the reviewer's visit.

One of the limitations of our study is that we did not relate development interventions to the typology. It was difficult for the team to address twelve types in the three agro-ecological zones.

Formulating research options

The team faced most difficulties in this phase of the whole field study. The team tried to use participatory approaches to screen and prioritise the research options. Development interventions were screened against environmental sustainability, economic competitiveness and social equity criteria organising separate group discussions with farmers, local stakeholders and the researchers in the host institute. The team was confronted with a scoring result, which differed between the three sources. The team selected the top 7 development strategies from the overall ranking. It would have been better, however, if the team itself had screened the development interventions.

The team developed research options and prioritised these with the researchers. The researchers developed the criteria to prioritise these research options. We consider that the farmer's voice has not been considered in the research prioritisation. The team did not dare to go to the farmers for this exercise because of a possibly different outcome. We would have liked to conduct the prioritisation of research options in a joint meeting with the researchers and farmers. It is important for researchers to listen to the direct priority of the farmers.

Finally, the team applied the acquired knowledge on ARD, balancing the tension between the two major objectives of the field study:

- the process orientation and learning from the view point of training participants of ARD, and
- the content orientation from the viewpoint of researchers invited by the host institute to recommend concrete research measures for solving the complex problem of food insecurity.

APPENDIX 3 FOOD BALANCE SHEETS

Appendix 3A-1 Food balance sheet for Arsi Negele Woreda, 1999

Food source	Production, Q	Export, Q	Import (aid), Q	Seed, kg	Other uses, Q	Food, Q	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								3833	111	21
Crops								3722	105	14
Livestock								111	7	7
Wheat	443700	141948	6749	0	0	308501	192	1491	45	5
Maize	651550	162888	0	0	6516	482147	299	1880	50	6
Barley	40119	8024	0	2006	0	30089	19	117	3	0
Teff	51600	30960	0	1032	0	19608	12	76	2	0
Sorghum	43050	12054	0	861	0	30135	19	117	3	0
Millet	250	50	0	13	0	188	0	1	0	0
Beans	6700	4020	0	335	0	2345	1	17	1	1
Haricot bean	9750	6825		975	0	1950	1	14	1	1
Potato	27720	20790	0	1386	0	5544	3	6	0	0
Onion	13920	10440	0	696	0	2784	2	1	0	0
Tomato	2160	1728	0	0	0	432	0	0	0	0
Beetroot	960	768	0	0	0	192	0	0	0	0
Carrot	675	540	0	0	0	135	0	0	0	0
Oil	0	0	5	0	0	5	0	0	0	0
Sugar	0	0	12	0	0	12	0	0	0	0
Sugarcane	0	0	0	0	0	0	0	0	0	0
Fruits	768	691	0	0	0	77	0	0	0	0
Milk	180	0	150	0	0	330	33	54	3	3
Beef	0	0	35	0	0	35	4	21	1	2
Mutton & Goat meat	25	0	0	0	0	25	3	18	1	2
Eggs	0	0	50	0		50	5	17	1	1

Source: Woreda Agriculture Development Department and team estimates, 2002

Appendix 3A-2 Food balance sheet for Arsi Negele Woreda, 2000

Food source	Production, Q	Export, Q	Import (aid), Q	Seed, kg	Other uses, Q	Food, Q	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								3226	95	21
Crops								3115	89	13
Livestock								111	7	7
Wheat	393912	126052	0	0	0	267860	162	1261	38	4
Maize	544160	136040	11045	0	5442	413723	250	1572	42	5
Barley	24900	4980	0	1245	0	18675	11	71	2	0
Teff	32368	19421	0	647	0	12300	7	47	1	0
Sorghum	32888	9209	0	658	0	23022	14	87	2	0
Millet	2100	420	0	105	0	1575	1	6	0	0
Beans	7326	4396	0	366	0	2564	2	18	1	1
Haricot bean	26250	18375		2625	0	5250	3	37	2	2
Potato	45408	34056	0	227	0	11125	7	12	0	0
Onion	28710	21533	0	1436	0	5742	3	3	0	0
Tomato	2400	1920	0	0	0	480	0	0	0	0
Beet root	840	672	0	0	0	168	0	0	0	0
Carrot	750	600	0	0	0	150	0	0	0	0
Oil	0	0	5	0	0	5	0	0	0	0
Sugar	0	0	12	0	0	12	0	0	0	0
Sugarcane	0	0	0	0	0	0	0	0	0	0
Fruits	888	796	0	0	0	92	0	0	0	0
Milk	180	0	150	0	0	330	33	54	3	3
Beef	0	0	35	0	0	35	4	21	1	2
Mutton & Goat meat	25	0	0	0	0	25	3	18	1	2
Eggs	0	0	50	0		50	5	17	1	1

Source: Woreda Agriculture Development Department and team estimates, 2002

Appendix 3A-3 Food balance sheet for Arsi Negele Woreda, 2001

Food source	Production, Q	Export, Q	Import (aid), Q	Seed, kg	Other uses, Q	Food, Q	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								3021	90	22
Crops								2910	84	15
Livestock								111	7	7
Wheat	354844	113551	0	0	0	241293	142	1107	33	4
Maize	507520	126880	0	0	5075	375565	221	1391	37	5
Barley	46835	9367	0	2342	0	35126	21	130	3	0
Teff	45423	27236	0	918	0	17269	10	64	2	0
Sorghum	38456	10768	0	769	0	26919	16	100	3	0
Millet	3420	684	0	171	0	2565	2	9	0	0
Beans	11250	7350	0	563	0	3338	2	23	1	1
Haricot bean	58630	41041		5863	0	11726	7	80	4	4
Potato	27280	20460	0	1364	0	5456	3	6	0	0
Onion	10440	7830	0	522	0	2088	1	1	0	0
Tomato	1920	1536	0	0	0	384	0	0	0	0
Beetroot	1230	984	0	0	0	246	0	0	0	0
Carrot	788	630	0	0	0	158	0	0	0	0
Oil	0	0	5	0	0	5	0	0	0	0
Sugar	0	0	12	0	0	12	0	0	0	0
Sugarcane	0	0	0	0	0	0	0	0	0	0
Fruits	636	572	0	0	0	64	0	0	0	0
Milk	180	0	150	0	0	330	33	54	3	3
Beef	0	0	35	0	0	35	4	21	1	2
Mutton & Goat meat	25	0	0	0	0	25	3	18	1	2
Eggs	0	0	50	0		50	5	17	1	1

Source: Woreda Agriculture Development Department and team estimates, 2002

Appendix 3B-1 **Food balance sheets for households, Keraru PA (lowland)**

Household Type 1 - Average land size - 0.83 ha, no cattle
Average family size - 8 (2 adults + 6 children)

Food source	Production, kg	Sold, kg	Bought, g	Seed, kg	Other uses, kg	Food, kg	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								762	20	24
Crops								600	16	8
Livestock								162	5	16
Wheat	200	67	83	17	0	200	26	199	6	1
Maize	133	0	67	0	0	200	24	153	4	1
Sorghum	33	0	37	0	0	70	8	47	1	0
Teff	170	140	0	10	0	20	3	16	0	0
Barley	0	0	8	0	0	8	1	7	0	0
Pea flour	0	0	31	0	0	31	4	49	2	2
Lentil	0	0	8	0	0	8	1	12	1	0
Potato	0	0	79	0	0	79	11	20	0	0
Onion	0	0	31	0	0	31	4	3	0	0
Cabbage	0	0	137	0	0	137	19	12	0	0
Carrot	0	0	2	0	0	2	0	0	0	0
Pepper	0	0	12	0	0	12	2	0	0	0
Oil	0	0	12	0	0	12	2	36	0	4
Salt	0	0	35	0	0	35	4	0	0	0
Sugar	0	0	39	0	0	39	5	47	0	0
Coffee	0	0	20	0	0	20	3	0	0	0
Milk	0	0	8	0	0	8	1	1	0	0
Butter, cheese	0	0	38	0	0	38	5	93	0	10
Beef	0	0	50	0	0	50	7	40	3	3
Eggs	0	0	65	0	0	65	8	28	2	2

Source: Interviewing of 3 households, June 2002

Appendix 3B-2 Food balance sheets for households, Keraru PA (lowland)

Household Type 2 - Average land size - 0.75 ha + 7 cattle
Average family size - 7 (2 adults + 5 children)

Food source	Production, kg	Sold, kg	Bought, kg	Seed, kg	Other uses, kg	Food, kg	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								2179	63	51
Crops								1744	46	15
Livestock								434	17	36
Wheat	0	0	103	0	0	103	16	123	4	0
Maize	1833	600	33	90	0	1177	176	1144	31	4
Sorghum	0	0	77	0	0	77	11	72	2	0
Teff	70	0	67	0	0	137	22	136	4	0
Pea flour	0	0	28	0	0	28	4	48	2	2
Lentil	0	0	32	0	0	32	5	56	3	2
Potato	0	0	99	0	0	99	14	25	1	0
Onion	0	0	44	0	0	44	7	6	0	0
Cabbage	0	0	104	0	0	104	16	10	0	0
Beetroot	0	0	14	0	0	14	2	1	0	0
Tomato	0	0	19	0	0	19	3	1	0	0
Pepper	0	0	18	0	0	18	3	0	0	0
Oil	0	0	16	0	0	16	2	54	0	6
Salt	0	0	45	0	0	45	6	0	0	0
Sugar	0	0	44	0	0	44	7	68	0	0
Coffee	0	0	15	0	0	15	2	0	0	0
Fruits	0	0	5	0	0	5	1	1	0	0
Milk	410	0	0	0	0	410	63	104	6	5
Butter, cheese	28	0	24	0	0	52	8	158	0	18
Beef	0	0	49	0	0	49	7	44	3	3
Mutton & Goat meat	0	0	7	0	0	7	1	8	0	1
Eggs	260	0	0	30	0	230	35	121	8	8

Source: Interviewing of 3 households, June 2002

Appendix 3B-3 **Food balance sheets for households, Keraru PA (lowland)**

Household Type 3 - Average land size - 0.70 ha + 15 cattle
Average family size - 8 (2 adults + 6 children)

Food source	Production, kg	Sold, kg	Bought, kg	Seed, kg	Other uses, kg	Food, kg	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								2316	76	64
Crops								1632	45	12
Livestock								684	32	52
Wheat	200	67	50	17	0	167	20	157	5	1
Maize	2333	1000	0	60	0	1273	153	947	25	3
Sorghum	0	0	73	0	0	73	9	62	2	0
Teff	347	0	0	17	0	330	40	222	6	1
Barley	0	0	50	0	0	50	6	34	1	0
Pea flour	0	0	32	0	0	32	4	44	2	2
Lentil	0	0	36	0	0	36	5	54	3	2
Potato	0	0	137	0	0	137	16	35	1	0
Onion	0	0	36	0	0	36	4	4	0	0
Cabbage	0	0	64	0	0	64	7	4	0	0
Beet root	0	0	7	0	0	7	1	1	0	0
Tomato	0	0	8	0	0	8	1	0	0	0
Pepper	0	0	12	0	0	12	2	0	0	0
Oil	0	0	10	0	0	10	1	30	0	3
Salt	0	0	30	0	0	30	4	0	0	0
Sugar	0	0	32	0	0	32	4	37	0	0
Coffee	0	0	15	0	0	15	2	0	0	0
Fruits	0	0	7	0	0	7	1	1	0	0
Milk	820	0	0	0	0	820	99	159	9	8
Butter, cheese	96	24	0	0	0	72	9	180	0	20
Beef	0	0	20	0	0	20	2	13	1	1
Mutton & Goat meat	0	0	16	0	0	16	2	19	1	2
Eggs	0	0	600	0	0	600	72	313	21	21

Source: Interviewing of 3 households, June 2002

Appendix 3B-4 Food balance sheets for households, Keraru PA (lowland)

Household Type 4 - Average land size - 1.5 ha + 5 cattle
Average family size - 10 (2 adults + 8 children)

Food source	Production, kg	Sold, kg	Bought, kg	Seed, kg	Other uses, kg	Food, kg	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								1270	42	28
Crops								1031	29	11
Livestock								239	14	17
Wheat	383	100	50	67	0	267	27	172	5	1
Maize	1333	533	0	75	0	725	73	457	12	2
Sorghum	50	0	50	0	0	100	10	72	2	0
Teff	83	33	50	0	0	100	10	72	2	0
Barley	117	33	50	17	0	117	12	85	2	0
Pea	0	0	40	0	0	40	4	53	3	2
Lentil	0	0	36	0	0	36	4	46	2	2
Potato	0	0	23	0	0	23	2	4	0	0
Onion	0	0	28	0	0	28	3	3	0	0
Cabbage	0	0	56	0	0	56	6	4	0	0
Beet root	0	0	4	0	0	4	0	0	0	0
Tomato	0	0	13	0	0	13	1	1	0	0
Oil	0	0	16	0	0	16	2	41	0	5
Sugar	0	0	20	0	0	20	2	22	0	0
Fruits	0	0	2	0	0	2	0	0	0	0
Milk	207	0	0	0	0	207	21	36	2	2
Butter, cheese	8	0	6	0	0	14	2	29	0	3
Beef	0	0	33	0	0	33	4	22	1	2
Eggs	390	148	160	37	0	364	36	152	10	10

Source: Interviewing of 3 households, June 2002

Appendix 3C-1 **Food balance sheets for households, Karsa PA (midland)**

Household Type 1 - Average land size - 0.83 ha, no ox
Average family size - 8 (2 adults + 6 children)

Food source	Production, kg	Sold, kg	Bought, kg	Seed, kg	Other uses, kg	Food, kg	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								1751	60	36
Crops								1522	45	19
Livestock								229	14	17
Wheat	500	233	0	33	0	233	32	344	10	1
Maize	575	0	767	8	600	733	100	514	14	2
Sorghum	133	0	33	0	0	166	23	146	4	0
Barley	0	0	33	0	0	33	5	52	1	0
Pea flour	0	0	28	0	0	28	5	53	3	2
Chick pea	0	0	8	0	0	8	1	12	1	0
Lentil	0	0	33	0	0	33	4	48	2	2
Haricot bean	33	0	62	17	0	79	11	152	8	5
Potato	0	0	283	0	0	283	40	80	2	0
Onion	0	0	63	0	0	63	9	8	0	0
Cabbage	0	0	149	0	0	149	20	19	1	0
Tomato	0	0	12	0	0	12	2	1	0	0
Pepper	0	0	12	0	0	12	2	0	0	0
Oil	0	0	12	0	0	12	2	50	0	6
Salt	0	0	12	0	0	12	2	0	0	0
Sugar	0	0	24	0	0	24	3	38	0	0
Coffee	0	0	35	0	0	35	5	0	0	0
Fruits	0	0	16	0	0	16	2	5	0	0
Milk	60	0	50	0	0	110	15	18	1	1
Butter, cheese	0	0	3	0	0	3	0	10	0	1
Beef	0	0	87	0	0	87	12	89	6	7
Mutton & Goat meat	0	0	0	0	0	0	0	0	0	0
Eggs	240	120	23	0	0	143	20	112	7	7

Source: Interviewing of 3 households, June 2002

Appendix 3C-2 Food balance sheets for households, Karsa PA (midland)

Household Type 2 - Average land size - 0.80 ha + 1 ox
Average family size - 6 (2 adults + 4 children)

Food source	Production, kg	Sold, kg	Bought, kg	Seed, kg	Other uses, kg	Food, kg	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								2273	67	28
Crops								2079	56	14
Livestock								194	11	14
Wheat	800	103	0	110	0	587	98	721	22	2
Maize	750	333	200	25	83	508	85	625	17	2
Sorghum	200	0	8	0	0	208	34	215	6	1
Teff	200	33	0	7	0	160	28	173	5	1
Barley	67	0	0	0	0	67	11	84	2	0
Millet	67	0	0	0	17	50	8	37	1	1
Pea flour	0	0	4	0	0	4	1	9	0	0
Lentil	0	0	2	0	0	2	0	5	0	0
Potato	100	0	233	0	0	333	56	95	2	0
Onion	0	0	100	0	0	100	16	14	0	0
Cabbage	0	0	150	0	0	150	25	14	1	0
Carrot	0	0	25	0	0	25	4	3	0	0
Tomato	0	0	20	0	0	20	4	2	0	0
Pepper	0	0	12	0	0	12	2	0	0	0
Oil	0	0	13	0	0	13	2	50	0	6
Salt	0	0	28	0	0	28	5	0	0	0
Sugar	0	0	19	0	0	19	3	29	0	0
Coffee	0	0	30	0	0	30	5	0	0	0
Fruits	0	0	27	0	0	27	4	5	0	0
Milk	220	0	2	0	0	222	37	61	3	3
Butter, cheese	0	0	2	0	0	2	0	8	0	1
Beef	0	0	63	0	0	63	11	65	4	5
Mutton & Goat meat	15	0	0	0	0	15	3	22	1	2
Eggs	0	0	63	0	0	63	11	39	3	3

Source: Interviewing of 3 households, June 2002

Appendix 3C-3 Food balance sheets for households, Karsa PA (midland)

Household Type 3 - Average land size - 1.44 ha + 1 ox
Average family size - 7 (2 adults + 5 children)

Food source	Production, kg	Sold, kg	Bought, kg	Seed, kg	Other uses, kg	Food, kg	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								2287	75	43
Crops								2011	59	21
Livestock								276	16	22
Wheat	1183	500	0	167	0	517	74	688	21	2
Maize	237	0	240	4	240	233	33	209	6	1
Sorghum	67	0	117	1	0	182	26	177	5	1
Teff	200	67	0	12	0	121	17	123	3	0
Barley	267	0	0	33	0	233	33	293	8	1
Millet	33	0	0	0	0	33	5	40	1	1
Pea flour	0	0	56	0	0	56	8	115	6	4
Lentil	0	0	32	0	0	32	5	64	3	2
Haricot bean	58	0	0	0	0	58	8	77	4	3
Potato	0	0	324	0	0	324	46	82	2	0
Onion	0	0	40	0	0	40	6	5	0	0
Cabbage	0	0	344	0	0	344	49	31	1	0
Carrot	0	0	56	0	0	56	8	7	0	0
Tomato	0	0	8	0	0	8	1	1	0	0
Pepper	0	0	18	0	0	18	3	0	0	0
Oil	0	0	12	0	0	12	2	46	0	5
Salt	0	0	30	0	0	30	4	0	0	0
Sugar	0	0	31	0	0	31	4	51	0	0
Coffee	0	0	40	0	0	40	6	0	0	0
Fruits	0	0	7	0	0	7	1	2	0	0
Milk	0	0	0	0	0	0	0	0	0	0
Butter, cheese	0	0	11	0	0	11	2	34	0	4
Beef	0	0	93	0	0	93	13	94	6	7
Mutton & Goat meat	13	0	0	0	0	13	2	19	1	2
Eggs	120	0	73	0	0	193	28	129	9	9

Source: Interviewing of 3 households, June 2002

Appendix 3C-4 Food balance sheets for households, Karsa PA (midland)

Household Type 4 - Average land size - 1.7 ha + 2 ox
Average family size - 9 (2 adults + 7 children)

Food source	Production, kg	Sold, kg	Bought, kg	Seed, kg	Other uses, kg	Food, kg	Per Capita Supply			
							Kg per year	Calories per day	Grams per day	
									Protein	Fat
Total								1754	53	34
Crops								1513	43	13
Livestock								241	9	21
Wheat	1567	800	0	167	0	600	66	513	15	2
Maize	683	200	0	83	0	400	44	290	8	1
Sorghum	100	0	0	0	0	100	11	83	2	0
Teff	117	67	0	7	0	43	6	39	1	0
Barley	167	0	0	10	0	157	17	134	4	0
Chick pea	0	0	4	0	0	4	0	7	0	0
Lentil	0	0	30	0	0	30	3	37	2	1
Haricot beans	33	0	8	1	0	41	6	67	3	2
Potato	400	100	700	0	0	1000	111	174	4	0
Onion	300	267	125	0	0	158	19	16	1	0
Cabbage	167	83	1200	0	0	1283	143	74	3	1
Carrot	50	0	40	0	0	90	10	8	0	0
Tomato	0	0	23	0	0	23	2	1	0	0
Pepper	0	0	24	0	0	24	3	0	0	0
Oil	0	0	16	0	0	16	2	40	0	5
Salt	0	0	45	0	0	45	5	0	0	0
Sugar	0	0	23	0	0	23	3	26	0	0
Coffee	0	0	35	0	0	35	4	0	0	0
Fruits	17	0	23	0	0	40	5	5	0	0
Milk	167	0	0	0	0	167	19	32	2	2
Butter, cheese	2	0	56	0	0	58	6	93	0	11
Beef	0	0	67	0	0	67	7	58	4	5
Eggs	200	100	17	0	0	117	13	58	4	4

Source: Interviewing of 3 households, June 2002

APPENDIX 4 COST BENEFIT ANALYSES OF IMPROVED TECHOLOGY

Appendix 4.1: Cost benefit analysis of maize with *improved* seed and *chemical fertilisers* (high input) in the lowland

Per hectare

S.N.	Particulars	Unit	Quantity	Rate	Amount	Who works (M/F)	Labour use (I/H)
I	Variable cost						
A	Labour work						
	Land preparation - three times	Man/days	18	6	108	M	I
	Chemical fertiliser purchase	Man/days	5	6	30	M/F	I
	Planting	Man/days	6	6	36	M/F	I
	Weeding						
	First time	Women/days	6	5	30	F	H
	Second time	Man/days	6	6	36	M/F	H
	Third time	Women/days	6	5	30	F	H
	Fertilization						
	First time	Women/days	2	5	10	M/F	I
	Second time	Man/days	0				
	Harvesting	Women/days	22	5	110	F	I
	Transporting to home	Man/days	12	6	72	M	I
	Threshing/Graining	Man/days	20	6	120	M	I
	Product transporting to market	Man/days	8	6	48	M	I
	Oxen for land preparation	Oxen/days	18	14	252		
	Oxen for second weeding	Oxen/days	6	14	84		
	Donkey for carrying harvest to home	Donkey/Days	20	5	100		
	Total of labour cost				***1066***		
B	Procurement and other costs						
	Seed	Kg	25				
	Fertilisers			634	634	Package cost	
	DAP	Kg	100				
	Urea	Kg	100				
	Interest on loan (Package)	Birr			50		
	Transportation cost of fertiliser	Birr	Ls	1	22		
	Transportation to market	Birr/Quintal	30	5	150		
	Total of procurement and other costs	Birr			***856***		
	Total variable costs	Birr			***1922***		

Appendix 4.1 Cost benefit of improved technology in lowland maize (continued)

S.N.	Particulars	Unit	Quantity	Rate	Amount	Who works (M/F)	Labour use (I/H)
I	Variable cost						
A	Labour work						
II	Fixed costs						
	Depreciation cost on tools and equipment	Birr/year	1	35	35		
	Land tax	Birr/year	Ls	40	40		
	Total fixed costs	Birr			*75*		
III	***Total costs***	Birr			*1997*		
IV	Gross Income						
a)	In good year						
	Main production	Kg	6000	0.35	2100		
	By product	Ls	0				
b)	In bad year						
	Main production	Kg	2400	0.52	1248		
	By product	Ls	0				
V	Net profit						
a)	In good year	Birr			103		
b)	In bad year	Birr			-749		
VI	Net profit without considering human labour cost						
a)	In good year	Birr			539		
b)	In bad year	Birr			-313		
VII	Cost Benefit Ratio						
a)	In good year				0.05		
b)	In bad year				-0.38		

Note: Following basis are used to do above analysis

- There is no change in the total labour requirement in the past and at present
- Depreciation cost of tools and equipment is calculated dividing the total cost of each item by its lifetime.
- Depreciation on tools and equipment is charged for one year.
- Interest on loan is charged for 9 month @ 10,5 % per annum on the credit amount only for both times
- Land tax is not based on single variables; therefore it is taken as highest mode.
- Land tax for the 5 years before is assumed to be Birr 30, based on farmers response
- By product of maize is not sold, therefore difficult to convert in monetary value hence has not considered
- Work done by women is considered as women/days considering the different rate of women/days

Appendix 4.2: Cost benefit analysis of maize with *local* seed and *chemical fertilisers* (intermediate input) in the lowland

Per hectare

S.N.	Particulars	Unit	Quantity	Rate	Amount	Who works (M/F)	Labour use (I/H)
I	Variable cost						
A	Labour work						
	Land preparation - three times	Man/days	12	6	72	M	I
	Chemical fertiliser purchase	Man/days	2	6	12	M/F	I
	Planting	Man/days	2	6	12	F	I
	Weeding						
	First time	Man/days	16	5	80	F	H
	Second time	Man/days	12	6	72	M/F	H
	Third time	Man/days	0	5	0		
	Fertilization						
	First time	Man/days	2	6	12	M	I
	Second time	Man/days	0				
	Harvesting	Man/days	16	5	80	F	I
	Transporting to home	Man/days	20	6	120	M	I
	Threshing/Grain	Man/days	12	6	72	M	I
	Product transporting to market	Man/days	2	6	12	M	I
	Oxen for land preparation	Oxen/days	12	14	168		
	Oxen for second weeding	Oxen/days	6	14	84		
	Donkey for carrying harvest to home	Donkey/Days	20	5	100		
	Total of labour cost	Birr			***896***		
B	Procurement and other costs						
	Seed	Kg	50	0.75	37.5		
	Fertilisers						
	DAP	Kg	100	2.6	260		
	Urea						
	Transportation cost of fertiliser	Birr	Ls	1	13		
	Transportation to market	Birr/Quintal	36	5	180		
	Total of procurement and other costs				***491***		
	Financial cost of seed and fertilisers	Birr			23		
	Total of variable cost	Birr			***1410***		

Appendix 4.2 Cost benefit of intermediate technology in lowland maize (continued)

S.N.	Particulars	Unit	Quantity	Rate	Amount	Who works (M/F)	Labour use (I/H)
I	Variable cost						
A	Labour work						
II	Fixed costs						
	Depreciation cost on tools and equipment	Birr/year	1	35	35		
	Land tax	Birr/year	Ls	40	40		
	Total fixed costs	Birr			*75*		
III	***Total costs***				*1485*		
IV	Gross Income						
a)	In good year						
	Main production	Kg	3600	0.35	1260		
	By product	Ls	0				
b)	In bad year						
	Main production	Kg	800	0.52	416		
	By product	Ls	0				
V	Net profit						
a)	In good year	Birr			-225		
b)	In bad year	Birr			-1069		
VI	Net profit without considering human labour cost						
a)	In good years	Birr			127		
b)	In bad years	Birr			-717		
VII	Cost Benefit Ratio						
a)	In good years				-0.15		
b)	In bad years				-0.72		

Note: Following basis are used to do above analysis

- There is no change in the total labour requirement in the past and at present
- Depreciation cost of tools and equipment is calculated dividing the total cost of each item by its lifetime.
- Depreciation on tools and equipment is charged for one year.
- Financial cost on seed and fertiliser is charged for 9 month @ 10.5 % per annum as an opportunity cost of fund
- Land tax is not based on single variables and varies among farmers; therefore mode cost is taken.
- Land tax for the 5 years before is assumed to be Birr 30, based on farmers response
- By product of maize is not sold, therefore difficult to convert in monetary value hence has not considered
- Work done by women is considered as women/days considering the different rate of women/days
- M = Male, F = Female, I = Internal, H = Hired

Appendix 4.3: Cost benefit analysis of maize with *local seed* and *no chemical fertilisers* (low input) in the lowland

Per hectare

S.N.	Particulars	Unit	Quantity	Rate	Amount	Who works (M/F)	Labour use (I/H)
I	Variable cost						
A	Labour work						
	Land preparation - three times	Man/days	12	6	72	M	I
	Planting	Man/days	2	6	12	F	I
	Weeding						
	First time	Man/days	24	5	120	F	I
	second time	Man/days	24	6	144	M/F	I
	Third time	Man/days	10	5	50		
	Fertilization						
	First time	Man/days	0	0	0	M	I
	second time	Man/days	0	0	0		
	Harvesting and transporting	Man/days	40	5	200	F	I
	Threshing/Graining	Man/days	20	6	120	M	I
	Product transporting to market	Man/days	2	6	12	M	I
	Oxen for land preparation	Oxen/days	12	14	168		
	Donkey for carrying harvest to home	Donkey/Days	20	5	100		
	Total of labour cost				***998***		
B	Procurement and other costs						
	Seed	Kg	50	0.75	38		
	Transportation to market	Birr/Quintals	18	5	90		
	Total of procurement and other costs				***128***		
	Financial cost of seed	Birr			3		
	Total of variable cost				***1129***		
II	Fixed costs						
	Depreciation cost on tools & equipment	Birr/year	1	35	35		
	Land tax	Birr/year	Ls	40	40		
	Total fixed costs				***75***		
III	***Total costs***				***1204***		

Appendix 4.3 Cost benefit of low input technology in lowland maize (continued)

S.N.	Particulars	Unit	Quantity	Rate	Amount	Who works (M/F)	Labour use (I/H)
I	Variable cost						
A	Labour work						
IV	Gross Income						
a)	In good years						
	Main production	Kg	1800	0.35	630		
	By product	Ls	0				
b)	In bad years						
	Main production	Kg	1100	0.52	572		
	By product	Ls	0				
V	Net profit						
a)	In good years	Birr			-574		
b)	In bad years	Birr			-632		
VI	Net profit without considering human labour cost						
a)	In good years	Birr			-306		
b)	In bad years	Birr			-364		
VII	Cost Benefit Ratio						
a)	In good years				-0.48		
b)	In bad years				-0.52		

Note: Following basis are used to do above analysis

- There is no change in the total labour requirement in the past and at present
- Depreciation cost of tools and equipment is calculated dividing the total cost of each item by its lifetime.
- Depreciation on tools and equipment is charged for one year.
- Financial cost on seed is charged for 9 month @ 10.5 % per annum as an opportunity cost of fund
- Land tax is not based on single variables and varies among farmers; therefore mode cost is taken.
- Land tax for the 5 years before is assumed to be Birr 30, based on farmers response
- By product of maize is not sold, therefore difficult to convert in monetary value hence has not considered
- Work done by women is considered as women/days considering the different rate of women/days
- According to farmers version, price of product goes up in the bad years, therefore price in bad year is 50 per cent
- Higher than the estimated price.
- M=Male, F= Female, I= Internal, H=Hired

Appendix 4.4 (a): Depreciation cost calculation on farm tools and equipment for the comparative cost benefit analysis on maize in the lowland

S.N.	Tools and equipment	Total cost	Lifetime (years)	Cost per year
1	Hoe	3	1	3
2	Spade	18	5	3.6
3	Plough – Qenbera	18	8	2.25
4	Plough – Mofera	27	4	6.75
5	Sickle	18	1	18
6	Layida	8	10	0.8
7	Menshi	15	15	1
	Total	**107**		**35**

Appendix 4.4 (b): Depreciation cost calculation on farm tools and equipment for the comparative cost benefit analysis on maize in the midland, 5 years ago

S.N.	Tools and equipment	Total cost	Life time (years)	Cost per year
1	Hoe	1	1	1
2	Plough – Qenbera	3	8	0.375
3	Plough – Mofera	5	4	1.25
4	Sickle	0.75	1	0.75
5	Layida	2	10	0.2
6	Menshi	3	15	0.2
	Total	**15**		**4**

Appendix 4.4 (c): Depreciation cost calculation on Farms tools and equipment for the comparative cost benefit analysis on maize in the midland at present

S.N.	Tools and equipment	Total cost	Life time in year	Cost per year
1	Hoe	3	1	3
2	Plough – Qenbera	20	8	2.5
3	Plough – Mofera	60	4	15
4	Sickle	16	1	16
5	Layida	10	10	1
6	Menshi	15	15	1
	Total	**124**		**39**

Appendix 4.5: Cost benefit analysis of maize with *improved seed* and *chemical fertilisers* in midland at present and in the past (5 years ago)

Per hectare

S.N.	Particulars	Unit	At present			Five years before			Who works (M/F)	Labour Use (I/H)
			Quantity	Rate	Amount	Quantity	Rate	Amount		
I	Variable cost									
A	Labour work									
	Land preparation – x 3	Days - M	18	7	126	18	3	54	M	I
	Chemical fertiliser purchase	Days - M	2	7	14	2	3	6	M/F	I
	Planting	Days - M	4	5	20	4	2	8	M/F	I
	Weeding									
	First time	W-D	16	5	80	16	2	32	F	H
	second time	W-D	12	5	60	12	2	24	M/F	H
	Fertilization									
	First time	Days - M	4	7	28	4	3	12	M/F	I
	second time	W-D								
	Harvesting	W-D	20	5	100	20	2	40	F	I
	Transporting to home	Days - M	10	7	70	10	3	30	M	I
	Threshing/Graining	Days - M	10	7	70	10	3	30	M	I
	Product transporting to market	Days - M	2	7	14	2	3	6	M	I
	Oxen for land preparation	days	18	18	324	18	5	90		
	Donkey cart for carrying harvest to home	days	4	20	80	4	12	48		
	Total livestock and human labour cost	Birr			*986*			*380*		
B	Procurement and other costs									
	Seed	Kg	25			25				
	Fertilisers			634	634		330	330	Package cost	
	DAP	Kg	100			100				
	Urea	Kg	100			100				
	Transportation cost of fertiliser	Birr/Sack	4	3	12	4	1	4		
	Transportation to market	Birr/Quintal	40	3	120	40	1	40		
	Interest on loan (Package)	Birr			50			26		
	Total of procurement and other costs	Birr			*816*			*400*		
	Total variable cost	Birr			1802			780		

Appendix 4.5 Cost benefit of high input technology in midland maize (continued)

II	Fixed costs									
	Depreciation cost on tools and equipment	Birr/year	1	39	39	1	4	4		
	Land tax	Birr/year	Ls	40	40	Ls	40	30		
	Total fixed costs				*79*			*34*		
III	Total costs				1881			814		
IV	Gross Income									
	Main production	Kg	3600	0.3	1260	4400	0.4	1760		
	By product	Ls	0			0				
V	Net profit	Birr			-621			946		
VI	Net profit without considering labour cost	Birr			365			1326		
VII	Benefit Cost Ratio				0.67			2.16		

Note: Following basis are used to do above analysis

- There is no change in the total labour requirement in the past and at present
- Days – M = days of male labour, Days W = days of women's labour
- Depreciation cost of tools and equipment is calculated dividing the total cost of each item by its lifetime.
- Depreciation on tools and equipment is charged for one year.
- Interest on loan is charged for 9 month @ 10,5 % per annum on the credit amount only for both times
- Land tax is not based on single variables; therefore it is taken as highest mode.
- Land tax for the 5 years before is assumed to be Birr 30, based on farmers response
- By product of maize is not sold, therefore difficult to convert in monetary value hence has not considered
- Work done by women is considered as women/days considering the different rate of women/days

Appendix 4.6: Cost benefit analysis of maize with *local seed without chemical fertilisers* in the mid land at present and in the past (5 years before)

Per hectare

S.N.	Particulars	Unit	At present			Five years before			Who works (M/F)	Labour use (I/H)
			Quantity	Rate	Amount	Quantity	Rate	Amount		
I	Variable cost									
A	Labour work									
	Land preparation - three times	Days-M	12	7	84	12	3	36	M	I
	Planting	Days-M	4	5	20	4	2	8	M/F	I
	Weeding									
	First time	Days-W	20	5	100	20	2	40	F	H
	Second time	Days-M	24	5	120	24	2	48	M/F	H
	Harvesting	Days-W	20	5	100	20	2	40	F	I
	Transporting to home	Days-M	12	7	84	12	3	36	M	I
	Threshing/Graining	Days-M	20	7	140	20	3	60	M	I
	Product transporting to market	Days-M	2	7	14	2	3	6	M	I
	Oxen for land preparation	Days	12	18	216	12	5	60		
	Oxen for weeding	Days	4	18	72	4	5	20		
	Donkey cart carrying harvest to home	Days	4	20	80	4	12	48		
	Total labour cost	Birr			*1030*			*402*		
B	Procurement and other costs									
	Seed	Kg	100	1	100	100	0.8	80		
	Transportation to market	Birr/Q	12	3	36	12	1	12		
	Financial cost of seed	Birr			8			6		
	Total of procurement and other costs	Birr			*144*			*98*		
	Total variable cost	Birr			1174			500		

Appendix 4.6 Cost benefit of low input technology in midland maize (continued)

II	Fixed costs									
	Depreciation cost on tools and equipment	Birr/year	1	39	39	1	4	4		
	Land tax	Birr/year	Ls	40	40	Ls	40	30		
	Total fixed costs				*79*			*34*		
III	Total costs	Birr			1253			534		
IV	Gross Income									
	Main production	Kg	1200	0.4	420	1200	0.4	480		
	By product	Ls	0			0				
V	Net profit	Birr			-833			-54		
VI	Net profit without considering labour cost	Birr			197			348		
VII	Benefit Cost Ratio				0.34			0.90		

Note: Following basis are used to do above analysis

- There is no change in the total labour requirement in the past and at present
- Depreciation cost of tools and equipment is calculated dividing the total cost of each item by its lifetime.
- Depreciation on tools and equipment is charged for one year.
- Financial cost on seed is charged for 9 month @ 10,5 % per annum as an opportunity cost of fund
- Land tax is not based on single variables and varies among farmers; therefore mode cost is taken.
- Land tax for the 5 years before is assumed to be Birr 30, based on farmers response
- By product of maize is not sold, therefore difficult to convert in monetary value hence has not considered
- Work done by women is considered as women/days considering the different rate of women/days

Appendix 4.7 (a): Number of loan disbursements, collected, outstanding and overdue in Arsi Negele Woreda as of May 31, 2002

FY in GC	Disbursement	Collected	Outstanding	Overdue
1996/97	1651	1408	243	243
1997/98	2611	2017	594	594
1998/99	4198	3684	514	514
1999/00	5194	3979	1215	1215
2000/01	9298	6889	2409	2409
2001/02	11839	4110	7729	7729
Total	**34791**	**22087**	**12704**	**12704**

Data source: WADO, June 2002

Appendix 4.7 (b): Sums of loan disbursements, collected, outstanding and overdue in Arsi Negele Woreda, as of May 31, 2002 (in Birr)

FY in GC	Disbursement	Collection	Outstanding	Overdue	Repayment rate
1996/97	398010	336865	61145	61145	85%
1997/98	617336	465280	152056	152056	75%
1998/99	787621	634706	152915	152915	81%
1999/00	913272	713383	199889	199889	78%
2000/01	1418236	1012405	405831	405831	71%
2001/02	1810537	845845	964692	964692	47%
Total	**5945012**	**4008484**	**1936528**	**1936528**	**67%**

Data source: WADD, June 2002

Note: 1 USD = 8.56 Birr

Appendix 4.8 Status of Community Based Savings and Credit Organisations in Arsi Negele Woreda as of May, 2002

Type of organisations	No. of groups/ co-operatives	Members			Total Resources (Birr)						Cumulative disbursement (Birr)	Outstanding amount (Birr)
		Male	Female	Total	Members savings	Share capital	Donation	External credit	Others	Total		
RS & CC	1	24	-	24	2414	2400	-	-	-	4814	N/A.	2414
NRS & CG	39	30	658	688	133828	2800	10000	102543	1120	250291	129935	98400
Total	40	54	658	712	136242	5200	10000	102543	1120	255105	129935	100814

Source: Woreda Co-operative Promotion Department, Arsi Nelelle, June, 2002

Notes: RS&CC - Registered Savings and Credit co-operatives
NRS&CG - Non Registered savings and credit groups
N/A. – not available

APPENDIX 5 SCREENING OF R&D OPTIONS BY STAKEHOLDERS

Appendix 5a: Farmers' rating on the screening of developmental interventions

DI**	Environmental Sustainability			Economic Competitiveness			Social Equity			Total pluses	Total Minuses
	Soil	Forest	Water	Profitability	Market potential	Affordability	Gender balance	Wealth group	Social acceptance		
1	2	2	2	2	2	0	2	2	2	16	0
2	2	2	2	2	2	2	2	2	2	18	0
3	2	2	2	2	2	1	2	1	2	16	0
4	2	2	2	2	2	-2	2	2	2	16	2
5	2	2	2	2	2	-1	1	1	2	14	1
6	2	2	2	2	2	0	2	-1	2	16	1
7	2	2	2	2	2	0	2	2	2	17	0
8	2	2	2	2	2	1	2	2	2	14	0
9	2	2	2	2	2	0	1	1	2	15	0
10	2	2	2	2	2	-1	1	2	2	18	1
11	2	2	2	2	2	2	2	2	2	14	0
12	2	-1	2	2	2	-1	2	2	2	18	2
13	2	2	2	2	2	2	2	2	2	17	0
14	2	2	2	2	2	1	2	2	2	16	0
15	2	2	2	2	2	0	2	2	2	17	0
16	2	2	2	2	2	-2	2	-1	2	11	3
17	2	2	2	2	2	0	2	1	2	15	0
18	2	2	2	2	2	-1	2	-1	2	12	2

Note: For identification of research and development interventions (see Appendix 5d, Notes, page 158).

Appendix 5b: Researchers' rating on the screening of developmental interventions

DI**	Environmental Sustainability			Economic Competitiveness			Social Equity			Total pluses	Total minuses
	Soil	Forest	Water	Profitability	Market potential	Affordability	Gender balance	Wealth group	Social acceptance		
1	1	2	1	2	1	2	2	2	-1	13	1
2	1	1	1	2	2	2	2	2	-1	13	1
3	1	1	1	2	2	1	2	2	2	14	0
4	2	2	2	1	1	2	2	1	2	15	0
5	2	0	1	2	2	2	2	2	2	15	0
6	1	1	-1	2	2	2	2	1	2	13	1
7	2	2	1	1	2	1	2	1	2	13	0
8	2	2	2	2	2	-1	2	2	2	16	1
9	0	-1	0	2	2	2	2	2	2	12	1
10	1	1	1	2	2	1	2	2	2	15	1
11	1	1	2	2	2	2	2	2	1	15	0
12	0	1	0	2	2	1	2	2	2	12	0
13	1	1	2	2	2	2	2	2	2	16	0
14	1	1	1	2	2	2	-1	2	2	13	1
15	0	2	2	2	2	2	2	2	2	18	0
16	2	2	0	2	2	1	2	2	2	15	0
17	2	1	0	2	2	0	2	2	2	13	0
18	2	1	2	2	1	1	2	2	2	15	0

Note: For identification of research and development interventions (see Appendix 5d, Notes, page 158).

Appendix 5c: Development agents rating of the screening of developmental interventions

DI**	Environmental Sustainability			Economic Competitiveness			Social Equity			Total pluses	Total minuses
	Soil	Forest	Water	Profitability	Market potential	Affordability	Gender balance	Wealth group	Social acceptance		
1	2	2	2	2	0	1	-1	2	-1	13	2
2	2	2	2	2	1	1	-1	2	1	14	1
3	2	2	1	2	2	1	2	2	1	15	0
4	2	2	1	2	2	1	2	2	1	15	0
5	2	2	2	2	2	1	2	1	2	16	0
6	2	2	1	2	2	1	2	2	1	15	0
7	2	2	2	2	2	1		2	2	17	0
8	2	2	2	2	2	1	2	2	2	17	0
9	2	2	2	2	2	1	2	2	2	17	0
10	2	2	2	2	2	1	2	2	2	17	0
11	2	2	2	2	2	1	2	2	1	16	0
12	0	0	0	2	2	1	2	2	1	10	0
13	0	0	0	2	2	1	2	2	1	10	0
14	2	2	2	2	2	2	-1	2	2	17	1
15	2	2	2	2	2	1	-1	2	1	15	1
16	2	2	2	2	2	1	2	2	2	17	0
17	2	2	2	2	2	1	-1	2	1	15	1
18	2	2	2	2	2	1	-1	2	1	15	1

Note: For identification of research and development interventions (see Appendix 5d, Notes, page 158).

Appendix 5d: Notes: Identified developmental interventions for the different agro-ecological zones in Arsi Negele

DI No.	Developmental Intervention (DI)
1.	Awareness on household budgeting and efficient use of family labour Creation of awareness and promotion of family planning
2.	Alternative ways of utilizing staple food crops
3.	Introduction of high value crops like vegetables and oil crops (onion, garlic, coffee in the highland, linseed oil) Diversification of package programme for food and cash crops
4.	Promotion of multiple cropping system in the midland and highland (Inter cropping of fingermillet with other crops)Improve crop management practices: Broadcasting to row planting; plant population; tie ridging; response farming (weather forecasting promotion); mulching; scooping;
5.	Development and introduction of improved crop varieties suitable to each agro-ecological zones Development and introduction of drought tolerance crop varieties and root varieties: Early maturing varieties; drought escaping type Development of low input responsive varieties with respect to nutrients
6.	Development of appropriate fertiliser recommendation: Site specific recommendation for various crops Determination of fertility status of different soil types
7.	Introduction of integrated nutrition management Development of alternative soil fertility (maintenance) management practices (manure, compost manure, green manure)
8.	Water harvesting techniques for irrigation and livestock drinking: Roof water harvesting; Catchment harvesting Development of small scale irrigation schemes
9.	Establishment of informal seed systems: Seeds and or planting materials
10.	Initiate and promote on farm and or off farm income generating micro-enterprises (sericulture; Carpentry; animal fattening) Generation of off farm employment
11.	Development of efficient credit delivery mechanism
12.	Development of efficient storage structures and dissemination Awareness on post harvest management
13.	Strengthening service co-operation that benefit individual members (farmers): Establishing informal community based saving and credit groups
14.	Improvement and promotion of home garden /Kitchen garden
15.	Promotion of agroforestry practices; Introduction and integration of fodder trees into cropping systems (e.g. *Sesbania*, *Leucaena*, *Gliricidia*, *Calliandra*)
16.	Development and introduction of improved livestock breeds: Appropriate for zero grazing/ Stall feeding; Improved cows; Dual purpose / dairy goats Improve animal health services: Establishment of veterinary services close to farmers
17.	Introduction of improved forage species into the farming system (Inter cropping & Under sowing): Improve utilization of by products as feed source: Crop residues and agro-industry by products
18.	Alternative sources of draft power and harnessing methods Development and introduction of improved agricultural implements: Assessing the efficiency of traditional agricultural draft implements

APPENDIX 6 RESEARCH RESULTS, MARC AND SUB-CENTRE

a) On-station Research Activities, 2001

Crop	No. of trials	Co-ordinating Centre
Sorghum	26	Melkassa
Maize	15	Awassa
Haricot bean	7	Melkassa
Shallot	1	Debre Zeit
Wheat	7	Kulumsa
Lentil & chickpea	2	Debre Zeit

b) Technology dissemination, 1994-2001

Year	No. of PAs	No. of farmers	Seed disseminated		Amount (kg)	Area of land (ha)	Yield (q/ha)
			Crop	Variety			
1994	1	1	F. millet	Taddese	1.5	0.06	32
1995	3	3	F. millet	Taddese	9.4	0.40	33
	3	3	Sorghum	PGRC 166	5.6	0.40	30
	3	3	Sorghum	Local	5.6	0.40	15
1996	4	6	F. millet	Taddese	15.0	0.60	36
	4	6	F. millet	Local	15.0	0.60	12
	4	6	Sorghum	PGRC 166	9.0	0.60	35
	4	6	Sorghum	Local	9.0	0.60	18
1997	6	20	F. millet	Taddese	61.2	2.50	27
	6	20	Sorghum	PGRC 166	37.0	2.50	27
	6	20	Wheat	HAR1685	250.0	1.30	29
1998	7	70	F. millet	Taddese	438.0	17.50	25
	7	70	Sorghum	PGRC 166	263.0	17.50	22
	7	20	Wheat	HAR1685	1000.0	5.00	17
1999	11	106	F. millet	Taddese	663.0	26.50	27
	11	106	Sorghum	PGRC 166	97.5	6.50	29
	11	30	Wheat	HAR1685	1500.0	7.50	23
2000	22	119	F. millet	Taddese	440.8	17.63	30
	22	110	Sorghum	PGRC 166	241.0	15.44	31
	22	35	Wheat	HAR1685	1100.0	5.50	23
	7	30	Beans	Roba	60.0	0.50	9
2001	9	13	Sorghum	IS 9302	46.0	3.06	n.a.
	9	23	F. millet	Taddese	83.0	3.32	n.a.
	3	3	Sorghum	AL 70	9.0	0.60	n.a.
	2	3	F. millet	Paddet	12.0	0.48	n.a.
	2	2	Maize	A511	6.0	0.24	n.a.

APPENDIX 7 RESEARCH PROPOSAL

Ethiopian Agricultural Research Organization

Contents for the write-up of the executive summary for an activity proposal

1. Sector: Crops
2. Program: Cereals
3. Project: Maize
4. Sub-project: Agronomy
5. Thrust: midland and highland ago-ecological zones of Arsi Negele Woreda
6. Category of activity: Research
7. Title: Development of appropriate fertiliser recommendations for maize in lowland and highland AEZ of Arsi Negele Woreda
8. Code: 01/01/04/Mz/Ag MS (2003-01)
9. Justification/rational:

Maize (*Zea mays, L.*) is one of the main crops and staple food in western and southern regions of Ethiopia. Farmers grow maize in all 3 AEZ – highland (2000-2300masl), midland (1800-2000masl) and lowland (1500-1800masl) of Arsi Negele Woreda. The area of maize in average for the last three years was 16200 ha and average yield was 3,5 t/ha. In the mid- and high altitude zones, the nutrient status of the soil is too much denuded. As a result the majority of farmers use easily available commercial fertilisers to maintain the fertility level of their field and obtain optimum maize yield. Despite considerable differences in response of the crop to fertiliser applied, farmers still use blanket recommendation (100 kg of DAP and 100 kg of urea) given by EPID in 1970s.

According to comparative cost benefit analysis made for growing maize using blanket fertiliser recommendations and improved seeds in midland, is becoming not profitable (ICRA, 2002). Because of recurrent drought growing maize in lowland itself is too risky while farmers use improved seeds and fertilisers and becoming homeless. Recently National Fertiliser Agency started activity on soil analysis and developing of a woreda soil map. Thus, considering different soil type and fertility, using by farmer's varieties and climatic conditions of AEZ, it appears very important to develop appropriate fertiliser recommendations for maize in highland and midland AEZs of Arsi Negele.

10. Objectives: to develop appropriate fertiliser recommendations for obtaining high & stable yield of maize in highland and midland of Arsi Negele Woreda on the basis of soil fertility and plant uptake.
11. Logical Frame Work Matrix (Please refer Table 3)
12. Monitoring and Evaluation Matrix (Please refer Table 4)
13. Executing Agency: EARO
14. Implementing Agency: MARC
15. Locations: on-farm in highland and midland AEZ of Arsi Negele Woreda
16. Duration of the research activity: Three years
17. Initiator: ICRA team 2002 (Ethiopia-1)
18. Program Co-ordinator: Bedded Grim

19. Project/commodity co-ordinator: Tolessa Debele
20. Persons responsible: Agronomy/soil research division of MARC.
21. Within sector linkages: None
22. Between sector linkages: Crop and Soil & Water Management
23. Work plan (Please refer Table 1)
24. Financial requirement and source(s) of finance/budget: Government (Please refer to Table 2)

Table 1 Work plan

Title of the activity: Development of appropriate fertiliser recommendations for maize in lowland and highland AEZ of Arsi Negele Woreda

Program: Cereals Project Maize Code 01/01/04/Mz/Ag MS (2003-01)

Research center Melkassa Duration Three years Starting date January 2003 Ending date December 2005

Sample Activity	Unit	Implementation Schedule												Responsible bodies	Risk/ assumptions
		Year I				Year II				Year III					
		1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q		
Proposal write-up	%	35	65	-	-		-	-	-	-	-	-	-	Agronomy staff	
Review at center level	"	-	100	-	-	-	-	-	-	-	-	-	-	"	
Review at program/project level	"	-	100	-	-	-	-	-	-	-	-	-	-	"	
Review at directorate level	"	-	100	-	-	-	-	-	-	-	-	-	-	"	
National review	"	-	-	100	-	-	-	-	-	-	-	-	-	"	
Soil sample collection	"	-	50	50	-	-	50	50	-	-	50	50	-	"	
Land preparation	"	-	5	20	75	-	5	20	75	-	5	20	75	"	
Seed and fertiliser preparation	"	-	-	30	70	-	-	30	70	-	-	30	70	"	
Planting	"	-	-	-	100	-	-	-	100	-	-	-	100	"	
Weeding	"	90	-	-	-	90	-	-	-	90	-	-	-	"	
Evaluation of rates	"	50	30	10	10	50	30	10	10	50	30	10	10	"	
Data collection	"	60	30	5	5	60	30	5	5	60	30	5	5	"	
Harvesting	"	25	75	-	-	25	75	-	-	25	75	-	-	"	
Data analysis & interpretation	"	-	10	40	50	-	10	40	50	-	10	40	50	"	
Reporting	"	10	5	10	75	10	5	10	75	10	5	10	75	"	

** Q = Quarter

Quarter = Please follow the Ethiopian Government budgetary quarter system.

The 1st quarter of the Ethiopian Government budgetary system starts Hamle 1st and ends Meskerem 30, 2nd quarter (Tikemet 1st to Tahisas 30), 3rd quarter (Tir 1st to Megabit 30), 4th quarter (Miazia 1st to Sene 30).

Table 2 Summary of total budget requirement for the research activity by year and source of finance

Title of the activity: Development of appropriate fertiliser recommendations for maize in lowland and highland AEZ of Arsi Negele Woreda
Program: Cereals Project Lowland pulses Code 01/01/04/Mz/Ag MS (2003-01)
Research center Melkassa Duration Three years Starting date January 2003 Ending date December 2005

Budget category	Year 1				Year 2				Year 3				Total			
	Gov.	Asst.	Loan	Total	Gov.	Asst.	Loan	Total	Gov.	Asst.	Loan	Total	Gov.	Asst.	Loan	Total
Investment	1.16	-	-	1.16	1.16	-	-	1.16	1.16	-	-	1.16	3.48	-	-	3.48
Recurrent	38.5	-	-	38.5	38.5	-	-	38.5	38.5	-	-	38.5	115.4	-	-	115.4
Total	39.6	-	-	39.6	39.6	-	-	39.6	39.6	-	-	39.6	118.8	-	-	118.8

Ethiopian Agricultural Research Organization

Contents for the write-up of a detailed activity proposal

1. Sector: Crops
2. Program: Cereals
3. Project: Maize
4. Sub-project: Agronomy
5. Thrust:mid to high altitude AEZ of Arsi Negele Woreda
6. Category of activity: Research
7. Title: Development of appropriate fertiliser recommendations for maize in lowland and highland AEZ of Arsi Negele Woreda
8. Code:01/01/04/Mz/Ag MS (2003-01)
9. Background and Justification:

Maize growths better in deep and well-drained soils and it is highly responsive to improved management practices, particularly to nutrient management. Nitrogen and phosphorus are considered to be the most limited nutrients in almost all soils of Ethiopia. Various aspects of fertiliser management in maize, particularly management aspects of important nutrients (nitrogen and phosphorus), fertiliser management in cropping systems, integrated nutrient management, soil and water conservation, fertiliser recommendations, fertiliser management problems and suggestions for future research on maize in Ethiopia reviewed by Tolessa Debelle *et al.* (2001).

Considerable research has been carried out of determine the nitrogen and phosphorus requirements of the maize in different parts of Ethiopia and was observed progressive increase in maize yield with incremental levels of nutrients (Tolessa, 1996; Tenaw, 1998). The effect of nitrogen and phosphorus fertiliser was particularly pronounced with the first increment than with subsequent increments. The recommended rate of fertiliser depends on the soil type and weather conditions, particularly rainfall. Average rate of response of maize to nitrogen ranged between 5.8 and 25.0 kg grain/kg nitrogen at 46 kg N/ha. Significant response of maize grain yield up to 92 kg N/ha and 69 kg P_2O_5/ha was obtained on farmers' fields around Bako, 75 kg N/ha and 50 kg P_2O_5/ha in the west Shewa, 75 kg N/ha and 75 kg P_2O_5/ha in west Wellega, 23 kg N/ha and 46 kg P_2O_5/ha at Abobo, 41 kg N/ha and 46 kg P_2O_5/ha around Melkassa. Preliminary experiments at Dera, in north-west Ethiopia, indicate significant response of maize grain yield up to 128 kg N/ha and 92 kg P_2O_5/ha (Tolessa et al., 2002).

Effect of fertiliser also depends on time and methods of application. The best use of nitrogen is obtained when 50% of the total requirement is applied at sowing and the remaining 50% is given as top dressing (Tolessa et al., 2002). The maximum efficiency of phosphorus fertiliser is obtained when the fertiliser is applied in a band 5 cm to the side of
seed at sowing time (Tolessa et al., 2002).

10. Objectives: to develop appropriate fertiliser recommendations for obtaining high stable yield of maize in highland and midland of Arsi Negele Woreda on the basis of soil fertility and plant uptake.

11. Literature Review: See background and justification
12. Materials and Methods:

Treatment: - 6 different N:P_2O_5 rates of fertiliser (64:46, 18:46, 96:69, 41:46, 50:69, 82:92)

Design: - RCBD with three replications

Plot size: - 4 rows X 5.1 meters long X 0.75 m apart between the rows (15.3 m^2). Data will be collected from the central two rows.

Cultural practice: Recommended agronomic practices (planting time, plant population and weeding) for the area will be followed. Nitrogen fertiliser will be applied in two splits: 50 % at sowing and the remaining half at knee height stage. Phosphorous fertiliser will be applied in bands, all rate at sowing. The maize hybrid BH 660 will be used for both AEZs. The trials will be conducted on five selected farmers' field in each AEZ.

Parameters to be measured:

- Days to emergence, tasseling and silking
- Vigour
- Disease and insect pest incidence
- Plant height (cm)
- Number of cobs/plot,
- Stand count at emergence and harvesting
- Ear length and diameter
- Cob length and diameter
- 1000-grain weight (gm)
- Grain yield (kg/ha)
- Soil N and P_2O_5 content before planting and after harvesting
- Plant tissue N and P_2O_5 content

13. Logical Frame Work (please refer Table 3)
14. Monitoring and Evaluation Matrix (please refer Table 4)
15. Beneficiaries: Farmers
16. Executing Agency: EARO
    Implementing Agency: MARC
17. Locations: farms located in highland and midland AEZ of Arsi Negele Woreda
18. Duration of the activity: Three years
19. Initiator: ICRA team 2002, Ethiopia 1
20. Program Co-ordinator: Bedada Girma
21. Project/commodity co-ordinator: Tolessa Debele
22. Person (s) Responsible: Agronomy and/or Soil research division of MARC
23. Within sector linkages: None
24. Between sector linkages: Crops and Soil and Water Research
25. Work plan (Please refer Table 5)
26. Financial requirement and source(s) of finance/budget: (Please refer Table 2)

27. References/Bibliography

1. Tolessa Debelle, Tesfa Bogale, Wakene Negassa, Tenaw Worayehu, Minale Liben, Tewodros Mesfin, Burtukan Mekonen ana Waga Mazengia. A review of fertiliser management research on maize in Ethiopia. *In:* Second National Maize Workshop of Ethiopia, 12-16 November, 2001
2. Tolessa Debele. 1996. Evaluation of maize yield response to nitrogen and phosphorus fertiliser in Western Ethiopia. African Crop Science Proceedings 4: 291- 294.
3. Tenaw Workayehu. 1998. Response of grain yields of maize variety BH 140 to different levels of nitrogen fertiliser and plant populations. *In:* Tadelle G/Sillasie and Sahlemedhin Sertsu (eds.). proceedings of the 4th Conference of the Ethiopian Soil Science Society. February 26-27, 1998. Addis Ababa, Ethiopia.

Table 3 Logical Framework Matrix: Expected outputs, Activities and Indicators of Performance

Narrative Summary	Indicators	Means of verification	Important Assumptions
Goal: Production and productivity of maize in midland and highland of Arsi Negele Woreda improved.	5 to 15 percent increase in maize yields by the year 2010	-CSA report, - MoA/BoA report, - Socio-economic survey report	- Suitable development policy - Infrastructure improved - Fertiliser & grain price
Purpose: Rates of fertiliser for maize for midland and highland agro-ecologies of Arsi Negele Woreda and cropping systems developed.	At least one appropriate rate of nitrogen and phosphorus fertiliser for maize by 2005.	➢ Woreda Agriculture development Department report ➢ Research bulletins & proceedings	- Fertiliser rates extended to farmers fields - Price of fertiliser
Outputs: Appropriate fertiliser recommendations for obtaining high & stable yield of maize in highland and midland of Arsi Negele Woreda on the basis of soil fertility and plant uptake developed.	2 fertiliser rates to the on-farm fertiliser trials by the year 2005.	➢ Progress report ➢ Review meeting report ➢ Annual report	- Adequate on-farm trials and active participation of collaborating centers.
Activities: ➢ Prepare seeds to test fertiliser rates ➢ Plant seeds and make evaluations. ➢ Data collection. ➢ Data analysis and reporting.	- Seeds of maize and 6 rates of N P_2O_5 prepared. - Planting the trials on at least ten farmers field. -At least twelve parameters measured, analyzed and reported at the end of the experimental duration. Inputs: -Personnel: 0.05 M.Sc., 0.14 Diploma -Facility/material: seeds of maize variety BH660, DAP and urea - Finance:237 680 birr	➢ Quarterly report ➢ Field visit ➢ Progress report ➢ Review meetings	- Enough budget and inputs available. - The test plants exhibit differences of the rates of fertiliser application.

Table 4 Monitoring and Evaluation Matrix: Development of appropriate fertiliser recommendations for maize in lowland and Highland AEZ of Arsi Negele Woreda

Purpose	**Rates of fertiliser for maize for midland and highland agro-ecologies of Arsi Negele Woreda and cropping systems developed.**					
Outputs/ Results	**M&E Objectives**	**Indicators**	**Information to be collected**	**How to get the information**		**Method of Analysis**
				Method of collection	***Tools for collecting***	
Appropriate fertiliser recommendations for obtaining high & stable yield of maize in highland and midland of Arsi Negele Woreda on the basis of soil fertility and plant uptake developed.	- To assess whether efficient fertiliser rates for obtaining high & stable yield of maize in highland and midland of Arsi Negele are identified.	- 2 fertiliser rates to the on-farm fertiliser trials by the year 2005.	- How many efficient rates of fertiliser for obtaining high & stable yield of maize in highland and midland AEZ were identified?	- Interview - Field visit - Review meetings - Reviewing documents	- Data sheet - Check list - Field visit - Minutes	- Descriptive statistics (percent, range, mean, etc.)
- Prepare seeds the test fertiliser rates - Plant seeds and make evaluations. - Data collection. - Data analysis and reporting.	- To verify whether or not the required activities and processes are done.	- Seeds of maize and 6 rates of N P_2O_5 prepared. - Planting the trials on at least ten farmers field. - At least twelve parameters measured, analyzed and reported at the end of the experimental duration.	- How many rates of fertiliser were tested? - How many parameters were measured, analyzed and reported?			
Inputs: - Personnel - Facility/material - Finance	- To assess whether the required inputs are utilized	0.05 M.Sc., 0.14 Diploma spent their time. - 796 m^2 land, seeds, fertiliser, computer, vehicle used - 237 680 Birr utilized	- Are the facilities properly utilized? -How much of the budget allocated utilized?			

Table 5 Work Plan for a Single Year

Title of the activity: Development of appropriate fertiliser for maize grown in the highland & Mid-altitude of A/Negele
Program: Cereals Project Maize Code 01/01/04/Mz/Ag MS (2003-01)
Research center Melkassa Duration Three years Starting date January 2003 Ending date December 2005

Sample Activity	Unit	1st Quarter			2nd Quarter			3rd Quarter			4th Quarter			Responsible bodies	Risk/ assumptions
		July	Aug.	Sept.	Oct.	Nov	Dec	Jan.	Feb.	March	April	May	June		
Proposal write-up	%	5	10	20	25	25	15	-	-	-	-	-	-	LLP staff	
Review at center level	"	-	-	-	-	-	100	-	-	-	-	-	-	"	
Review at program/project level	"	-	-	-	-		100	-	-	-	-	-	-	"	
Review at directorate level	"	-	-	-	-		100	-	-	-	-	-	-	"	
National review	"	-	-	-	-	-	-	100	-	-	-	-	-	"	
Soil sample collection	"	-	-	-	-	-	50	-	-	-	-	50	-	"	
Land preparation	"	-	-	-	-	-	5	5	20	30	20	20	-	"	
Seed and fertiliser preparation	"	-	-	-	-	-	-	-	10	30	50	10	-	"	
Planting	"	-	-	-	-	-	-	-	-	-	-	100	-	"	
Weeding	"	40	40	-	-	-	-	-	-	-	-	-	20	"	
Evaluation of rates	"	10	40	20	5	5	10	-	-	-	10		10	"	
Data collection	"	10	10	10	5	10	40	-	-	-	-	5	10	"	
Harvesting	"	-	-	-	-	15	75	10	-	-	-	-	-	"	
Data analysis & interpretation	"	-	-	-	-	-	-	20	15	15	30	15	5	"	
Reporting	"	-	-	-	-	-	-	5	10	10	20	20	35	"	

Quarter = Please follow the Ethiopian government budgetary quarter system.
The 1st quarter of the Ethiopian government budgetary system starts Hamle 1st and ends Meskerem 30, 2nd quarter (Tikemet 1st to Tahisas 30), 3rd quarter (Tir 1st to Megabit 30), 4th quarter (Miazia 1st to Sene 30).

APPENDIX 8 CROPPING CALENDARS

Appendix 8a Cropping calendar of Watera PA, highland AEZ

Crop	Months																																				
	February			March			April			May			June			July			August			September			October			November			December			January		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Maize						LP			S				HC			W		HC			IC				GC						DC							
Wheat													LP					S			Hrb										H			T				
Barley																LP			S					Hrb							H				T			
Potato		LP		P			I C		H C						H																							
Faba bean													LP					S			HC										H							

Source: Farmers' group interview, May 2002

Legends for all calendars: LP – land preparation; S – sowing; IC – inter-row cultivation by oxen; GC – harvesting of green cobs; DC – harvesting of dry cobs; W – weeding; HC – hand cultivation; Hrb – herbicide application; H – harvesting; T – threshing; SP – seedlings preparation; P – planting M – manure application; DC – disease control; IR – irrigation.

Appendix 8b Cropping calendar of Karsa PA, midland AEZ

Crop	Months																																				
	January			February			March			April			May			June			July			August			September			October			November			December		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Maize									LP			S			HC			IC			HC										GC				DC				
Wheat	T							LP												S						Hrb							H				T		
Teff	T									LP											S					Hrb		W					H				T		
Barley	T									LP											S					Hrb							H				T		
Sorghum	T						LP			S					HC							I C			HC								H						
Potato						LP		P			IC				HC			HC		H																			
															DC																								
Shallot							LP			P					HC						H																		

Appendix 8c Cropping calendar of Kararu PA, lowland AEZ