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Appendix 1 Background Information about Ethiopia

A1.1 Geographic and demographic information

Ethiopia is located in the horn of Africa (between 3^{o} 25' N and 18^{o} N latitude, and 33^{o} E and 48^{o} E longitude). The altitude varies from below sea-level to more than 4 500 metres above sea-level, providing remarkable diversity in climate and terrain. The ecology varies from desert-like scrub to forests, grasslands and wetlands of contrasting diversity, density and breathtaking physical beauty. Total land area[1] is estimated 1.13 million km^2. Official estimate of the population in 1991 was 52.9 million and is expected to grow to about 69.6 million by the year 2000 and about 113.6 million by the year 2015. Annual population growth is about 3.1 percent. The population doubling time is estimated at 23 years. More than 88 percent of the population live in the highlands and is engaged in agriculture.

The average population density is about 105 persons per square kilometre. However, the population density varies with agro-ecological regions. The rather less productive lowlands have lower population densities than in the highlands. Urbanisation is estimated at about 10.6 percent, although effects of previous civil wars and droughts would make urbanisation higher.

A1.2 People and health statistics

The age distribution of the population is heavily pyramidal. About 35 percent of the population is under 10 years while more than half of the population is under 20 years. Life expectancy at birth is estimated at 50 years for males and 53 years for females. The crude birth rate is estimated at 45 births per 1 000 while the crude death rate is about 15 deaths per 1 000 population. Infant mortality is estimated at 1.13 percent.

The average number of people per hospital is 579 000 and the average number of persons per hospital bed is 4 500. The average number of persons per physician is 40 100 while there is approximately one dentists for 0.31 million people and about one pharmacist for 177 000 people. The average number of persons per nurse is estimated at about 4 thousand.

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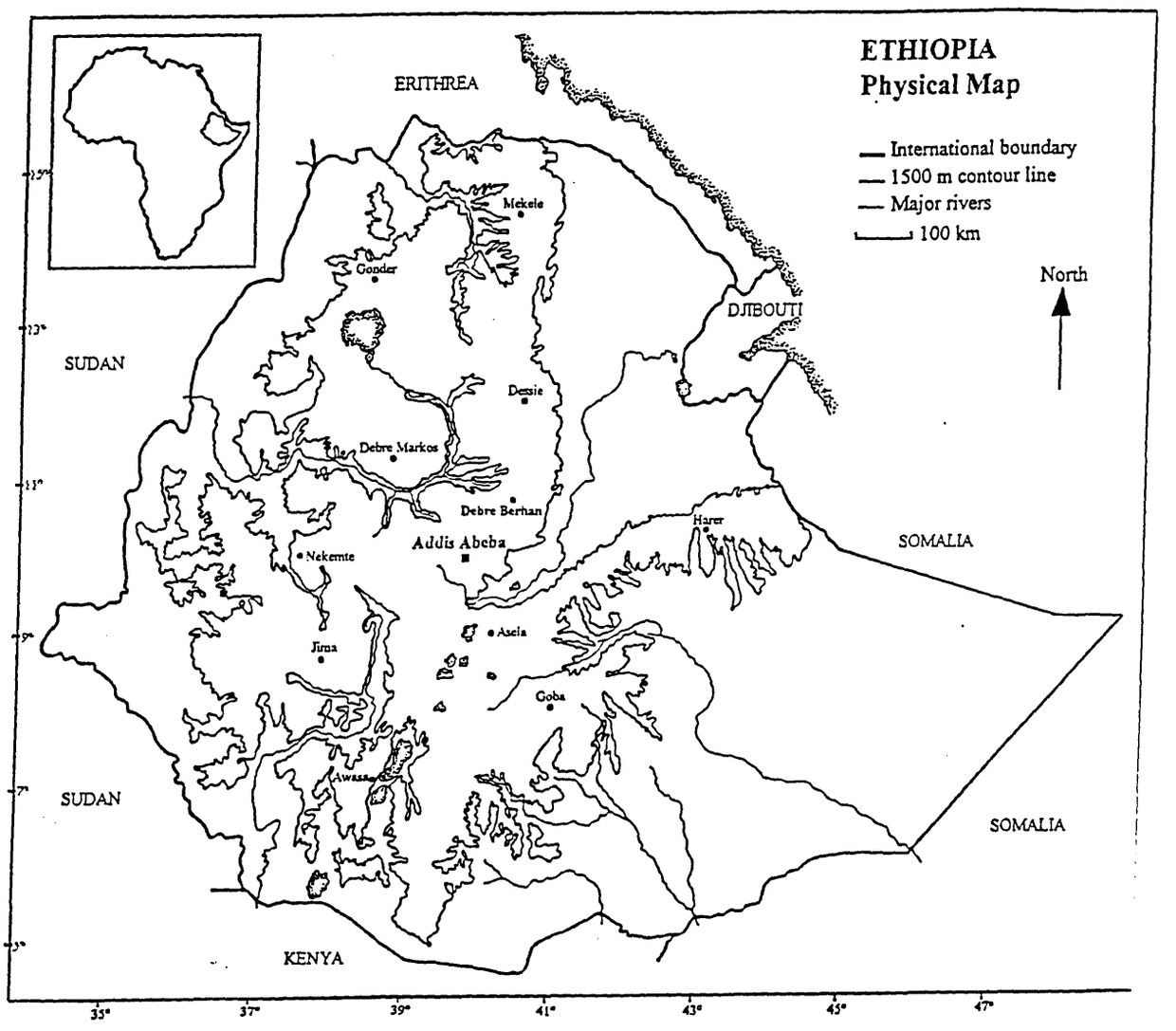
[1]Excluding 91 600 km^2 that constitutes the State of Eritrea (since its popular secession from Ethiopia in 1993).

Figure A1 Physical Map of Ethiopia



Source : Ethiopian Mapping Authority.

Languages: Ethiopia has an estimated 76 `nationalities', the largest of which are the Oromo, Amhara and Tigrinya speaking nationalities. There are more than 286 languages and dialects. The main languages are *Amharic, Oromo* and *Tigrinya.* Other languages include *Somali, Sidamo, Hadiyya, Gurage* and *Saho-Afar.* The official language is *Amharic.* English and Arabic are widely used in government and commercial circles.

Religion: About 45 percent of the population are members of the Coptic Orthodox faith. About 35 percent are Moslems especially of the Sunni Islamic faith. The remainder belong to traditional indigenous beliefs.

Education: There are about 7 900 elementary schools enrolling about 2.5 million pupils. The estimated number of teachers is 51 thousand to give a ratio of 48 pupils per teacher. Net primary school enrolment was estimated at just 28 percent in 1989. There are about 1 200 secondary schools employing about 15 610 teachers to train about 661 000 students. The approximate number of students per teacher is 42. There are two public universities (Addis Ababa University and Alemaya University of Agriculture) with about 11 campuses to train about 18 500 students. There are about 1300 lecturers to give a student : lecturer ratio of 14. About 4 percent of GNP is spent on education. Despite a adult education campaign, adult illiteracy was estimated at 38 percent in 1985. Shortage of local skilled manpower is an important economic problem. The stagnant economy has been forced to absorb and increasing number of job-seekers. There is more than 600 000 persons registered as unemployment in major urban centres.

A1.3 Economy: Natural resources, agriculture, industries

Natural resources: Excluding land, the main natural resources are potash, salt, gold, copper, platinum, cement, limestone and both freshwater and marine fish.

Agriculture: The land is often categorised as lowlands and highlands. Highlands lie above the 1 500 metre contour. The highlands account for about 44 percent (48.95 million ha) of total land area. The lowlands generally receive unreliable and insufficient rainfall (45 to 70 cm/yr) to sustain arable farming. Although faced with disease challenge from trypanosomiasis and malaria, nomadic pastoralism and agro-pastoralism are the main land use features in the lowland semi-arid savanna range lands. Because of weather and disease problems in the lowlands, sedentary agriculture is the dominant economic activity in the highlands to provide for increasing demand of food, pasture and fibre. However, about one third of the Ethiopian highlands is either too steep, or land degradation is severe or experience rainfall that is unreliable for crop cultivation.

The main agricultural enterprises include production of sugarcane, maize, sorghum, barley, pulses, wheat, yams, potatoes, millet, coffee, cotton, tobacco, soybeans and oil crops. Not more than 16 million ha of the 85 million ha of arable land are cultivated; the rest of the land is devoted to permanent pastures. There is severe soil erosion and overcrowding in most of the drought prone areas, making farming marginal at the best of the times. Most of the land is cultivated, in small parcels of land, by individual households, often, pursuing subsistence goals and employing rudimentary technologies. Agricultural productivity is low and attributed to diversion of official assistance to state farms, disruption caused by villagisation and resettlement during the (1974-1991) socialist military regime, deficiencies in infrastructure and marketing and environmental degradation.

Per capita food production has steadily declined since the early 1960s. Ethiopia has come to be associated with food imports, which regularly exceed 100 000 metric tons annually since 1980. Recognising the food deficit problem, the government has set an ambitious, perhaps unrealistic, target of 8 percent in annual growth in agricultural production.

Livestock : The main livestock are cattle, sheep, goats, equines and poultry. Hides and skins account for more than half of the manufactured exports. Livestock population is estimated about 27 million cattle, 24 million sheep, 18 million goats, 7 million equines, 52 million poultry and over one million camels. About 80 percent of the cattle and 75 percent of the small ruminants are found in the highlands.

Where available, most of the land under pasture is used communally. Overstocking is over-stretching pasture resources to support increasingly large livestock populations leading to low livestock productivity and worsening land degradation. Indeed, available estimates indicate that half of the land suffers from severe soil erosion. About 28 percent of the land is severely eroded and another 24 percent is moderately eroded. Agricultural soil loss is estimated between 0.2 tonnes/ha/yr to about 300 tonnes/ha/yr under different land use systems and weather conditions, with a modal value of about 42 tonnes/ha/yr.

Each year about 2.65 million cattle and about 14.2 million sheep and goats are slaughtered for domestic consumption. Between 11 000 and 15 000 head of cattle and between 21 000 and 25 000 head of sheep and goats are exported live to the international market (especially in the Middle East) annually. About 650 million tonnes of butter and 4.9 million tonnes of liquid milk are produced for domestic consumption. Ethiopia receives about 3.1 million tonnes of powder milk as food aid each year. Political and climatic factors have hindered much of the planned interventions to improve livestock development such as pasture management.

Forestry: Area under forest cover has dropped dramatically and is less than 3 percent of the total land area. Deforestation over many decades has resulted in massive soil erosion and contributed significantly to agricultural decline. About 22 000 ha have been planted with trees between 1975 and 1985. Ethiopia needs a 20 year program costing more than US $400 million to commit 4 million ha to afforestation. Without such a program, demand for fuel will exceed current resources within two decades.

Fishing: Coastal catch was estimated at 25 000 tons, in the 1980s, although the potential to triple the volume of catch existed. Ethiopia is now land-locked since Eritrea became independent in 1993. Inland catch is estimated to have a potential of about 30 000 tons per year on a sustainable basis, against current production of 4 000 tons.

Industries: The major industries include textiles, food processing, beverages, leather goods, footwear, metal works, cigarettes, chemicals, paper mills, mineral production, construction, cement, hydro-electric power generation, coal production, petroleum products and printing. Though the industrial base is small, mineral reserves would contribute substantially to income earnings. Over time, mining activities have been affected by previous civil or rebel activity. However, new investment and tax incentives have rekindled both domestic and foreign interests in the mineral industry.

Gross National Product (GNP): GNP (US $ million) in Ethiopia was estimated at 5 760, 5 956 and 6 158 in 1988, 1989 and 1990, respectively. Annual growth rate of GNP is estimated at 3.4 percent. However, real GDP growth was negative in both 1989 and 1990, at -0.4 and -0.6 percent, respectively. Per capita GNP is estimated at US $ 120. Consumer price inflation is estimated at about 10.6 percent (in 1992). Agriculture accounts for more than 45 percent of GDP while distribution and manufacturing accounted for 16 percent and 6 percent of GDP, respectively. Banking and insurance accounted for 4 percent of GDP while public administration accounted for about 6 percent.

Exports: The main exports are coffee, hides and skins, live animals, pulses, oilseeds and gold. The main destinations of exports are Germany, Japan, Yemen and Djibouti.

Imports: Major imports include foodstuffs, beverages, vehicles, machinery, aircraft, petroleum products and chemicals. The main origins of exports are USA, USSR, Italy and Germany. About 25 percent of domestic food requirements are met through humanitarian food aid and commercial food imports. Within declining agricultural production and exportable surpluses, food and other essential imports (e.g., energy, machinery and spare parts) are and will be severely constrained.

Tourism: Major tourist attractions include sights in Addis Ababa, Blue Nile Gorge, Bahar Dar, Tississat Blue Nile Falls, Lalibela and Axum. At least 7 mammals and 21 birds are endemic to Ethiopia. Tourist arrivals are estimated at about 60 000, spending about US $7 million in each year. Although the volume of tourism dropped during the periods of civil and rebel activity, hotel occupancy rates remained high largely due to the flood of relief aid workers. Visas and yellow fever and cholera vaccinations are required for entry into the country. Malaria suppressants are recommended. It is generally hot in lowlands and temperate in highlands. A light wrap is suitable year-round and a raincoat may be necessary between June and September. The average official exchange rate was, in 1994, about 6.20 birr = US $1. Previously, political instability and banditry along key roads deterred visitors. However, planners are very keen to develop holiday resorts, hotels and other infrastructure to attract more tourists.

Roads and Railways: Roads and railways have been major targets and casualties during civil and international wars. Constant rebel activity had rendered most of the major roads and railway networks damaged and unusable for extended periods. Rehabilitation and maintenance efforts have also been directly hampered. In times of famine, relief programs have placed heavy burdens on the transport network. Paradoxically, poor infrastructure also hampered relief supplies reaching the remote cut-off places, raising the numbers of famine victims. However, there are now ambitious programs to rehabilitate damaged infrastructure and undertake new ventures.

Farm production and internal markets: Due to improved security in most of the country, there has been tremendous increase in area planted and harvested volume for the last three years. Better distribution of farm inputs such as fertilisers and deregulated and improved farm gate prices have resulted in marked increase in cereal and pulse production. However, despite improvements in harvests and prices, the drought-prone regions (Gonder, Hararghe, Omo, Tigray and Wollo) still face significant structural food deficits. Price differentials coupled with deregulated transport are encouraging traders to transfer grain from surplus to deficit regions but is only a partial solution to the food problem. Food prices have remained relatively static as output volume has increased.

A1.4 New Economic Policy (Agricultural sector highlights)

With reference to the agricultural sector, the transitional government introduced a new economic policy (NEP) in 1991 to address issues related to land ownership, liberalisation of input and agricultural commodity markets, conservation and development of natural resources, institutional support services and other

incentives to make the farming community responsive to reform and better farming techniques.

Land Ownership: The NEP will assist in re-allocation of land to the landless, ensure the existing right of occupation and the ability to pass that right to the next of kin, and attempt to prevent further fragmentation of land holdings. Where State Farms are of no strategic importance to the economy, they will either (i) be handed over to those people around or working on the state farm, or (ii) be sold to private investors or moveable assets be sold and the land returned to the local people.

Improved Farming Techniques: The NEP will create conditions that private capital will be sought to expand and develop large scale farming enterprises based on modern farming techniques. Land may be occupied, either individually or on joint venture basis, provided that land use does not run into conflict with the interests of local farmers.

Access to Free Markets: Farmers will have the right to sell on the free market at competitive prices although Government will still act to prevent excessive price fluctuations in grains. The agricultural taxation systems will be revised and tax collection methods be improved.

Special Support Services: Increased budgetary support will be provided to assist small farmers with the construction of rural roads, price stabilisation, distribution and use of fertiliser, improved seed and provision of extension services. The special needs of nomadic people will be recognised and protected while land resettlement will be based on goodwill and co-operation

Conservation and Development of Natural Resources: Priority will be given to the conservation and development of forestry and livestock resources. Policies will be implemented that will optimise the use of the range lands, prevent further land degradation, encourage range lands research and promote use of modern inputs.

Despite sounding ambitious, the NEP was introduced against a background of political instability, the shift from a centrally planned socialist structure towards a free market economic structure has been slow and tentative. With considerable donor support from the World Bank, African Development Bank and bilateral funds for economic reconstruction and recovery programs, there has been some progress on some of the NEP objectives such deregulation of grain prices. Others are long-term goals that will depend on adjustments to political, social and economic realities and challenges.

Source: ILCA (1990), E.I.U. (1990-1993), FAO (1992), Negussie and Lemma (1992)

Appendix 2 Questionnaire on Household Resource Endowment

International Livestock Centre For Africa (Ilca)

University Of New England, Armidale

Crop-Livestock Integration[1] In The Ethiopian Highlands

Farmer's Name _____

Farmer's Number _____

Enumerator's Name _____

Peasant Association _____

Village _____

Settlement Pattern _____

Distance from main road _____ Kms

Date(s) of Interview _____

_____

Checked by _____

Data entered by _____

Data Entry validated by _____

[1] Except for variables that assume continuous values, all entries were coded and have been excluded from the appendix for purposes of brevity.

Household Characteristics

	Name	Age (years)	Sex	Marital Status	Relationship to household head	Residence	Work Type	Religion
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Land Size and Land Use (Including Pasture Land, Waste Land)

Field Number	Field Type	Distance from house (Kms)	Size (Ha)	Main Soil Type	Fertiliser type used	Method of fertiliser application	Crops grown	Years field has been used	Remarks
Rented Land Or Exchanged Land								Type and Amount of Payment	

Livestock Herd Structure

Animal type	Present Number		Number of animals bought				Number of animals sold				Ribi taken in		Ribi taken out	
	Local	Crosses	Number		Cost		Number		Price		Number		Number	
	(L)	(X)	L	X	L	X	L	X	L	X	L	X	L	X
Cows														
Heifers														
Calves														
Oxen														
Ewes														
Rams														
Donkeys														
Mules														
Chicken														

Importance of Rainfall to Crop Farming

Which crops do you plant when expecting a bad Belg or a bad meher (*Crops planted*)? Why (*Reason for crop choice*)?

Which crops do you plant when expecting a good Belg or a good Meher (*Crops planted*)? Why (*Reason for crop choice*)?

How do you plant during a bad year or a good year (*Farming plan*)? What are the benefits / problems of the plan?

How do you recognise a good and bad year? (*Description of the year*)

Season	Crop planted			Reason (s) for crop choice			farming plan			Benefits of the plan			Problems with the plan			Description of the year	Remarks
BAD BELG																	
BAD MEHER																	
GOOD BELG																	
GOOD MEHER																	

Trees and Afforestation

Do you have your own trees? 01 = Yes 02 = No Which fields are they planted? (*Field Number*)

When were the trees planted (*When planted*) Where do you get seedlings to plant the trees (*source of seedling*)?

Why did you plant trees? (*Reason for planting trees*) why do you not plant trees? (*Reason for not planting trees*)

Have you planted any trees since 1982 (*EC)*? 01 = Yes 02 = No Did you plant trees before 1982 (*EC*)? 01 = Yes 02 = No

Do you use trees for firewood? 01 = Yes 02 = No Do trees stop soil erosion? 01 = Yes 02 = No 03 = Do not know

Name of tree	Field Number	Number of trees	When planted	Source of seedling	Reason for planting trees			Reason for not planting trees		Remarks

Appendix 3 Questionnaire on Farming Practices

Fallow and Soil Burning (guie) Practices

Are some of your field plot left uncultivated during the crop growing period? 01 = Yes, 02 = No

For how many years are the fields left uncultivated (*fallow period*)? Why do you leave some fields uncultivated (*Reason for fallow*)?

For how many years do you cultivate your fields after fallow period (*cultivation period*)?

Do you practice soil burning (*guie*)? 01 = Yes, 02 = No For how many years do you cultivate your fields after *guie (Guie interval)*?

Why do you practice *Guie* (*Reason for guie*)? Which problems does *Guie* cause on your farm (*Guie problems*)?

Field Number	Fallow Period	Reason for Fallow	Cultivation Period	*Guie* interval	Reason for *Guie*	*Guie* Problems	Fallow period 10 years ago	Guie interval 10 years ago	Remarks

Use of Fertilisers and Manure

Are different fields used for specific crops or pasture? 01 = Yes, 02 = No

On which fields is manure or fertiliser applied (*fertiliser types*)?

What is the source of your fertiliser or manure (*source of fertiliser*)?

How many times do you use fertiliser (*Number of times fertiliser used*)?

Which crops are grown on fertilised or manured fields (*crops grown*)?

If chemical fertilisers are not used, why (*reason for non-use of fertiliser*)?

What alternative methods do you use to improve the soil (*alternatives to fertiliser*)?

Field Number	Ownership type	Fertiliser type used	Source of fertiliser	Number of times fertiliser used	Crops grown				Reason for Non-use of fertiliser	Alternatives to fertilisers	Use of fertiliser alternatives	Factors stopping use of manure
					1	2	3	4				

Soil Erosion

Is soil erosion seen as a problem on your land? 01 = Yes 02 = No

If yes, what are the main causes of soil erosion (*Cause of soil erosion*)?

What are the main effects of soil erosion on your farming activities (*Effects of soil erosion*)?

What have you done (or tried to do) to survive under soil erosion conditions (*Methods to survive under soil erosion*)?

If soil conservation has been tried, for how many years have you tried soil conservation (*Period of soil conservation*)?

What factors stop the use of soil conservation? (*Factors stopping the use of soil conservation*)

Field Number	Main Soil type	Cause of soil erosion	Effects of soil erosion	Methods to survive under soil erosion	Period of soil conservation	Factors stopping use of soil conservation techniques	Remarks

Crop Rotations

Do you plant different crops in same fields? 01 = Yes 02 = No

Do you follow a particular sequence of crop rotations? 01 = Yes 02 = No

Please describe recent crop rotations on your farm (*use table below*).

Why do you follow a particular sequence of crops (*Reason for crop sequence*).

Field Number	Crops Grown																		Reason for crop sequence		Remarks
	1992						1991						1990								
	Meher			Belg			Meher			Belg			Meher			Belg					
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3			

Livestock Production

Are there fields devoted to grazing animals the whole year? 01 = Yes 02 = No How big is the land for grazing _____ (ha).

When do you experience shortage of animal feed (*01 = Yes 02 = No*)? What feeding method do you use in various periods ?

How do you solve problems of shortage of feed and pasture (*Use of animal feeds and alternatives to shortage of feed?)*

		Period of feed scarcity (Yes/No)	Feeding method	use of animal feeds		Other Alternatives to shortage of feed and pasture		
				Feed Type	Source of feed	Alternative	Benefit of Alternative	Problem of alternative
B E L G	Ploughing							
	Weeding							
	Pre-Harvest							
	Harvest							
	Post-Harvest							
M E H E R	Ploughing							
	Weeding							
	Pre-Harvest							
	Harvest							
	Post-Harvest							

Most Important Uses and Sources of Money and Farming Information

When you spend money on crop production, which activities do you consider most important and urgent in crop production (*crop production*)?
When you spend money on livestock production, which activities do you consider most important and urgent in livestock husbandry (*livestock farming*)?
When you spend money on improving your land, which activities do you consider most important and urgent in land improvement (*land improvement*)?
Which is your most important sources of information about farming (*source of information*)? What are the most important uses (*household expenditure*) and sources of income (*source of income*)?

Crop production		Livestock production		Land improvement		Household expenditure		Source of information		Source of income	
Activity	Rank	Activity	Rank	Activity	Rank	Expense	Rank	Source	Rank	Source	Rank
buy seed		Buy cow		Fence farm		Buy food		Neighbour		Crop sales	
buy fertiliser		Buy oxen		Plant trees		School fees		MoA Agent		sale of cattle	
buy manure		Buy donkey		Terraces		Buy radio		Market		Sale of sheep	
hire labour		Buy horse		Fodder		health care		Church		Cowdung cakes	
Hire oxen		Buy sheep		Water-hole		Land tax		Radio		Sale of milk	
Chemicals		Hire pasture		Make dam		Pay edir		Rallies		Off-farm job	
Repair tools		Night shed		Other		*Equb*		From Elders		Rent out land	
Other		Buy Mule				*Kurban*		NGOs		Remittance	
		Buy drugs				Other		Other		Other	

Appendix 4 Questionnaire on Resource Scarcity

Changing Farm Size

Has the size of your farm changed during the last four or five years? 01 = Yes 02 = No

If Yes, what is the reason for change in your farm size (*Reason for change in farm size*)?

What difficulties/benefits do you experience with change in land size (*Effects of change in farm size*)?

Are you now cultivating land that was for grazing livestock a few years ago? 01 = Yes 02 = No

Have you bought land during the last four or three years? 01 = Yes 02 = No

Field Number	Change in farm size	Reason for change in farm size		Effects of change in farm size		Remarks

Shortage of Farm Labour

Season	Field Activity	Labour Shortage Yes/No	Affected crops or Livestock	Solution to Labour Shortage	Cash Payment Yes/No	In-Kind Payment Yes/No
B E L G	Ploughing					
	Sowing					
	Weeding					
	Harvesting					
	Herding					
	watering					
M E H E R	Ploughing					
	Sowing					
	Weeding					
	Harvesting					
	Herding					
	watering					

Shortage of Work Oxen

Season	Field Activity	Oxen Shortage Yes/No	Affected crops	Solution to Oxen Shortage	Cash Payment Yes/No	In-Kind Payment Yes/No
B E L G	Ploughing					
	Sowing					
	Harvesting					
	Threshing					
	Grain Transport					
M E H E R	Ploughing					
	Sowing					
	Harvesting					
	Threshing					
	Grain Transport					

Crop Farming Problems (*circle farmer's responses*)

What major problems do you face with crop farming (*Farming problem*) and (*Nature of the Problem*) ?

What have you tried to do to remove these problems (*solution tried*)?

Does growing crops and keeping livestock remove some of these problems? 01 = Yes 02 = No

	Crop			Farming				
Farming Problem	Weather **Yes/No**	Disease **Yes/No**	Pests **Yes/No**	Market **Yes/No**	Labour shortage **Yes/No**	Small land **Yes/No**	Lack of oxen **Yes/No**	Land not fertile **Yes/No**
NATURE OF THE PROBLEM	01=waterlogging	01=scales	01=weeds	01=Low price	01= weeding	01=No food	01= No cultn	01=No food
	02= too cold	02 Root rot	02=birds	02=Bad roads	02=Herding	02=No grass	02= No hired oxen	02=soil erosion
	03=rain risk	03 =	03=Rats	03=No credit	03=Others	03=No fallow	03=No money	03= many weeds
	04 =	04 =	04=Animals	04=No inputs	04 =	04=No hired land	04=No food	04=No hired land
SOLUTION TRIED	01 = Drainage	01 = spray	01 = spray crops	01 = diff. dates	01 = hire labour	01=hire land	01 = hire oxen	01 = hire land
	02 =stagger sow	02 = new crops	02 = new crops	02 = diff. places	02 =Debo	02=land exch	02 = mekenajo	02=land exch
	03 = irrigation	03 = rotation	03 = rotation	03 = store crop	03=employ worker	03 = buy land	03 = buy ox	03 = buy land
	04 = build dam	04 = Idari	04 = Idari	04 =	04 = *Ribi Out*	04 =	04 = *Ribi in*	04 = use manure
	05=diff. crops	05 =	05 = bird scare	05 =	05 =	05 =	05 =	05= use fert
	06=diff. fields	06 =	06 = plough	06 =	06 =	06 =	06 =	06 =

Livestock Farming Problems

What major problems do you face with livestock farming (*Farming problem*) and (*Nature of the Problem*)? What have you tried to overcome these problems (*Solution tried*)? Does growing crops and keeping livestock remove some of these problems? 01 = Yes 02 = No

	Livestock		Farming			
Farming Problem	Weather Yes/No	Disease Yes/No	Pests Yes/No	Market Yes/No	Labour shortage Yes/No	Small land Yes/No
Nature of the Problem	01 = waterlogging)	01 = Pneumonia	01 = Hyenas	01=low price	01 = milking	01 = Not food
	02 = too cold	02 = Foot and Mouth	02 = Birds	02=Bad roads	02 = Herding	02=No grass
	03= rain risk	03 = Black leg	03 = Flukes	03=No credit	03 = Others	03=No fallow
	04 =	04 =	04 =	04=No inputs	04 =	04=No hired land
SOLUTION ATTEMPTED	01 = Drainage	01 = Vaccinate	01 = traps	01=diff dates	01=hire labor	01 = hire land
	02=diff fields	02 = fence fields	02 = Enclose	02=diff places	02 =Debo	02 = land exchange
	03 = try irrigation	03 = rotn graze	03=chemicals	03 = store	03 = employ worker	03 = buy land
	04 = build dam	04 = drugs	04=bird scare	04 =	04 = *Ribi Out*	04 =
	05= Road graze	05 =	05 =	05 =	05 =	05 =

Other Sources of Income

Because of these problems, do engage in some other income-earning activities? 01 = Yes 02 = No

What are your other sources of income?

Month (EC)	Source of other household income	Amount	Units of Amount	Number of times received	Remarks

Appendix 5 Questionnaire on Crop-Livestock Production

Crop Production

Field No. _____ Toposequence _____

Field Type _____ Distance from House _____ Km.

Plot No. _____ Land ownership type _____

Area (M^2) _____ Crop Grown _____

Soil type _____ Crop variety _____

Date	Field operation	Labour use								Animal traction Use					Input Use and Farm Output					Area Covered (M^2)
		Source	Male		Female		Child		Cost (EB)	Source	Animal Type	No.	Hrs	Cost (EB)	Type of input or output	Source	Qty (Units)	Cost (EB)	Total cost (EB)	
			No	Hrs	No	Hrs	No	Hrs												

Livestock Production

Animal Type _____

Breed 01 = Local 02 = Crossbreed 03 = Pure imported (Exotic)

Number of Animals 01 = ____ 02 = _____ 03 = _____

Date	Activity	Labour use in Livestock production										Input use and farm output				
		Source	Male		Female		Child(7-15 yrs)		Child (under 7)		Cost	Type of input or output	source	Qty (Units)	Cost (EB)	No. of animals given input
			No	Hrs	No	Hrs	No	Hrs	No	Hrs	(EB)					

Milk Production

How many milking cows do you have _____

What is the average amount of milk produced by one cow in one day _____ (litres)

For how long do your cows keep producing milk? _____ (months) for a local cow, _____ (months) for a crossbred cow

How much milk do you use at home:

(a) when your own cows are producing milk _____ (lts) per day

(b) when your cows are not producing milk _____ (lts) per day

Date (EC)	Number of cows	Breed	Milk (Lts) Produced		Milk consumed	Milk sold	Price of milk	Amount Milk Processed			Remarks
			Morning	Evening	(lts)	(lts)	(EB/lt)	Butter (kgs)	Cheese (Kgs)	Whey (Lts)	

Household Food Consumption

Which are your most important food items? 1._____ 2. _____ 3. _____ (*Ask about milk if not mentioned*)

In general, how much food do you use (*eat*) in one day? How frequently do you use (*eat*) the food items (*Rate of consumption*)?

Do you buy any food items? 01 = Yes, 02 = No

Date (*EC*)	Food item	Amount of food item eaten						Remarks
		Amount		Units		Rate of consumption		
		Adults	Children	Adults	Children	Adults	Children	

Crop Sales and Storage

Date (*EC*)	Crop Type	Amount of **grain sold**			Amount of grain **stored**		Amount of **crop residue sold**			Amount of **crop residue stored**		Remarks
		Amount	Units	Price	Amount	Units	Amount	Units	Price	Amount	Units	

Selling / Buying of Live Animals

Date (*EC*)	Livestock type	Number of animals sold					Number of animals bought					Remarks
		Number	Price	Use of money received			Number	Cost	Source of money used			

Income from Sale of Livestock Products

Date (*EC*)	Livestock type	Product type	Amount of Product sold						Amount stored		Remarks
			Amount	Units	Price	Use of money received			Amount	Units	

Sources of Cooking Energy

What do you use for cooking (energy type)?

Date (*EC*)	Energy type	Amount used		Source of energy type	Rate of use	Cost (*birr*)	Cow dung cakes sold		Price	Remarks
		Amount	Unit				Number	Unit		

Purchase of Farm Inputs

Date (EC)	Input type	Amount purchased	Units	Cost (EB)	Rate of purchase	Use of input	Remarks

Expenditure on Household Items

Date (EC)	Type of item	Amount purchased	Units	Cost (EB)	Rate of purchase	Remarks

Field Notebook Observations - Crop Production

Field No. _____ Land ownership type ____ Field Type _____ Distance from House ____ Km.
Plot No. _____ Crop Grown ____
Area (M^2) _____ crop variety ____
Soil type _____ Field Operation ____
Date _____ Rain day (Yes/No) _____
Tools used _____,_____,_____

Labour	Family (No.)	Start	End	Hours	Hired (No.)	Start	End	Hours	Cost (EB)	Exchanged (No.)	Start	End	Hours	Input/output Type	Source	Qty (units)	Cost (EB)
Male Adult																	
Female Adult																	
Child (7-15 yrs)																	
Child (under 7 yrs)																	
Oxen (Pair)																	
Single Ox																	
Crossbred Cow																	
Donkey																	
Horse																	
Mule																	

Field Notebook Observations - Livestock Husbandry

Animal Type _____
Breed of animal 01 = Local 02 = Crossbreed 03 = Pure (exotic)
Number of Animals 01 = ____ 02 = _____ 03 = _____
Livestock Activity _____
Tools used _____,_____,_____,_____

Labour	Family (No.)	Start	End	Hours	Hired (No.)	Start	End	Hours	Cost (EB)	Exchanged (No.)	Start	End	Hours	Input/output Type	Source	Qty (units)	Cost (EB)
Male																	
Female																	
Child (7-15 Yrs)																	
Child (under 7 Yrs)																	
Oxen (Pair)																	
Single Ox																	
Crossbred Cow																	
Donkey																	
Horse																	
Mules																	

Appendix 6 Technical Derivation of Livestock Feed Requirements[1]

A6.1 Requirements for sheep

Estimation of energy requirements in feed for sheep, like other livestock, must take into consideration of requirements for growth, production (pregnancy and lactation) and maintenance. The metabolic energy requirements for maintenance ($\mathbf{M_m}$) including a safety margin for grazing sheep are estimated by:

$$M_m = 1.80 + 0.1\,W$$

where **W** is the metabolic body weight. For ewes with single lambs, the energy requirements for maintenance and pregnancy are estimated by:

$$M_m = (1.20 + 0.05\,W)^{e^{0.0072t}}$$

where **t** is the number of days in pregnancy. For growing sheep, the energy requirements are estimated by the following relationship:

$$M_m = 1.20 + 0.15\,W$$

where **W** is the metabolic body weight. For lactating ewes, the energy requirements must consider the energy value of milk and the efficiency of utilisation of metabolic energy for lactation demands. Assuming an energy value of 4.6 m/kg of milk at 0.62 efficiency level of efficiency in utilisation of energy for lactation, a lactating ewe requires 7.8 m/kg of milk.

A6.2 Energy requirements for work oxen

Assuming an average body weight of 300 kg and working approximately 6 hours per day for 3 months in a year, the energy requirements for work oxen are estimated using the relationship:

$$M_m = 8.3 + 0.091\,W$$

where **W** is the metabolic body weight. Allowing for 20 percentage grazing activity, the energy requirements for work oxen are estimated as:

$$M_m = [\,(8.3 + 0.091 * 300) * 1.20\,] + 4\,\frac{mJ}{hr} * 6\,hr = 67\,\frac{mJ}{day}$$

For one year, one work ox requires (42.7 mJ ME /day * 365 days) = 15 695 MJ of ME), an additional traction requirement for (24 mJ/day * 120 days) = 2 880 mJ and is thus required to generate 18 095 mJ of energy per year.

---

[1] Derived from technical discussions with ILCA's Animal Nutrition Research Team. Comments by David Anindo have been very helpful in developing these relationships (Anindo et al 1994).

A6.3 Energy requirements for cattle

The energy requirements for cows are estimated using the relationship:

$$M_m = 8.3 + 0.091\,W$$

where **W** is the metabolic body weight. Allowing for 20 percentage grazing or walking activity, a cow requires approximately 37.26 mJ per day. However, if a cows ration is deficient in energy, the animal will mobilise body tissue reserves to avoid significant body weight loss (which may continue for about 2 months).

Body tissue has an energy value of 26 mJ/kg and can be utilised at an efficiency level of 0.82 for milk production. Each kilogram of body tissue will allow the secretion of 26 * 0.82 = 23.3 mJ as milk. This is equivalent to a dietary energy intake of (21.3 *1.05/0.62) = 36 mJ. Thus 1 kilogram body weight loss is equivalent to 36 mJ of dietary net energy intake. However, body tissue is laid down with higher efficiency in lactating than non-lactating cows. The dietary energy allowance for body weight gain is derived as (26*1.05/0.62) = 42 mJ/kg of body weight gain.

The energy requirements for maintenance and pregnancy can be estimated by the relationship:

$$M_m + 1.13\,e^{0.0106t}$$

where **t** is the gestation period. However, under natural mating conditions and assuming that animals conceive 90 days post partum, this energy calculation procedure may not be necessary when pastures are abundant. This is because lactating animals tend to have depressed appetite during the early phase of lactation (first 10 weeks).

On average and considering growth, maintenance and production requirements, a zebu cow will require about 49.1 mJ/day or an average of about 12 000 mJ/yr. A cross bred cow will require about 21 000 mJ/yr.

Appendix 7 Linear Programming Model Solutions

A7.1 Codes for variables and parameters

BMILK = Purchasing activity for milk

BOXN1D = Rental of oxen in period 1

BOXN3D = Oxen rental in period 3

BOXN4D = Oxen rental in period 4

BR1LY (BR2LY, BR3LY) = Barley grown of LAND1, LAND2, LAND3, respectively

BRLYCONS = Consumption activity for barley

BRLYP = Acreage devoted to barley production

CONSBRLY = Minimum subsistence consumption barley

CONSFPEA = Minium subsistence consumption of field peas

CONSHRSBN = Minimum subsistence consumption horse beans

CONSMANU = Minimum household requirement of cow dung cakes (fuel)

CONSMILK = Minimum subsistence consumption of milk

CONSWHT = Subsistence consumption of wheat

EW1EP = Raising Of Unimproved Indigenous Ewes

EW2EP = Raising Of improved Indigenous Ewes

F1PEA (F2PEA, F3PEA) = Field peas grown on LAND1, LAND2. LAND3, respectively

FEN1U (FEN2U, FEN3U) = Fenugreek grown on LAND1, LAND2, LAND3

FENUP = Acreage devoted to production of fenugreek

FPEACONS = Consumption activity for field peas

FPEAP = Acreage devoted to production of field peas

HAY = Production Of Hay

HRS1BN (HRS2BN, HRS3BN) = Horse beans grown on LAND1, LAND2, LAND3, respectively

HRSBNCONS = Consumption activity for horse beans

HRSBNP = Acreage devoted to horse bean production

L1COW = Keeping local cow on Unimproved pasture

L2COW = Keeping local cow on improved pasture

LAB1T = Family labour in period 1 (Land preparation)

LAB2T = Family labour in period 2 (Weeding time)

LAB3T = Family labour in period 3 (Harvesting time)

LAB4T = Family labour in period 4 (Threshing and storage)

LAMB1P = Local Lambs

LAND1 = Most productive land (*areda* land)

LAND2 = Moderately productive land (*areda* non-productive land)

LAND3 = Distant and less productive land (*yemeda* land)

LCALFP = Local Zebu Calves

LCOWP = Activity of Keeping Local Zebu Cows

LENT1L (LENT2L, LENT3L) = Lentils grown on LAND1, LAND2, LAND3, respectively

LENTCONS = consumption activity of lentils

LENTLP = Acreage devoted to production of lentils

LN1SED (LN2SED, LN3SED) = Linseed grown on LAND1, LAND2, LAND3, respectively

LNSEDP = Acreage devoted to linseed production

LOCOW = Number of Local Zebu Cows

MANUCONS = Consumption activity of cow dung cakes (fuel)

MANUP = Manure Production

MILKCONS = Consumption activity for milk

MILKP = Milk Production

OA1TS (OA2TS, OA3TS) = Oats grown of LAND1, LAND2, LAND3, respectively

OATSP = Acreage devoted to production of oats

OXN1D = Animal traction in period 1 (Ploughing and harrowing)

OXN3D = animal traction in period 3 (Harvesting and transporting)

OXN4D = Animal traction in period 4 (Threshing)

PAS1TURE = Production of local unimproved pasture

PAS2TURE = Production of improved pasture

RAM1P = Keeping Of Unimproved Indigenous Rams

ROTN = Cereal-legume-fallow crop rotation

RQTS = Requirements

SBRLY = Selling activity for barley

SEW1E = Selling activity for unimproved ewes

SEWE = Sale of ewes (undifferentiated byproductivity)

SFENU = Selling activity for fenugreek

SFPEA = Selling activity for field peas

SHE1EP = Keeping unimproved sheep on native pasture

SHE2EP = Keeping improved sheep on improved pasture

SHRSBN = Selling activity for horse beans

SLAB1T = Off-farm wage labour in period 1

SLAB2T = Off-farm wage labour in period 2

SLAMB1 = Selling activity for fattened local lambs

SLCALF = Selling activity for weaned local calves

SLCOW = Selling activity for indigenous zebu cows

SLENTL = Selling activity for lentils

SLNSED = Selling activity for linseed

SMANU = Selling activity for cow dung cakes

SMILK = Selling activity for milk

SOATS = Selling activity for oats

SOXN1D = Renting out oxen in period 1

SOXN3D = Renting out oxen in period 3

SOXN4D = Renting out oxen in period 4

SRAM1 = Selling activity for unimproved rams

SSTRAW = Selling activity for straw

STRAW = Production of Straw

SWHT = Selling activity for wheat

WH1T (WH2T, WH3T) = Wheat grown of LAND1, LAND2, LAND3, respectively

WHTCONS = Consumption activity for wheat

WHTP = Acreage devoted to wheat production

X.L = Derived optimal activity levels

X.M = Marginal value product (shadow prices) of resources and activity levels

X1COW = Keeping crossbred cow on unimproved pasture

X2COW = Keeping crossbred cow on improved pasture

A7.2 Original linear programming matrix

(**partly shown in Table 6.1, column 6.** Other solution procedures followed similar routines with the necessary alterations in activities, coefficients and constraints)

```
  2  * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
  3  * SUBSISTENCE REQUIREMENTS
  4  * TIMELY HIRE OXEN PREVAILING RENTAL RATES FOR TRACTION
  5  * LAND USE RESTRICTIONS

  8    J   ACTIVITIES
  9   /WH1T, BR1LY, OA1TS, F1PEA, LENT1L, HRS1BN, FEN1U, LN1SED, WH2T,
 10   BR2LY, OA2TS, F2PEA, LENT2L, HRS2BN, FEN2U, LN2SED, WH3T, BR3LY,
 11  OA3TS, F3PEA, LENT3L, HRS3BN, FEN3U, LN3SED , WHTCONS, BRLYCONS,
 12  FPEACONS, HRSBNCONS, LENTCONS, SWHT, SBRLY, SOATS, SFPEA,
 13  SLENTL,   SHRSBN, SLNSED, SFENU, BOXN1D, BOXN3D, BOXN4D/
 15
 16    I   CONSTRAINTS
 17  /LAND1, LAND2, LAND3, LAB1T, LAB2T, LAB3T, LAB4T, OXN1D, OXN3D,
 18  OXN4D, ROTN, WHTP, BRLYP, OATSP, FPEAP, LENTLP, HRSBNP, FENUP,
     LNSEDP/
 21    S    SUBSISTENCE NEEDS
 22         /CONSWHT, CONSBRLY, CONSHRSBN, CONSFPEA/
 23
 24   PARAMETERS
 26     R(J) CURRENT UNIT PRICES OF ACTIVITIES (ETHIOPIAN BIRR)
 27   /SWHT 1.35 , SBRLY 0.95, SOATS 0.35, SFPEA 1.15, SLENTL 1.75,
 28   SHRSBN 0.95, SFENU 2.05, SLNSED 1.35, BOXN1D -0.65, BOXN3D -0.35,
 29   BOXN4D -0.35/
 30
 31   B(I) CONSTRAINT SPECIFICATION
 32   /LAND1 1.0, LAND2 0.60, LAND3 0.80, LAB1T 494, LAB2T 410,
     LAB3T 434, LAB4T 446, OXN1D 0, OXN3D 0, OXN4D 0, ROTN 0, WHTP 0,
     BRLYP 0,  OATSP  0, FPEAP 0, LENTLP 0, HRSBNP 0, FENUP 0, LNSEDP 0/

 37   C(S) SUBSISTENCE LEVELS
 38   /CONSWHT 280, CONSBRLY 300, CONSHRSBN 125, CONSFPEA 125/

 41   TABLE A(I,J) USE OF INPUTS PER ACTIVITY
 42          WH1T    BR1LY   OA1TS
 43  LAND1   1.0     1.0     1.0
 44  LAB1T   160     155     115
 45  LAB2T   90      70      50
 46  LAB3T   105     115     90
 47  LAB4T   75      65      55
 48  OXN1D   150     140     110
 49  OXN3D   65      50      55
 50  OXN4D   55      60      50
 51  ROTN    0.5    0.5     0.5
 52  WHTP    -780
 53  BRLYP          -830
 54  OATSP                  -625
 56    +     WH2T    BR2LY   OA2TS
 57  LAND2   1.0     1.0     1.0
 58  LAB1T   160     155     115
 59  LAB2T   90      70      50
 60  LAB3T   105     115     90
 61  LAB4T   75      65      55
 62  OXN1D   150     140     110
 63  OXN3D   65      50      55
 64  OXN4D   55      60      50
 65  ROTN    0.5    0.5     0.5
 66  WHTP    -625
 67  BRLYP          -710
 68  OATSP                  -560
```

```
 71    +     WH3T    BR3LY   OA3TS
 72   LAND3  1.0     1.0     1.0
 73   LAB1T  160     155     115
 74   LAB2T  90      70      50
 75   LAB3T  105     115     90
 76   LAB4T  75      65      55
 77   OXN1D  150     140     110
 78   OXN3D  65      50      55
 79   OXN4D  55      60      50
 80   ROTN   0.5    0.5     0.5
 81   WHTP   -500
 82   BRLYP          -570
 83   OATSP                  -450
 85
 86   +      F1PEA   LENT1L  HRS1BN   FEN1U   LN1SED
 87   LAND1   1.0     1.0     1.0      1.0    1.0
 88   LAB1T   140     110     135      125    90
 89   LAB2T   70      50      60       50     30
 90   LAB3T   110     80      145      70     90
 91   LAB4T   60      60      75       100    40
 92   OXN1D   100     105     110      115    70
 93   OXN3D   45      30       50      40     25
 94   OXN4D   65      45      120      75     45
 95   ROTN    -1      -1      -1       -1
 96   FPEAP  -755
 97   LENTLP         -610
 98   HRSBNP                 -755
 99   FENUP                          -440
100   LNSEDP                                  -660
101
102    +     F2PEA   LENT2L  HRS2BN   FEN2U   LN2SED
103   LAND2   1.0     1.0     1.0      1.0    1.0
104   LAB1T   140     110     135      125    90
105   LAB2T   70      50      60       50     30
106   LAB3T   110     80      145      70     90
107   LAB4T   60      60      75       100    40
108   OXN1D   100     105     110      115    70
109   OXN3D   45      30       50      40     25
110   OXN4D   65      45      120      75     45
111   ROTN    -1      -1     -1        -1
112   FPEAP  -630
113   LENTLP         -510
114   HRSBNP                 -620
115   FENUP                          -360
116   LNSEDP                                  -580
117
118    +     F3PEA   LENT3L  HRS3BN   FEN3U   LN3SED
119   LAND3   1.0     1.0     1.0      1.0    1.0
120   LAB1T   140     110     135      125    90
121   LAB2T   70      50      60       50     30
122   LAB3T   110     80      145      70     90
123   LAB4T   60      60      75       100    40
124   OXN1D   100     105     110      115    70
125   OXN3D   45      30       50      40     25
126   OXN4D   65      45      120      75     45
127   ROTN    -1      -1     -1        -1
128   FPEAP  -530
129   LENTLP         -430
130   HRSBNP                 -530
131   FENUP                          -310
132   LNSEDP                                  -490
133
134    +    BOXN1D  BOXN3D  BOXN4D
135   OXN1D  -1
136   OXN3D          -1
137   OXN4D                  -1
138
```

```
 139    +      WHTCONS  BRLYCONS  HRSBNCONS  FPEACONS  LENTCONS
 140   WHTP       +1
 141   BRLYP              +1
 142   HRSBNP                        +1
 143   FPEAP                                    +1
 144   LENTLP                                             +1
 145
 146    +     SWHT    SBRLY   SOATS
 147  WHTP    +1
 148  BRLYP           +1
 149  OATSP                  +1
 150
 151    +     SFPEA     SLENTL    SHRSBN   SLNSED  SFENU
 152  FPEAP    +1
 153  LENTLP            +1
 154  HRSBNP                       +1
 155  LNSEDP                                 +1
 156  FENUP                                          +1
 157
 158  TABLE M(S,J) SUBSISTENCE REQTS

 159           WHTCONS  BRLYCONS  HRSBNCONS  FPEACONS
 160   CONSWHT    1
 161   CONSBRLY             1
 162   CONSHRSBN                       1
 163   CONSFPEA                                  1
 164
 165   VARIABLES
 166    Z      FARM INCOME
 167    X(J)   ACTIVITY LEVELS
 168           POSITIVE VARIABLE  X;
 169
 170   EQUATIONS
 171    OBJFN            DEFINE OBJECTIVE FUNCTION
 172    SUPPLY (I)       OBSERVE AVAILABILITY OF INPUTS
 173    SUBSIST (S)      SUBSISTENCE LEVELS;
 174
 175   OBJFN..       Z =E= SUM(J, X(J)*R(J));
 176
 177   SUPPLY (I)..  SUM(J, A(I,J) * X(J)) =L= B(I);
 178   SUBSIST (S)..  SUM (J, M(S,J) * X(J)) =G= C(S);
 179   MODEL  FARM /ALL/ ;
 180   SOLVE FARM USING LP MAXIMIZING Z ;
```

SETS

I	CONSTRAINTS
J	ACTIVITIES
S	SUBSISTENCE NEEDS

PARAMETERS

A	USE OF INPUTS PER ACTIVITY
B	CONSTRAINT SPECIFICATION
C	SUBSISTENCE LEVELS
M	SUBSISTENCE REQTS
R	CURRENT UNIT PRICES OF ACTIVITIES (ETHIOPIAN BIRR)

VARIABLES

X	ACTIVITY LEVELS
Z	FARM INCOME

EQUATIONS

OBJFN	DEFINE OBJECTIVE FUNCTION
SUBSIST	SUBSISTENCE LEVELS
SUPPLY	OBSERVE AVAILABILITY OF INPUTS

MODELS

```
OBJFN..  Z - 1.35*X(SWHT) - 0.95*X(SBRLY) - 0.35*X(SOATS) - 1.15*X(SFPEA)
    - 1.75*X(SLENTL) - 0.95*X(SHRSBN) - 1.35*X(SLNSED) - 2.05*X(SFENU)
    + 0.65*X(BOXN1D) + 0.35*X(BOXN3D) + 0.35*X(BOXN4D) =E= 0 ; (LHS = 0)

---- SUPPLY      =L=  OBSERVE AVAILABILITY OF INPUTS

SUPPLY(LAND1)..  X(WH1T) + X(BR1LY) + X(OA1TS) + X(F1PEA) + X(LENT1L)
      + X(HRS1BN) + X(FEN1U) + X(LN1SED) =L= 1 ; (LHS = 0)
SUPPLY(LAND2)..  X(WH2T) + X(BR2LY) + X(OA2TS) + X(F2PEA) + X(LENT2L)
      + X(HRS2BN) + X(FEN2U) + X(LN2SED) =L= 0.6 ; (LHS = 0)
SUPPLY(LAND3)..  X(WH3T) + X(BR3LY) + X(OA3TS) + X(F3PEA) + X(LENT3L)
      + X(HRS3BN) + X(FEN3U) + X(LN3SED) =L= 0.8 ; (LHS = 0)

REMAINING 16 ENTRIES SKIPPED

---- SUBSIST     =G=  SUBSISTENCE LEVELS
SUBSIST(CONSWHT)..  X(WHTCONS) =G= 280 ; (LHS = 0 ***)
SUBSIST(CONSBRLY)..  X(BRLYCONS) =G= 300 ; (LHS = 0 ***)
SUBSIST(CONSHRSBN)..  X(HRSBNCONS) =G= 125 ; (LHS = 0 ***)

REMAINING ENTRY SKIPPED
---- Z           FARM INCOME
                 (.LO, .L, .UP = -INF, 0, +INF)
        1        OBJFN

---- X           ACTIVITY LEVELS

X(WH1T)
                 (.LO, .L, .UP = 0, 0, +INF)
        1        SUPPLY(LAND1)
      160        SUPPLY(LAB1T)
       90        SUPPLY(LAB2T)
      105        SUPPLY(LAB3T)
       75        SUPPLY(LAB4T)
      150        SUPPLY(OXN1D)
       65        SUPPLY(OXN3D)
       55        SUPPLY(OXN4D)
        0.5      SUPPLY(ROTN)
     -780        SUPPLY(WHTP)
X(BR1LY)
                 (.LO, .L, .UP = 0, 0, +INF)
        1        SUPPLY(LAND1)
      155        SUPPLY(LAB1T)
       70        SUPPLY(LAB2T)
      115        SUPPLY(LAB3T)
       65        SUPPLY(LAB4T)
      140        SUPPLY(OXN1D)
       50        SUPPLY(OXN3D)
       60        SUPPLY(OXN4D)
        0.5      SUPPLY(ROTN)
     -830        SUPPLY(BRLYP)
X(OA1TS)
                 (.LO, .L, .UP = 0, 0, +INF)
        1        SUPPLY(LAND1)
      115        SUPPLY(LAB1T)
       50        SUPPLY(LAB2T)
       90        SUPPLY(LAB3T)
       55        SUPPLY(LAB4T)
      110        SUPPLY(OXN1D)
       55        SUPPLY(OXN3D)
       50        SUPPLY(OXN4D)
        0.5      SUPPLY(ROTN)
     -625        SUPPLY(OATSP)

REMAINING 37 ENTRIES SKIPPED
```

MODEL STATISTICS

BLOCKS OF EQUATIONS	3	SINGLE EQUATIONS	24
BLOCKS OF VARIABLES	2	SINGLE VARIABLES	41
NON ZERO ELEMENTS	269		

S O L V E S U M M A R Y

**** SOLVER STATUS	1	NORMAL COMPLETION
**** MODEL STATUS	1	OPTIMAL
**** **OBJECTIVE VALUE**		**825.9297**

OBJFN DEFINE OBJECTIVE FUNCTION

---- EQU SUPPLY OBSERVE AVAILABILITY OF INPUTS

	LOWER	LEVEL	UPPER	MARGINAL
LAND1	-INF	1.000	1.000	973.000
LAND2	-INF	0.600	0.600	798.000
LAND3	-INF	0.800	0.800	658.000
LAB1T	-INF	310.069	494.000	.
LAB2T	-INF	147.777	410.000	.
LAB3T	-INF	231.492	434.000	.
LAB4T	-INF	153.981	446.000	.
OXN1D	-INF	.	.	0.650
OXN3D	-INF	.	.	0.350
OXN4D	-INF	.	.	0.350
ROTN	-INF	-.228	.	.
WHTP	-INF	.	.	1.426
BRLYP	-INF	.	.	1.306
OATSP	-INF	.	.	0.350
FPEAP	-INF	.	.	1.426
LENTLP	-INF	.	.	1.750
HRSBNP	-INF	.	.	1.462
FENUP	-INF	.	.	2.473
LNSEDP	-INF	.	.	1.486

---- EQU SUBSIST SUBSISTENCE LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
CONSWHT	280.000	280.000	+INF	-1.426
CONSBRLY	300.000	300.000	+INF	-1.306
CONSHRSBN	125.000	125.000	+INF	-1.462
CONSFPEA	125.000	125.000	+INF	-1.426

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR Z	-INF	825.930	+INF	.

Z FARM INCOME

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.359	+INF	.
BR1LY	.	.	+INF	-18.239
OA1TS	.	.	+INF	-862.500
F1PEA	.	0.166	+INF	.
LENT1L	.	0.310	+INF	.
HRS1BN	.	0.166	+INF	.
FEN1U	.	.	+INF	.
LN1SED	.	.	+INF	-62.429
WH2T	.	.	+INF	-46.074
BR2LY	.	0.423	+INF	.

OA2TS	.	.	+INF	-710.250
F2PEA	.	.	+INF	-3.228
LENT2L	.	0.177	+INF	.
HRS2BN	.	.	+INF	-22.404
FEN2U	.	.	+INF	-22.818
LN2SED	.	.	+INF	-6.286
WH3T	.	.	+INF	-84.359
BR3LY	.	.	+INF	-42.887
OA3TS	.	.	+INF	-608.750
F3PEA	.	.	+INF	-5.811
LENT3L	.	0.800	+INF	.
HRS3BN	.	.	+INF	-14.007
FEN3U	.	.	+INF	-6.455
LN3SED	.	.	+INF	.
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	.	+INF	-0.076
SBRLY	.	.	+INF	-0.356
SOATS	.	.	+INF	.
SFPEA	.	.	+INF	-0.276
SLENTL	.	623.546	+INF	.
SHRSBN	.	.	+INF	-0.512
SLNSED	.	.	+INF	-0.136
SFENU	.	.	+INF	-0.423
BOXN1D	.	282.943	+INF	.
BOXN3D	.	98.810	+INF	.
BOXN4D	.	133.656	+INF	.

USER: GAMS/PC STUDENT VERSION
General Algebraic Modelling System

A 7.3 Alternative model solutions

```
* MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   3  * MINIMUM SUBSISTENCE RESTRICTIONS
   4  * 20 PERCENT LESS CEREAL YIELD
   5  * 15 PERCENT LESS PULSE YIELD
   6  * LATE CULTIVATION PENALTY
   7  * HIRE OXEN

                [RESULTS ON TABLE 6.1, COLUMN 2 [BASELINE]]

                    --- SOLUTION PROCEDURE CUT HERE ---

MODEL STATISTICS

BLOCKS OF EQUATIONS       3     SINGLE EQUATIONS       23
BLOCKS OF VARIABLES       2     SINGLE VARIABLES       35
NON ZERO ELEMENTS       194

              S O L V E      S U M M A R Y

**** MODEL STATUS      1 OPTIMAL
**** OBJECTIVE VALUE              425.3512

 EXIT -- OPTIMAL SOLUTION FOUND

---- EQU SUPPLY      OBSERVE AVAILABILITY OF INPUTS

         LOWER    LEVEL    UPPER    MARGINAL

LAND1      -INF      1.000     1.000   701.882
LAND2      -INF      0.600     0.600   561.500
LAB1T      -INF    494.000   494.000     0.650
LAB2T      -INF    410.000   410.000     0.850
LAB3T      -INF    175.266   434.000       .
LAB4T      -INF    108.160   446.000       .
OXN1D      -INF          .         .     0.650
OXN3D      -INF          .         .     0.350
OXN4D      -INF          .         .     0.350
ROTN       -INF     -0.177         .       .
WHTP       -INF          .         .     1.638
BRLYP      -INF          .         .     1.493
OATSP      -INF          .         .     0.350
FPEAP      -INF          .         .     1.494
LENTLP     -INF          .         .     1.750
HRSBNP     -INF          .         .     1.518
FENUP      -INF          .         .     2.508
LNSEDP     -INF          .         .     1.445


---- EQU SUBSIST     SUBSISTENCE LEVELS

             LOWER     LEVEL     UPPER    MARGINAL

CONSWHT    280.000   280.000     +INF      -1.638
CONSBRLY   300.000   300.000     +INF      -1.493
CONSHRSBN  125.000   125.000     +INF      -1.518
CONSFPEA   125.000   125.000     +INF      -1.494
```

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.449	+INF	.
BR1LY	.	0.161	+INF	.
OA1TS	.	.	+INF	-752.382
F1PEA	.	0.195	+INF	.
LENT1L	.	.	+INF	-0.382
HRS1BN	.	0.195	+INF	.
FEN1U	.	.	+INF	.
LN1SED	.	.	+INF	-46.427
WH2T	.	.	+INF	-62.685
BR2LY	.	0.339	+INF	.
OA2TS	.	.	+INF	-629.500
F2PEA	.	.	+INF	-8.975
LENT2L	.	0.261	+INF	.
HRS2BN	.	.	+INF	-26.618
FEN2U	.	.	+INF	-22.661
LN2SED	.	.	+INF	.
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	.	+INF	-0.288
SBRLY	.	.	+INF	-0.543
SOATS	.	.	+INF	.
SFPEA	.	.	+INF	-0.344
SLENTL	.	114.768	+INF	.
SHRSBN	.	.	+INF	-0.568
SLNSED	.	.	+INF	-0.095
SFENU	.	.	+INF	-0.458
BOXN1D	.	205.686	+INF	.
BOXN3D	.	80.537	+INF	.
BOXN4D	.	102.539	+INF	.
SLAB1T	.	262.330	+INF	.
SLAB2T	.	296.195	+INF	.

**** REPORT SUMMARY : 0 NONOPT
 0 INFEASIBLE
 0 UNBOUNDED

---- 152 VARIABLE X.L ACTIVITY LEVELS

WH1T	0.449,	BR1LY	0.161,	F1PEA	0.195
HRS1BN	0.195,	BR2LY	0.339,	LENT2L	0.261
WHTCONS	280.000,	BRLYCONS	300.000,	FPEACONS	125.000
HRSBNCONS	125.000,	SLENTL	114.768,	BOXN1D	205.686
BOXN3D	80.537,	BOXN4D	102.539,	SLAB1T	262.330
SLAB2T	296.195				

---- 152 VARIABLE X.M ACTIVITY LEVELS

OA1TS	-752.382,	LENT1L	-0.382,	LN1SED	-46.427
WH2T	-62.685,	OA2TS	-629.500,	F2PEA	-8.975
HRS2BN	-26.618,	FEN2U	-22.661,	LENTCONS	-1.750
SWHT	-0.288,	SBRLY	-0.543,	SFPEA	-0.344
SHRSBN	-0.568,	SLNSED	-0.095,	SFENU	-0.458

```
 * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   3  * MINIMUM SUBSISTENCE RESTRICTIONS
   4  * 20 PERCENT LESS CEREAL YIELD
   5  * 15 PERCENT LESS PULSE YIELD
      * LATE CULTIVATION PENALTY
   7  * LATE HIRE OF RENTAL OXEN
......*AVERAGE CROP YIELDS [NO PRODUCTIVITY DIFFERENCES IN LAND]

                    [RESULTS ON TABLE 6.1, COLUMN 3]

                  --- SOLUTION PROCEDURE CUT HERE ---
MODEL STATISTICS

BLOCKS OF EQUATIONS       3     SINGLE EQUATIONS       22
BLOCKS OF VARIABLES       2     SINGLE VARIABLES       25
NON ZERO ELEMENTS       110

**** SOLVER STATUS     1 NORMAL COMPLETION
**** MODEL STATUS      1 OPTIMAL
**** OBJECTIVE VALUE              520.8511

 EXIT -- OPTIMAL SOLUTION FOUND

                       LOWER     LEVEL     UPPER    MARGINAL
---- EQU OBJFN          .         .         .         1.000

  OBJFN       DEFINE OBJECTIVE FUNCTION

---- EQU SUPPLY      OBSERVE AVAILABILITY OF INPUTS

          LOWER     LEVEL     UPPER    MARGINAL

LAND       -INF      2.400     2.400   745.500
LAB1T      -INF    323.979   494.000       .
LAB2T      -INF    156.208   410.000       .
LAB3T      -INF    246.882   434.000       .
LAB4T      -INF    154.737   446.000       .
ROTN       -INF     -.1607       .         .
WHTP       -INF         .        .       1.575
BRLYP      -INF         .        .       1.418
OATSP      -INF         .        .       0.350
FPEAP      -INF         .        .       1.150
LENTLP     -INF         .        .       1.750
HRSBNP     -INF         .        .       1.493
FENUP      -INF         .        .       2.050
LNSEDP     -INF         .        .       1.350
OXN1D      -INF         .        .       0.650
OXN3D      -INF         .        .       0.350
OXN4D      -INF         .        .       0.350

---- EQU SUBSIST     SUBSISTENCE LEVELS

             LOWER     LEVEL     UPPER    MARGINAL

CONSWHT    280.000   280.000     +INF      -1.575
CONSBRLY   300.000   300.000     +INF      -1.418
CONSHRSBN  125.000   125.000     +INF      -1.493
CONSFPEA   125.000   125.000     +INF      -1.150
```

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WHT	0.210	0.498	+INF	.
BRLY	0.230	0.486	+INF	.
OATS	.	.	+INF	-687.500
FPEA	0.340	0.340	+INF	-170.500
LENTL	0.250	0.740	+INF	.
HRSBN	0.160	0.216	+INF	.
FENU	.	.	+INF	-146.250
LNSED	0.120	0.120	+INF	-113.500
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	.	+INF	-0.225
SBRLY	.	.	+INF	-0.468
SOATS	.	.	+INF	.
SFPEA	.	75.600	+INF	.
SLENTL	.	355.218	+INF	.
SHRSBN	.	.	+INF	-0.543
SLNSED	.	62.400	+INF	.
SFENU	.	.	+INF	.
BOXN1D	.	286.615	+INF	.
BOXN3D	.	107.973	+INF	.
BOXN4D	.	136.774	+INF	.

**** REPORT SUMMARY : 0 NONOPT
0 INFEASIBLE
0 UNBOUNDED

---- 122 VARIABLE X.L ACTIVITY LEVELS

WHT	0.498,	BRLY	0.486,	FPEA	0.340
LENTL	0.740,	HRSBN	0.216,	LNSED	0.120
WHTCONS	280.000,	BRLYCONS	300.000,	FPEACONS	125.000
HRSBNCONS	125.000,	SFPEA	75.600,	SLENTL	355.218
SLNSED	62.400,	BOXN1D	286.615,	BOXN3D	107.973
BOXN4D	136.774				

---- 122 VARIABLE X.M ACTIVITY LEVELS

OATS	-687.500,	FPEA	-170.500,	FENU	-146.250
LNSED	-113.500,	LENTCONS	-1.750,	SWHT	-0.225
SBRLY	-0.468,	SHRSBN	-0.543		

```
  * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   3  * IMPOSE MINIMUM SUBSISTENCE FOOD REQUIREMENTS
   4  * TIMELY HIRE OXEN PREVAILING MARKET RENTAL RATES
   5  * DIFFERENCES IN LAND PRODUCTIVITY
```

[RESULTS ON TABLE 6.1, COLUMN 6]

--- SOLUTION PROCEDURE CUT HERE ---

MODEL STATISTICS

BLOCKS OF EQUATIONS	3	SINGLE EQUATIONS	24
BLOCKS OF VARIABLES	2	SINGLE VARIABLES	41
NON ZERO ELEMENTS	269		

**** SOLVER STATUS 1 NORMAL COMPLETION
**** MODEL STATUS 1 OPTIMAL
****** OBJECTIVE VALUE 825.9297**

EXIT -- OPTIMAL SOLUTION FOUND

	LOWER	LEVEL	UPPER	MARGINAL
---- EQU OBJFN	.	.	.	1.000

---- EQU SUPPLY OBSERVE AVAILABILITY OF INPUTS

	LOWER	LEVEL	UPPER	MARGINAL
LAND1	-INF	1.000	1.000	973.000
LAND2	-INF	0.600	0.600	798.000
LAND3	-INF	0.800	0.800	658.000
LAB1T	-INF	310.069	494.000	.
LAB2T	-INF	147.777	410.000	.
LAB3T	-INF	231.492	434.000	.
LAB4T	-INF	153.981	446.000	.
OXN1D	-INF	.	.	0.650
OXN3D	-INF	.	.	0.350
OXN4D	-INF	.	.	0.350
ROTN	-INF	-0.228	.	.
WHTP	-INF	.	.	1.426
BRLYP	-INF	.	.	1.306
OATSP	-INF	.	.	0.350
FPEAP	-INF	.	.	1.426
LENTLP	-INF	.	.	1.750
HRSBNP	-INF	.	.	1.462
FENUP	-INF	.	.	2.473
LNSEDP	-INF	.	.	1.486

---- EQU SUBSIST SUBSISTENCE LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
CONSWHT	280.000	280.000	+INF	-1.426
CONSBRLY	300.000	300.000	+INF	-1.306
CONSHRSBN	125.000	125.000	+INF	-1.462
CONSFPEA	125.000	125.000	+INF	-1.426

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.359	+INF	.
BR1LY	.	.	+INF	-18.239
OA1TS	.	.	+INF	-862.500
F1PEA	.	0.166	+INF	.
LENT1L	.	0.310	+INF	.
HRS1BN	.	0.166	+INF	.
FEN1U	.	.	+INF	.
LN1SED	.	.	+INF	-62.429
WH2T	.	.	+INF	-46.074
BR2LY	.	0.423	+INF	.
OA2TS	.	.	+INF	-710.250
F2PEA	.	.	+INF	-3.228
LENT2L	.	0.177	+INF	.
HRS2BN	.	.	+INF	-22.404
FEN2U	.	.	+INF	-22.818
LN2SED	.	.	+INF	-6.286
WH3T	.	.	+INF	-84.359
BR3LY	.	.	+INF	-42.887
OA3TS	.	.	+INF	-608.750
F3PEA	.	.	+INF	-5.811
LENT3L	.	0.800	+INF	.
HRS3BN	.	.	+INF	-14.007
FEN3U	.	.	+INF	-6.455
LN3SED	.	.	+INF	.
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	.	+INF	-0.076
SBRLY	.	.	+INF	-0.356
SOATS	.	.	+INF	.
SFPEA	.	.	+INF	-0.276
SLENTL	.	623.546	+INF	.
SHRSBN	.	.	+INF	-0.512
SLNSED	.	.	+INF	-0.136
SFENU	.	.	+INF	-0.423
BOXN1D	.	282.943	+INF	.
BOXN3D	.	98.810	+INF	.
BOXN4D	.	133.656	+INF	.

**** REPORT SUMMARY : 0 NONOPT
0 INFEASIBLE
0 UNBOUNDED

```
   2  * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   3  * SUBSISTENCE REQUIREMENTS
   4  * TIMELY OXEN RENTAL
   6  * SELL SURPLUS FAMILY LABOUR
```

[RESULTS ON TABLE 6.2, COLUMN 3]

--- SOLUTION PROCEDURE CUT HERE ---

MODEL STATISTICS

BLOCKS OF EQUATIONS	3	SINGLE EQUATIONS	24
BLOCKS OF VARIABLES	2	SINGLE VARIABLES	43
NON ZERO ELEMENTS	273		

S O L V E S U M M A R Y

MODEL	FARM	OBJECTIVE	Z
TYPE	LP	DIRECTION	MAXIMIZE
SOLVER	MINOS5	FROM LINE	180

**** SOLVER STATUS 1 NORMAL COMPLETION
**** MODEL STATUS 1 OPTIMAL

****** OBJECTIVE VALUE 1168.3749**

EXIT -- OPTIMAL SOLUTION FOUND

---- EQU SUPPLY OBSERVE AVAILABILITY OF INPUTS

	LOWER	LEVEL	UPPER	MARGINAL
LAND1	-INF	1.000	1.000	859.000
LAND2	-INF	0.600	0.600	684.000
LAND3	-INF	0.800	0.800	544.000
LAB1T	-INF	494.000	494.000	0.650
LAB2T	-INF	410.000	410.000	0.850
LAB3T	-INF	231.492	434.000	.
LAB4T	-INF	153.981	446.000	.
OXN1D	-INF	.	.	0.650
OXN3D	-INF	.	.	0.350
OXN4D	-INF	.	.	0.350
ROTN	-INF	-0.128	.	.
WHTP	-INF	.	.	1.512
BRLYP	-INF	.	.	1.371
OATSP	-INF	.	.	0.350
FPEAP	-INF	.	.	1.474
LENTLP	-INF	.	.	1.750
HRSBNP	-INF	.	.	1.495
FENUP	-INF	.	.	2.495
LNSEDP	-INF	.	.	1.424

---- EQU SUBSIST SUBSISTENCE LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
CONSWHT	280.000	280.000	+INF	-1.512
CONSBRLY	300.000	300.000	+INF	-1.371
CONSHRSBN	125.000	125.000	+INF	-1.495
CONSFPEA	125.000	125.000	+INF	-1.474

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.359	+INF	.
BR1LY	.	.	+INF	-10.423
OA1TS	.	.	+INF	-865.750
F1PEA	.	0.166	+INF	.
LENT1L	.	0.310	+INF	.
HRS1BN	.	0.166	+INF	.
FEN1U	.	.	+INF	.
LN1SED	.	.	+INF	-72.837
WH2T	.	.	+INF	-59.288
BR2LY	.	0.423	+INF	.
OA2TS	.	.	+INF	-713.500
F2PEA	.	.	+INF	-9.272
LENT2L	.	0.177	+INF	.
HRS2BN	.	.	+INF	-26.829
FEN2U	.	.	+INF	-24.591
LN2SED	.	.	+INF	-11.796
WH3T	.	.	+INF	-108.231
BR3LY	.	.	+INF	-52.007
OA3TS	.	.	+INF	-612.000
F3PEA	.	.	+INF	-16.689
LENT3L	.	0.800	+INF	.
HRS3BN	.	.	+INF	-21.382
FEN3U	.	.	+INF	-9.335
LN3SED	.	.	+INF	.
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	.	+INF	-0.162
SBRLY	.	.	+INF	-0.421
SOATS	.	.	+INF	.
SFPEA	.	.	+INF	-0.324
SLENTL	.	623.546	+INF	.
SHRSBN	.	.	+INF	-0.545
SLNSED	.	.	+INF	-0.074
SFENU	.	.	+INF	-0.445
BOXN1D	.	282.943	+INF	.
BOXN3D	.	98.810	+INF	.
BOXN4D	.	133.656	+INF	.
SLAB1T	.	183.931	+INF	.
SLAB2T	.	262.223	+INF	.

```
   2  * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   4  * USE OWN OXEN FOR CULTIVATION
   5  * MINIMUM SUBSISTENCE FOOD REQUIREMENTS
   7  * RESTRICT FUEL REQUIREMENTS
   8  * LAND PRODUCTIVITY DIFFERENCES
```

[RESULTS ON TABLE 6.2, COLUMN 4]

--- SOLUTION PROCEDURE CUT HERE ---

MODEL STATISTICS

BLOCKS OF EQUATIONS	3	SINGLE EQUATIONS	35
BLOCKS OF VARIABLES	2	SINGLE VARIABLES	59
NON ZERO ELEMENTS	354		

S O L V E S U M M A R Y

**** MODEL STATUS 1 OPTIMAL

****** OBJECTIVE VALUE 803.8794**

EXIT -- OPTIMAL SOLUTION FOUND.

---- EQU SUPPLY OBSERVE AVAILABILITY OF INPUTS

	LOWER	LEVEL	UPPER	MARGINAL
LAND1	-INF	1.000	1.000	1032.754
LAND2	-INF	0.600	0.600	714.566
LAND3	-INF	0.800	0.800	434.332
LAB1T	-INF	494.000	494.000	0.650
LAB2T	-INF	410.000	410.000	0.850
LAB3T	-INF	214.868	434.000	.
LAB4T	-INF	144.808	446.000	.
OXN1D	-INF	216.000	216.000	1.694
OXN3D	-INF	190.000	190.000	0.350
OXN4D	-INF	195.000	195.000	0.350
ROTN	-INF	-0.295	.	.
WHTP	-INF	.	.	1.700
BRLYP	-INF	.	.	1.482
OATSP	-INF	.	.	1.660
FPEAP	-INF	.	.	1.496
LENTLP	-INF	.	.	1.750
HRSBNP	-INF	.	.	1.545
FENUP	-INF	.	.	2.559
LNSEDP	-INF	.	.	1.350
STRAW	-INF	.	.	0.188
HAY	-INF	.	.	0.258
EW1EP	-INF	.	.	75.000
RAM1P	-INF	.	.	125.000
LAMB1P	-INF	.	.	55.000
LCOWP	-INF	.	.	1000.000
LCALFP	-INF	.	.	250.000
MILKP	-INF	.	.	1.250
MANUP	-INF	.	.	0.100

---- EQU SUBSIST SUBSISTENCE LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
CONSWHT	280.000	280.000	+INF	-1.700
CONSBRLY	300.000	300.000	+INF	-1.482
CONSHRSBN	125.000	125.000	+INF	-1.545
CONSFPEA	125.000	125.000	+INF	-1.496
CONSMANU	1000.000	1000.000	+INF	-0.100
CONSMILK	150.000	150.000	+INF	-1.250

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.359	+INF	.
BR1LY	.	0.020	+INF	.
OA1TS	.	.	+INF	-151.435
F1PEA	.	.	+INF	-130.114
LENT1L	.	.	+INF	-189.314
HRS1BN	.	.	+INF	-62.528
FEN1U	.	.	+INF	-156.626
LN1SED	.	.	+INF	-368.942
WH2T	.	.	+INF	-27.643
BR2LY	.	0.399	+INF	.
OA2TS	.	.	+INF	.
F2PEA	.	.	+INF	-25.251
LENT2L	.	.	+INF	-49.889
HRS2BN	.	0.197	+INF	.
FEN2U	.	.	+INF	-68.133
LN2SED	.	.	+INF	-183.744
WH3T	.	.	+INF	-61.058
BR3LY	.	.	+INF	-25.819
OA3TS	.	.	+INF	-27.897
F3PEA	.	0.236	+INF	.
LENT3L	.	0.558	+INF	.
HRS3BN	.	0.006	+INF	.
FEN3U	.	.	+INF	.
LN3SED	.	.	+INF	.
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	.	+INF	-0.350
SBRLY	.	.	+INF	-0.532
SOATS	.	.	+INF	-1.310
SFPEA	.	.	+INF	-0.346
SLENTL	.	240.052	+INF	.
SEW1E	.	0.212	+INF	.
SRAM1	.	0.053	+INF	.
SLAMB1	.	1.646	+INF	.
SLCOW	.	.	+INF	.
SLCALF	.	.	+INF	.
SMILK	.	.	+INF	-0.100
SHRSBN	.	.	+INF	-0.595
SLNSED	.	.	+INF	EPS
SFENU	.	.	+INF	-0.509
SMANU	.	265.262	+INF	.
PAS1TURE	.	0.621	+INF	.
PAS2TURE	.	0.005	+INF	.
OXEN	0.990	0.990	+INF	-593.301
LOCOW	.	.	+INF	-50.237
SHE1EP	.	1.062	+INF	.
MANUCONS	.	1000.000	+INF	.
MILKCONS	.	150.000	+INF	.
BMILK	.	150.000	+INF	.
SSTRAW	.	.	+INF	-0.088
SLAB1T	.	212.350	+INF	.
SLAB2T	.	264.891	+INF	.
SOXN1D	.	.	+INF	-1.044
SOXN3D	.	109.219	+INF	.
SOXN4D	.	86.354	+INF	.

**** REPORT SUMMARY : 0 NONOPT
0 INFEASIBLE
0 UNBOUNDED

INPUT C:\JOMITI\GAMS\TB62C42R
OUTPUT C:\JOMITI\GAMS\TB62C42R.LST

```
   2  * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   3  * RENT WORK OXEN
   4  *MINIMUM SUBSISTENCE FOOD REQUIREMENTS
   5  * INTRODUCE LOCAL CATTLE  ON CROP FARMS
   6  * MAINTAIN LAND PRODUCTIVITY DIFFERENCES
```

[RESULTS ON TABLE 6.3, COLUMN 1]

--- SOLUTION PROCEDURE CUT HERE ---

MODEL STATISTICS

BLOCKS OF EQUATIONS	3	SINGLE EQUATIONS	32
BLOCKS OF VARIABLES	2	SINGLE VARIABLES	52
NON ZERO ELEMENTS	322		

S O L V E S U M M A R Y

**** SOLVER STATUS 1 NORMAL COMPLETION
**** MODEL STATUS 1 OPTIMAL
****** OBJECTIVE VALUE 983.3197**

---- EQU SUPPLY OBSERVE AVAILABILITY OF INPUTS

	LOWER	LEVEL	UPPER	MARGINAL
LAND1	-INF	1.000	1.000	1708.250
LAND2	-INF	0.600	0.600	1304.890
LAND3	-INF	0.800	0.800	750.788
LAB1T	-INF	341.042	494.000	.
LAB2T	-INF	154.146	410.000	.
LAB3T	-INF	234.327	434.000	.
LAB4T	-INF	163.005	446.000	.
OXN1D	-INF	.	.	0.650
OXN3D	-INF	.	.	0.350
OXN4D	-INF	.	.	0.350
ROTN	-INF	.	.	92.788
WHTP	-INF	.	.	1.350
BRLYP	-INF	.	.	0.950
OATSP	-INF	.	.	1.374
FPEAP	-INF	.	.	1.321
LENTLP	-INF	.	.	1.750
HRSBNP	-INF	.	.	1.123
FENUP	-INF	.	.	2.296
LNSEDP	-INF	.	.	1.675
STRAW	-INF	.	.	0.863
HAY	-INF	.	.	0.332
EW1EP	-INF	.	.	75.000
RAM1P	-INF	.	.	125.000
LAMB1P	-INF	.	.	55.000
LCOWP	-INF	.	.	1000.000
LCALFP	-INF	.	.	250.000
MILKP	-INF	.	.	1.150

---- EQU SUBSIST SUBSISTENCE LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
CONSWHT	280.000	280.000	+INF	-1.350
CONSBRLY	300.000	300.000	+INF	-0.950
CONSHRSBN	125.000	125.000	+INF	-1.123
CONSFPEA	125.000	125.000	+INF	-1.321

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.322	+INF	.
BR1LY	.	0.678	+INF	.
OA1TS	.	.	+INF	-158.771
F1PEA	.	.	+INF	-117.405
LENT1L	.	.	+INF	-211.106
HRS1BN	.	.	+INF	-36.119
FEN1U	.	.	+INF	-219.643
LN1SED	.	.	+INF	-672.699
WH2T	.	0.187	+INF	.
BR2LY	.	.	+INF	-193.758
OA2TS	.	.	+INF	.
F2PEA	.	0.198	+INF	.
LENT2L	.	0.012	+INF	.
HRS2BN	.	0.202	+INF	.
FEN2U	.	.	+INF	.
LN2SED	.	.	+INF	-403.345
WH3T	.	.	+INF	-261.682
BR3LY	.	.	+INF	-385.182
OA3TS	.	.	+INF	-287.193
F3PEA	.	.	+INF	-61.157
LENT3L	.	0.387	+INF	.
HRS3BN	.	.	+INF	-193.974
FEN3U	.	.	+INF	-61.095
LN3SED	.	.	+INF	.
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	88.198	+INF	.
SBRLY	.	262.899	+INF	.
SOATS	.	.	+INF	-1.024
SFPEA	.	.	+INF	-0.171
SLENTL	.	172.987	+INF	.
SEW1E	.	.	+INF	.
SRAM1	.	.	+INF	.
SLAMB1	.	.	+INF	.
SLCOW	.	0.198	+INF	.
SLCALF	.	0.337	+INF	.
SMILK	.	237.600	+INF	.
SHRSBN	.	.	+INF	-0.173
SLNSED	.	.	+INF	-0.325
SFENU	.	.	+INF	-0.246
PAS1TURE	.	.	+INF	-426.007
PAS2TURE	.	.	+INF	-354.806
PAS3TURE	.	0.412	+INF	.
BOXN1D	.	255.359	+INF	.
BOXN3D	.	98.023	+INF	.
BOXN4D	.	123.793	+INF	.
LOCOW	0.990	0.990	+INF	-1151.498
SHE1EP	.	.	+INF	-214.090

**** REPORT SUMMARY : 0 NONOPT
0 INFEASIBLE
0 UNBOUNDED

```
   2  * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   3  * RENT WORK OXEN
   4  * IMPOSE MINIMUM SUBSISTENCE FOOD REQUIREMENTS
   5  * INTRODUCE DAIRY ZEBU COWS  ON CROP FARMS
   6  * REMOVE LAND USE CONSTRAINT (PRODUCTIVITY DIFFERENCES MAINTAINED)
```

[RESULTS ON TABLE 6.3, COLUMN 2]

--- SOLUTION PROCEDURE CUT HERE ---

MODEL STATISTICS

BLOCKS OF EQUATIONS	3	SINGLE EQUATIONS	32
BLOCKS OF VARIABLES	2	SINGLE VARIABLES	56
NON ZERO ELEMENTS	358		

**** MODEL STATUS 1 OPTIMAL

****** OBJECTIVE VALUE 1072.1237**

EXIT -- OPTIMAL SOLUTION FOUND.

---- EQU SUPPLY OBSERVE AVAILABILITY OF INPUTS

	LOWER	LEVEL	UPPER	MARGINAL
LAND1	-INF	1.000	1.000	1732.482
LAND2	-INF	0.600	0.600	1329.122
LAND3	-INF	0.800	0.800	702.324
LAB1T	-INF	361.477	494.000	.
LAB2T	-INF	167.106	410.000	.
LAB3T	-INF	246.866	434.000	.
LAB4T	-INF	172.919	446.000	.
OXN1D	-INF	.	.	0.650
OXN3D	-INF	.	.	0.350
OXN4D	-INF	.	.	0.350
ROTN	-INF	.	.	44.324
WHTP	-INF	.	.	1.350
BRLYP	-INF	.	.	0.950
OATSP	-INF	.	.	1.374
FPEAP	-INF	.	.	1.437
LENTLP	-INF	.	.	1.750
HRSBNP	-INF	.	.	1.240
FENUP	-INF	.	.	2.494
LNSEDP	-INF	.	.	1.350
STRAW	-INF	.	.	0.863
HAY	-INF	.	.	0.213
EWEP	-INF	.	.	75.000
RAMP	-INF	.	.	125.000
LAMBP	-INF	.	.	55.000
LCOWP	-INF	.	.	1000.000
LCALFP	-INF	.	.	250.000
MILKP	-INF	.	.	1.150

---- EQU SUBSIST SUBSISTENCE LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
CONSWHT	280.000	280.000	+INF	-1.350
CONSBRLY	300.000	300.000	+INF	-0.950
CONSHRSBN	125.000	125.000	+INF	-1.240
CONSFPEA	125.000	125.000	+INF	-1.437

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.403	+INF	.
BR1LY	.	0.597	+INF	.
OA1TS	.	.	+INF	-158.771
F1PEA	.	.	+INF	-102.981
LENT1L	.	.	+INF	-283.802
HRS1BN	.	.	+INF	-20.290
FEN1U	.	.	+INF	-205.624
LN1SED	.	.	+INF	-911.482
WH2T	.	0.309	+INF	.
BR2LY	.	.	+INF	-193.758
OA2TS	.	.	+INF	.
F2PEA	.	0.090	+INF	.
LENT2L	.	.	+INF	-72.696
HRS2BN	.	0.202	+INF	.
FEN2U	.	.	+INF	-1.748
LN2SED	.	.	+INF	-616.122
WH3T	.	.	+INF	-188.986
BR3LY	.	.	+INF	-312.486
OA3TS	.	.	+INF	-214.497
F3PEA	.	0.129	+INF	.
LENT3L	.	0.379	+INF	.
HRS3BN	.	.	+INF	-131.831
FEN3U	.	.	+INF	.
LN3SED	.	.	+INF	-110.824
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	227.614	+INF	.
SBRLY	.	195.234	+INF	.
SOATS	.	.	+INF	-1.024
SFPEA	.	.	+INF	-0.287
SLENTL	.	163.158	+INF	.
SEWE	.	.	+INF	.
SRAM	.	.	+INF	.
SLAMB	.	.	+INF	.
SLCOW	.	0.198	+INF	.
SLCALF	.	0.337	+INF	.
SMILK	.	237.600	+INF	.
SHRSBN	.	.	+INF	-0.290
SLNSED	.	.	+INF	.
SFENU	.	.	+INF	-0.444
PAS1TURE	.	.	+INF	-689.223
PAS2TURE	.	.	+INF	-498.947
PAS3TURE	.	0.291	+INF	.
BOXN1D	.	274.270	+INF	.
BOXN3D	.	107.440	+INF	.
BOXN4D	.	130.469	+INF	.
L1COW	0.990	0.990	+INF	-1032.423
L2COW	.	.	+INF	-1015.582
SHE1EP	.	.	+INF	-178.368
SHE2EP	.	.	+INF	-278.106
X1COW	.	.	+INF	-586.358
X2COW	.	.	+INF	-440.331

**** REPORT SUMMARY : 0 NONOPT
0 INFEASIBLE
0 UNBOUNDED

INPUT C:\JOMITI\GAMS\TB63C21R
OUTPUT C:\JOMITI\GAMS\TB63C21R.LST

```
   2  * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   3  * RUMINANT LIVESTOCK  RAISED ON MIXED FARMS
   4  * KEEP WORK OXEN FOR CULTIVATION
   5  *  MINIMUM SUBSISTENCE FOOD REQUIREMENTS
   7  * RESTRICT FUEL REQUIREMENTS
   8  * RETAIN LAND PRODUCTIVITY DIFFERENCES
```

[RESULTS ON TABLE 6.3, COLUMN 4]

--- SOLUTION PROCEDURE CUT HERE ---

S O L V E S U M M A R Y

```
     MODEL   FARM                OBJECTIVE  Z
     TYPE    LP                  DIRECTION  MAXIMIZE
     SOLVER  BDMLP               FROM LINE  190

**** SOLVER STATUS     1 NORMAL COMPLETION
**** MODEL STATUS      1 OPTIMAL
**** OBJECTIVE VALUE              1221.0805
 EXIT -- OPTIMAL SOLUTION FOUND.
```

---- EQU SUPPLY OBSERVE AVAILABILITY OF INPUTS

	LOWER	LEVEL	UPPER	MARGINAL
LAND1	-INF	1.500	1.500	1081.748
LAND2	-INF	1.200	1.200	858.885
LAB1T	-INF	394.132	679.000	.
LAB2T	-INF	275.099	563.000	.
LAB3T	-INF	369.977	596.000	.
LAB4T	-INF	260.732	613.000	.
OXN1D	-INF	405.000	405.000	0.650
OXN3D	-INF	356.000	356.000	0.350
OXN4D	-INF	366.000	366.000	0.350
ROTN	-INF	-0.175	.	.
WHTP	-INF	.	.	1.407
BRLYP	-INF	.	.	1.265
OATSP	-INF	.	.	0.350
FPEAP	-INF	.	.	1.415
LENTLP	-INF	.	.	1.750
HRSBNP	-INF	.	.	1.438
FENUP	-INF	.	.	2.501
LNSEDP	-INF	.	.	1.350
STRAW	-INF	.	.	0.127
HAY	-INF	.	.	0.270
EW1EP	-INF	.	.	75.000
RAM1P	-INF	.	.	125.000
LAMB1P	-INF	.	.	55.000
LCOWP	-INF	.	.	1000.000
LCALFP	-INF	.	.	250.000
MILKP	-INF	.	.	1.250
MANUP	-INF	-1291.461	.	.

---- EQU SUBSIST SUBSISTENCE LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
CONSWHT	400.000	400.000	+INF	-1.407
CONSBRLY	420.000	420.000	+INF	-1.265
CONSHRSBN	160.000	160.000	+INF	-1.438
CONSFPEA	220.000	220.000	+INF	-1.415
CONSMANU	1000.000	1000.000	+INF	EPS
CONSMILK	250.000	250.000	+INF	-1.250

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.513	+INF	.
BR1LY	.	0.168	+INF	.
OA1TS	.	.	+INF	-846.940
F1PEA	.	.	+INF	-28.249
LENT1L	.	.	+INF	-45.326
HRS1BN	.	0.212	+INF	.
FEN1U	.	.	+INF	-22.793
LN1SED	.	.	+INF	-260.748
WH2T	.	.	+INF	-23.785
BR2LY	.	0.395	+INF	.
OA2TS	.	.	+INF	-669.660
F2PEA	.	0.349	+INF	.
LENT2L	.	0.455	+INF	.
HRS2BN	.	.	+INF	-3.017
FEN2U	.	.	+INF	.
LN2SED	.	.	+INF	-145.885
WHTCONS	.	400.000	+INF	.
BRLYCONS	.	420.000	+INF	.
FPEACONS	.	220.000	+INF	.
HRSBNCONS	.	160.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	.	+INF	-0.057
SBRLY	.	.	+INF	-0.315
SOATS	.	.	+INF	.
SFPEA	.	.	+INF	-0.265
SLENTL	.	232.255	+INF	.
SEW1E	.	1.620	+INF	.
SRAM1	.	0.405	+INF	.
SLAMB1	.	12.554	+INF	.
SLCOW	.	.	+INF	.
SLCALF	.	.	+INF	.
SMILK	.	.	+INF	-0.100
SHRSBN	.	.	+INF	-0.488
SLNSED	.	.	+INF	.
SFENU	.	.	+INF	-0.451
PAS1TURE	.	0.607	+INF	.
PAS2TURE	.	.	+INF	-47.574
OXEN	.	.	+INF	-669.718
LOCOW	.	.	+INF	-47.738
SHE1EP	5.900	8.099	+INF	.
MANUCONS	.	1000.000	+INF	.
MILKCONS	.	250.000	+INF	.
BMILK	.	250.000	+INF	.
SOXN1D	.	143.181	+INF	.
SOXN3D	.	254.535	+INF	.
SOXN4D	.	235.382	+INF	.

```
   2  * MODELLING CROP-LIVESTOCK INTEGRATION IN THE ETHIOPIAN HIGHLANDS
   3  * RENT OXEN
   4  * MINIMUM SUBSISTENCE FOOD REQUIREMENTS
   5  * INTRODUCE SHEEP  ON CROP FARMS
   6  * LAND PRODUCTIVITY DIFFERENCES
```

[RESULTS ON TABLE 6.3, COLUMN 5]

--- SOLUTION PROCEDURE CUT HERE ---

MODEL STATISTICS

BLOCKS OF EQUATIONS	3	SINGLE EQUATIONS	32
BLOCKS OF VARIABLES	2	SINGLE VARIABLES	50
NON ZERO ELEMENTS	325		

S O L V E S U M M A R Y

**** SOLVER STATUS	1 NORMAL COMPLETION
**** MODEL STATUS	1 OPTIMAL
**** OBJECTIVE VALUE	1195.2203

EXIT -- OPTIMAL SOLUTION FOUND.

---- EQU SUPPLY OBSERVE AVAILABILITY OF INPUTS

	LOWER	LEVEL	UPPER	MARGINAL
LAND1	-INF	1.000	1.000	1063.277
LAND2	-INF	0.600	0.600	842.176
LAND3	-INF	0.800	0.800	637.966
LAB1T	-INF	313.772	494.000	.
LAB2T	-INF	213.611	410.000	.
LAB3T	-INF	291.539	434.000	.
LAB4T	-INF	207.951	446.000	.
OXN1D	-INF	216.000	216.000	1.091
OXN3D	-INF	80.008	190.000	.
OXN4D	-INF	107.248	195.000	.
ROTN	-INF	-0.394	.	.
WHTP	-INF	.	.	1.406
BRLYP	-INF	.	.	1.260
OATSP	-INF	.	.	1.527
FPEAP	-INF	.	.	1.391
LENTLP	-INF	.	.	1.750
HRSBNP	-INF	.	.	1.390
FENUP	-INF	.	.	2.463
LNSEDP	-INF	.	.	1.458
STRAW	-INF	.	.	0.134
HAY	-INF	.	.	0.266
EW1EP	-INF	.	.	75.000
RAM1P	-INF	.	.	125.000
LAMB1P	-INF	.	.	55.000
LCOWP	-INF	.	.	1000.000
LCALFP	-INF	.	.	250.000
MILKP	-INF	.	.	1.370

---- EQU SUBSIST SUBSISTENCE LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
CONSWHT	280.000	280.000	+INF	-1.406
CONSBRLY	300.000	300.000	+INF	-1.260
CONSHRSBN	125.000	125.000	+INF	-1.390
CONSFPEA	125.000	125.000	+INF	-1.391

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR Z	**-INF**	**1195.220**	**+INF**	.

Z FARM INCOME

---- VAR X ACTIVITY LEVELS

	LOWER	LEVEL	UPPER	MARGINAL
WH1T	.	0.359	+INF	.
BR1LY	.	0.361	+INF	.
OA1TS	.	.	+INF	-97.764
F1PEA	.	.	+INF	-28.495
LENT1L	.	.	+INF	-43.425
HRS1BN	.	0.068	+INF	.
FEN1U	.	.	+INF	-27.585
LN1SED	.	.	+INF	-177.485
WH2T	.	.	+INF	-26.886
BR2LY	.	.	+INF	-5.055
OA2TS	.	.	+INF	.
F2PEA	.	0.198	+INF	.
LENT2L	.	0.282	+INF	.
HRS2BN	.	0.119	+INF	.
FEN2U	.	.	+INF	-3.493
LN2SED	.	.	+INF	-73.008
WH3T	.	.	+INF	-98.721
BR3LY	.	.	+INF	-72.272
OA3TS	.	.	+INF	-70.782
F3PEA	.	.	+INF	-9.804
LENT3L	.	0.395	+INF	.
HRS3BN	.	.	+INF	-21.223
FEN3U	.	.	+INF	.
LN3SED	.	.	+INF	.
WHTCONS	.	280.000	+INF	.
BRLYCONS	.	300.000	+INF	.
FPEACONS	.	125.000	+INF	.
HRSBNCONS	.	125.000	+INF	.
LENTCONS	.	.	+INF	-1.750
SWHT	.	.	+INF	-0.056
SBRLY	.	.	+INF	-0.310
SOATS	.	.	+INF	-1.177
SFPEA	.	.	+INF	-0.241
SLENTL	.	313.969	+INF	.
SEW1E	.	1.213	+INF	.
SRAM1	.	0.303	+INF	.
SLAMB1	.	9.399	+INF	.
SLCOW	.	.	+INF	.
SLCALF	.	.	+INF	.
SMILK	.	.	+INF	-0.220
SHRSBN	.	.	+INF	-0.440
SLNSED	.	.	+INF	-0.108
SFENU	.	.	+INF	-0.413
PAS1TURE	.	0.212	+INF	.
PAS2TURE	.	.	+INF	-44.719
PAS3TURE	.	0.405	+INF	.
OXEN	.	.	+INF	-663.974
LOCOW	.	.	+INF	.
SHE1EP	5.900	6.064	+INF	.

**** REPORT SUMMARY : 0 NONOPT
0 INFEASIBLE
0 UNBOUNDED

JOHN MOTURI OMITI
DEPT. OF AGRICULTURAL AND RESOURCE ECONOMICS., UNE

**** FILE SUMMARY

INPUT C:\JOMITI\GAMS\TB63C52R
OUTPUT C:\JOMITI\GAMS\TB63C52R.LST