



National Library  
of Canada

Bibliothèque nationale  
du Canada

Canadian Theses Service    Service des thèses canadiennes

Ottawa, Canada  
K1A 0N4

The author has granted an irrevocable non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of his/her thesis by any means and in any form or format, making this thesis available to interested persons.

The author retains ownership of the copyright in his/her thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without his/her permission.

L'auteur a accordé une licence irrévocable et non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de sa thèse de quelque manière et sous quelque forme que ce soit pour mettre des exemplaires de cette thèse à la disposition des personnes intéressées.

L'auteur conserve la propriété du droit d'auteur qui protège sa thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

ISBN 0-315-54900-9

Canada

THE PROSPECT FOR ETHIOPIA'S SELF SUFFICIENCY IN CEREAL  
PRODUCTION

by

BERHANE GIZAW

A thesis  
presented to the University of Manitoba  
in fulfillment of the  
thesis requirement for the degree of  
MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS  
in  
DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

Winnipeg, Manitoba

(c) BERHANE GIZAW, 1989

October 1989

THE PROSPECT FOR ETHIOPIA'S SELF SUFFICIENCY IN CEREAL PRODUCTION

BY

BERHANE GIZAW

A thesis submitted to the Faculty of Graduate Studies of  
the University of Manitoba in partial fulfillment of the requirements  
of the degree of

MASTER OF SCIENCE

© 1989

Permission has been granted to the LIBRARY OF THE UNIVERSITY OF MANITOBA to lend or sell copies of this thesis, to the NATIONAL LIBRARY OF CANADA to microfilm this thesis and to lend or sell copies of the film, and UNIVERSITY MICROFILMS to publish an abstract of this thesis.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

I hereby declare that I am the sole author of this thesis.

I authorize the University of Manitoba to lend this thesis to other institutions or individuals for the purpose of scholarly research.

BERHANE GIZAW

I further authorize the University of Manitoba to reproduce this thesis by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

BERHANE GIZAW

The University of Manitoba requires the signatures of all persons using or photocopying this thesis. Please sign below, and give address and date.

## ABSTRACT

This study has assessed the prospect for attaining self sufficiency in cereal production in twelve of the fourteen regions of Ethiopia in 1994. Tigrai and Eritrea Regions are not included.

The analysis is based on an econometric model estimated for the production of the five major cereal crops in the country as well as on an estimate of the amount of cereals required to meet the minimum nutritional needs of the population. Due to inadequacy of degrees of freedom the production model was estimated using a pooled time series - cross section data in a covariance model.

The estimate of the production model shows a declining trend in the over all cereal production in all twelve regions. The trend is possibly due to the absence or inadequacy of technical inputs. The highest rate of decline indicated was in Shewa followed by Harerghe and Wello, while the lowest rate was in Bale. In Shewa, production declined by nearly eight times as much as Arssi, where as in Harerghe and Wello it dropped by about four times as much. The rate of decline in Gojjam, Gonder, and Sidamo was nearly three times as much as Arssi, while in Keffa and Wellega it was about twice. Illubabor and Gamogofa show the same rate of

decline as Arssi, where as in Bale it was lower than Arssi. All production increases are indicated to have been due to area expansion and/or rainfall.

Among the five crops included in the study, the trend shows a decline in the production of teff, maize and sorghum where as it shows an increase in wheat production. No trend is indicated in barley production. The result also shows no significant effect of rainfall on the production of teff, barley and wheat. The effect of rainfall on maize was also not significant at the five percent level. It was only on sorghum production that it was significant.

Assuming normal climatic conditions, the 1993 forecasted production of the five major cereal crops in the peasant sector of the country is 7.8 million tonnes. The quantity demanded and supplied in 1994 shows that five regions - Wel-lo, Harerghe, Gonder, Sidamo and Bale - could face a deficit while the remaining seven regions could have a marketable surplus.

The focus of Ethiopia's short term food self sufficiency strategy appears to be on increasing the country's over all production through greater support to high potential areas. The implicit assumption of such an approach is that if adequate grain can be made available at a national level the regional level deficits could be eliminated through redistribution. In peasant economies of the type which exist in

Ethiopia, however, income is low, this limits peasants access to food sold in a market. The problem of income is particularly evident in the deficit regions of Ethiopia following the recent long droughts. Hence, redistribution of surplus food through the market is not a reliable option unless the food is subsidized in the deficit regions.

A doubt is also often cast as to the possibility of generating desired levels of surpluses from peasant agriculture. It is often argued that peasants are not profit motivated and that their desire to expand production beyond the level which meets their food needs and social obligations is limited. Even if surpluses are available, the distribution infrastructure in Ethiopia is also not well developed to be a reliable mechanism for redistribution. In light of so many of these uncertainties, therefore, a viable short term strategy for attaining self sufficiency in cereal production in Ethiopia could be a one which maximizes the remaining potentials for increasing production in the deficit regions, though perhaps at a relatively higher cost, while at the same time encouraging the surplus regions to produce more.

The result of this study shows that the deficit regions still have some potential for production expansion. The potential for higher production in most of the surplus producing regions is also great. A 20% increase over the projected (for 1993) yield levels in the surplus regions could, for example, be enough to offset the anticipated over all deficits of the country.

## ACKNOWLEDGEMENTS

I would like to express my gratitude to all people who helped me complete this thesis. First and foremost I would like to express my thanks and appreciations to my advisor, Dr. D.Kraft, for leading me through the thesis work as well as for the open mindedness and interest he showed in my study. I am also grateful to Dr. J.A.McMillan for his encouragement and interest in my study, and for the useful comments he made on my thesis. I would also like to thank Dr. R.C.McGinnis for his assistance.

Special thanks are due to my friend Gebre Meskel Dessalegn, and my colleagues at the Relief and Rehabilitation Commission (Ethiopia), Melaku Ayalew, Meresiet Woldu and Mesfin Asamere, for their assistance in collecting most of the data I used. Mr G.D.V.Williams, a Canadian agro-climatologist, has also helped me get some useful meteorological data for which I am grateful.

The deepest gratitude goes to my beloved wife, Meaza Kahsai. Not only was the courage and determination she showed during our two years forced separation (after being married for only five months) a source of confidence to me but also that she was instrumental in making sure that I got all the data I needed from home on time.

## CONTENTS

<b>ABSTRACT</b>		iv
<b>ACKNOWLEDGEMENTS</b>		vii
 <u>Chapter</u>		<u>page</u>
<b>I.</b>	<b>BACKGROUND</b>	<b>1</b>
	LOCATION AND DEMOGRAPHIC CHARACTERISTICS	1
	AGRICULTURAL RESOURCES	1
	CLIMATE AND VEGETATION	2
	ECONOMY	4
<b>II.</b>	<b>THE PROBLEM</b>	<b>5</b>
<b>III.</b>	<b>SPECIFIC OBJECTIVES</b>	<b>13</b>
<b>IV.</b>	<b>THEORETICAL FRAME WORK</b>	<b>17</b>
<b>V.</b>	<b>REVIEW OF RELATED STUDIES</b>	<b>26</b>
	REVIEW OF STUDIES RELEVANT TO AFRICA'S FOOD PROBLEMS	26
	STRATEGIC ISSUES IN COMBATING HUNGER AND POVERTY IN AFRICA	28
	GOVERNMENTAL STRATEGIES FOR AGRICULTURAL DEVELOPMENT	29
	FOOD PRODUCTION STRATEGY DEBATES IN REVOLUTIONARY ETHIOPIA	31
	CLIMATE, DROUGHT AND FAMINE IN AFRICA	33
	REVIEW OF METHODS OF ESTIMATING DEMAND AND SUPPLY OF FOOD	36
	AGRICULTURAL COMMODITIES - PROJECTIONS FOR 1975 AND 1985	36
	WORLD FOOD PRODUCTION, DEMAND AND TRADE	40
	5.2.3 EUROPE'S FUTURE FOOD AND AGRICULTURE	42
<b>VI.</b>	<b>THE MODEL AND ITS ESTIMATION METHOD</b>	<b>48</b>
	SUPPLY MODEL	51
	DEMAND MODEL	56
	SOURCES OF DATA	61

<b>VII.</b>	<b>ANALYSIS OF ESTIMATES OF THE MODEL . . . . .</b>	<b>62</b>
	ESTIMATES OF PRODUCTION MODEL . . . . .	65
	AGGREGATE CROP PRODUCTION . . . . .	65
	TEFF PRODUCTION MODEL . . . . .	67
	WHEAT PRODUCTION MODEL . . . . .	69
	BARLEY PRODUCTION MODEL . . . . .	71
	MAIZE PRODUCTION MODEL . . . . .	73
	SORGHUM PRODUCTION MODEL . . . . .	75
	ESTIMATES OF AREA SEEDED MODEL . . . . .	76
	ESTIMATE OF AGGREGATE AREA SEEDED MODEL . . . . .	76
	ESTIMATE OF AREA SEEDED MODEL FOR TEFF . . . . .	78
	ESTIMATE OF AREA SEEDED MODEL FOR WHEAT . . . . .	79
	ESTIMATE OF AREA SEEDED MODEL FOR BARLEY . . . . .	81
	ESTIMATE OF AREA SEEDED MODEL FOR MAIZE . . . . .	82
	ESTIMATE OF AREA SEEDED MODEL FOR SORGHUM . . . . .	84
	ESTIMATES OF CROP YIELDS . . . . .	85
	ESTIMATE OF TEFF YIELD MODEL . . . . .	86
	ESTIMATE OF WHEAT YIELD MODEL . . . . .	87
	ESTIMATE OF BARLEY YIELD MODEL . . . . .	89
	ESTIMATE OF MAIZE YIELD MODEL . . . . .	91
	ESTIMATE OF SORGHUM YIELD MODEL . . . . .	92
<b>VIII.</b>	<b>DEMAND AND SUPPLY OF CEREALS IN 1994 . . . . .</b>	<b>94</b>
	PRODUCTION AREA AND YIELD IN 1993 . . . . .	94
	DEMAND AND SUPPLY IN 1994 . . . . .	98
<b>IX.</b>	<b>ALTERNATIVE MEASURES OF ATTAINING SELF SUFFICIENCY . . . . .</b>	<b>104</b>
	SELF SUFFICIENCY IN THE DEFICIT REGIONS . . . . .	111
	SELF SUFFICIENCY THROUGH PRODUCTIVITY INCREASE . . . . .	113
	SELF SUFFICIENCY THROUGH AREA EXPANSION . . . . .	115
	OPTIMAL POLICY OPTIONS . . . . .	117
	PRODUCTION EXPANSION IN THE SURPLUS AREAS . . . . .	118
<b>X.</b>	<b>SUMMARY AND CONCLUSION . . . . .</b>	<b>123</b>
 <u>Appendix</u> <span style="float: right;"><u>page</u></span>		
<b>A.</b>	<b>ESTIMATES OF AREA PROPORTION MODEL . . . . .</b>	<b>131</b>
<b>B.</b>	<b>ESTIMATES OF PRODUCTION PROPORTION MODELS . . . . .</b>	<b>136</b>
<b>REFERENCE</b>	<b>. . . . .</b>	<b>141</b>

## LIST OF TABLES

<u>Table</u>	<u>page</u>
1. ANNUAL RAINFALL (MM) OBSERVED IN FOUR MET. STATIONS . . . . .	6
2. TOTAL GRAIN PRODUCTION IN SELECTED REGIONS . . . . .	7
3. PERCAPITA GRAIN PRODUCTION AVAILABLE FOR FOOD (1979-85) . . . . .	8
4. USE OF FERTILIZER IN THE AGRICULTURAL AREAS . . . . .	10
5. PERCENTAGE DISTRIBUTION OF REGIONAL GRAIN PRODUCTION . . . . .	16
6. ESTIMATE OF AGGREGATE PRODUCTION MODEL . . . . .	67
7. ESTIMATE OF TEFF PRODUCTION MODEL . . . . .	69
8. ESTIMATE OF WHEAT PRODUCTION MODEL . . . . .	71
9. ESTIMATE OF BARLEY PRODUCTION MODEL . . . . .	72
10. ESTIMATE OF MAIZE PRODUCTION MODEL . . . . .	74
11. ESTIMATE OF SORGHUM PRODUCTION MODEL . . . . .	76
12. ESTIMATE OF AGGREGATE AREA MODEL . . . . .	77
13. ESTIMATE OF AREA SEEDED MODEL FOR TEFF . . . . .	79
14. ESTIMATE OF AREA SEEDED MODEL FOR WHEAT . . . . .	80
15. ESTIMATE OF AREA SEEDED MODEL FOR BARLEY . . . . .	82
16. ESTIMATE OF AREA SEEDED MODEL FOR MAIZE . . . . .	83
17. ESTIMATE OF AREA SEEDED MODEL FOR SORGHUM . . . . .	85
18. ESTIMATE OF YIELD MODEL FOR TEFF . . . . .	87
19. ESTIMATE OF YIELD MODEL FOR WHEAT . . . . .	89
20. ESTIMATE OF YIELD MODEL FOR BARLEY . . . . .	90

21.	ESTIMATE OF YIELD MODEL FOR MAIZE . . . . .	92
22.	ESTIMATE OF YIELD MODEL FOR SORGHUM . . . . .	93
23.	LEVELS OF THE EXOGENOUS VARIABLES IN THE MODEL . . .	95
24.	CEREAL PRODUCTION AREA AND YIELD IN 1982 AND 1993 . . . . .	97
25.	AGGREGATE PRODUCTION OF FIVE CEREAL CROPS IN 1993 . . . . .	98
26.	THE BALANCE BETWEEN DEMAND AND SUPPLY IN 1994 . .	100
27.	THE BALANCE BETWEEN DEMAND AND SUPPLY IN 1987 . .	102
28.	AREA AND PRODUCTION PROPORTION IN THE DEFICIT REGIONS IN 1993 . . . . .	112
29.	PRODUCTION AREA AND YIELD IN THE DEFICIT REGIONS IN 1993 . . . . .	113
30.	REQUIRED AND POTENTIAL YIELD IN 1993 IN THE DEFICIT REGIONS . . . . .	115
31.	PROJECTED AND REQUIRED AREA SEEDED IN 1993 . . . .	116
32.	AREA AND PRODUCTION PROPOR. IN THE SURPLUS REGIONS IN 1993 . . . . .	119
33.	PROJECTED AND POTENTIAL YIELD IN THE SURPLUS REGIONS . . . . .	120
34.	PRODUCTION WITH A TWENTY PERCENT INCREASE IN YIELD . . . . .	121
35.	PRODUCTION AREA AND YIELD IN THE SURPLUS REGIONS IN 1993 . . . . .	122
36.	ESTIMATE OF AREA PROPORTION MODEL FOR TEFF . . . .	131
37.	ESTIMATE OF AREA PROPORTION MODEL FOR WHEAT . . .	132
38.	ESTIMATE OF AREA PROPORTION MODEL FOR BARLEY . . .	133
39.	ESTIMATE OF AREA PROPORTION MODEL FOR MAIZE . . .	134
40.	ESTIMATE OF AREA PROPORTION MODEL FOR SORGHUM . .	135
41.	ESTIMATE OF PRODUCTION PROPORTION MODEL FOR TEFF .	136
42.	ESTIMATE OF PRODUCTION PROPORTION MODEL FOR WHEAT . . . . .	137

43.	ESTIMATE OF PRODUCTION PROPORTION MODEL FOR BARLEY . . . . .	138
44.	ESTIMATE OF PRODUCTION PROPORTION MODEL FOR MAIZE . . . . .	139
45.	ESTIMATE OF PRODUCTION PROPORTION MODEL FOR SORGHUM . . . . .	140

**FLOW CHART AND MAP**

<u>Figure</u>	<u>page</u>
1. SUMMARY OF VARIABLES AND RELATIONSHIPS IN THE MODEL . . . . .	50
2. REGIONAL MAP OF ETHIOPIA . . . . .	64

## Chapter I

### BACKGROUND

#### 1.1 LOCATION AND DEMOGRAPHIC CHARACTERISTICS

Ethiopia is located in the north eastern part of Africa, north of the equator. Its size is about 1,222,000sq km. The total population is estimated at forty eight million and growing at an annual rate of 2.9%.

#### 1.2 AGRICULTURAL RESOURCES

Ethiopia is endowed with sufficient agricultural resources to feed more than the current population. It has a vast fertile land. Only seven million of the cultivable seventy nine million hectares are currently being farmed (D.Wolde Mariam,1986). There is an abundant supply of fresh water along with a large livestock population, perhaps the largest in Africa. About 65% of the total size of the country is said to be suitable for agriculture. The soil type is also suitable for growing different types of crops.

### 1.3 CLIMATE AND VEGETATION

Ethiopia is a country of diversities in both climate and vegetation, with several crops indigenous to its high lands. Four major (Wodajo, pp7-13) and ten micro (Degefu and Befikadu, pp20) climatic zones are said to be identifiable in the country. The four major zones are "cool" (locally called dega), which covers areas of 2400 meters (mts) in altitude and above, "moderate" (weinadega), where the altitude ranges from 1600 to 2400 mts, "hot" (kola), which covers areas of 1200 to 1600 mts in altitude, and "very hot" (berha) covering all areas less than 1200 mts. The temperature also varies with the altitude. It is below 16 degree centigrade in the cool areas, 16 to 25 degrees in the moderate areas, 25 to 30 degrees in the hot areas and over 30 degrees in the very hot areas. The first three major climatic zones sustain crop growth where as the fourth - berha - is largely inhabited by nomadic herds men. The altitude in the country varies from below sea level in the coastal areas to over 4500 mts above sea level in the central high lands.

Dry land crops are the major source of food. There are two major rainy seasons. The higher elevation areas (above 2400 mts) which get both rains grow crops twice, where as the lower elevation areas use both rains to grow long maturing crops such as maize and sorghum. The first rainy season is between February and April, and the second between June and October. Annual rainfall in the areas which can sustain

crop growth ranges from about 600 mm in the semi arid to over 2500 mm in the wet areas, most of the crop growing areas receive between 1000mm and 1500mm.

The country grows many types of crops, including cereals such as teff ( a crop which only grows in Ethiopia), wheat, barley, maize, sorghum, millet and oats, pulses such as faba beans, field peas, chick peas and lentils, oil crops such as sesame, nigerseed and flax, and root crops such as sweet and irish potato and false banana (locally called enset), and coffee. Cereals account for about 85% of the total grain production, followed by pulses (13%) and oil crops (2%). Over 95% of the crops are produced by peasant farmers. The share of state farm production is around 3%. There is no reliable data regarding root crops production.

The climatic diversity described above is a reflection of the complexity of the physical feature of the country. In most regions, one can encounter significant changes in altitude and climate within a distance of a few miles, and the vegetation changes accordingly. The cool (dega) areas mainly grow barley, wheat and a few pulses. The moderate (weina dega) areas grow almost all kinds of crops, where as in the hot (kola) areas the major crops are maize and sorghum, with a few areas growing teff and some pulses.

#### 1.4 ECONOMY

Although its vegetation and natural resources attest to its high potential, Ethiopia is one of the poorest countries in the world. The percapita GNP is about U.S \$110 (World Development Report, 1986). Agriculture is the main industry of the economy with over 80% of the population depending on it in terms of food and employment. Agriculture also accounts for a significant portion of the GNP and the bulk of export earnings. According to the World Bank, agriculture's share of the GNP in 1984 was 48% whereas its growth between 1973 and 1984 was only 1.2%. Coffee is the major export commodity, accounting for about 60% of the country's total earnings. Other export commodities include pulses, oil crops, cotton as well as animal products.

## Chapter II

### THE PROBLEM

The poverty of countries like Ethiopia lies not in their resource endowments but in their capacity to effectively utilize what they have. Ethiopia is potentially a rich country in terms of natural resources, though very poor since it lacks the ability to make use of it.

While there are areas of high potential for crop production there are also other areas which are devastated by recurrence of drought and soil erosion. Records dating back hundreds of years show problems of drought and other natural calamities in several regions. The problem of drought has particularly been serious in the northern and eastern parts and since 1973 hardly a year has passed without drought causing some degree of crop damage and food shortages. Although it has not often resulted in crop failure the rainfall in many of the non drought prone regions has also been unstable (table 1). Two locations in table 1 are in drought prone areas (Mekele and Asmara) and two in areas normally producing surplus crops (Nekemte and Debremarkos).

According to Wodajo (pp 23), the optimal annual crop water requirement for teff is 900 mm to 1100 mm, wheat 1150

TABLE 1  
ANNUAL RAINFALL (MM) OBSERVED IN FOUR MET. STATIONS

STATION(REGION)	Y E A R						
	1980	81	82	83	84	85	1986
MEKELE(TIGRAI)	989	618	588	699	293	531	NA
ASMARA(ERITREA)	861	734	689	448	451	688	489
NEKEMTE(WELLEGA)	2148	2047	1778	1905	1219	1726	1388
DEBREMARKOS(GOJJAM)	1453	1152	1366	1240	1084	1407	1077

mm to 1250 mm, barley 1000 mm to 2000 mm, maize 850 mm to 1050 mm, and sorghum 700 mm to 900 mm, and the figures in table 1 prove how much low the observed rainfall in the drought prone regions was.

Soil erosion resulting from thousands of years of improper farm practices has also been a major problem. According to D.Wolde mariam (1986), about 27 million hectares of land is seriously affected by erosion, two million of which is said to be beyond rehabilitation. If the erosion continues at the current annual rate, 20% of the high lands (1500 mts in altitude and above) are expected not to sustain crop growth by the year 2010 (B.Debele, 1986).

The unstable weather, less productive soil and ineffective technology has resulted in an alarmingly declining food production in several parts of the country. Table 2 shows grain production in two drought prone regions (Wello and

Harerghe) and two surplus producing regions (Shewa and Gojjam). In the drought prone areas production has fallen by about a half in a period of seven years, and no overall trend in production exists in the surplus areas.

TABLE 2  
TOTAL GRAIN PRODUCTION IN SELECTED REGIONS

REGION	POP/88 (million)	Y E A R						
		1979	80	81	82	83	84	1985
		( ' 0 0 0 tonnes )						
WELLO	4.1	765	1016	871	793	507	200	441
HARERGHE	4.7	604	327	363	465	335	208	228
GOJJAM	3.6	816	742	762	926	802	753	834
SHEWA	9.1	2058	1738	1458	2026	1651	1235	1200
NATIONAL	47.3	7496	6561	6296	7805	6337	4855	5404

The seriousness of the situation is better revealed when one considers the extent to which the level of grain production has failed to keep pace with the increase in population. Table 3 shows the annual percapita grain production which was available for food during 1979 to 1985. In 1984 the amount available in Wello and Harerghe was as low as 50 kgs, and the national average for the same year was only 120 kgs. The situation was not much different in the years prior to and following 1984. In terms of daily percapita calories

(kcl) the highest national level shown here was for 1979, when it was equivalent to 1956 kcl, and the lowest was in 1984 and 85 when it was 1118 kcl.

TABLE 3  
PERCAPITA GRAIN PRODUCTION AVAILABLE FOR FOOD (1979-85)

REGION	Y E A R						
	1979	80	81	82	83	84	1985
	( kilogrames)						
WELLO	240	310	260	230	140	50	120
HARERGHE	170	90	100	120	80	50	50
GOJJAM	290	260	260	300	250	230	250
SHEWA	290	240	200	270	210	150	140
NATIONAL	210	170	160	200	150	120	120

It should be noted here that the data in table 3 does not in any way show the food which was actually available. To arrive at the food available losses and seed requirements must be subtracted and food from other sources, such as root crops and animal products, need to be added.

The Food and Agricultural Organization (FAO, 1977, pp78) indicates that the acceptable percapita daily calorie requirement for Ethiopia is 2330 kcl, and that at least since the 1960s the country has not attained this level of

consumption through own production. During the pre-drought years (1972-74) the percapita consumption level was about 2051 kcal, down from a level of 2097 kcal in 1961-63.

For a heavily grain dependent country like Ethiopia it is obvious that given the decline in production and increase in population the recent percapita calorie available has been far lower than 2057 kcal. In fact, the production during 1976 to 1987 was so low that, according to the government's Relief and Rehabilitation Commission's reports (1976-87), two to seven million people were unable to feed themselves adequately, making it necessary for the country to import a substantial amount of food. The FAO shows an increase in net cereal import requirements from as low as 2330 MT in 1974 to 985,500 MT in 1985.

The hope for Ethiopia's recovery partly lies on the natural resource potentials. The task, however, is enormous given the backwardness of the economy and the subsistence nature of food production. The agricultural technology is very backward. Productivity is very low. Average cereal yield does not exceed 1.2 tones/ha. Use of technical inputs, such as fertilizer, is negligible. It is, for example, nowhere near the level of utilization in such African countries as Kenya and Zimbabwe (table 4). In fact, according to D.Woldemariam (1986), no more than 10% of the peasants use chemical fertilizers and have access to extension services. An average peasant farmer often ploughs less than a hectare with hand tools or oxen.

The capacity of a peasant farmer who operates under such an economic and technological environment to withstand adverse natural calamities such as drought is minimal. A single harvest rarely sustains a farm family beyond one year, and if it fails it almost immediately exposes it to food shortages, eventually leading to famine if there is no external intervention.

TABLE 4  
USE OF FERTILIZER IN THE AGRICULTURAL AREAS

COUNTRY	Y E A R					
	1978	79	80	81	82	1983
	( KG./HA. )					
ETHIOPIA	0.5	0.6	0.7	0.8	0.6	0.8
KENYA	8.4	6.3	10.3	13.1	11.2	14.3
GHANA	3.1	3.0	1.9	5.0	4.4	3.4
ZIMBABWE	14.4	15.2	22.5	24.2	19.4	20.5
CANADA	26.5	26.8	27.6	27.6	28.7	32.1

At present, there is a growing awareness that the decline in food production in Ethiopia is serious, and that urgent measures need to be taken to reverse it. There is also an understanding that for a very poor country like Ethiopia the task is enormous. Nevertheless, efforts are being made, and there is a hope. At least, in as much as the low level of input utilization reveals the backwardness of the agricul-

tural technology it also shows the potential for production expansion through more use of such inputs.

Ethiopia's heavy dependence on agriculture reveals that its recovery to a large extent also depends on its ability to rehabilitate this sector of the economy. The government has devised a strategy which could help reverse the declining trend. The strategy envisages a three pronged approach, namely: 1) the introduction of support programmes to private peasants, 2) the transformation of peasant farms to producer co-operatives through the merger of existing peasant farms as well as transferring people from drought prone to more fertile areas, and 3) the expansion of mechanized state farms.

Ethiopia has a plan which targets attainment of food self sufficiency by 1994. This target was set in 1983. Two major droughts have hit the country since then, and therefore is unlikely to be realized. The major targets of the plan for agricultural production, according to D.Wolde Mariam (1986), were an increase in grain production from 6.6 million tones in 1983/84 to 12.2 million tones in 1993/94. This was envisaged to be attained through an increase in both cultivated area and land productivity, with most of the efforts concentrated on attaining higher production in the surplus producing regions. Area cropped was to increase from 6.9 million hectares in 1983/84 to about 8.2 million in 1993/94. D.Woldemariam's report does not provide the targets for pro-

ductivity increase though informal reports show 4%/year. Percapita grain consumption was targeted to increase from 1740 Kcl in 83/84 to at least 2000 Kcl in 1993 with an extra three months food security reserve.

With over ninety percent of the land holding in Ethiopia under peasants and the growing emphasis on peasant rather than large scale farming, any realistic food self sufficiency target can only be assumed to be attained largely through peasant production. In such a situation, therefore, the issues of particular interest are: first, whether there is a chance of attaining self sufficiency within a short period of time from the point of view of existing trends and resource constraints, and second what options are available which could lead to this end. This research focuses on answering these and related issues.

## Chapter III

### SPECIFIC OBJECTIVES

Analysis of the prospect for food self sufficiency in Ethiopia requires looking at three population groups in the country, namely: crop growers, nomads and urban dwellers. The major source of food for each group is different—crop grown by the croppers is also consumed, livestock herds provide food to the nomads, and urban residents buy their food in the market. The data and analytical technique each requires is therefore different.

Data and methodological limitations have made it necessary that the investigation be restricted to the crop growers, who by far are the largest (about 80% of the population) and most important in the country's effort to attain self sufficiency. In spite of being restricted to one sector of the population this study is still capable of providing adequate insight into the overall food situation of the country. A favourable performance of the crop growers has a big impact on the food situation of the other two groups. The major source of market supply is the "surplus" production of peasant farmers.

Analysis of the problems of food self sufficiency involves a number of factors which influence or determine

production. Some are technical in nature and others are economic and/or institutional. The focus of this research is on the technical rather than the more controversial and often inconclusive institutional and related issues. With this background, therefore, the major objectives of the research are:

1. to analyze the trends and levels of peasant production of the major five cereal crops - teff, wheat, barley, maize, and sorghum - in twelve of the fourteen administrative regions of the country. A lack of data for two regions, namely Eritrea and Tigray, has resulted in their exclusion from the study.
2. to estimate the demand and supply of the five crops in 1994;
3. to identify the likely cereal deficit and surplus regions in 1994 and estimate the magnitudes of such deficits and surpluses;
4. to identify alternative measures of offsetting the projected deficits, and evaluate their feasibilities.

In this study all possible options of attaining self sufficiency in cereal production are looked into. The year 1993 is selected so that the prospects in five years time could be analyzed. There is also an additional advantage in such a projection since the period coincides with the end of the current government ten year plan, and provides the convenience of looking at how much of the self sufficiency target

set in 1983 is likely to be met. (The crop year in Ethiopia ends with the calendar year, and a given years production is consumed in the following year. For example, the production in 1993 is compared with the demand in 1994.)

Only five crops are involved in this analysis. This is dictated primarily by their importance, and work load of adding more crops. Although the country grows twenty or more crops it is the performance of teff, wheat, barley, maize and sorghum, which largely determines availability of adequate food. The only exceptions among the peasants are the few root crop growers of south western Ethiopia.

At the national level, these five crops account for nearly 80% of the total area under crop and over 80% of the total grain production. The crop specific area shares are about 25% for teff, nearly 15% each for barley, maize and sorghum, and 10% for wheat. The equivalent figure for production is about 20% each for teff, maize and sorghum, 15% for barley and 10% for wheat. The relative importance of the crops is different from one region to another depending on their agro-climatic conditions (table 5). Barley and wheat are dominant in the cooler predominantly higher altitude areas whereas maize and sorghum dominate in the lower elevation areas. Teff is the major crop in the mid altitude areas.

TABLE 5

## PERCENTAGE DISTRIBUTION OF REGIONAL GRAIN PRODUCTION

REGION	C R O P				
	TEFF	BARLEY	WHEAT	MAIZE	SORGHUM
ARSSI	5	30	35	10	5
BALE	2	30	50	5	0
GAMOGOFA	2	13	1	40	21
GOJJAM	30	15	7	20	5
GONDER	20	20	5	6	15
HARERGHE	5	3	3	25	60
ILLUBABOR	25	2	0.5	45	20
KEFFA	16	3	4	50	20
SHEWA	20	20	15	20	15
SIDAMO	10	5	1	70	5
WELLEGA	20	5	2	50	15
WELLO	15	20	6	5	30

## Chapter IV

### THEORETICAL FRAME WORK

Eicher (1986,pp257) defines food self sufficiency as "the ability of a country to meet all its staple food needs with domestic production and storage under all weather conditions". He says "food self sufficiency has a built in supply bias". This is particularly true in a subsistence economy where agricultural activities are characterized by a production-consumption relationship, absence or low level of purchasing power limiting access to market supply.

Before discussing the problems of subsistence production understanding its specific characteristics is necessary. Todaro (1981,pp270) describes the nature of subsistence farming as one where:

output and consumption are identical and one or two staple crops(..)are the chief sources of food intake. Output and productivity are low and only the simplest tools are used. Capital investment is minimal while land and labour are the principal factors of production. The law of diminishing returns is in operation as more labour is applied to shrinking (or shifting) parcels of land ... The peasant usually cultivates only as much land as his family can manage without the need for hired labour, although many peasant farmers intermittently employ one or two landless labourers. The environment is harsh and static. Technological limitations, rigid social institutions, and fragmented markets and communication networks between rural areas and urban centers tend to discourage higher levels of production...

When the problem of food self sufficiency is cast as supply problem its analysis involves a number of technical, economic, and institutional issues. The well developed economic theory which is assumed to explain many of these issues is the neo-classical theory of production. This theory, however, is essentially a theory of market demand and supply, and has limited applicability in a subsistence economy of the type which exists in Ethiopia, where most of the food produced does not pass through the market.

A brief look at the neo-classical theory of production and its essential elements and assumptions provides a useful insight into the extent to which such a theory is capable of explaining the nature and problems of subsistence production. The theory starts from a key assumption that the objective of a firm or a farm in producing a certain level of output is to maximize profit subject to given technical and economic constraints. There are also other assumptions though not discussed here due to their limited relevance to the issues of interest.

The major determinants in a firms decision of how, what and how much to produce are assumed to be its technical knowledge, factor supply and product demand. Technical knowledge influences the decision of how to produce. The firm has to decide as to what combination of factors to use, depending on whether the factors are substitutes, complements or independent. A given out put can be produced using

different levels of factor combinations allowed by the technical substitution. The profit motive is assumed to determine the level of factor demand as well as the type and amount of output to be produced. According to the neo-classical theory, given a certain technology, production can be increased or decreased or entirely abandoned depending on whether the price of a product is higher or lower than the marginal cost to produce it. The decision of how much input to use is also determined by whether or not the contribution to revenue of the added input is more or less than to cost.

Some of the theoretical issues so far discussed could be adequate to explain part of the problems of food production in a subsistence sector. There are, however, different viewpoints and reservations as to the relevance of a number of its assumptions, particularly the assumption of profit maximization. One of these is Todaro (1981, pp 271), who says that the theory does not adequately explain why

Peasant agriculturals are often resistant to technological innovation in farming technique or to the introduction of new seeds or different crops. According to the standard theory a rational income or profit maximizing farm or firm will always choose a method of production that will increase output for a given cost or lower cost for a given output level. But the theory is based on the crucial assumption that farmers possess "perfect Knowledge" of all input-output relationships in the form of a stable technological production function for their crop. This is the point at which the theory loses a good deal of its validity when applied to the environment of subsistence agriculture.... Subsistence agriculture is a highly risky and uncertain venture ... In Regions where farms are extremely small and cultivation is dependent on the uncertainties of a highly variable rainfall, average output will be low and in

poor years the peasant and his family will be exposed to the very real danger of starvation. In such circumstances, the main motivating force in the peasant's life may be the maximization, not of income, but rather of his family's chances of survival. Accordingly, when risk and uncertainty are high, a small farmer may be very reluctant to shift from a traditional technology and crop pattern that over the years he has come to know ... it is more important to avoid a bad year than to maximize the output in better years ...

Francis Foland (Todaro pp259) appears to hold a similar view point in his description of peasant life:

peasant is a rural cultivator whose prime concern is survival. Subsistence defines his concept of life. He may strive to obtain his and his family's minimal needs by tilling an adequate piece of land...or by selling his labour...profit which might come to him through the fortunes of weather or market are windfalls, not preconceived goals ...

Seavoy (1986,pp347-348) also expresses similar view points to that of Todaro and Foland, though perhaps of less extreme. He says:

peasants are not money motivated. They seek their social security by controlling the use of enough land to grow sufficient quantities of food with the least expenditure of labour. This is the practice of subsistence compromise.....Confusion results when economists use the assumptions and terminology of commercial rationality to describe and analyze subsistence rationality..... Economists categorize all forms of food production as a commercial activity. This is not accurate. Only in commercial societies is food production a commercial activity. Farmers produce food for market sale...There is a radical distinction between farmers and peasants. Farmers attempt to maximize their incomes by maximizing product for market sale. Peasants seek to maximize indolence by practicing the subsistence compromise.

The limitations of the neo-classical theory as described above are probably true, and this will be elaborated later.

Some of the extreme views expressed could, however, be difficult to fully support. Though perhaps not the major motivating factor, outright rejection of the validity of profit maximization may, for example, contradict some of the current contentions of development economists and international agencies such as the World Bank.

There is a growing strong argument these days that one of the major causes for the stagnation or decline of food production in Africa and other third world countries is the imposition of administered prices which do not favour peasant farmers. Such price policies are said to have eroded peasants incentives to increase production, and price reform is among the urgently needed measures which have been advocated for increasing food production.

In a World Bank publication (1982,pp3), Tolley, Thomas and Wong argue that "farmers respond to price changes, although the magnitude of their production response depends on the availability of inputs, social and economic institutions, and many other factors", and they indicate Korea (pp13-39) as one of the countries where self sufficiency in food has been achieved partly due to a favourable price policy. Wong (1989,pp79) also makes similar arguments about China and India. Wong argues that in China "agricultural production and productivity" has increased significantly since 1978 largely due to the "introduction of the Household Responsibility System, which ... granted production autonomy

and established new price policies". He also argues (pp90) that after India "began to adjust its policy to discriminate less against the agricultural sector" in the early 1970s the "peasants effectively responded to the changes of market conditions and agricultural prices".

If price incentives can make peasants produce more, one could argue that there is still a profit motive in their production decision. On the other hand, in countries such as Korea price reforms have been accompanied by technological changes, and it is possible that it was the later which played the major role. In peasant economies where market orientations are low the limited influence of the profit motive, as strongly under scored by Seavoy, Foland, and Todaro, could still bring into question the extent to which peasants can be motivated to increase production.

Inorder to get further insight into the nature of subsistence production in Ethiopia and assess the ability of the neo-classical theory to provide adequate explanation detailed discussion of the relevance of the major elements of the theory is important.

First factor demand: For a subsistence farmer in Ethiopia land and labour are the major factors of production. Use of capital is limited to such inputs as seed, oxen drawn simple farm implements, and chemicals such as fertilizer. In Ethiopia, a peasant farmer often protects his seed, which is nor-

mally set aside from the previous year's production. Animal power, particularly oxen is also important, though most peasants own only one ox or nothing at all. According to government reports, more than 35% of the peasant farmers do not have a single ox and that nearly 30% own only one. Use of fertilizer and other chemical inputs is very limited, and often it is not used. As was noted earlier, only 10% have access to chemical fertilizers.

The decision of how much labour to employ does not involve consideration of marginal value product and marginal factor costs but rather the size of the family. The labour involved is mainly that of the farmer and his family, and as long as the average product does not fall below subsistence requirement labour is added to production. In Ethiopia, a farm household engaged in agriculture can have access to a maximum of ten hectares of land although the existing technology does not enable cultivating more than one hectare. Land can not be sold or leased, nor is hiring farm labour possible since allocation of land is restricted to a size which a household is capable of farming using its own labour. Hence, the market has no role in determining the demand and supply of labour and land.

Most of the factor inputs used in subsistence agriculture are either complements or independent rather than substitutes. With no labour saving devices available or encouraged there is no real substitution between capital and labour.

Though limited, however, there is still substitution when it involves a choice between traditional or better farm implement, or between the use of technical inputs or not. In making such a choice, relative prices are important, and it is here that the factor market plays a role and that the neo-classical theory's description of factor interdependence provides adequate explanation. Given the necessary information peasant producers act rationally in their decision of how much of a new factor input to use. In spite of the argument that their risk aversion prevents them from adopting a new technology it remains true that peasants adopt if they can be convinced (get enough information) that it can pay better.

A major element of the neo-classical theory which has limited relevance to subsistence agriculture is the assumption regarding the decision of how much to produce. As was noted earlier, peasant farmers initial production decision does not involve marginal considerations since food has to be produced at any affordable cost. This becomes relevant only when an opportunity arises for producing over subsistence requirements.

There is another dimension, which is of crucial importance to traditional agriculture, but which does not get prominence (if at all any) in the neo-classical theory. This is the impact of institutions. Subsistence farming being characterized by low level of saving and investment, and

hence low level of demand for most modern agricultural inputs, the competitive market has very limited role in encouraging higher production through technological changes. As part of the development process, therefore, state institutions substitute the market in this respect. These are institutions which are responsible for such crucial activities as research and extension, supply of fertilizer and other chemicals, and infrastructural development.

In as much as they have had positive impacts on subsistence agriculture, through the diffusion and adoption of technology, agriculture related state institutions in Africa are often criticised for their negative impacts. They are criticized for failing to recognize the importance of peasant agriculture and not giving it a fair share of available resources. They are also criticized for encouraging the introduction of inappropriate technology and imposition of administered prices rather than allowing market forces to play greater roles. The failure of African agriculture to feed the population is often attributed to such institutional problems in as much as to the most apparent climatic and resource constraints.

## Chapter V

### REVIEW OF RELATED STUDIES

Two different types of studies relevant to the issues of food self sufficiency in Africa and other developing countries are reviewed here. The first part deals with problems of agricultural development vis-a-vis institutions and related policy issues. Selected studies which attempt to identify the causes of the problems and suggest solutions are briefly reviewed. In the second part, alternative methods of estimating demand and supply of food relevant to developing countries are presented. The reviews made here only cover parts of the studies which are relevant to this research and not necessarily the entire subject treated in each study.

#### 5.1 REVIEW OF STUDIES RELEVANT TO AFRICA'S FOOD PROBLEMS

Any study which deals with the problems of food self sufficiency in Africa will not be complete with out looking at institutional and policy related issues. This dimension of the problem is, however, complex and difficult to treat within the scope of this research. It requires independent treatment. The difficulty is mainly because such issues almost always have ideological undertones as is evident in some of the reviews made here, and are often inconclusive.

The intention in including this review, with out evaluating the relative merits of the views expressed, is to provide a frame work within which the findings of the research and the solutions to be sought are to be treated.

The problem of food production in Africa has led to wide ranging and seemingly un resolved debates among development economists. These debates mainly focus on whether Africa's agricultural development strategy should be along a small or large scale farming and whether the state should encourage private or socialized mode of production. The over all consensus tends to be towards the former. There are, however, still contentions that neither system has been effective in Africa and that the few relatively successful policies are hybrids rather than entirely following a single strategy (R.Lemarchand,pp35).

Five separate studies are reviewed here, three of which are by proponents of a development strategy which favours an individual small farm approach in a competitive market environment. One of these three, which specifically deals with the Ethiopian situation, also provides a brief summary of the rationale for socialized agriculture. The remaining two deal with climatic and technological problems.

### 5.1.1 STRATEGIC ISSUES IN COMBATING HUNGER AND POVERTY IN AFRICA

Eicher argues that many countries in Africa have lost the capacity to produce enough food for their rapidly growing population. He attributes this to the effects of long term problems associated with rapid population growth and the pressure this has created on land and natural resources, and the inadequacy and inappropriateness of the efforts made to address the problem.

Like many others, he believes that no single factor, such as climate, ideology or appropriate technology, is to be blamed as the cause of the problem, though wrong policies could take the major share. He mentions India as a success story, where appropriate government policy in the field of research, human resource and infrastructural development has helped attain food self sufficiency (though he agrees that poverty and hunger still prevail due to distribution problems). Unlike many who argue that inadequate development assistance has been a factor in the African problem, he notes that India achieved self sufficiency with an annual per capita aid of \$1.5 as against the current aid level to some West African countries of \$50 to \$70.

The short term solution to the problem of food, according to Eicher, is to increase the production of staple food through small scale farming. In the medium and long run, he says that the solution largely depends on whether a country

can attain adequate technological development, development of "human capital and managerial skill", "accretionary growth of biological capital investment" (improving live-stock herding, planting, spraying) and "physical capital investment", "improvement in the performance of institutions" (research, marketing), and "favourable economic policy".

#### 5.1.2 GOVERNMENTAL STRATEGIES FOR AGRICULTURAL DEVELOPMENT

The major issue addressed by Johnston is whether a "bi-modal" or "uni-modal" production approach is preferable for Africa's agricultural development. The former encourages large scale while the later gives emphasis to small scale farming. Johnston recognizes the need for a shift from "traditional resource-based agriculture" to a "science-based agriculture", but argues that it must be based on a labour intensive small farm approach.

Except in a few cases where the nature of the crop requires it, such as sugarcane, he rejects the bi-modal approach as inappropriate for Africa, where 80% of the population depends on agriculture for employment with no off-farm alternatives. He argues that the cost of hiring labour in relation to what is supplied by the farm family is very high since family members have the incentive to work hard to attain higher production and profit. He also notes the ability of a farm family to provide day to day supervision and

immediate decision in situations of environmental changes, which otherwise is not true.

The small farm strategy's another but major economic advantage, according to Johnston, is also identified to be its ability to "fit between the resource requirements of such a strategy and the resource endowments that characterizes late developing countries...". His argument in favour of the small farm approach goes beyond its immediate effect on production in that it encourages growth in non farm output and employment. This, he says, is through the linkages the increase in rural demand for inputs and consumer goods creates for the expansion of small and medium scale industries that depend on labour intensive technologies and "indigenous resource", in contrast to the bi-modal approach which encourages goods and inputs which need to be imported.

Johnston also notes other aspects of policy problems which affect agricultural development, such as the relative inadequacy of the resources allocated and deficiency of institutions of research and extension. He attaches greater importance to institution building, and like Eicher, attributes the success in Asia of the green revolution of the 1960s to the availability of "indigenous research capability" in as much as to the technological transferability.

### 5.1.3 FOOD PRODUCTION STRATEGY DEBATES IN REVOLUTIONARY ETHIOPIA

Cohen and Isaksson, in addition to conveying their own favourable view of a small holder food production strategy as against "agrarian socialism", also provide a brief outline of the rationale given by those who support the latter. Their argument is along the Eicher/Johnston line. They believe that "with the right price incentives, and the public support of research, extension, credit, and private market infrastructure small holders can dramatically raise their yields, marketed output, and income". Hence, they are critical of the socialized production strategy Ethiopia favours. Their reason for not supporting agrarian socialism is simple - it has not been effective anywhere else. They, on the other hand, appear to tacitly admit that Ethiopia might have had an organizational capacity, which other African countries where the strategy has failed did not have, which could make the approach work better.

The authors note that there is a strong conviction among its proponents, including Ethiopia, that agrarian socialism is superior to its alternatives. This, they say, is based on the belief that it:

1. creates wider sharing of rural economic and political power;
2. promotes more equal access to land;

3. facilitates more efficient short term use of rural labour for agricultural production, capital formation, self help activities, and rural industry while ultimately aiming at releasing labour for industry;
4. reduces rural-urban migration by increasing rural security and creating opportunities for employment;
5. increases the quality of rural life by making it easier for governments to provide basic human services;
6. allows government policies for development to be more effectively implemented because of greater control over co-operative decisions;
7. allows economies of scale in agricultural production and marketing; and
8. reinforces equity among rural producers and between agricultural regions.

The reason for the failure so far of such a strategy is also said to be viewed differently by its supporters in that "the problem is not socialist policies per se but the failure to follow consistent, mutually supporting policies on a rigorous basis for a sustained period of time, no matter what the short term cost is".

Cohen and Isaksson's reservation regarding the viability of agrarian socialism in countries like Ethiopia is from their belief that "it requires government capacity to induce or otherwise force small holders to change their pattern of production and join collectives, as well as substantial

investments in land development, subsidies,..., provision of agricultural and basic human services, establishment of effective parastatals to provide input, credit and marketing services, infrastructure, storage..." It also requires "detailed planning..." and "a well established system of management for the farm, organization, and institutions of the agricultural sector, and efficient and pervasive information network...". The achievement of this, they say, is a function of time and massive investment. The authors also add to theirs the views of "reformests" who say that "organizing workers in large scale productive units does not necessarily increase productivity, small farms may absorb labor better than large co-operatives or state farms... co-operatives are far harder to manage and agriculture too complex to plan for..."

#### 5.1.4 CLIMATE, DROUGHT AND FAMINE IN AFRICA

Nicholson assesses the trend in the African climate, the recurrence of drought through the centuries, the prospect for the future and the measures which need to be taken to minimize the effects of unstable weather.

Nicholson argues that drought in Africa is not a recent phenomenon as there have been intermittent dry and wet seasons for many centuries. Records of droughts in the 17th and 18th centuries which lasted for decades are noted as evidences of this. She, however, recognizes that the long term trend has been showing an increasing aridity.

"General atmospheric circulation" rather than human activity (through desertification) was mentioned as the major cause of the droughts since, according to the author, many of them were experienced globally and not locally. The contribution of the later was, however, not discounted since "changes in vegetation cover and soil moisture" influence rainfall pattern. She cautions that there are still no evidences of long term climatic changes in Africa though this can not disprove its possibility.

Taking into account the issues mentioned above the following policy measures are recommended:

1. treat climate as a variable not as a constant and that for planning purposes "the true carrying capacity of the land should be based on that of the driest year."
2. since it is not possible to predict rainfall "the best approach to planning is a flexible one that minimizes the consequence of dry years and quickly adapts to take advantage of wetter years.
3. identify drought prone areas, and lessen pressure on these lands.

5.1.5 TECHNOLOGY AS A SOURCE OF ECONOMIC AND SOCIAL ADVANCEMENT  
IN LESS DEVELOPED COUNTRIES

Recognizing the enormous difficulty many developing countries are facing to maintain the current inadequate production, and the need to double it by the the first decade of the 21st century, Molnar and Clonts stress the importance of developing a production technology appropriate for third world countries. Such a technology, the authors say, is needed for both increasing production and prevention of damages to future productivity "through soil erosion, desertification, and other consequences of wasteful grazing and cropping practices".

Molnar and Clont argue that the failure to replicate the success of the green revolution in Asia in other developing countries is to be found in either the appropriateness of the technology itself or the inadequacy or the absence of local capacity to absorb it. A successful technology transfer is indicated to require passing through three phases. The first phase is described as "material transfer", which involves the adoption and diffusion of the technology. The second phase is said to be "design transfer", which involves the "inculcation of knowledge about new products and process into the nations experiment stations"; and the third phase is "capacity transfer", which involves institution building. The last phase, also referred to as "technological mastery",

is identified to be the most crucial in the success or failure of a technology transfer.

## 5.2 REVIEW OF METHODS OF ESTIMATING DEMAND AND SUPPLY OF FOOD

In this section, methods used by selected national and international institutions for estimating demand and supply of food, and which appear to be appropriate for developing countries, are reviewed. Due to the nature of their economy as well as data availability sophisticated methods, as are commonly used in many developed countries, are of limited relevance to countries like Ethiopia, and hence are excluded from this review.

### 5.2.1 AGRICULTURAL COMMODITIES - PROJECTIONS FOR 1975 AND 1985

The Food and Agricultural Organization (FAO) of the United Nations has been conducting commodity projections for a number of years and countries, and there are detailed reports of such studies made in the 1960s, 1970s and 1980s. The approaches followed in these studies have generally been similar, although the recent reports indicate some refinements. The 1967 study is selected for this review since the recent reports do not provide enough details of the methods used. Ninety nine countries and a number of commodities were covered by this study.

Two approaches were used for estimating (projecting) demand. The first was to derive percapita consumption of food, both in terms of kg/year as well as in terms of calories, protein and fat, from food balance sheets estimated for each country and multiply it by projected population.

The second approach, which was limited to a few countries due to data availability, was to estimate percapita consumption from a regression model which relates time series of percapita consumption to income. Similar to the first approach, demand again was the product of the projected percapita consumption and population. Income elasticities were also estimated from this model.

SUPPLY projection was based on extrapolation of past trends of area and yield. There were certain difficulties in such projections, one of which was making commodity specific projections since the commodities were assumed to be competing for the use of the same land and other scarce resources.

The general functional relationship established for both demand and supply estimation was:

$$Y = f( X ), \text{ where } \dots\dots\dots(1)$$

Y was percapita consumption in the demand model, and either of yield, area or production in the supply model.

X was income in the demand model and time in the supply model.

The functional forms fitted were either one of the following.

For both demand and supply:

$$\text{Double-log} : \log Y = a + \beta \log X, \dots\dots\dots(2)$$

$$\text{Semi-log} : Y = a + \beta \log X, \dots\dots\dots(3)$$

$$\text{Log-inverse} : \log Y = a - \beta/X, \dots\dots\dots(4)$$

In addition,

$$\text{Linear} : Y = a + \beta X \text{ for supply, and } \dots\dots(5)$$

$$\text{Log-log inverse} : \log Y = a - \beta/X - \gamma \log X \dots\dots(6)$$

for demand.

The criteria set for selecting the appropriate functional forms for demand estimation were different from that of supply. For supply, the selection was largely based on which ever gave the best fit. For demand, however, different forms were used for developed and developing countries, depending on the assumptions regarding the behavior of demand for different commodities. For the developed countries, the log-inverse function was used for commodities such as cereals, sugar and milk since the level of their consumption was said to be "near saturation". This model, according to the report, shows an elasticity which tends to zero as income approaches infinity. The semi-log function was used for all other commodities since the function implies "no saturation levels" but rather "a decline in the relative value of the income elasticity coefficient proportional to the changes in the quantity consumed".

For the developing countries, the log-log inverse was used for staple food in order "to allow for a maximum level of consumption". The other commodities were estimated using the most appropriate (in statistical terms) of either the semi-log or the double-log functional forms. The log-log inverse implies an increase in percapita consumption up to a maximum and a decline as income rises. The double-log function, on the other hand, implies a constant elasticity through out.

Although they appear to be of limited relevance to countries like Ethiopia, recent FAO reports show changes in some of the model specifications. The 1986 report, for example, shows the following demand and supply models.

SUPPLY :  $AREA = f( A , P_c , P_{cc} , t )$ , where .....(7)

A is lagged amount of seeded area,  $P_c$  and  $P_{cc}$  are prices of the crop planted and its competitors respectively, and  $t$  is time.

$YIELD = f( t , P_c , A_h , I )$ , where .....(8)

$A_h$  is area harvested, and  $I$  is a crop index.

PRODUCTION = Area x Yield .....(9)

DEMAND : PERCAPITA DEMAND =  $f(\text{percapita income}, P_c, P_{cc}, t)$  ... (10)

### 5.2.2 WORLD FOOD PRODUCTION, DEMAND AND TRADE

The purpose of Blakeslee, Heady and Framingham was to project the demand and supply of a number of food crops in 96 countries.

There are a number of similarities between this and the FAO study mentioned above, both in model specification and estimation methods. Several models and functional forms were used for estimation, and different criteria were set in selecting functional forms.

Setting the demand for a commodity as the product of per-capita consumption of that commodity and population its projection was based on estimates of the two variables. Estimation of per capita consumption involved three steps. First, total income was estimated using the best of five functional forms for:

$$Y = f(t), \text{ where } \dots\dots\dots(11)$$

Y was total income and t was time. Where ever data was available aggregate personal consumption expenditure was taken to represent income. Where such data was lacking national income, GDP etc were taken as proxy.

The projection of Y was then used to derive percapita income, which was the ratio of the projected income to population. Percapita income was inturn used in four functional forms to derive percapita consumption. The four functional forms used were said to be recommended by the F.A.O for different countries and commodities. Two of these were the following:

$$C_t = C_o Y_t^\mu Y_o^{-\mu} \dots\dots\dots(12)$$

$$C_t = C_o \exp [\mu(1 - Y_o Y_t^{-1})], \text{ where } \dots\dots\dots(13)$$

$\mu$  is income elasticity, C and Y are percapita consumption and percapita income respectively with the subscript o denoting a base period and t future value of time.

Production projection involved two approaches. For the countries for which data was available area and yield trends were estimated separately and production was the product of the two. For the countries where no such data was available, which included almost all African countries, the projection was based on estimates of production trends. Wherever separate area projection was made it was restricted to land availability. A separate study was undertaken to estimate the availability of cultivable land in each country.

The functional relationship established for production projection was:

$$Z_t = f(t), \text{ where } \dots\dots\dots(14)$$

Z was either area, yield or production, and t was time. Both linear and non linear functional forms were fitted, depending on which ever gave the best fit.

Following the separate estimation of the demand for and production of each commodity the difference between the two was taken to determine the deficit and surplus in each country.

### 5.2.3 EUROPE'S FUTURE FOOD AND AGRICULTURE

Food demand and supply projection models built for different Western European countries are discussed by their respective authors in McFarquhar. The models specified for three countries- Belgium, Denmark and France - are briefly reviewed here.

For Belgium, the demand model was:

$$C_p = f( Y, P, t ), \text{ where } \dots\dots\dots(15)$$

$C_p$  was private consumption of the commodity,  
 $Y$  was personal income,  $P$  was price, and  
 $t$  was time, which was included to represent  
 such changes as consumption habits.

Estimation of agricultural production was based on the following two models, one for production and the other for acreage:

$$O_t = f( I_t, P_{t-1}, P^1_{t-1}, P^{11}_{t-1}, C, t ) \dots\dots(16)$$

$$I_t = f( P_{t-1}, P^1_{t-1}, t ), \text{ where } \dots\dots\dots(17)$$

$O$  was production of a crop,  $I$  was acreage under that crop,  
 $P$  was producers price for a crop,  $P^1$  and  $P^{11}$  were  
 prices of alternative products,  $C$  was weather, and  $t$  was time.

Estimation of demand for Denmark involved two different models. First, income elasticity was estimated from:

$$X_{ij} = a + \beta \log Y_j + \epsilon_{ij}, \text{ where } \dots\dots\dots(18)$$

$X_{ij}$  was consumption of commodity  $i$  by the  $j$  th household,  $Y$  was disposable income and  $\epsilon$  was an error term.

Although no further explanation was given, the main purpose of this model, according to the author, was to help in selecting appropriate functional relationships as well as to indicate areas of further research. It was also indicated that the semi-log model was used to avoid problems of "zero observations". In this and the second model effects of wealth and substitute/complementary goods were not taken into account. The exclusion of wealth was due to lack of data, where as the substitute/complementary goods were dropped to avoid multicollinearity.

Demand projection was based on the second model, which involved estimating percapita consumption of each commodity. The model was:

$$X_t = f( Y_t, P_t, t ), \text{ where } \dots\dots\dots(19)$$

X was percapita consumption of a product, Yt was percapita total private consumption, which was taken as a proxy for income, P was price, and t was time. Yt and Pt were projected values

For some commodities t was found to be a better explanatory variable than Y, in which case Y was dropped where ever t was used and vice versa. The preference of Yt to disposable income or percapita GNP was said to be partly due to the likelihood of short run changes in income not affecting consumption and partly due to the difficulty of getting "true" disposable income because of tax evasion.

Production was forecasted from a yield trend model. Area under crop was assumed not to change during the projection period.

The approach used for France was much simpler. Demand estimation was based on:

$$C_t = a + \beta_1 \log R_t + \beta_2 \log C_{t-1} + \beta_3 \log P_t \dots (20)$$

where C was consumption of a product, R was income, P was relative price of the product, and t was time.

Production was projected using a single trend model - production = f(t). It was indicated that due to uncertainties in future agricultural policies use of more sophisticated methods was not entertained.

#### 5.2.4 DEMAND AND SUPPLY PROJECTION OF AGRICULTURAL PRODUCTS IN CHILE

This was a study made in 1969 by the Catholic University of Chile to estimate and project the demand and supply of 38 agricultural commodities.

Estimation of demand was based on a family budget survey conducted for two population groups - labourers and independent workers. The rural population was included with the labourers since their consumption habit was said to be similar. The survey was mainly used to estimate family incomes and expenditures so that elasticities of different commodities could be derived. The respective elasticities were in turn used in the following model to project consumption.

$$C_t = C_0 [1 + \eta_{x1} \Delta X_1 / X_1 + \eta_{x2} \Delta X_2 / X_2] [1 + \Delta X_3 / X_3] \dots\dots(21)$$

$C_t$  was consumption of a commodity at time  $t$ ,  $C_0$  was base period consumption,  $\eta_x$ 's were respective elasticities,  $\Delta X_1 / X_1$  was change in family income during a period, which was assumed to increase uniformly,  $\Delta X_2 / X_2$  was change in family size during the period, and  $\Delta X_3 / X_3$  was change in the number of families.

Supply projection was based on estimates of trends of area and yield. The relationship estimated was  $Y = f(t)$ , where  $Y$  was either area or yield, and  $t$  was time. According to the authors, labour availability was not considered since no constraint was anticipated, supply of capital was also ignored due to lack of data, and relative prices and government policies were assumed as constant.

#### 5.2.5 CHINA'S GRAIN PRODUCTION AND TRADE

One of the objectives of this study by Carter and Zhong was to "project China's grain production, consumption and trade in the year 2000". The projections were based on separate models specified for national and regional level estimates.

At the national level, the following production model was described as the "theoretically appropriate":

$$A = f ( POP, P_g, P_r ) \dots\dots\dots(22)$$

$$Y = f ( P_g, P_r, t ) \dots\dots\dots(23)$$

$$Q = A \times Y \dots\dots\dots(24)$$

where  $A$  was area seeded to grains,  $Y$  was yield,  $Q$  was production,  $POP$  was population,  $P_g$  was grain price,  $P_r$

was price ratio of grain to cash crops, and  $t$  was time.

This model, according to the authors, could not be estimated due to data and other limitations, and hence, the following modifications were introduced. The price variables in the area model were dropped due their "little" effect during the period before 1979 and inadequacy of the time series since then. Area seeded was, therefore, estimated with a population variable only. In the yield model  $P_g$  was retained along with the time variable, where as  $P_r$  was dropped to avoid multicollinearity.

The model specified for regional level production estimate was similar to the national level. The only changes introduced were the substitution of the population variable in the area model by the "national population growth index" since regional level population data was not available, and the exclusion of the trend variable from the yield model due to multicollinearity.

Unlike the other models, which were estimated using simple linear regression equations, the method used for estimating the regional level yield model was different. The data available was at provincial level (each region was divided into provinces) and only five years data was available for each province. In order to overcome the inadequacy of the degrees of freedom a pooled time series - cross section estimation method was used, and the regional level

estimate was taken as the weighted average of the provincial level estimates.

The model specified for consumption was:

$$C_t = a + b I_t + c C_{t-1} + e, \text{ where } \dots\dots\dots(25)$$

$C_t$  was percapita consumption of a given commodity at time  $t$  and  $C_{t-1}$  was its lagged value, and  $I_t$  was percapita income.

This model was estimated for rural and urban areas separately, and for three commodities, namely: grain, meat and spirits.

The estimated models were then used to project demand and supply of the commodities considered and estimate the countries import requirements.

## Chapter VI

### THE MODEL AND ITS ESTIMATION METHOD

Most of the analysis in this research is based on an econometric model estimated for the supply (production) of the major cereal crops in Ethiopia. Demand is estimated using other methods.

The conventional demand model which represents the neo-classical theory's utility maximizing consumer is:

$$X_i = f( Z_i, Z_j, I ), \text{ where } \dots\dots\dots(26)$$

$X_i$  is amount of commodity  $i$  purchased,  $Z_i$  is its price,  $Z_j$  is price of competing commodity and  $I$  is income.

Estimation of such a model using econometric methods involves, among other things, specifying a system of equations and imposing demand restrictions. The relevance of such a sophisticated approach is, however, limited to a consumer who depends on purchased food, and not to a peasant farmer who largely depends on his own production. As was noted earlier, in a subsistence economy like that of rural Ethiopia market demand for food is minimal, and in some cases virtually non-existent. It is the ability to produce rather than price and cash income which largely determines consumption.

Like wise, the supply model of a market oriented, profit maximizing producer reduced from a given production and profit functions is:

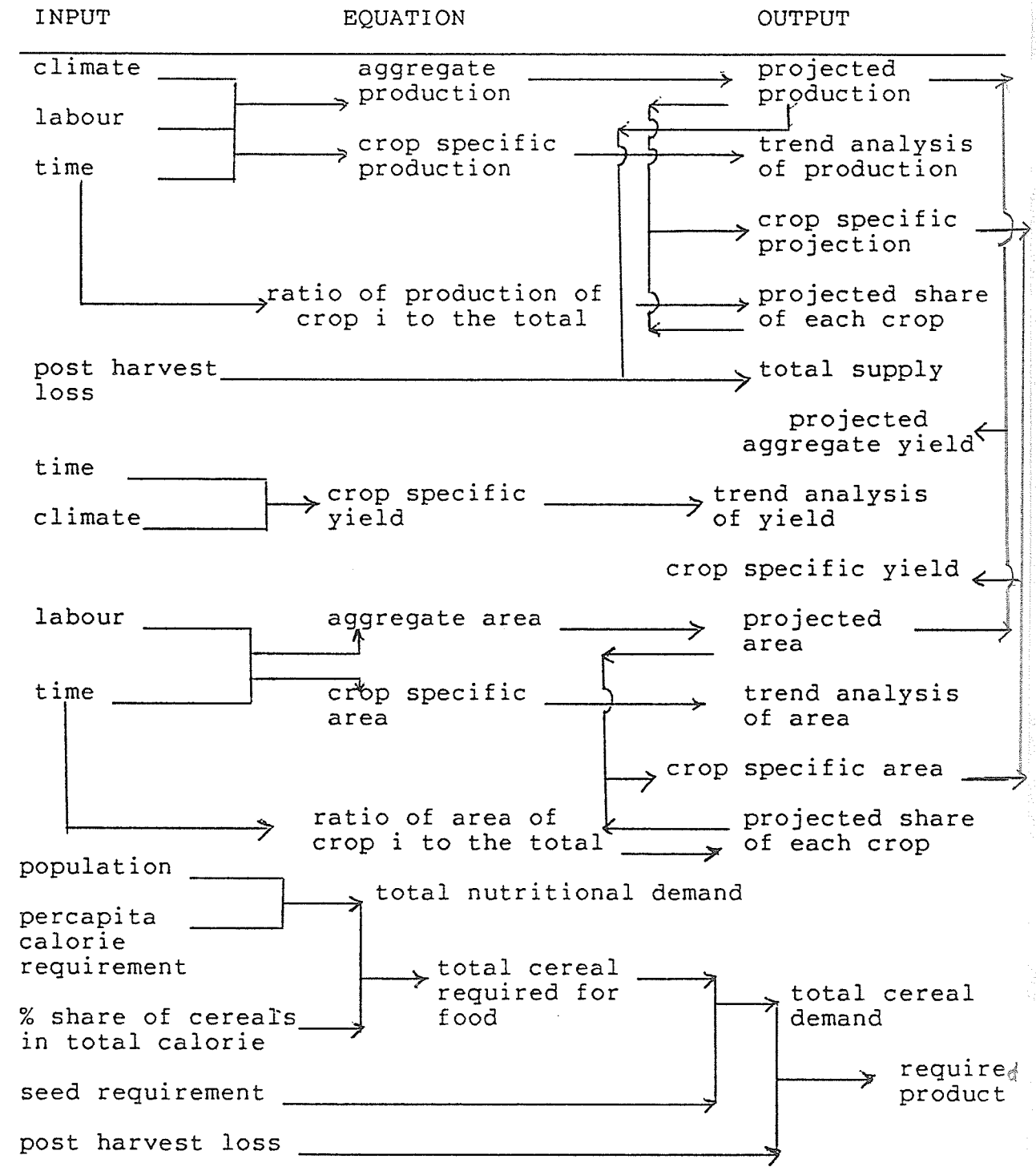
$$O_i = f( r_i, r_j, W) \dots\dots\dots(27)$$

where  $O$  is output,  $r_i$  and  $r_j$  are prices of  $O_i$  and its competing commodities respectively, and  $W$  is factor price.

Supply in such an economy is thus entirely determined by output and factor prices. This model, again, has very limited relevance to subsistence agriculture since many of the major factor inputs are not purchased, and production is primarily for own consumption and not for sale.

Market demand and supply models being of limited relevance to analyze the food situation in rural Ethiopia, the following alternative and more appropriate models are specified.

SUMMARY OF VARIABLES AND RELATIONSHIPS IN THE MODEL



## 6.1 SUPPLY MODEL

Three separate models are specified for supply - one each for production, yield and area seeded. These are

PRODUCTION :

$$P_{aj} = f( T, R_j, L_j ) \dots\dots\dots(28)$$

$$P_{ij} = f( T, R_j, L_j ) \dots\dots\dots(29)$$

$$P_{ij}/P_{aj} = f( T ) \dots\dots\dots(30)$$

YIELD :

$$Y_{ij} = f( T, R_j ) \dots\dots\dots(31)$$

AREA :

$$A_{aj} = f( T, L_j ) \dots\dots\dots(32)$$

$$A_{ij} = f( T, L_j ) \dots\dots\dots(33)$$

$$A_{ij}/A_{aj} = f( T ) \dots\dots\dots(34)$$

$P_{ij}$ ,  $Y_{ij}$  and  $A_{ij}$  are production, yield and area of the  $i$ th crop in the  $j$ th region respectively, the subscript "a" stands for aggregates of production and area,  $T$  is time,  $R$  is precipitation, and  $L$  is labour. The explanatory variables in the model are  $T$ ,  $R$ , and  $L$ .  $T$  explains the effects of technological changes on both area

and productivity, while L and R explain the effects of the factors they represent. The effect of L is revealed through area seeded while R affects yield. A preliminary test of significance of L on yield did not justify its inclusion in the yield model. Variables for area seeded and fertilizer were also initially included in the yield model, but were later dropped for the same reason. The labour variable used here is not actual labour but rather the rural male population between the ages 20 to 59. This is taken as a proxy for labour since real data is difficult to obtain. The opportunities for off farm employments in Ethiopia are very low. Hence, such an approximation is not unrealistic, and statistical tests strongly support its inclusion. The male rather than the total labour force is taken since the size of cultivated area is almost entirely determined by male labour availability.

The three models have been used for both trend analysis and projections - the aggregate models for projection and the crop specific models for trend analysis. The preference for the aggregates rather than the crop specific models for projection is the likelihood of annual shifts in the crops planted, depending on the timeliness of the rain and availability of inputs. For example, it often happens that if rain is late for planting maize it is substituted by sorghum, and if it is late for sorghum as well teff is planted instead. The same is true for the other crops. It may,

therefore, be unrealistic to make crop specific projections in light of such flexibilities.

For the analysis which requires crop specific data the projection from the area and production models which relate the proportionate share of each crop to time (equations 30 and 34) have been used to break down the aggregates. In addition, due to the low  $R^2$  of the estimated yield model projected yield is indirectly derived from the ratio of production to area rather than from the yield model itself.

The model involves single equations in which all the explanatory variables are exogenously determined. Hence, there are no estimation problems which require the use of techniques other than Ordinary Least Squares (OLS) method. The only major problem is adequacy of degrees of freedom. In Ethiopia, there are two data sets on grain production and related variables covering the period 1974 to 1988. The first set is for 1974 to 1978 and was collected by the Ministry of Agriculture, and the second is for the period since 1979 and was collected by the Central Statistical Office (C.S.O). Due to differences in sample designs and related problems the combined use of both data sets is not advised by the agencies concerned, particularly the C.S.O. Hence, the agricultural data used for this study is entirely that of the C.S.O.

It is the dependence on the C.S.O data which has made the degrees of freedom inadequate. Only nine years data are available for each region, which is inadequate to make reliable estimates and conduct statistical tests. The only solution to this problem is to use cross section-time series data pooling approach. Accordingly, the entire data for the twelve regions (n=108) has been pooled to estimate the model.

There are a number of ways of estimating a model which uses a pooled time series-cross section data, depending on the assumption one makes regarding the slopes, intercepts, and the nature of the error terms. One of the assumptions which can be made is a common intercept and slope, in which case OLS method is used by simply stacking the data (Jonston, pp397). This same model could also be estimated by varying the assumptions about the error terms. Assumption of a constant slope and intercept is, however, said to be unreasonable unless it is justified by an appropriate statistical tests (Pindyck and Rubinfeld, pp254). The second approach, which is called a covariance model, allows the intercept to vary. This is the method used here since it enables deriving regional level estimates.

The general form of the equation estimated using the covariance model is described below. It is shown here for  $P_{ij}$  only, but the approach used for the remaining components of the model has also been the same.

## COVARIANCE MODEL FOR PRODUCTION :

$$\begin{aligned}
 P_{ij} &= a_0 + \beta_1 T + \beta_2 R + \beta_3 L \dots\dots\dots(35) \\
 &+ \gamma_2 T_2 + \dots + \gamma_{12} T_{12} \\
 &+ a_2 D_2 + \dots + a_{12} D_{12}
 \end{aligned}$$

$$\begin{aligned}
 \text{Where } T_j &= T D_j \\
 D_j &= 1 \text{ for the } j\text{th region} \\
 &= 0 \text{ otherwise}
 \end{aligned}$$

$$j = 2, \dots, 12$$

The variable  $T$  explains the trend in the entire data set where as  $T_2$  to  $T_{12}$  take into account the additional region specific trends. The dummies  $D_2$  to  $D_{12}$  are the variables which shift the intercept for their respective regions. Additional shift variables are not specified for  $R$  and  $L$  since no regional level differences in labour productivity or effects of rainfall are anticipated. Any other differences, such as in soil type, are taken into account by the intercept. The intercept also accounts for  $D_1$ , while  $T$  accounts for  $T_1$ .

From the general covariance model region specific equations (setting  $D_j = 1$ ) can be derived as follows:

$$P_{ij} = a_0 + a_j + (\beta_1 + \gamma_j) T + \beta_2 R + \beta_3 L \dots\dots(36)$$

## 6.2 DEMAND MODEL

The applicability of a market demand for Ethiopia, as noted earlier, is limited to the ten percent urban population. For the peasants, due to their mode of production and level of technology production dictates the level of consumption.

The earlier theoretical discussion has indicated that most of the economic activities of a subsistence population are characterized by a survival strategy. Hence, the best approach to determine their demand for food or consumption is perhaps to undertake a house hold consumption or budget survey, though it often is very expensive and operationally difficult.

There are alternative methods of determining demand for food which is associated with survival strategy. If one carefully uses such approaches commodity specific demand estimation is possible. The most frequently used approach is to determine the amount of food (calorie) required to survive and work, which is here defined as nutritional demand. Looking at nutritional rather than market demand is also a more realistic approach when the problem is that of inadequate production, and that the effort being made is to produce an acceptable minimum, as is the case in Ethiopia. Hence, it is the minimum nutritional demand which has been estimated for this part of the analysis. The model which describes such a demand is:

$$N_d = f( PA, BS, AG, S, C ) \dots\dots\dots(37)$$

where Nd is total nutritional demand, PA is physical activity, BS is body size and composition, AG is age, S is sex, and C is climate.

Such a demand model assumes that individuals of the same age, sex and size, who live in areas of the same climate, and who do the same type of job have similar calorie requirements (FAO/WHO,1973,pp22-40). The implications of such an assumption are that calorie needs only differ when they involve men and women, people who do different types of physical activity, younger and older and lighter and heavier people, as well as people living in different climates.

A number of studies and data sources have been used to estimate the nutritional demand of the five crops in Ethiopia. One of this is the FAO's fourth world food survey report, and the other is the 1973 FAO/WHO expert committee study, which has established the total calorie needs of a reference person who lives under different environments. Additional data from the Ethiopian Nutrition Institute (ENI) has also been used.

In rural Ethiopia, cereals and other starchy foods are the major sources of calorie (except in the special case of nomadic herdsmen), and therefore account for the major part of the nutritional demand. The other food sources are pulses and oil crops as well as animal products.

In the FAO's fourth world food survey report (1977, pp 21 and 24) the contribution of cereals to the total calorie supply in a group of developing countries, including Ethiopia, in 1972-74 was indicated as 65.8%. The similar figure for 1961-63 was 64.6%. These are percentages corresponding to daily consumption levels of 2051 kcal and 2097 kcal respectively. Given the heavy cereal dependence of the Ethiopian food consumption pattern such percentages appear to be realistic except probably for a few root crop dependent regions in the southern and south eastern parts of the country. According to the FAO report, the remaining food sources and their shares in 1972-74 were: 7.2% for pulses, 4.2% for roots and tubers, 7.8% for sugar, 8.8% for vegetables, fruits, and vegetable products, and 6.2% for animal products.

If reliable data on imports and exports of cereals as well as the levels of percapita calorie consumptions were available it was possible to directly estimate such percentage figures using statistical methods [ total cereal available =  $f(N_{djt})$  ]. The absence of such a data has made it necessary to use the FAO's estimate of cereals calorie share of 65.8%. Hence, the total amount of cereal required for consumption in region  $j$  ( $CC_j$ ) at time  $t$  is:

$$CC_{jt} = 0.658 \times N_{djt} \quad , \text{ where } \dots\dots\dots(38)$$

$N_{djt}$  is the total nutritional demand of the whole population in region  $j$  at time  $t$ .

A number of scenarios can be considered to determine Ndj. The FAO study shows the optimal percapita calorie required in Ethiopia as 2330 kcal where as the amount available in 1972-74 (pre-drought years), as noted earlier, was only 2051 kcal. The Ethiopian government's ten year plan, on the other hand, sets a target of attaining a minimum of 2000 kcal in 1994. Converting this three alternatives into their cereal equivalent based on the average of the ENI's estimate of the calorie content of the five cereals (each 100 gm of teff provides 336 kcal, wheat 339, barley 334, maize 356, and sorghum 338) gives:

2330 kcal = 684 gm/day = 0.25 tones/year	.....(39)
2051 kcal = 602 gm/day = 0.22 tones/year	.....(40)
2000 kcal = 587 gm/day = 0.21 tones/year	.....(41)

For each of the three calorie consumption levels therefore:

$$Nd_{jt} = 0.25 \times POP_{jt} \text{ or } 0.22 \times POP_{jt} \text{ or } 0.21 \times POP_{jt} \quad \dots\dots(42)$$

where  $POP_{jt}$  is total population of region  $j$  at time  $t$ .

The model described so far is adequate to determine the amount of cereals required for food. There are, however, additional demand components which share the peasants total cereal production. One of these is market requirement. The requirement of the market dependent population of each region is already included in the estimate of the total

cereal demand. In the final demand-supply analysis any amount of food which is in excess of the local requirement will be the potential export, and the deficit the likely import.

Another demand component is inventory requirement. In normal years peasants dispose of all grain stock before a new harvest is in, and the level of inventory at the end of a year is zero. Zero inventory is therefore assumed here. The final demand component is seed requirement. This is estimated by multiplying the normal seeding rates by the projected cropped area. The average per hectare seeding rate in Ethiopia, according to the FAO (1980 food balance sheet report, pp321), is 5kg for Teff (assumed here to be the same as millet), 70kg for Wheat, 75kg for Barley, 25kg for maize, and 5kg for Sorghum.

The total demand for cereals in region  $j$  is therefore:

$$TD_{jt} = CC_{jt} + \sum_{i=1} R_{ij}, \text{ where } R_{ij} \text{ is } \dots\dots\dots(43)$$

seed requirement of the  $i$ th crop.

### 6.3 SOURCES OF DATA

The major sources of data are official Ethiopian government reports. All data on area, yield, and production were obtained from reports of the C.S.O. These are results of proper (scientific) agricultural sample surveys. All demographic data, also from C.S.O reports, are results derived from the recent census. The meteorological data were obtained from the National meteorological Services Agency. Other data sources were reports of the Relief and Rehabilitation Commission, and papers presented at a national workshop on food strategy. In limited cases data from the F.A.O and the World Bank's World Development Reports were also used.

## Chapter VII

### ANALYSIS OF ESTIMATES OF THE MODEL

Estimating an econometric model requires, among other things, selecting appropriate functional forms for the equations. In some cases, there are theoretical reasons which require the use of certain forms. Frequently, however, the choice is made on goodness of fit. This is particularly true in estimating forecasting models.

The supply model specified earlier has been estimated using a linear functional form since it has provided very high  $R^2$  (adjusted) for crop production and area seeded. In spite of the low  $R^2$  (which is often the case with yield models), the yield model has also been estimated using the same functional form. None of the non-linear forms attempted gave higher  $R^2$ .

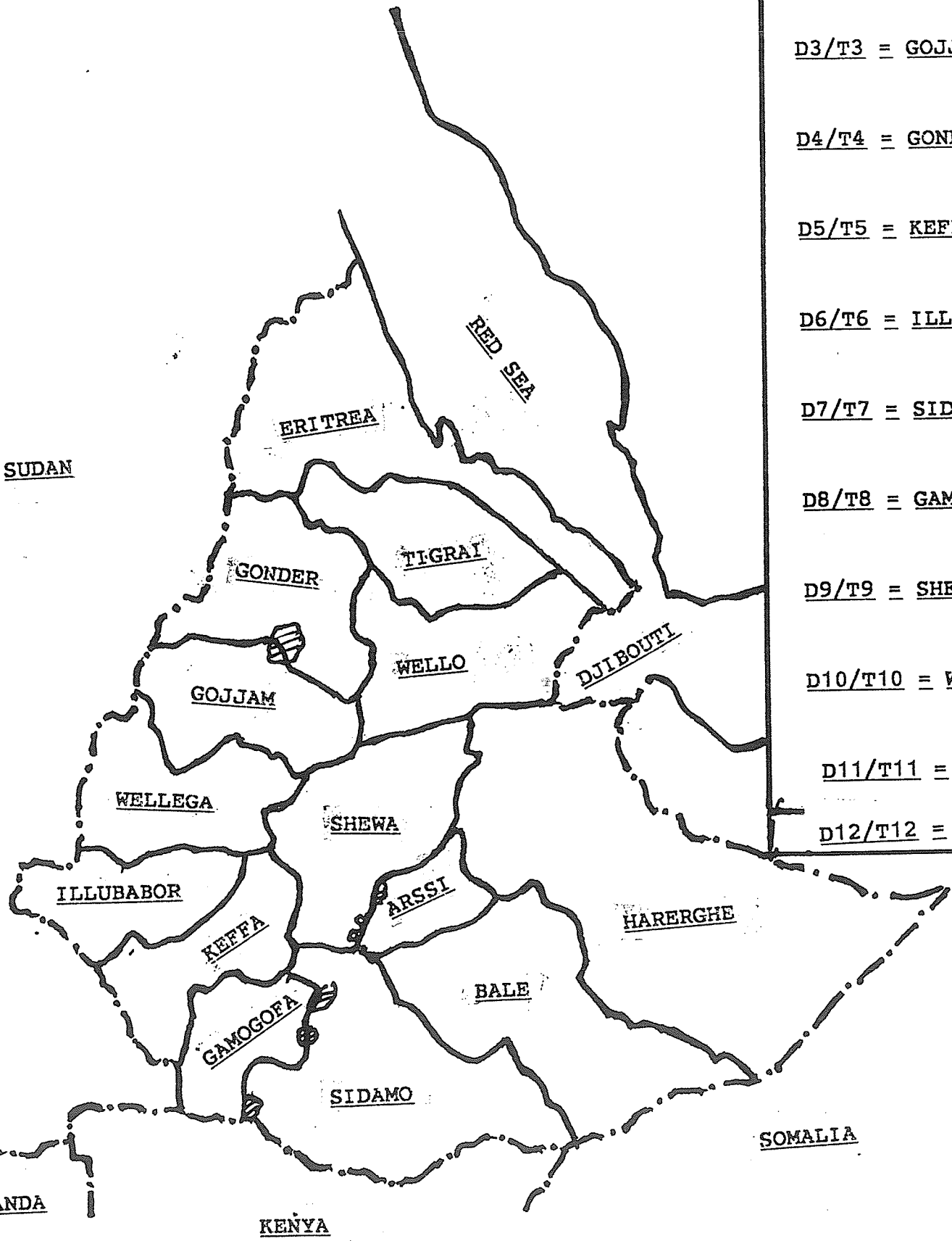
The level of significance chosen for analysis is 5%. Among the variables originally included in the estimate, those with a t value of less than one have been dropped. The remaining variables were retained even when not significant at the 5% level since they helped improve the  $R^2$ . The only exceptions are the dummy variables, which have been kept even with low t values. Dropping the dummies, according to Pindyck and Rubinfeld (PP 255), biases the statistical test.

The shift variables in the model represent the following regions (see regional map):

T2 and D2 = Bale	T3 and D3 = Gojjam
T4 and D4 = Gonder	T5 and D5 = Keffa
T6 and D6 = Illubabor	T7 and D7 = Sidamo
T8 and D8 = Gamogofa	T9 and D9 = Shewa
T10 and D10 = Wellega	T11 and D11 = Wello
T12 and D12 = Harerghe	

The twelfth region - Arssi - is represented by T and the overall intercept term.

REGIONAL MAP OF ETHIOPIA



D2/T2 = BALE

D3/T3 = GOJJAM

D4/T4 = GONDER

D5/T5 = KEFFA

D6/T6 = ILLUBABOR

D7/T7 = SIDAMO

D8/T8 = GAMOGOFA

D9/T9 = SHEWA

D10/T10 = WELLEGA

D11/T11 = WELLO

D12/T12 = HARERGI

## 7.1 ESTIMATES OF PRODUCTION MODEL

The labour variable, as noted earlier, indicates the effect of changes in area seeded on production. The correlation between total area seeded and labour is 0.84. Rainfall represents the influence of climate on productivity, while the trend variable shows the effect of technological changes. The intercept represents all other natural resources which contribute to production, such as soil type.

### 7.1.1 AGGREGATE CROP PRODUCTION

The model estimated is equation 28. The estimates of the model (table 6) show significant values for most of the parameters. Labour and rainfall are positive and significant. The trend is also significant but declining in all regions. Hence, changes in area seeded as well as increases in productivity due to rainfall are the only factors which have been causing the over all production to increase. The elasticity of labour is 18.11 and the elasticity of rainfall 0.34. The negative trend indicates the decline in production associated with the inadequacy or absence of inputs such as fertilizer and other chemicals.

The trend shows different rates of production decline among the regions. Shewa, followed by Harerghe and Wello, appear to have experienced larger rates of decline than the other regions, and the lowest rate of decline was in Bale. Where as in Arssi production fell at an annual rate of 840

quintals (qts), it dropped in Shewa by nearly eight times as much and in Harerghe and Wello by about four times. The rate of decline in Gojjam, Gonder and Sidamo was nearly three times as much as Arssi while in Keffa and Wellega it was about twice. In Bale it fell by 620 qts/year, which is lower than Arssi, and Illubabor and Gamogofa show the same rate of decline as Arssi.

The intercept is negative for all regions, and is significant for all except Bale and Illubabor. This indicates the absence of extra resources which could increase production apart from labour and rainfall. The regional level intercepts reveal the relative scarcity of such resources in each region. Shewa, Harerghe, Well, Sidamo, Gojjam, Gonder, Keffa, and Wellega, in that order, are indicated to have scarcer resources than Arssi, while Bale, Illubabor and Gamogofa appear to have higher extra resource basis than Arssi.

TABLE 6  
ESTIMATE OF AGGREGATE PRODUCTION MODEL

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT ('000QT)		-29172.36	9312.54	-3.13
D2		10204.76	3979.62	2.56
D3		-38388.95	11471.08	-3.35
D4		-32127.32	9467.76	-3.39
D5		-24337.96	6526.43	-3.73
D6		7489.50	3442.46	2.18
D7		-46323.31	12577.88	-3.68
D8		886.72	1274.39	0.70
D9		-135419.01	42455.82	-3.19
D10		-18618.45	5245.03	-3.55
D11		-46669.45	14578.28	-3.20
D12		-60444.12	17870.79	-3.38
Trend(T)	(year)	-840.92	276.39	-3.04
T2		220.35	154.20	1.43
T3		-1484.64	465.83	-3.19
T4		-1557.34	399.31	-3.90
T5		-952.46	304.97	-3.12
T7		-1608.12	502.05	-3.20
T9		-5542.20	1520.84	-3.64
T10		-981.53	266.35	-3.68
T11		-2543.90	569.45	-4.47
T12		-2579.83	680.02	-3.79
Rainfall(R)	(mm)	1.25	0.56	2.25
Labour (L)	(unit)	0.15	0.04	3.45

$$R^2 = 0.93 \quad D.W = 2.36$$

$$n = 108 \quad F = 67.77$$

### 7.1.2 TEFF PRODUCTION MODEL

In the equation estimated for teff (table 7) rainfall was not significant, and was therefore dropped. The trend shows a significant decline in all regions except Bale and Illubabor. Labour is significant and positive. The insignificant

rainfall and declining trend show that yield or productivity did not have any positive effect on production. All increases in teff production are indicated to have been due to labour ie changes in area seeded. The elasticity of labour is 32.72.

The highest rate of production decline, as revealed by the trend, was in Shewa, followed by Wello and Harerghe. Where as in Arssi teff production declined at an annual rate of 433 qts it was six times as much in Shewa and nearly three times in Wello and Harerghe. Teff Production in Sidamo, Gonder, and Gojjam dropped by about twice as much as Arssi, while the decline in Keffa and Wellega was only slightly higher than Arssi. The rate of decline in Bale, Illubabor and Gamogofa was lower than Arssi.

The intercepts are negative for all regions, and significant for all except Bale, Illubabor and Gamogofa. Similar to the trend, lower negative intercepts than Arssi are indicated for Bale, Illubabor and Gamogofa, and this shows that the extra resources needed for teff production were not as scarce in these Regions as they were in Arssi. The largest negative intercept indicated is for Shewa, followed by Harerghe, Wello and Sidamo, reflecting greater resource constraints in these regions. Larger negative intercepts than Arssi are also indicated for Gonder, Gojjam, Keffa and Wellega.

TABLE 7  
ESTIMATE OF TEFF PRODUCTION MODEL

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	('000QT)	-11461.89	3026.01	-3.79
D2		4389.12	1246.41	3.51
D3		-13424.72	3890.40	-3.45
D4		-11407.64	3222.21	-3.54
D5		-8846.82	2243.49	-3.94
D6		3625.32	979.30	3.70
D7		-16891.62	4257.09	-3.97
D8		1007.34	414.62	2.43
D9		-52441.61	14198.19	-3.69
D10		-6120.53	1809.30	-3.38
D11		-17814.35	4923.27	-3.62
D12		-23931.83	6015.80	-3.98
Trend(T)	(year)	-433.84	108.19	-4.01
T2		194.40	59.22	3.28
T3		-474.50	140.12	-3.39
T4		-517.74	118.28	-4.38
T5		-244.05	87.40	-2.79
T6		163.78	52.93	3.09
T7		-576.11	152.26	-3.78
T8		65.40	43.21	1.51
T9		-2018.56	490.94	-4.11
T10		-284.26	74.50	-3.82
T11		-855.77	174.48	-4.91
T12		-803.11	211.27	-3.80
Labour(L)	(unit)	0.06	0.01	3.94
		$R^2 = 0.95$	$D.W = 2.49$	
		$n = 108$	$F = 90.24$	

### 7.1.3 WHEAT PRODUCTION MODEL

The estimate of the wheat production model (table 8) also shows no significant effect of rainfall on production, where as the trend is positive and significant for most of the regions. It is only for Bale and Illubabor that though posi-

tive it is not significant. Labour, on the other hand, is negative but significant.

Unlike teff, the result shows all increases in wheat production to have been due to changes in productivity, apparently caused by more use of inputs. The trend also indicates the same rate of annual production increase as Arssi in all regions except Shewa, Bale, Illubabor, Gamogofa and Wellega. In Shewa, the rate of increase in wheat production was higher than Arssi. In Arssi, wheat production increased at the rate of 161 qts while in Shewa it increased by nearly three times as much. In Bale and Illubabor, on the other hand, it increased by less than half as much as Arssi. In Gamogofa and Wellega the increase was at a slightly lower rate than Arssi. The negative labour variable probably reflects a decline in area seeded to wheat, and its elasticity is 10.08.

The intercept is positive and significant for all regions except Bale and Gamogofa, and lower intercept levels than Arssi are indicated for Bale, Gamogofa, and Illubabor, and higher levels for the remaining regions. The level of the intercept also indicates Shewa to have greater extra resources needed for wheat production other than labour, rainfall and technological factors than the other regions. Such resources also appear to be larger in Wello, Harerghe, Gojjam, Sidamo, Gonder, Keffa, and Wellega, in that order, than the remaining regions.

TABLE 8  
ESTIMATE OF WHEAT PRODUCTION MODEL

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT ('000QT)		2901.79	306.21	9.48
D2		-1560.99	154.63	-10.09
D3		1928.87	567.82	3.40
D4		1221.20	471.82	2.59
D5		225.05	332.08	0.68
D6		-1613.72	140.94	-11.45
D7		1620.56	620.61	2.61
D8		-1249.61	138.05	-9.05
D9		9525.50	1834.35	5.19
D10		171.03	325.33	0.53
D11		2555.10	716.65	3.57
D12		2980.53	874.39	3.41
Trend (T)	(year)	161.74	28.87	5.60
T2		-123.76	29.94	-4.13
T6		-116.18	29.17	-3.98
T8		-90.61	27.56	-3.29
T9		276.27	50.66	5.45
T10		-60.22	23.33	-2.58
Labour(L)	(unit)	-0.01	0.002	-5.01
R <sup>2</sup> = 0.94		D.W = 2.16		
n = 108		F = 95.67		

#### 7.1.4 BARLEY PRODUCTION MODEL

None of the explanatory variables in the barley model (table 9) are significant, the intercept accounts for all the variations between regions and years. Production has, therefore, been generally stable with no significant shifts in area seeded and changes in productivity.

The intercept is positive and significant for all regions, and its level is very high for Arssi and Shewa.

This indicates the higher resource endowments of Shewa and Arssi interms of barley production. Gojjam, Wello and Gondar appear to have the next higher resource basis. There is no much difference between the remaining regions, although Illubabor and Harerghe seem to be the least suited for barley production.

TABLE 9  
ESTIMATE OF BARLEY PRODUCTION MODEL

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	('000QT)	1781.50	122.52	14.54
D2		-1292.99	151.24	-8.55
D3		-526.20	151.24	-3.48
D4		-730.16	151.24	-4.83
D5		-1565.08	151.24	-10.35
D6		-1676.37	151.24	-11.08
D7		-1531.51	151.24	-10.13
D8		-1524.31	151.24	-10.08
D9		1029.49	151.24	6.81
D10		-1451.62	151.24	-9.60
D11		-536.61	151.24	-3.55
D12		-1616.39	151.24	-10.69
Trend(T)	(year)	-11.66	11.96	-0.98
R <sup>2</sup> = 0.86		D.W = 1.85		
n = 108		F = 55.51		

### 7.1.5 MAIZE PRODUCTION MODEL

Maize production shows a significantly declining trend in all regions except Bale and Illubabor (table 10). Although not significant at 5%, rainfall also appears to have had an effect on maize production by a larger magnitude than that revealed in the models for teff, wheat and barley.

Similar to teff, the effect of labour on maize production is both positive and significant, and this shows area expansion as the principal factor for increasing maize production. The only productivity increase shown is through rainfall, but it is not significant. The elasticity of labour is 33.26, and the elasticity of rainfall 0.44.

The negative trend indicates a decline in production caused by inadequacy of technical inputs. All regions except Bale, Illubabor and Gamogofa show higher rates of decline than Arssi. The same rate of decline as Arssi is indicated in Gamogofa while it was lower than Arssi in Bale and Illubabor. Maize production dropped at the rate of 514 qts in Arssi, while it dropped in Shewa by nearly six times as much, and in Wello and Harerghe by about three times. The rate of decline in Gojjam, Gonder, Sidamo, keffa and Wellega was about twice as much as Arssi.

The intercept is negative for all regions and shows the same pattern from one region to the other as for teff. This again reflects the absence of favourable extra natural

resource basis for the production of maize apart from labour and rainfall.

TABLE 10  
ESTIMATE OF MAIZE PRODUCTION MODEL

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	('000QT)	-15314.21	5386.13	-2.84
D2		5862.79	2249.68	2.61
D3		-19332.49	6816.68	-2.84
D4		-16644.24	5641.71	-2.95
D5		-10539.50	3904.54	-2.70
D6		4903.10	1812.89	2.71
D7		-21611.05	7472.73	-2.89
D8		1894.38	735.18	2.58
D9		-70743.23	25046.08	-2.83
D10		-8287.14	3134.10	-2.64
D11		-25363.78	8648.80	-2.93
D12		-30167.84	10590.33	-2.85
Trend(T)	(year)	-514.38	178.12	-2.89
T2		205.17	92.06	2.23
T3		-607.10	255.81	-2.37
T4		-573.02	216.21	-2.65
T5		-392.11	160.20	-2.45
T6		130.61	81.52	1.60
T7		-629.84	277.04	-2.27
T9		-2357.79	877.73	-2.69
T10		-336.34	137.62	-2.44
T11		-866.36	317.10	-2.73
T12		-1036.88	382.33	-2.71
Rainfall(R)	(mm)	0.41	0.27	1.53
Labour(L)	(unit)	0.07	0.02	2.88
R <sup>2</sup> = 0.79		D.W = 2.24		
n = 108		F = 18.04		

### 7.1.6 SORGHUM PRODUCTION MODEL

Like the other crops, the trend in sorghum production is significant and declining in all regions except Bale and Illubabor. Sorghum is the only crop for which the effect of rainfall is significant (table 11). Labour is also positive and significant. The elasticity of labour is 39.46 and the elasticity of rainfall 1.28, and such high elasticities indicate the importance of the two factors in sorghum production.

The pattern of the estimates of the region specific trends and intercepts for sorghum is similar to maize. The trend indicates Shewa, followed by Harerghe and Wello, to have experienced higher rates of production decline than Arssi. Where as in Arssi sorghum production fell by 451 qts per annum in Shewa it dropped by seven times as much and in Harerghe and Wello by nearly four times. The decline in sorghum production in Sidamo was by about three times as much as Arssi, while in Keffa, Wellega, Gojjam and Gonder it was by about twice. Lower rates of decline than Arssi are indicated in Bale and Illubabor, and the same rate in Gamo-gofa.

TABLE 11  
ESTIMATE OF SORGHUM PRODUCTION MODEL

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	('000QT)	-14753.37	4193.67	-3.52
D2		5750.44	1751.61	3.28
D3		-18289.40	5307.51	-3.45
D4		-14499.82	4392.67	-3.30
D5		-10428.79	3040.09	-3.43
D6		4224.52	1411.53	2.99
D7		-20231.37	5818.31	-3.48
D8		1993.61	572.42	3.48
D9		-63743.53	19501.02	-3.27
D10		-8164.86	2440.23	-3.35
D11		-20344.52	6734.01	-3.02
D12		-25049.89	8245.70	-3.04
Trend (T)	(year)	-451.24	138.69	-3.25
T2		163.40	71.68	2.28
T3		-687.41	199.18	-3.45
T4		-588.79	168.34	-3.50
T5		-390.43	124.74	-3.13
T6		116.07	63.47	1.83
T7		-732.68	215.71	-3.40
T9		-2592.26	683.41	-3.79
T10		-377.61	107.15	-3.52
T11		-1090.34	246.89	-4.42
T12		-1252.16	297.69	-4.21
Rainfall(R)	(mm)	0.54	0.21	2.59
Labour (L)	(unit)	0.07	0.02	3.45
R <sup>2</sup> = 0.89		D.W = 2.22		
n = 108		F = 38.64		

## 7.2 ESTIMATES OF AREA SEEDED MODEL

### 7.2.1 ESTIMATE OF AGGREGATE AREA SEEDED MODEL

The estimate of the aggregate area model (table 12) shows all parameters as significant, and the trend declining in all regions. Rainfall did not show any significant effect,

and was therefore dropped. The aggregate model estimated is equation 32, where as the crop specific model is equation 33.

TABLE 12  
ESTIMATE OF AGGREGATE AREA MODEL

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	('000HA)	-1029.57	362.12	-2.84
D2		367.56	165.93	2.22
D3		-1346.44	433.27	-3.11
D4		-1214.11	356.59	-3.41
D5		-1017.31	244.42	-4.16
D6		254.68	129.39	1.97
D7		-1955.18	475.37	-4.11
D8		-0.35	63.41	-0.01
D9		-5190.18	1617.58	-3.21
D10		-646.59	194.78	-3.32
D11		-1817.61	551.87	-3.29
D12		-2558.38	677.36	-3.78
Trend (T)	(year)	-29.17	9.53	-3.06
T3		-63.55	19.12	-3.23
T4		-62.07	16.61	-3.74
T5		-39.82	13.02	-3.06
T7		-70.89	20.51	-3.46
T8		-9.50	5.90	-1.61
T9		-211.72	59.37	-3.57
T10		-43.77	11.49	-3.81
T11		-108.46	23.06	-4.70
T12		-101.34	27.28	-3.72
Labour(L)	(unit)	0.006	0.002	3.69

$R^2 = 0.98$   
n = 108

D.W = 2.08  
F = 267.46

### 7.2.2 ESTIMATE OF AREA SEEDED MODEL FOR TEFF

The trend in area seeded to teff (table 13) also shows a significant decline in all regions except Bale and Illubabor. The decline is observed not only in absolute terms but also in relation to the total area seeded to cereals. A significant decline in the share of area seeded to teff (Appendix A) is indicated in most of the regions. Again, it is only in Bale and Illubabor that such a shift is not significant. The area proportion<sup>1</sup> model is equation 34.

---

<sup>1</sup> Estimates of the area and production proportion (equation 30) models are in Appendix.

TABLE 13  
ESTIMATE OF AREA SEEDED MODEL FOR TEFF

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	('000HA)	-581.40	203.12	-2.86
D2		212.54	83.66	2.54
D3		-565.49	261.14	-2.17
D4		-527.85	216.29	-2.44
D5		-450.67	150.59	-2.99
D6		185.03	65.74	2.82
D7		-890.62	285.76	-3.12
D8		48.60	27.83	1.75
D9		-2593.50	953.05	-2.72
D10		-253.33	121.45	-2.09
D11		-878.50	330.48	-2.66
D12		-1266.85	403.81	-3.14
Trend(T)	(year)	-22.76	7.26	-3.13
T2		10.83	3.98	2.72
T3		-23.49	9.40	-2.50
T4		-25.47	7.94	-3.21
T5		-11.16	5.87	-1.90
T6		9.39	3.55	2.64
T7		-29.75	10.22	-2.91
T8		3.06	2.90	1.05
T9		-99.76	32.95	-3.03
T10		-13.56	5.00	-2.71
T11		-48.12	11.71	-4.11
T12		-41.51	14.18	-2.93
Labour(L)	(unit)	0.003	0.001	3.07
		$R^2 = 0.98$	$D.W = 2.17$	
		$n = 108$	$F = 250.95$	

### 7.2.3 ESTIMATE OF AREA SEEDED MODEL FOR WHEAT

Unlike teff, the trend in area seeded to wheat (table 14) shows a significant increase in all regions except two - Bale and Illubabor. It was not significant for Bale and Illubabor. An increasing trend is also observed in the pro-

portional area share of the crop, this time for all regions. The effect of labour, though significant, is negative, perhaps indicating the increase in area seeded to wheat to have been due to availability of labour saving farm implements rather than availability of labour itself.

TABLE 14  
ESTIMATE OF AREA SEEDED MODEL FOR WHEAT

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	('000HA)	428.62	52.31	8.19
D2		-179.63	20.29	-8.85
D3		440.82	77.26	5.71
D4		344.96	64.85	5.32
D5		207.23	49.04	4.23
D6		-182.71	15.77	-11.59
D7		434.96	84.09	5.17
D8		-111.70	8.51	-13.13
D9		1764.60	269.50	6.55
D10		145.31	39.52	3.68
D11		564.77	96.49	5.85
D12		651.19	116.84	5.57
Trend(T)	(year)	21.07	2.89	7.29
T2		-15.48	2.16	-7.17
T3		9.60	2.15	4.47
T4		6.27	1.84	3.40
T6		-12.36	2.03	-6.09
T7		9.70	2.33	4.16
T8		-8.70	1.77	-4.93
T9		57.47	8.39	6.85
T11		12.84	2.69	4.77
T12		16.28	3.31	4.92
Labour(L)	(unit)	-0.002	0.0003	-6.34

$R^2 = 0.97$                       D.W = 2.22  
n = 108                                  F = 169.78

#### 7.2.4 ESTIMATE OF AREA SEEDED MODEL FOR BARLEY

The trend in area seeded to barley also shows a significant increase in most of the regions (table 15). It is only for three regions - Bale, Illubabor, and Gamogofa - that it is not significant. The proportional area share of the crop, on the other hand, shows no significant change in all regions except one, Harerghe, where an increase is indicated. Similar to wheat, the effect of labour is significant but negative.

TABLE 15

## ESTIMATE OF AREA SEEDED MODEL FOR BARLEY

## PARAMETER ESTIMATES

VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT ('000HA)		306.30	67.50	4.54
D2		-123.24	26.64	-4.63
D3		299.45	104.80	2.86
D4		238.41	93.57	2.55
D5		73.72	65.20	1.13
D6		-156.35	21.21	-7.37
D7		221.52	113.81	1.95
D8		-104.73	14.15	-7.40
D9		1144.00	359.40	3.18
D10		49.01	52.63	0.93
D11		345.12	130.21	2.65
D12		339.28	157.15	2.16
Trend(T)	(year)	13.40	4.25	3.15
T2		-11.39	3.50	-3.25
T3		3.35	2.95	1.13
T6		-8.35	3.34	-2.50
T7		4.30	3.15	1.37
T8		-6.32	2.99	-2.11
T9		23.20	10.83	2.14
T11		6.67	3.55	1.88
T12		7.93	4.29	1.85
Labour(L)	(unit)	-0.001	0.0004	-2.83

$$R^2 = 0.94$$

$$n = 108$$

$$D.W = 1.94$$

$$F = 77.68$$

7.2.5 ESTIMATE OF AREA SEEDED MODEL FOR MAIZE

Maize area shows a significantly declining trend (table 16) in most regions. Again, the exceptions are Bale and Illubabor, where it is not significant. Labour is positive and significant. The trend in the proportional share of the crop, on the other hand, is not significant for most of the regions. It is only for Gamogofa (declining) and Harerghe (increasing) that it is significant.

TABLE 16  
ESTIMATE OF AREA SEEDED MODEL FOR MAIZE

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT ('000HA)		-476.34	199.49	-2.39
D2		176.44	83.12	2.12
D3		-639.96	252.14	-2.54
D4		-573.32	208.49	-2.75
D5		-347.63	144.53	-2.41
D6		167.15	65.61	2.55
D7		-722.27	276.10	-2.62
D8		62.98	27.21	2.31
D9		-2339.79	925.52	-2.53
D10		-250.18	116.14	-2.15
D11		-870.59	319.63	-2.72
D12		-1039.49	391.00	-2.66
Trend(T)	(year)	-18.54	6.57	-2.82
T2		7.71	3.40	2.27
T3		-18.84	9.45	-1.99
T4		-17.63	8.00	-2.20
T5		-10.86	5.93	-1.83
T6		6.07	3.01	2.02
T7		-19.51	10.25	-1.90
T9		-73.40	32.43	-2.26
T10		-8.47	5.05	-1.68
T11		-27.43	11.71	-2.34
T12		-28.95	14.13	-2.05
Labour(L)	(unit)	0.002	0.0009	2.63

$R^2 = 0.91$                       D.W = 2.68  
n = 108                                      F = 46.92

### 7.2.6 ESTIMATE OF AREA SEEDED MODEL FOR SORGHUM

Similar to maize, the trend in area seeded to sorghum (table 17) shows a significant decline in all regions except Bale and Illubabor. In Bale and Illubabor, the decline is not significant. The share of area under sorghum, on the other hand, shows the reverse of that of Maize for some of the regions. In Harerghe and Gamogofa, where sorghum and maize are the major crops, this trend shows a decrease in Harerghe (it shows an increase for maize), and an increase in Gamogofa (it shows a decrease for maize). This could indicate a shift from one crop to the other. In the remaining regions the trend is insignificant. The influence of labour on area seeded to sorghum is positive.

TABLE 17  
ESTIMATE OF AREA SEEDED MODEL FOR SORGHUM

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	('000HA)	-890.44	214.36	-4.15
D2		357.52	88.30	4.05
D3		-1120.65	275.60	-4.07
D4		-884.04	228.26	-3.87
D5		-637.33	158.93	-4.01
D6		297.78	69.37	4.29
D7		-1260.67	301.57	-4.18
D8		123.66	29.37	4.21
D9		-4036.80	1005.81	-4.01
D10		-463.20	128.17	-3.61
D11		-1281.19	348.77	-3.67
D12		-1612.28	426.16	-3.78
Trend(T)	(year)	-29.01	7.66	-3.78
T2		10.71	4.19	2.55
T3		-42.08	9.93	-4.24
T4		-33.86	8.38	-4.04
T5		-22.38	6.19	-3.61
T6		7.67	3.75	2.04
T7		-44.32	10.78	-4.11
T8		3.55	3.06	1.16
T9		-148.92	34.78	-4.28
T10		-22.35	5.28	-4.23
T11		-62.51	12.36	-5.06
T12		-67.50	14.97	-4.51
Labour(L)	(unit)	0.004	0.001	4.19
		$R^2 = 0.92$	$D.W = 2.26$	
		$n = 108$	$F = 55.67$	

### 7.3 ESTIMATES OF CROP YIELDS

The yield model was initially estimated with all the major variables in it, including rainfall and fertilizer. In the initial estimate, all except trend and rainfall were not significant, and therefore were dropped.

### 7.3.1 ESTIMATE OF TEFF YIELD MODEL

The trend in teff yield (table 18) shows a significant decline in Gonder, Sidamo, Wello and Harereghe. With the statistically significant rainfall variable taking into account the effect of recent weather events, such a decline is attributed to resource availability to produce teff. The elasticity of rainfall is 0.53. The trend is insignificant for the remaining regions.

The intercept is positive for all regions, this indicating the contribution of other natural resources towards teff productivity increases. Contrary to their significantly declining trend, the intercept for Wello, Harerghe and Sidamo is higher than Arssi. This could perhaps indicate that the natural resource basis for increasing teff yield, such as quality of land, are higher in Wello, Harerghe and Sidamo although their ability to acquire adequate technical inputs could have kept the yield level declining. These three regions are among the food deficit areas of the country. The extra resources in the remaining regions, as indicated by their intercepts, appear to be lower than Arssi, the least endowed being Wellega, Gamogofa and Bale.

TABLE 18  
ESTIMATE OF YIELD MODEL FOR TEFF

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	(QT/HA)	6.84	1.40	4.87
D2		-4.96	1.71	-2.89
D3		-2.41	1.11	-2.17
D4		-0.41	1.72	-0.24
D5		-2.99	1.20	-2.49
D6		-2.73	1.61	-1.70
D7		0.86	1.72	0.50
D8		-3.55	0.97	-3.66
D9		-1.78	1.09	-1.64
D10		-5.61	1.57	-3.56
D11		1.91	1.73	1.10
D12		5.95	1.75	3.40
Trend(T)	(year)	-0.12	0.10	-1.23
T2		0.44	0.28	1.54
T4		-0.42	0.28	-1.47
T7		-0.54	0.28	-1.92
T11		-0.68	0.28	-2.40
T12		-0.63	0.28	-2.23
Rainfall(R)	(mm)	0.004	0.001	2.98
		$R^2 = 0.43$	$D.W = 2.00$	
		$n = 108$	$F = 5.53$	

### 7.3.2 ESTIMATE OF WHEAT YIELD MODEL

Unlike teff, the wheat yield model shows (table 19) no statistically significant effect of rainfall, and the elasticity of rainfall is 0.31. The trend for most of the regions is also insignificant. In Gonder and Wello some annual declines in wheat yield are indicated, but they are still not significant at the five percent level.

The level of the intercept is positive for all regions, and shows considerable differences among them. Keffa, Gondar, and Harerghe are indicated as marginally superior to Arssi in terms of extra resource basis for wheat yield increases once the effect of rainfall is taken into account, while Wello appears to be marginally inferior. The remaining regions potential is considerably lower than Arssi, and the least favourable regions are Wellega and Illubabor, followed by Sidamo and Gojjam. Then come Shewa, Bale and Gamogofa at a more or less equivalent levels.

TABLE 19  
ESTIMATE OF YIELD MODEL FOR WHEAT

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	(QT/HA)	10.19	2.16	4.72
D2		-3.49	1.50	-2.32
D3		-5.01	1.73	-2.90
D4		0.76	2.64	0.29
D5		0.41	2.78	0.15
D6		-7.87	2.50	-3.14
D7		-5.60	1.53	-3.66
D8		-3.11	1.51	-2.06
D9		-3.71	1.69	-2.20
D10		-7.35	2.45	-3.00
D11		-0.60	2.66	-0.23
D12		0.62	1.58	0.39
Trend(T)	(year)	0.12	0.14	0.89
T4		-1.05	0.43	-2.41
T5		-0.73	0.44	-1.68
T11		-0.89	0.43	-2.04
Rainfall(R)	(mm)	0.003	0.002	1.73

$R^2 = 0.19$                        $D.W = 1.81$   
 $n = 108$                                $F = 2.60$

### 7.3.3 ESTIMATE OF BARLEY YIELD MODEL

The effect of rainfall is significant for barley yield (table 20), and its elasticity is 0.39. The trend, on the other hand, is significant only for Wello. Although inadequacy of technical inputs could have caused the yield level in Wello to decline, the intercept shows Wello to be better than the other regions interms of other resources needed for increasing barley yield. The equally high and significant intercept for Arssi also shows its similar potential. The

intercepts for the remaining regions are also positive and significant, although they are less than Arssi. Except Gamo-gofa, and to a certain extent Harerghe and Shewa, the intercepts for the remaining regions are less by more than half as much as Arssi.

TABLE 20  
ESTIMATE OF YIELD MODEL FOR BARLEY

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	(QT/HA)	12.42	1.76	7.05
D2		-6.78	2.20	-3.08
D3		-7.00	1.44	-4.85
D4		-6.10	1.29	-4.71
D5		-7.08	1.56	-4.53
D6		-9.70	2.08	-4.65
D7		-5.78	1.28	-4.51
D8		-1.96	1.26	-1.55
D9		-4.16	1.41	-2.94
D10		-8.37	2.04	-4.10
D11		0.75	2.22	0.34
D12		-3.83	1.32	-2.89
Trend(T)	(year)	-0.12	0.11	-1.07
T2		0.64	0.36	1.78
T11		-0.96	0.36	-2.67
Rainfall(R)	(mm)	0.004	0.002	2.50

$R^2 = 0.29$                       D.W = 1.79  
n = 108                                      F = 3.96

#### 7.3.4 ESTIMATE OF MAIZE YIELD MODEL

Rainfall is the only significant variable in the maize yield model (table 21), and its elasticity is 0.72, which is the highest among the elasticities of the five crops. The trend is highly insignificant in all regions, indicating no effect of technological changes.

The intercepts are also insignificant for all regions except Harerghe, Wellega and Bale. The different resource basis favourable for maize yield, as reflected by the levels of the intercepts, show Harerghe to have the highest potential for increasing productivity of maize, and it is followed by Bale, Sidamo and Arssi. Wello is only marginally below Arssi. The intercept for Wellega, Illubabor, and Gonder, on the other hand, is negative, showing the absence of favourable extra resource basis once the effects of rainfall and technical inputs are taken into account. Although positive, the levels of the intercepts for the remaining regions are lower than Arssi.

TABLE 21  
ESTIMATE OF YIELD MODEL FOR MAIZE

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	(QT/HA)	2.95	3.03	0.98
D2		3.46	2.17	1.59
D3		-1.65	2.50	-0.66
D4		-4.48	2.23	-2.01
D5		-2.42	2.70	-0.90
D6		-9.27	3.60	-2.57
D7		0.53	2.22	0.24
D8		-2.41	2.18	-1.11
D9		-2.70	2.44	-1.10
D10		-10.70	3.53	-3.03
D11		-0.41	2.21	-0.19
D12		5.62	2.29	2.46
Trend (T)	(year)	0.06	0.17	0.33
Rainfall(R)	(mm)	0.01	0.003	4.53

$$R^2 = 0.25$$

$$n = 108$$

$$D.W = 2.32$$

$$F = 3.73$$

### 7.3.5 ESTIMATE OF SORGHUM YIELD MODEL

The model for sorghum also shows a significant effect of rainfall (table 22). The elasticity of rainfall is 0.65. Unlike maize, the trend is significant and declining in all regions. The rate of decline is also the same for all regions except Gamogofa, where it is higher than Arssi.

The intercept, which is significant for most of the regions, again shows Harerghe to have better natural resource basis favourable for sorghum yield. Arssi comes next to Harerghe, followed by Gamogofa, Shewa, Wello and

Keffa. Then come Sidamo, Gonder, Gojjam and Illubabor at a more or less equivalent levels. Bale and Wellega are the only regions with negative intercepts, this indicating constraints in natural resources favourable for sorghum.

TABLE 22  
ESTIMATE OF YIELD MODEL FOR SORGHUM

PARAMETER ESTIMATES				
VARIABLES	UNITS	ESTIMATES	STANDARD ERROR	T
INTERCEPT	(QT/HA)	11.57	2.26	5.12
D2		-14.11	1.62	-8.71
D3		-7.16	1.86	-3.85
D4		-6.72	1.66	-4.04
D5		-4.90	2.01	-2.43
D6		-7.83	2.68	-2.91
D7		-6.36	1.65	-3.85
D8		-2.04	2.83	-0.72
D9		-2.68	1.82	-1.47
D10		-11.02	2.63	-4.19
D11		-2.69	1.65	-1.64
D12		0.57	1.70	0.34
Trend(T)	(year)	-0.29	0.13	-2.17
T8		-0.64	0.46	-1.38
Rainfall(R)	(mm)	0.007	0.002	3.18
R <sup>2</sup> = 0.56		D.W = 1.90		
n = 108		F = 10.92		

## Chapter VIII

### DEMAND AND SUPPLY OF CEREALS IN 1994

In this chapter, the 1993 projections of production, area, and yield are discussed first. This focuses upon how much closer the country would be towards attaining the production targets set for the year. The projections are also compared with the similar levels for 1982, which was the best production year in the last ten years. Finally, the demand in 1994 is compared with the projected supply, and the likely shortfalls and surpluses in each region are estimated. An estimate of the demand and supply of cereals in 1987 based on actual production data has also been provided in order to serve as a bench mark for comparison.

#### 8.1 PRODUCTION AREA AND YIELD IN 1993

As is always the case with projections from the types of models specified here, the projections of production, area and yield (tables 25) were made with the assumption that the situations which prevailed in the last ten years would not change over the coming years. The levels of the three exogenous variables in the model (see table 23 for the actual levels) were 1993 for trend, the normal or long term average rainfall observed in the stations considered for rainfall (R), and a projection of the labour variable

defined earlier for labour (L). A growth rate of 2.9% has been assumed for labour, the same growth rate as population. The use of normal rainfall implies that the projection is made with the assumption that climatic factors would be generally favourable.

TABLE 23

## LEVELS OF THE EXOGENOUS VARIABLES IN THE MODEL

REGION	BASE YEAR (1979)			PROJECTION YEAR (1993)		
	TIME (year)	RAINFALL (mm)	LABOUR (unit)	TIME (year)	RAINFALL (mm)	LABOUR (unit)
ARSSI	1	942.8	211538	15	823	317780
BALE	1	773.6	125826	15	958	189021
GAMOGOFA	1	844.7	187571	15	789	281776
GOJJAM	1	1257.8	483416	15	1341	726206
GONDER	1	989.2	436533	15	1172	655776
HARERGHE	1	678.0	632392	15	885	950002
ILLUBABOR	1	1705.4	144961	15	2318	217765
KEFFA	1	1169.3	367751	15	1469	552449
SHEWA	1	1263.1	1205434	15	1225	1810847
SIDAMO	1	976.6	509131	15	961	764836
WELLEGA	1	1885.4	337146	15	2158	506473
WELLO	1	1021.6	555832	15	1069	834992

The target set in the country's plan for agricultural production, as noted earlier, was an increase from 6.6 million tonnes of grain in 1983 to 12.2 million tonnes in 1993. Similarly, the target for area seeded was an increase from 6.9 to 8.2 million hectares. The planned annual rates of

growth were 5.9% for cereal production, and 1.7% for area seeded.

The initial planning figures - 6.6 million tonnes for production and 6.9 million hectares for area - are different from what is given as production, area, and yield for 1983 in the C.S.O publications, and this has created a problem of making proper comparisons of the projections with the targets. An attempt has been made to overcome this problem by taking the plan figures as given, and breaking them down into cereals, pulses and oil seed crops using the crop specific distribution of the 1983 production and area provided in the C.S.O publication.

According to the C.S.O, the five crops considered in this study account for 84% of the total grain production and 78% of total area seeded in 1983. The share of State Farms of the same crops were 4% for production, and 3% for area. Hence, the derived initial (1983) planning figures for peasant production based on these percentages were 5.32 million tonnes of production and 5.22 million hectares of land. (In the C.S.O report, 5.31 million tonnes was the total cereal production of the country in 1983, including State Farms). With an annual growth rate of 5.9% for production and 1.7% for area, the targets for 1993 were 9.4 million tonnes of cereal production and 6.7 million hectares of land.

The three levels of production arrived at - the projection and target set for 1993 and the estimate for 1982 - are summarized in table 24.

TABLE 24

## CEREAL PRODUCTION AREA AND YIELD IN 1982 AND 1993

CEREALS	PRODUCTION ( '000 tonne)	AREA ( '000hectare)	YIELD (tonne/hectare)
PROJECTION FOR 1993	7,838.20	5,715.00	1.37
TARGET FOR 1993	9,437.80	6,178.46	1.53
LEVELS IN 1982	6,164.25	4,586.68	1.34

The result in table 24 indicates that even with normal rainfall peasants cereal production in 1993 could be about 17% less than the target, but 27% higher than that of 1982. This means cereal production will have been increasing at an average rate of just under 4% compared with the initial planning figure for 1983, and 2.5% when compared to 1982. Area seeded would be 8% below target but 24% higher than 1982. Productivity would be down by 11% from the target and up by only 2% from 1982.

TABLE 25

## AGGREGATE PRODUCTION OF FIVE CEREAL CROPS IN 1993

REGION	PRODUCTION ( '000 MT)	AREA ( '000HA)	YIELD (MT/HA)
ARSSI	808.36	531.67	1.52
BALE	197.18	89.34	2.21
GAMOGOFA	339.41	162.40	2.09
GOJJAM	1084.67	801.04	1.35
GONDER	498.19	512.47	0.97
HARERGHE	619.21	429.83	1.44
ILLUBABOR	206.67	157.26	1.31
KEFFA	633.36	393.11	1.61
SHEWA	1951.77	1557.02	1.25
SIDAMO	652.33	325.08	2.01
WELLEGA	541.04	415.43	1.30
WELLO	305.83	340.40	0.90
TOTAL	7838.02	5715.05	1.37

**8.2 DEMAND AND SUPPLY IN 1994**

The projection given in table 25 is adjusted (deducted) by 10% waste to estimate the 1994 supply of the five crops. The assumption of a 10% waste is rather arbitrary (though very often assumed in some reports). There is no specific country wide study which indicates the actual waste. A study of post harvest loss in selected areas of two regions - Shewa, and Harerghe - by Y.Kidane and Y.Habteyes showed a weight loss of 6.1% and in storage damage of 9.2% for cereals, and yet these figures did not include losses in harvesting, threshing and transporting. In its 1975-77 food balance sheet analysis the F.A.O, on the other hand, assumed 5% loss for many countries, including Ethiopia, although the

total losses in Ethiopia are often assumed to be high, some times as high as 15% to 20%.

The supply - demand balance given here is mainly for twelve regions. The capital, Addis Abeba, where the demand for cereals is estimated at 269,927 mt, is not included since it is considered as a region by itself, and its supply comes from all sources, including State Farms. As noted earlier, Tigray and Eritrea, which are among the regions often seriously affected by food shortages, are also not included due to lack of data.

The 1994 demand and supply of cereals in the twelve regions (table 26) shows that even under normal climatic conditions five regions - Wello, Harerghe, Sidamo, Gonder, and Bale - would not be able to produce enough to meet their cereal requirements. The major deficit would be in Wello, where the short fall is estimated at about 60% of the total demand, followed by Harerghe - 29%, Gonder - 19%, Sidamo - 17%, and Bale - 6%. The remaining seven regions could, on the other hand, have surplus to sell. The bulk of the surplus (92%) would be from four regions - Arssi, Gojjam, Shewa, and Keffa in that order. Arssi is expected to produce a surplus which is more than double of its food requirement. The similar figure for Gojjam is 56%, Shewa 14%, and Keffa 23%.

TABLE 26

## THE BALANCE BETWEEN DEMAND AND SUPPLY IN 1994

REGIONS	POPULATION ( ' 000 )	DEMAND ( ' 000MT )	SUPPLY ( ' 000MT )	B A L A N C E ( ' 000MT )	%OF DEMAND
ARSSI	2209.17	323.41	727.52	+ 404.11	+ 125
BALE	1337.74	188.74	177.46	- 11.28	- 6
GAMOGOFA	1657.25	235.39	305.47	+ 70.08	+ 30
GOJJAM	4312.70	624.13	976.20	+ 352.07	+ 56
GONDER	3882.90	555.56	448.37	- 107.19	- 19
HARERGHE	5530.43	782.12	557.29	- 224.83	- 29
ILLUBABOR	1280.53	182.86	186.00	+ 3.14	+ 2
KEFFA	3254.86	464.58	570.02	+ 105.44	+ 23
SHEWA	10755.99	1543.14	1756.59	+ 213.45	+ 14
SIDAMO	5036.84	710.29	587.10	- 123.19	- 17
WELLEGA	3290.37	470.20	486.94	+ 16.74	+ 4
WELLO	4839.76	683.35	275.25	- 408.10	- 60

In spite of the absence of data to make detailed analysis of their food prospect, there is no doubt that Tigray and Eritrea would also fall into the category of the major deficit regions. There are a number of similarities between Wello and these two regions both in physical features and climatic conditions. The difference in population size is also not significant. Yet, Tigray and Eritrea are not as productive as Wello. Hence, it may not be very much off target if one assumes that the deficit in Tigray and Eritrea would be the same as in Wello. Such an assumption allows to estimate the order of magnitude of the national level deficits.

The data in table 26 plus the assumed figures for Tigray and Eritrea can be summarized as follows:

Surplus in seven regions = + 1,165,030 mt

Deficit in five regions	= -	874,590 mt
Demand in Addis Abeba	= -	269,930 mt
Deficit in Tigrai/Eritrea	= -	816,200 mt
NET DEFICIT	= -	795,690 mt

From this analysis, it appears that the country's aggregate shortfall in 1994 could be in the order of 795,690 mt. If State Farms are allowed to continue producing cereals they could offset part of the deficit, and the rest has either to be imported or that appropriate means need to be devised to produce it locally. It may, however, be appropriate to assume that the deficit would be 795,690 mt as this can only be the minimum since normal rainfall is assumed in arriving at this figure. The deficit can increase with any abnormal rainfall. An aggregate cereal deficit of 795,690 mt, though large, could appear to be manageable. At least, it is lower than the import requirements of the country during the worst drought years of the past decade. On the other hand, at the percapita consumption level of 0.21 tonne this is also an amount which provides the entire calorie needs of 3,789,000 people, and to have such a minimum number of people at risk should be a cause for concern.

A separate analysis of the demand and supply of the five cereals in 1987 (table 27) shows that, given the assumption made about the level of consumption, only three regions - Arssi, Shewa and Gojjam - had marketable surplus in 1987

while the remaining regions experienced varying levels of shortfalls. Keffa was nearly self sufficient where as the deficits in the remaining regions ranged from 13% of demand in Illubabor to 63% in Bale. Clearly there is a better food situation in the trend than was experienced in 1987 in all regions except Wello.

TABLE 27

## THE BALANCE BETWEEN DEMAND AND SUPPLY IN 1987

REGIONS	POPULATION ( '000 )	DEMAND ( '000MT)	SUPPLY ( '000MT)	B A L A N C E	
				( '000MT)	%OF DEMAND
ARSSI	1808.51	263.17	448.99	+ 185.82	+ 71
BALE	1095.13	155.07	56.72	- 98.35	- 63
GAMOGOFA	1356.69	191.88	73.29	- 118.59	- 62
GOJJAM	3530.54	511.20	601.98	+ 90.78	+ 18
GONDER	3178.69	453.89	260.75	- 193.14	- 43
HARERGHE	4527.42	638.99	405.33	- 233.66	- 37
ILLUBABOR	1048.29	149.72	130.76	- 18.96	- 13
KEFFA	2664.56	379.45	370.14	- 9.31	- 2
SHEWA	8805.27	1262.07	1419.34	+ 157.27	+ 12
SIDAMO	4123.35	578.51	235.40	- 343.11	- 59
WELLEGA	2693.62	385.08	278.34	- 106.74	- 28
WELLO	3962.02	561.67	367.46	- 194.21	- 35

Although the trend indicates the likelihood of higher level of food availability in 1994 than in 1987, the magnitude of the estimated food shortages in 1994 could be far beyond and more complex than is indicated by the aggregates so far reached. Self sufficiency targets which judge its

attainment by the levels of such aggregates are often misleading and dangerous. The fact that ninety two percent of the potential surplus is in four regions, with big deficits expected in a number of other regions, indicates a major redistribution problem both interms of "entitlement" as well as interms of physical capacity to move the surplus. This and related issues are discussed in the next chapter.

## Chapter IX

### ALTERNATIVE MEASURES OF ATTAINING SELF SUFFICIENCY

The results so far show that if current trends prevail Ethiopia would still be deficit in cereal production, even with normal rainfall, by the end of 1993 and that appropriate measures need to be taken to reverse it.

Food self sufficiency, as defined earlier, is the problem of supply. The term supply, however, needs to be qualified when it is viewed within the context of a subsistence economy. The origin of supply is of crucial importance in such an economy, and self sufficiency can not be achieved in real terms unless the supply ensures every body access to food. The measurement of self sufficiency in countries like Ethiopia should not be from the level of aggregate production alone but rather from its distribution as well. Self sufficiency should ensure every body easy access to the minimum amount of required food. In the case of this study, attainment of self sufficiency should be measured at regional and not national levels.

It is argued here that from the analysis so far the likely scenario in the demand and supply of cereals in Ethiopia in 1994 will not be a mere deficit of 795,690 mt but rather

a deficit of 874,590 mt in the five regions (plus a likely deficit of 816,200 mt in Tigray and Eritrea) and a surplus of 1,165,030 mt in the seven regions. Part of the surplus would certainly go to Addis Abeba, and part of it to those in the deficit regions which could afford it (urban dwellers and a few richer peasants). The rest of the surplus could be consumed in the surplus areas themselves. It has to be noted that the assumption in arriving at this surplus is a consumption level of 65% of 2000 kcal, whereas the required level in Ethiopia goes up to 2330 kcal. For the vast majority of the rural population in the deficit regions, therefore, particularly those in Wello, Harerghe, Gonder, Sidamo, Tigray and Eritrea, their access to whatever surplus may be available will be constrained by lack of purchasing power. Furthermore, redistribution through the market requires an efficient marketing infrastructure, which often does not exist.

Ethiopia's attempt to attain food self sufficiency involves a number of approaches appropriate for the deficit and surplus regions. These approaches fall under two broad strategies. The first strategy focuses on the deficit regions while the second gives emphasis to increasing production in the surplus regions. A national food strategy draft document submitted for discussion in 1987 (not necessarily reflecting official policy) outlines the broad objectives of the two strategies as follows. The first strategy is described as aiming to (pp 56):

incorporate the principles of conservation based development approach to simultaneously improving conservation and productivity ie the intensification of farming systems through enhanced vegetative cover..

The detailed measures envisaged under this programme were outlined as intensification through such programmes as the introduction of drought and disease resistant crop varieties and "the use of mixed or inter cropping systems", and diversification through the introduction of non cereal food crops. Apparently, very little is said regarding the efforts to be made to increase production using existing crop varieties and farming systems. As a long term programme of rehabilitating the land and combating food shortages the strategy outlined so far is appropriate. Nothing could justify its importance more than the danger the country is facing of losing 20% of its cultivable land in a period of two decades. On the other hand, the effect of such a programme on food production in the short run (five years) could be minimal. Given the significant decline in food production in the deficit regions so far and the unfavourable forecasts, there must therefore be a vigorous effort in the short run to increase production using the maximum potential which might still be available in these regions.

The emphasis to increase food production in the short run appears to be on the surplus producing regions, where the strategy (pp 66) is described as concentrating

on exploiting the potential for major increases on marketed surplus of cereals through the application of bought in technology in selected high

potential areas....The increases will contribute to i) national food security through reducing the need for food imports and food aid... and ii) house hold food security for those producers who successfully apply the new technology, both through higher retained food stocks in store and through higher cash incomes and savings...

The major short term production enhancing programmes such as provision of improved seed and fertilizer are largely associated with the surplus producing regions. A clear implication of this second strategy is that the surplus produced would flow to those in deficit regions to off set the shortages. There is no doubt that such a strategy has a number of advantages. It is easier and cheaper to produce more in the high potential areas rather than in the deficits regions. For a country with limited resources it is a logical economic policy. It could minimize its dependence on imported grain, for example. Due to the inherent nature of peasant economy and way of life, however, it is possible that such an approach may not lead to the desired objectives interms of higher production, and that even if higher production is attained it may not solve the likely food shortages (and significantly reduce the need for food aid) in the deficit regions with out massive external intervention.

The following two view points strongly support and strengthen the line of argument of this research. The first stresses the limited scope for increased production in a peasant economy, and the other questions the reliability of the market for redistribution.

Seavoy (pp22) argues that

as long as peasants control enough cultivation units to achieve subsistence food safety, they are not money motivated except in so far as some money is required to pay a tax or a rent or is useful to purchase some manufactured items necessary for their subsistence welfare...Peasants refuse to expand the additional labour needed to produce an assured food surplus that can be marketed, even when unused or poorly cultivated land is available on which to grow more food and a transportation net work exists that can facilitate market sales. Once enough food has been produced to meet their subsistence nutritional and social needs peasants are little interested in further labour to earn money.

It is hard to verify to what extent such a general characterization would be true for Ethiopian peasants. Although there is a strong likelihood for further production expansion in the surplus areas of Ethiopia it nevertheless is appropriate to question to what extent the already surplus producing peasants in Arssi, Gojjam and Shewa can be motivated to produce more. The presumption of such a strategy is also that there would be adequate consumer or other goods, which could induce peasants to produce and earn more. But the possibility of availing such commodities to the extent which can encourage already surplus producing peasants to produce more could be limited.

The second view point, which is the major line of argument of this research, is that of A.Sen. He argues (pp154) that "famines could thrive even with out a general decline in food availability", and urges that there is a "need to

view the food problem as a relation between people and food in terms of a net work of entitlement relations". He mentions Ethiopia's own experience in 1973 (pp93-96), among others, to prove his case:

while there was no noticeable food availability decline for Ethiopia as a whole in the famine years of 1973, there was clearly a shortage of food in the province of Wollo. This shortage could in principle be explained in at least two quite different ways....there was not merely a decline in the food to which the Wollo population was directly entitled out of its own production, but also a collapse of income and purchasing power and of the ability of the Wollo population to attract food from else where in Ethiopia. People starved to death with out there being a substantial rise in food prices.

The collapse of purchasing power in the deficit regions of Ethiopia, except probably Bale, has never been as serious as it has been in the last few years. Continuous years of crop failure has depleted peasants assets. With the anticipated deficits in the forecasts it can only be expected to be depleted further. Even if purchasing powers are assumed to exist, the movement of such huge surpluses from a few regions to as many as five to seven deficit regions requires an efficient marketing infrastructure, which hardly exists in the country.

Taking the views of Seavoy and Sen into account, it is possible that heavily relying on the surplus peasant areas to produce more and the market to distribute it could achieve very little of both. The most reliable short term food self sufficiency strategy for Ethiopia could therefore

be a two pronged approach: one ensuring that the deficit areas are able to produce the minimum required, maximizing what ever potential they might have, and the other focusing on further production expansion in the surplus areas.

The direct support to the deficit regions helps to prevent food shortages where as further production expansion in the surplus areas helps to reduce the country's dependence on imported food as well as to build food security reserves for future emergencies. It is also probable that there would be a deficit in the remaining 35% of the calorie supply. The deficit so far indicated is just the minimum. Hence, producing more cereals could help to bridge such gaps. However, under no circumstance should a production strategy designed for surplus areas be a substitute for the deficits, nor should there be any short term priority which favours the surplus regions. Surplus areas should only be favoured when there is no potential for production expansion in the deficit regions, and the result of this study shows that the deficits still have some potential (assuming the national average yield potential represents the situation in Wello and Harerghe).

Regardless of the option preferred there are still a number of technology and resource related constraints which need to be addressed. The effort to increase production, whether it is in the surplus or deficit regions, requires identifying the optimal combination of all available options.

### 9.1 SELF SUFFICIENCY IN THE DEFICIT REGIONS

The magnitude of the forecasted deficit in some of these regions is very large, and a single approach might not be feasible to off-set it. It would certainly require a combination of different measures along the two broad alternatives - productivity increase and area expansion. This study has identified productivity decline due to a deteriorating resource basis as the major factor for the projected deficit. Hence, the effort to attain self sufficiency in the deficit regions should focus on programmes which can increase productivity. This could be achieved either through more use of inputs or by improving the utilization of current inputs and practices. Area expansion could involve expanding current holdings within the settlement areas or in new settlements.

The projection of the proportion of area and yield for the five crops (table 28) shows little prospect for teff production in Wello and Sidamo. If the trend is maintained no teff would be produced in these Regions. The focus of production increase in these Regions should therefore be on the other crops. In Wello, maize and wheat appear to be getting greater importance, perhaps replacing teff, while barley and sorghum remain the major crops. A significant shift from sorghum (the major crop) to maize is also indicated in Harerghe. In Bale, barley seems to be getting greater share. No major change is apparent in Gonder. These percentage fig-

ures have been used to break down the aggregate area and production projections (table 29), and the expected yield of each crop is derived from the ratio of production to area.

TABLE 28

AREA AND PRODUCTION PROPORTION IN THE DEFICIT REGIONS IN  
1993

(% corrected for rounding off errors)

REGIONS	TEFF	WHEAT	BARLEY	MAIZE	SORGHUM
<b>WELLO</b>					
production	0	20	36	15	29
area	0	27	41	10	22
<b>HARERGHE</b>					
production	2	7	1	53	37
area	4	5	3	45	43
<b>SIDAMO</b>					
production	0	6	7	81	6
area	0	11	8	70	11
<b>GONDER</b>					
production	19	14	26	16	25
area	37	14	22	7	20
<b>BALE</b>					
production	10	30	58	2	0
area	18	29	49	4	0

TABLE 29

## PRODUCTION AREA AND YIELD IN THE DEFICIT REGIONS IN 1993

(production='000 tones, area='000 ha, yield=tones/ha)

REGIONS	TEFF	WHEAT	BARLEY	MAIZE	SORGHUM	TOTAL
<b>WELLO</b>						
production	0.0	61.2	110.1	45.9	88.7	305.8
area	0.0	91.9	139.6	34.0	74.9	340.4
yield	0.0	0.7	0.8	1.4	1.2	0.9
<b>HARERGHE</b>						
production	12.4	43.3	6.2	328.2	229.1	619.2
area	17.2	21.5	12.9	193.4	184.8	429.8
yield	0.7	2.0	0.5	1.7	1.2	1.4
<b>SIDAMO</b>						
production	0.0	39.1	45.7	528.4	39.1	652.3
area	0.0	35.8	26.0	227.6	35.8	325.1
yield	0.0	1.1	1.8	2.3	1.1	2.0
<b>GONDER</b>						
production	94.7	69.8	129.5	79.7	124.6	498.2
area	189.6	71.7	112.7	35.9	102.5	512.5
yield	0.5	1.0	1.2	2.2	1.2	1.0
<b>BALE</b>						
production	19.7	59.2	114.4	3.9	0.0	197.2
area	16.1	25.9	43.8	3.6	0.0	89.3
yield	1.2	2.3	2.6	1.1	0.0	2.2

**9.1.1 SELF SUFFICIENCY THROUGH PRODUCTIVITY INCREASE**

At the out set, it is not difficult to see that higher production through yield increase alone is not a feasible alternative. In Ethiopia, only 10% of the peasants have access to fertilizer, and only a small proportion of this is available to the deficit regions. In light of the capacity and resource constraints total reliance on productivity

increase is improbable. The comparison of the projected and required yield<sup>2</sup> given in table 30 confirms this.

In Wello, self sufficiency through productivity increase implies doubling and tripling of the projected yield levels, and except for barley the capacity<sup>3</sup> for such an increase does not seem to exist. Nevertheless, the projected yield is still far lower than the potential, and there is a room for higher production through yield increase. In Harerghe, no further increase is possible for wheat and no increase is implied for sorghum, where as the other crops have to increase by about 28%. In Sidamo, all crop yields must increase by about 17% though the capacity seems not to exist for barley and maize (this is true if the national average is taken, where as if the capacity is the same as the neighbouring region, Bale, there could still be a potential). But still, the projected levels for barley and maize are below the potential. Gonder needs an increase by 19% and there is no capacity problem. In Bale, a mere 5% increase is what is needed, but the projected and required yield levels for barley and wheat appear to be beyond the

---

<sup>2</sup> The required level of production is total demand plus 10% post harvest loss, and the required yield is the ratio of this production and projected area.

<sup>3</sup> The potential yield data is taken from a study by the Ministry of Agriculture, which indicates the maximum yield level attainable using fertilizer and the existing rainfall, land resource and peasants capacity to absorb technological changes. The data used for Wello, Harerghe, and Sidamo is the national average since there is no region specific data for these Regions. It is because of this that some of the projected yield levels for these regions are indicated to be higher than the capacity available.

estimated capacity.

TABLE 30  
REQUIRED AND POTENTIAL YIELD IN 1993 IN THE DEFICIT REGIONS

REGION	( tonnes/ha )				
	TEFF	WHEAT	BARLEY	MAIZE	SORGHUM
WELLO					
projected	0.00	0.66	0.79	1.35	1.18
required	0.00	1.64	1.95	3.31	2.91
potential	0.00	1.91	1.86	2.54	1.93
HARERGHE					
projected	0.72	2.02	0.48	1.70	1.24
required	1.00	2.80	0.67	2.36	1.24
potential	1.27	1.91	1.86	2.54	1.93
SIDAMO					
projected	0.00	1.09	1.75	2.32	1.09
required	0.00	1.31	2.10	2.78	1.31
potential	0.00	1.91	1.86	2.54	1.93
GONDER					
projected	0.50	0.97	1.15	2.22	1.22
required	0.61	1.20	1.41	2.73	1.49
potential	1.25	1.54	1.75	3.24	1.73
BALE					
projected	1.23	2.28	2.61	1.10	0.00
required	1.29	2.40	2.75	1.16	0.00
potential	1.36	1.75	2.32	2.78	0.00

### 9.1.2 SELF SUFFICIENCY THROUGH AREA EXPANSION

Area expansion is a less feasible alternative in Wello, Harerghe and Sidamo than productivity increase. These Regions are among the intensively cultivated and highly

eroded parts of the country, and not much of idle cultivable land is available for expansion. And yet, if the reliance is to be entirely on area expansion massive additional land is needed (table 31). In Wello, more land than would be cultivated in 1993 would be needed, where as the required increase in the other regions is 39% in Harerghe, 20% in Sidamo, 23% in Gonder, and 5% in Bale.

TABLE 31  
PROJECTED AND REQUIRED AREA SEEDED IN 1993

('0 0 0 hectares)

REGION	PROJECTED	REQUIRED	DIFFERENCE
WELLO	340.40	838.59	+ 498.19
HARERGHE	429.83	596.56	+ 166.73
SIDAMO	325.08	390.06	+ 64.98
GONDER	512.47	627.87	+ 115.40
BALE	89.34	94.10	+ 4.76

Since resettlement of people is one of Ethiopia's long term strategy of combating food shortages such an option could also be looked into in this respect. If additional land is not available in or within the current settled parts of the regions concerned people could be moved to where extra land is available, in which case total reliance on resettling people on a farm size of one hectare per house hold requires the movement of 498,190 house holds from Wello, 166,730

house holds from Harerghe, 115,400 house holds from Gonder, 64,980 house holds from Sidamo and 4,760 house holds from Bale.

### 9.1.3 OPTIMAL POLICY OPTIONS

It was noted earlier that total reliance on either productivity increase or area expansion is not a feasible alternative for the deficit regions. In addition to the most apparent need for adequate technical inputs, productivity increase also requires an efficient organizational capacity, and these often are the major bottle necks of agricultural development in Africa. The scope for area expansion within the current technological and resource basis of the country is also limited, and its alternative - resettlement - is operationally difficult and expensive.

To attain self sufficiency in the deficit regions it is essential that one looks at the optimal combinations of all available options. With the data base given here, a number of alternative scenarios can be worked out depending on the resource which is likely to be available. Such an exercise can not be done here with out the knowledge of the potential resource. Nevertheless, the general direction of the measures which must be focussed at is obvious. In Wello, Harerghe, and Sidamo productivity increase is the first option, and the rest should be through resettlement of people out side of the current settlement areas. In Gonder,

due to the availability of excess unutilized land resettlement can be an option by itself. It could also be combined with productivity increases. In Bale, any option is feasible since the deficit is minimal. Resettlement may not, however, be required since the region is potentially surplus producing.

## 9.2 PRODUCTION EXPANSION IN THE SURPLUS AREAS

The projected proportion of area and production of the five crops in the surplus regions (table 32) shows no major shift in cropping patterns. Wheat and maize, however, appear to be getting greater importance in Shewa, perhaps at the expense of sorghum.

The projected vs the potential yield (table 33) in these regions shows that there is a greater scope for increased production through higher productivity. For most of the crops, the projected yield is far lower than the potential in each region.<sup>4</sup> This is particularly true for barley, maize and sorghum. A 20% increase over the projected yield of the crops in the six high potential regions (excluding Gamogofa) is, for example, adequate to offset the earlier estimated over all deficit of the country - 795,690 mt - (table 34). Such an increase could be achieved if the yield levels of

---

<sup>4</sup> The capacity estimate for Keffa has been used for Wellega and Illubabor as well since they are neighbours and there is a lot of similarity between them. No separate estimate is available for the two regions.

TABLE 32

AREA AND PRODUCTION PROPOR. IN THE SURPLUS REGIONS IN 1993

REGIONS	TEFF (% corrected)	WHEAT (% corrected)	BARLEY (% corrected)	MAIZE (% corrected)	SORGHUM (% corrected)
ARSSI					
production	4	48	38	3	7
area	4	45	38	7	6
SHEWA					
production	19	25	17	32	7
area	26	23	14	24	13
GOJJAM					
production	34	12	16	31	7
area	44	12	19	18	7
KEFFA					
production	26	5	3	45	21
area	34	7	6	33	20
WELLEGA					
production	25	3	5	57	10
area	36	3	7	40	14
ILLUBABOR					
production	34	2	1	42	21
area	42	3	4	36	15

1987 are allowed to increase at an annual rate of about 2% in Arssi, 3% in Shewa, and 3.5% in Gojjam and Wellega. In Keffa and Illubabor, on the other hand, maintaining the 1987 level could be adequate (the 1993 yield in these is Regions is indicated to be lower than that of 1987).

A 20% yield increase is not feasible for all crops. The potential for such an increase does not seem to exist for teff and wheat in many of the regions, which on the other

hand, means such a programme requires utilizing the full potential of these crops. Similar constraints are also indicated for maize and sorghum in Keffa.

TABLE 33

## PROJECTED AND POTENTIAL YIELD IN THE SURPLUS REGIONS

REGIONS	TEFF	WHEAT ( tonnes/ha)	BARLEY	MAIZE	SORGHUM
ARSSI					
projected	1.52	1.62	1.52	0.65	1.77
potential	1.59	1.92	2.24	1.91	4.08
SHEWA					
projected	0.92	1.36	1.52	1.67	0.67
potential	1.39	1.45	1.84	2.15	1.98
GOJJAM					
projected	1.05	1.35	1.14	2.33	1.35
potential	1.25	1.54	1.75	3.24	1.73
KEFFA					
projected	1.23	1.15	0.80	2.20	1.69
potential	1.21	1.48	2.26	2.50	1.81
WELLEGA					
projected	0.90	1.30	0.93	1.86	0.93
potential	1.21	1.48	2.26	2.50	1.81
ILLUBABOR					
projected	1.06	0.88	0.33	1.53	1.84
potential	1.21	1.48	2.26	2.50	1.81

TABLE 34

## PRODUCTION WITH A TWENTY PERCENT INCREASE IN YIELD

REGION	PROJECTION WITH OUT INCREASE ( ' 0 0 0 t o n n e s )	PROJECTION AFTER INCREASE
ARSSI	808.36	957.53
SHEWA	1951.77	2270.58
GOJJAM	1084.67	1291.67
KEFFA	633.36	691.66
WELLEGA	541.04	648.22
ILLUBABOR	206.67	234.30
<b>TOTAL</b>	<b>5225.87</b>	<b>6093.96</b>
	<b>INCREASE IN PRODUCTION</b>	<b>= 868.09</b>

TABLE 35

## PRODUCTION AREA AND YIELD IN THE SURPLUS REGIONS IN 1993

REGION	TEFF	WHEAT	BARLEY	MAIZE	SORGHUM	TOTAL
	(production='000mt, area='000ha, yield=mt/ha)					
<b>ARSSI</b>						
production	32.3	388.0	307.2	24.3	56.6	808.4
area	21.3	239.3	202.0	37.2	31.9	531.7
yield	1.5	1.6	1.5	0.7	1.8	1.5
<b>SHEWA</b>						
production	370.8	487.9	331.8	624.6	136.6	1951.8
area	404.8	358.1	218.0	373.7	202.4	1557.0
yield	0.9	1.4	1.5	1.7	0.7	1.3
<b>GOJJAM</b>						
production	368.8	130.2	173.6	336.3	75.9	1084.7
area	352.5	96.1	152.2	144.2	56.1	801.0
yield	1.0	1.4	1.1	2.3	1.4	1.4
<b>KEFFA</b>						
production	164.7	31.7	19.0	285.0	133.0	633.4
area	133.7	27.5	23.6	129.7	78.6	393.1
yield	1.2	1.2	0.8	2.2	1.7	1.6
<b>WELLEGA</b>						
production	135.3	16.2	27.1	308.4	54.1	541.0
area	149.6	12.5	29.9	166.2	58.2	415.4
yield	0.9	1.3	0.9	1.9	0.9	1.3
<b>ILLUBABOR</b>						
production	70.3	4.1	2.1	86.8	43.4	206.7
area	66.1	4.7	6.3	56.6	23.6	157.3
yield	1.1	0.9	0.3	1.5	1.8	1.3

## Chapter X

### SUMMARY AND CONCLUSION

This study has assessed the prospect for attaining self sufficiency in cereal production in twelve of the fourteen regions of Ethiopia in 1994. The analysis is based on an econometric model estimated for the production of the five major cereal crops in the peasant sector of the country as well as on an estimate of the amount of cereals needed to meet the minimum nutritional needs of the population. The production model was estimated using a pooled time series - cross section data in a covariance model. Based on these, the demand and supply of cereals in each of the twelve regions in 1994 have been estimated. The potential deficit and surplus regions have also been identified along with the magnitudes of the deficits and surpluses. The study has also assessed the feasibility of increasing cereal production in each region either through productivity increase or area expansion.

The result shows that, given the current trend, Ethiopia could still be deficit in cereal production in 1994, affecting five of the twelve regions covered in this study. It has also been concluded that due to their similarity to some of the projected deficit regions, the two remaining regions not

covered here - Tigrai and Eritrea - could also be deficit in production.

The major findings and conclusion of the study are the following:

1. The estimate of the production model shows a significantly declining trend in cereal production in all twelve regions. The trend is possibly due to the absence or inadequacy of technical inputs. The highest rate of decline indicated was in Shewa, followed by Harerghe and Wello, while the lowest rate of decline was in Bale. In Shewa, production dropped by about eight times as much as Arssi, while in Harerghe and Wello it dropped by about four times. The trend in Gojjam, Gonder and Sidamo shows a decline of about three times as much as Arssi, where as in Keffa and Wellega it was about twice. Illubabor and Gamogofa show the same rate of decline as Arssi, while in Bale it was lower than Arssi. All production increases are indicated to have been due to expansion of area seeded and rainfall.
2. Among the five cereal crops included in the study it is only for wheat that an increasing trend in production is indicated. There is no trend in barley production, while the trend for teff, maize and sorghum shows a decline. The result also shows no significant effect of rainfall on the production of teff, wheat

and barley. The effect of rainfall was significant only on sorghum production. Although there was some effect of rainfall on maize production it was not significant at the five percent level.

3. Assuming normal rainfall, the 1993 peasant production of the five major cereal crops in the country is forecasted to be about 7.8 million tonnes, which is 17% less than the target set in the country's plan. Area under crop would be 5.7 million hectares, which is 8% below target, and yield 1.37 mt, which is 11% off target.
4. The estimate of the quantity demanded and supplied in 1994 shows that five regions - Wello, Harerghe, Gondar, Sidamo, and Bale - could face a cereal deficit of 874,590 mt. The other two probable deficit regions - Tigray and Eritrea - could also have a short fall in the order of 816,200 mt. Adding to this the demand in Addis Abeba, the capital, of 269,930 mt the total cereal demand which needs to be supplied from other sources could be about 1,960,720 mt.
5. The remaining seven regions - Arssi, Gamogofa, Gojjam, Illubabor, keffa, Shewa, and Wellega - are forecasted to have a surplus of about 1,165,030 mt in 1994, which when balanced with the short fall of 1,960,720 mt in the other regions leaves a net deficit of 795,690 mt (with out taking into account State Farms production). This deficit is considered as the

minimum since it has been assumed that there would be no abnormality in climate. It has also been assumed that the producers in the surplus regions would only consume at a daily percapita rate of 2000 kcal and that cereals would only account for 65.8% of this. Abnormal climatic conditions as well as higher consumption levels are possible, in which case the surplus would be reduced and the deficit increased.

6. Ethiopia's effort towards self sufficiency in food production encompasses different strategies appropriate for the deficit and surplus regions. The recent emphasis, however, shows a shift towards increasing the country's over all production through greater support to high potential areas. The implicit assumption of such a strategy is that by redistributing the surplus through the market the short falls in the deficit regions would be reduced or eliminated. In the deficit regions, the focus appears to be more on rehabilitating the land and related programmes, the short term impact on production of which is minimal. It is argued here that given the subsistence nature of food production in the rural areas of Ethiopia, a production strategy which focuses heavily on generating larger surpluses from high potential areas without a parallel short term programme which attempts to exploit the existing potentials in the deficit regions may not in the short run solve the

food problem in the country. Exploiting the existing potentials in the deficit regions implies allowing such regions to have a fair (or more) access to available farm inputs.

7. It has been well understood and argued for a long time that in a peasant economy purchasing power is low and that with out external intervention peasants can starve to death when there is food in the market. This, at present, is particularly true in the deficit regions of Ethiopia due to the depletion of their purchasing power following the recent long droughts. Given the projected production short falls, further depletion of purchasing power in these areas is likely, thus minimizing the chance of redistributing food through the market. Although one can still argue that if food can be made available at a national level it can be bought and distributed freely this again assumes a well developed market infrastructure and adequate physical capacity to move grain from the surplus to the deficit regions. This often does not exist. Still, the market could have been viewed as a mechanism for redistribution if the levels of the deficits were low, but not to off set such projected huge deficits as 60% of demand in Wello, and 17% to 29% in the others.
8. The presence or absence of a profit motive in peasants production decision is frequently argued about

among development economists. Some argue that peasants desire to expand production beyond the level which maintains their food need and meets their social obligations is limited. Such an argument could be valid at least when it involves already surplus producing peasants. Motivating surplus producing peasants to expand their production requires, among other things, material incentives, whereas the resources of country's like Ethiopia for providing such incentives are limited. Hence, it is possible that the peasant producers in the high potential areas of Ethiopia could fail to generate desired levels of surpluses.

9. In light of so many of these uncertainties, a viable short term food self sufficiency strategy for Ethiopia could be a one which primarily focuses on maximizing the available potentials in the deficit regions so that they could be helped to produce the minimum food required, while at the same time encouraging the surplus regions to produce more. The former ensures a minimum level of self sufficiency in the deficit regions and reduces their vulnerability to food shortages, while the later helps to provide a buffer stock for bad years.
10. Emphasising on increased production in the high potential areas could have been a valid and perhaps the only option for solving the food problems in

Ethiopia if there were no potentials in the deficit regions. The result of this study shows that the deficit regions still have some potential for production expansion. The projected yield in many of the deficit regions is lower than the potential. Hence, higher production in these regions through more use of inputs is probable. This option alone is, however, not adequate to solve the problem since the yield potential for some of the crops is below the required level. The desired levels of inputs may also not be available given the current low levels of utilization in the country. Hence, the programme to increase productivity in the deficit regions needs to be combined with other programmes, the most obvious of which is resettlement of people.

11. The potential for higher production in most of the surplus regions, either through productivity increase or area expansion, is great. The projected yield levels in these regions are far lower than the potential. The country's future resettlement sites are also located here. A 20% yield increase over the projected level for these regions could, for example, be adequate to offset the country's estimated overall deficit of 795,690 mt, and this can be attained by allowing the 1987 average yield to increase at an annual rate of 2% in Arssi, 3% in Shewa, and 3.5% in Gojjam and Welleja. Maintaining the 1987 level could be adequate in Keffa and Illubabor.

Leaf inserted to correct page numbering

Appendix A

ESTIMATES OF AREA PROPORTION MODEL

TABLE 36

ESTIMATE OF AREA PROPORTION MODEL FOR TEFF

VARIABLES	PARAMETER	ESTIMATES	
	ESTIMATES	STANDARD ERROR	T
INTERCEPT	0.14	0.01	11.05
D2	-0.13	0.03	-4.84
D3	0.35	0.03	13.50
D4	0.28	0.01	19.15
D5	0.14	0.03	5.45
D6	0.16	0.03	6.00
D7	0.07	0.01	4.52
D8	0.04	0.01	2.52
D9	0.22	0.01	14.86
D10	0.30	0.01	20.85
D11	0.21	0.03	8.23
D12	-0.09	0.03	-3.38
Trend (T)	-0.007	0.001	-4.44
T2	0.02	0.004	4.05
T3	0.005	0.004	1.19
T5	0.01	0.004	2.54
T6	0.01	0.004	3.38
T11	-0.01	0.004	-3.67
T12	0.01	0.004	1.46

$R^2 = 0.95$       D.W = 2.32  
 $n = 108$       F = 121.43

TABLE 37

## ESTIMATE OF AREA PROPORTION MODEL FOR WHEAT

VARIABLES	PARAMETER		ESTIMATES
	ESTIMATES	STANDARD ERROR	T
INTERCEPT	0.28	0.01	20.94
D2	0.03	0.02	1.21
D3	-0.20	0.02	-8.12
D4	-0.20	0.02	-8.47
D5	-0.25	0.02	-10.46
D6	-0.28	0.02	-11.81
D7	-0.27	0.02	-11.42
D8	-0.29	0.01	-22.57
D9	-0.15	0.02	-6.10
D10	-0.26	0.02	-10.78
D11	-0.20	0.01	-15.54
D12	-0.25	0.02	-10.57
Trend (T)	0.01	0.002	5.68
T2	-0.01	0.004	-3.52
T3	-0.009	0.004	-2.17
T4	-0.007	0.004	-1.73
T5	-0.009	0.004	-2.72
T6	-0.01	0.004	-2.36
T7	-0.006	0.004	-1.44
T9	-0.006	0.004	-1.49
T10	-0.01	0.004	-2.84
T12	-0.01	0.004	-2.54

$R^2 = 0.94$   
 $n = 108$

D.W = 2.30  
 $F = 76.51$

TABLE 38  
ESTIMATE OF AREA PROPORTION MODEL FOR BARLEY

VARIABLES	PARAMETER	ESTIMATES	
	ESTIMATES	STANDARD ERROR	T
INTERCEPT	0.38	0.01	28.68
D2	0.18	0.03	6.52
D3	-0.17	0.01	-11.28
D4	-0.13	0.01	-8.60
D5	-0.31	0.01	-20.09
D6	-0.33	0.01	-21.46
D7	-0.21	0.03	-7.57
D8	-0.22	0.01	-14.41
D9	-0.16	0.03	-5.82
D10	-0.30	0.01	-19.59
D11	-0.21	0.03	-7.89
D12	-0.34	0.01	-21.98
Trend (T)	-0.0003	0.001	-0.206
T2	-0.006	0.004	-1.27
T7	-0.006	0.004	-1.32
T9	-0.005	0.004	-1.22
T11	0.02	0.004	3.55

$R^2 = 0.95$   
n = 108

D.W = 2.33  
F = 121.77

TABLE 39

## ESTIMATE OF AREA PROPORTION MODEL FOR MAIZE

VARIABLES	PARAMETER	ESTIMATES	
	ESTIMATES	STANDARD ERROR	T
INTERCEPT	0.15	0.02	7.35
D2	-0.03	0.02	-1.37
D3	-0.02	0.04	-0.61
D4	-0.10	0.04	-2.65
D5	0.27	0.02	13.33
D6	0.29	0.02	14.32
D7	0.36	0.04	9.72
D8	0.29	0.04	7.72
D9	-0.02	0.04	-0.43
D10	0.12	0.04	3.28
D11	-0.12	0.04	-3.22
D12	0.0005	0.04	0.01
Trend (T)	-0.005	0.003	-1.84
T3	0.009	0.006	1.48
T4	0.007	0.006	1.20
T7	0.01	0.006	2.54
T8	-0.02	0.006	-3.40
T9	0.01	0.006	1.91
T10	0.01	0.006	1.91
T11	0.01	0.006	1.65
T12	0.02	0.006	4.13

$$R^2 = 0.93$$

$$n = 108$$

$$D.W = 2.00$$

$$F = 70.60$$

TABLE 40  
ESTIMATE OF AREA PROPORTION MODEL FOR SORGHUM

VARIABLES	PARAMETER		T
	ESTIMATES	STANDARD ERROR	
INTERCEPT	0.03	0.01	2.36
D2	-0.04	0.01	-2.53
D3	0.012	0.015	0.80
D4	0.15	0.01	9.64
D5	0.14	0.01	8.82
D6	0.17	0.03	6.08
D7	0.03	0.01	2.11
D8	0.23	0.03	8.12
D9	0.13	0.03	4.51
D10	0.17	0.03	5.92
D11	0.32	0.03	11.33
D12	0.68	0.03	23.91
Trend (T)	0.002	0.0018	1.14
T6	-0.006	0.005	-1.25
T8	0.01	0.005	2.74
T9	-0.005	0.005	-1.08
T10	-0.007	0.005	-1.44
T11	-0.01	0.005	-2.27
T12	-0.02	0.005	-4.47

$R^2 = 0.96$   
n = 108

D.W = 2.40  
F = 137.57

Appendix B

ESTIMATES OF PRODUCTION PROPORTION MODELS

TABLE 41

ESTIMATE OF PRODUCTION PROPORTION MODEL FOR TEFF

VARIABLES	PARAMETER	ESTIMATES	
	ESTIMATES	STANDARD ERROR	T
INTERCEPT	0.10	0.01	6.7
D2	-0.08	0.03	-2.76
D3	0.32	0.02	19.17
D4	0.30	0.03	10.23
D5	0.06	0.03	2.08
D6	0.10	0.03	3.60
D7	0.12	0.03	4.00
D8	0.003	0.02	0.17
D9	0.16	0.02	9.60
D10	0.20	0.02	12.35
D11	0.19	0.03	6.31
D12	-0.04	0.02	-2.33
Trend (T)	-0.004	0.002	-2.13
T2	0.008	0.005	1.71
T4	-0.01	0.005	-2.49
T5	0.009	0.005	1.98
T6	0.01	0.005	2.61
T7	-0.02	0.005	-3.35
T11	-0.02	0.005	-3.39
R <sup>2</sup> = 0.91		D.W = 2.48	
n = 108		F = 63.83	

TABLE 42

## ESTIMATE OF PRODUCTION PROPORTION MODEL FOR WHEAT

VARIABLES	PARAMETER	ESTIMATES	
	ESTIMATES	STANDARD ERROR	T
INTERCEPT	0.30	0.01	18.80
D2	-0.008	0.03	-0.26
D3	-0.21	0.03	-7.31
D4	-0.19	0.03	-6.64
D5	-0.26	0.03	-8.88
D6	-0.29	0.03	-10.04
D7	-0.30	0.03	-10.22
D8	-0.28	0.02	-17.74
D9	-0.20	0.02	-12.43
D10	-0.28	0.03	-9.41
D11	-0.24	0.02	-14.71
D12	-0.27	0.03	-9.39
Trend (T)	0.01	0.002	4.98
T2	-0.01	0.005	-2.29
T3	-0.007	0.005	-1.54
T4	-0.009	0.005	-1.91
T5	-0.01	0.005	-2.09
T6	-0.01	0.005	-2.03
T7	-0.006	0.005	-1.22
T10	-0.01	0.005	-2.16
T12	-0.008	0.005	-1.58

$R^2 = 0.90$   
 $n = 108$

D.W = 1.81  
 $F = 51.88$

TABLE 43

## ESTIMATE OF PRODUCTION PROPORTION MODEL FOR BARLEY

VARIABLES	PARAMETER		T
	ESTIMATES	STANDARD ERROR	
INTERCEPT	0.40	0.02	19.57
D2	0.17	0.02	6.83
D3	-0.20	0.02	-7.98
D4	-0.12	0.02	-4.99
D5	-0.34	0.02	-13.77
D6	-0.36	0.02	-14.55
D7	-0.29	0.02	-11.60
D8	-0.25	0.04	-5.89
D9	-0.19	0.02	-7.76
D10	-0.32	0.02	-12.85
D11	-0.19	0.04	-4.48
D12	-0.36	0.02	-14.67
Trend (T)	-0.002	0.002	-0.94
T8	0.015	0.007	2.12
T11	0.013	0.007	1.83

$R^2 = 0.89$   
 $n = 108$

D.W = 2.17  
 $F = 65.96$

TABLE 44

## ESTIMATE OF PRODUCTION PROPORTION MODEL FOR MAIZE

VARIABLES	PARAMETER	ESTIMATES	
	ESTIMATES	STANDARD ERROR	T
INTERCEPT	0.17	0.03	5.65
D2	-0.01	0.03	-0.34
D3	0.04	0.06	0.63
D4	-0.12	0.06	-2.16
D5	0.40	0.03	12.89
D6	0.39	0.03	12.55
D7	0.44	0.06	7.75
D8	0.21	0.03	6.59
D9	-0.02	0.06	-0.28
D10	0.20	0.06	3.57
D11	-0.15	0.06	-2.60
D12	-0.01	0.06	-0.18
Trend (T)	-0.009	0.004	-2.37
T3	0.018	0.01	1.94
T4	0.016	0.01	1.73
T7	0.028	0.01	2.96
T9	0.02	0.01	2.30
T10	0.02	0.01	2.43
T11	0.018	0.01	1.98
T12	0.03	0.01	3.49
R <sup>2</sup> = 0.90		D.W = 1.86	
n = 108		F = 50.21	

TABLE 45

## ESTIMATE OF PRODUCTION PROPORTION MODEL FOR SORGHUM

VARIABLES	PARAMETER	ESTIMATES	
	ESTIMATES	STANDARD ERROR	T
INTERCEPT	0.05	0.02	1.90
D2	-0.05	0.03	-1.91
D3	0.005	0.03	0.19
D4	0.16	0.03	5.77
D5	0.14	0.03	4.83
D6	0.14	0.03	4.92
D7	0.002	0.03	0.07
D8	0.30	0.05	6.02
D9	0.21	0.05	4.13
D10	0.18	0.05	3.49
D11	0.36	0.05	7.11
D12	0.70	0.05	13.97
Trend (T)	0.002	0.003	0.60
T8	-0.01	0.008	-1.18
T9	-0.01	0.008	-1.64
T10	-0.01	0.008	-1.20
T11	-0.009	0.008	-1.06
T12	-0.03	0.008	-3.46

$R^2 = 0.88$   
 $n = 108$

D.W = 2.54  
 $F = 46.78$

## REFERENCE

- Agren,G and Gibson,R. Food Composition Table For Use In Ethiopia, 1968.
- Agricultural Marketing Corporation, Ethiopia. Statistical Digest On AMC Operations, 1987.
- Beattie,B and Taylor,C.R. The Economics Of Production, 1985.
- Belete,S. An Over View of Ethiopia's Agricultural Production Strategies and Policies, 1986.
- Debele,B. The Role Of Land Use Planning In Food Strategy Formulation For Ethiopia, 1986.
- Degefu,W and Befikadu,A. Impact Of Weather And Climate On Food Production, 1986.
- Blakeslee,L, Heady,E and Framingham,C. World Food Production, Demand, and Trade, 1973.
- Carter,C and Zhong,F. China's Grain Production and Trade, 1988.
- Catholic University Of Chile. Chile, Demand and Supply Projection For Agricultural Products, 1965-80, 1969.
- Central Statistical Office, Ethiopia. Annual Estimates Of Production, Area and Yield, 1979-87.
- Cohen,J.M and Isaksson,N. Food Production Strategy Debates In Revolutionary Ethiopia, World Development, march 1988, vol.16(3), pp 323-348.
- Eicher,C.K. Strategic Issues In Combating Hunger And Poverty In Africa, Strategies For African Development, 1986, pp242-278.
- Food And Agricultural Organization Of The United Nations (FAO). Agricultural Commodities - Projection For 1975 and 1985, 1967.
- FAO. Agro-meteorological Data For Africa, 1984.
- FAO. Fertilizer Year Books, 1978-85.

- FAO. Food Balance Sheets 1975-77 Average and Percapita Food Supplies 1961-65 Average 1967 to 1977, 1980.
- FAO. The Fourth World Food Survey, 1977.
- FAO. Trade Year Books, 1974-85.
- FAO/WHO, Report Of a Joint Ad hoc Expert Committee. Energy And Protein Requirements, 1973.
- Gura,S. A Note On Traditional Food Plants In East Africa: Their Value For Nutrition And Agriculture, Food and Nutrition, vol.12, no.1, 1986.
- Johnston,B.F. Government Strategies For Agricultural Development, Strategies For African Development, 1986, pp155-181.
- Johnston,J. Econometric Methods, 1984.
- Kidane,Y and Habteyes,Y. Food Grain Losses In Traditional Storage Facilities In Three Selected Areas Of Ethiopia, 1986.
- Koutsoyiannis,A. Theory Of Econometrics, 1977.
- Lemarchand,R. The Political Economy Of Food Issues, Food In Sub Saharan Africa, 1986.
- Maddala,G.S. Econometrics, 1977.
- McFarquher,A. Europe's Future Food and Agriculture, 1971.
- Ministry Of Agriculture, Ethiopia. Results Of Agricultural Sample Surveys, 1974-1978.
- Molnar,J.J and Clonts,H.A. Technology As A Source Of Economic And Social Advancement In Developing Countries, Transferring Food Production Technology To Developing Nations: Economic And Social Dimension, 1983, pp1-15.
- National Food Strategies For Ethiopia, Revised Draft, 1987.
- Nicholson,S.E. Climate, Drought And Famine In Africa, Food In Sub Saharan Africa, 1986, pp107-128.
- Pindyck,R and Rubinfeld,D. Econometric Models and Economic Forecasts, 1981.
- Ravallion,M. Markets and Famines, 1987.
- Relief and Rehabilitation Commission, Ethiopia. Early Warning System Reports, 1976-87.
- Seavoy,R.E. Famine In Peasant Societies, 1986.

- Sen,A. Poverty And Famines, An Essay On Entitlement And Deprivation, 1981.
- Todaro,M. Economic Development In The Third World, 1981.
- Tolley,G.S, Thomas,V and Wong,C.M. Agricultural Price Policies And The Developing Countries, 1982.
- Varian,H. Microeconomic Analysis, 1984.
- Wodajo,T. Agro-meteorological Activities In Ethiopia, Prospects For Improving Agro-climatic/Crop Condition Assessment, 1984.
- Woldemariam,D. The Food Policy Objectives In The Ten Year Perspective Plan, 1986.
- Wong,L. Agricultural Productivity In China And India: A comparative Analysis, Canadian Journal Of Agricultural Economics, 1989, pp77-93.
- World Bank. World Development Report, 1986.