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Rural Poverty and Food Insecurity in Ethiopia*:
The Quest for Sustainable Rural Institutions and Technologies

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ABSTRACT: This paper addresses the issue of rural poverty and food insecurity in Ethiopia, with the aim of exploring some policy options for their eradication. Specifically, it discusses the role of agriculture in alleviating poverty and food insecurity. The paper also explores the general problem of 'Environment-Food Security- Rural Poverty cycle', with emphasis on the need to develop productive and sustainable institutions and technologies aimed at eradicating absolute poverty, food insecurity and natural resource degradation (soil erosion and deforestation). Based on data from the First Round Ethiopian Household Survey conducted in 1994, it develops and uses an analytical model (known as Social Accounting Matrix or SAM) to show the nature of linkages within the agricultural/rural economy. Based on household data from peasant associations (PAs), the analysis also provides production trends and determinants or constraints of food crop production for selected provinces or zones. The paper shows the weak nature of linkages among the sub-sectors of the rural economy, and concludes by drawing some policy implications from the literature reviewed and the results of the analytical case model. An important policy implication of the paper is the critical need to develop market and non-market institutions to increase agricultural productivity and to overcome crop production constraints and the weak linkages in the rural economy, in order to eradicate absolute poverty and food insecurity. The paper is part of work in progress that will be further developed and revised based on more data from Ethiopia.

Keywords: Rural Poverty, Food security
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1. Introduction: The General Problem

Ethiopia is a large country with over 85 million people of which the majority or 85 percent are engaged in rural and agricultural based economic activities. It has one of the lowest per capita incomes in the world and high incidence of absolute poverty- with 50 percent of the population below the poverty line[1]. The country also faces a related problem of severe *food insecurity*[2] that manifests itself in the lowest calorie intake in Africa at about 1845 calories per person per day. It is estimated that more than half of the population is food insecure of which the largest group is rural people with insufficient land and capital to produce and purchase food (Tesfaye & Debebe, 1995). Thus, a major development challenge for Ethiopia is to reduce absolute poverty and food insecurity[3] at acceptable environmental and economic costs. In order to tackle this problem and devise appropriate policies and institutions to meet the challenge, it is necessary to understand the relationships among natural resource management, technology, agricultural productivity and food insecurity.

Ethiopia also faces a rapid population growth that contributes to the environmental problem, which manifests itself in land and water degradation and loss of biodiversity caused by low agricultural productivity and high dependence on fuel wood (Demel 2001). Soil degradation is the severest environmental problem (Paulos, 2001). Ethiopia loses about 400 tons/ha of topsoil every year (Shibru & Kfle, 1998). It is estimated that the amount of grain lost to land degradation alone can feed more than 4 million people according to a recent paper by Demel (2001). Although some aspects of the environmental problems are caused by natural factors such as draught and desertification, most of it is due to poverty driven human activity. Conditions of high absolute poverty induce the poor to become both agents and victims of environmental degradation in Ethiopia.

Table A.1 (in the Appendix) compares Ethiopia's agricultural performance to selected economies. The table shows Ethiopia ranks the third in terms of percentage land under crop following the United States and India among the selected countries. But, the

[1] Ethiopia's GNP per capita was about $110 per year in 1997 according to *World Development Report 1998/99.* The Country's Human Development Index (HDI), which is a composite index of income, life expectancy, and education ranks 171 out of 174 countries listed according to the *Human Development Report 2000*, published by the UNDP.

[2] The term *food insecurity* (the opposite of food security) is defined as lack of access to food. It has chronic or transitory. *Food security* is access by all peoples at all times to enough food for active and healthy life. It is based on food availability (supply) and ability or income to acquire food. See *Poverty and Hunger: Issues and Options for Food Security in Developing Countries* by the World Bank (1986)

[3] For a view of the various aspects of food insecurity and poverty in Ethiopia, see the *Proceedings of the Inaugural and First Annual Conference of the Agricultural Economics Society of Ethiopia*, edited by Mulat et al, AESE, (1995), especially the articles by Dagnew, Gezahegn, Hadgu, Itana, Mackinnon, Dagnew, Tesfaye and Debebe.

percentage of irrigated land of the total cropland shows that Ethiopia ranks second from the bottom. Thus, the Country has a potential to tap irrigation to increase agricultural production. In spite the potential for irrigation, Ethiopia lags behind even in Africa.

The productivity figures are even more revealing. Both land and labor productivity in the Country ranks second and third respectively from the bottom as shown in Table A1.

Thus, Ethiopia's current high level of absolute poverty and food insecurity is primarily due to a low productivity in the Country's huge agricultural sector. The high rate of population growth is also related to poverty, since people in absolute poverty have the incentive for high fertility to increase the number of potential income earners in the household and to provide for old age security (Smith, 1997). In order to survive in a subsistence economy, farmers are forced to mine soils and to cut down trees leading to land degradation and deforestation. Thus, environmental degradation becomes a result and a cause of economic stagnation and decline, which is aggravated by absolute poverty and food insecurity.

To address this problem, it is necessary to identify and generate appropriate technologies and institutions that significantly reduce food insecurity and absolute poverty in a sustainable manner. In other words, the key policy challenge is to develop institutions that impact on agro-ecologically specific *productive* and *sustainable* technologies, aimed at reducing food insecurity and absolute poverty in Ethiopia.

The rest of this paper is organized as follows. Section 2 discusses the inter-linkages among the environment, food security, and poverty in rural economy. Section 3 provides the rationale for an agricultural sector employment based strategy as a way out of the poverty trap. Section 4 presents a Social Accounting Matrix (SAM) based analysis of the Ethiopian rural economy. Section 5 presents productivity trends and production determinants or constraints of the major crops in selected provinces, including a discussion of sustainable and productive technologies. Section 6 discusses some institutional dimensions of sustainability. The final section provides concluding remarks and draws some policy implications.

2. The Environment- Food Insecurity and Poverty Problem in Ethiopia

There is a vicious cycle of environmental degradation and food insecurity driven by absolute poverty and population growth in Ethiopia. The Country, along with many African states, is caught up in a 'poverty – environmental degradation-poverty circle
(Shibru and Kifle, 998). This is a complex and multi-dimensional problem with no single or simplistic cause. For example, population growth is only one factor, which is both the cause and the result of the problem. On the other hand, one cannot say that the problem is insurmountable since it has been overcome by many societies in the developing world. The comparative and historical experiences of societies that have succeeded in this regard demonstrate that the solutions must involve long term and sustained *investment on people*, specifically in those areas that enhance the *capability* and *knowledge* of individuals and communities to produce and access resources for combating poverty and managing natural resources in efficient and sustainable manner. Such capability and knowledge enhancing factors (also

called 'human capital investments') involve public and private investments on education, training, as well as technologies and institutions that enhance economic welfare and progress. The specific problem of food insecurity, which is closely linked to absolute poverty, can also be best addressed within this framework of possible solutions.

Food insecurity can be defined as the lack of capability to produce food and to have access by all people at all times to enough food for an active and healthy life (World Bank, 1986). Food insecurity is directly linked to *absolute poverty*[4] and lack of purchasing power (Sen, 1983). Table 1 shows the fact that Ethiopia has the large population below international poverty line. It was estimated the level of poverty in rural Ethiopia has increased from about 53% in 1982 to about 66% in 1992 based on the poverty line of 500 grams of daily per capita consumption requirements or an equivalent annual expenditure of about 1478 Birr (Hadgu, 1995). The able also shows the international assistance is the lowest in per capita terms. Food insecurity, which is closely related to poverty, can be analyzed at the household, a community, a region or national levels (Eicher, 1998). But, mere focus on food production cannot solve the food security problem, since food security has both supply (production) and demand (income) dimensions. A successful food policy for Ethiopia needs to address both sides of the *food insecurity equation*. In this regard, a key policy research issue is to identify the combination of technologies and institutions aimed at providing both availability and access to food by local communities and regions in Ethiopia. Providing food availability involves increasing agricultural production or supply, which can be addressed by public and private investments on what has been called the *prime movers* of agricultural development (Eicher, 1988,1995). These include public and private investments on: 1.new technology and agricultural research, 2. human capital and managerial skills produced by investments in schools, training, and on-the-job experience, 3. physical capital investments in rural infrastructure such as irrigation, dams and roads, 4. farmer support institutions such as marketing, credit, and extension services.

But, a crucial pre-condition to implement the above prime movers is a favorable public policy and institutional environment guided by a political leadership committed to agriculture. In this regard, the adoption of an agriculture and rural-centered development strategy known as Agricultural Development-Led Industrialization (ADLI) by the current government is encouraging. ADLI is focused on the development of smallholder farm productivity and the expansion of commercial farms. If successfully implemented, it has the potential to reduce food insecurity, absolute poverty and environmental degradation.

[4] Poverty has relative and absolute dimensions. *Relative Poverty* is a function of inequality and cannot be abolished unless there is perfect equality which not possible or desirable. The concern here is with Absolute *Poverty*, which is based on minimum standard of basic consumption. It is calculated by minimum caloric intake and other necessities required by an average person. Absolute poverty can in principle be eradicated. The global absolute poverty line is estimated to be $370 per person per year in constant 1985 PPP prices. See Meier and Rauch 2000, P. 19-20

Table 1. Ethiopia's Poverty and Inequality Indicators in Relation to Selected Countries

	International Poverty lines (1991-1997)			Official Development Assistance ($/ capita)	
	Population below $1 a day (%)	Population Below $2 a day (%)	Gini Index (%)	1990	1998
Ethiopia	31.3	76.4	40	20	11
Egypt	3.1	52.7	28.9	104	31
Kenya	26.5	62.3	44.5	50	16
Tanzania	19.9	59.7	38.2	46	31
Zimbabwe	36	64.2	56.8	35	24
India	44.2	86.2	37.8	2	2
Brazil	5.1	17.4	60	1	2

Source: World development Indicators 1998/99 and 2000/2001

3. The Relevance of Agricultural and Employment Based Economic Growth Strategy

An agricultural and employment based economic growth strategy as articulated by Mellor (1986) is the most appropriate strategy for the development of the Ethiopian economy, where 85 percent of the population is rural and agricultural based. Given that the Ethiopian highlands, which constitute 35-40 % of the landmass, are home to 85 percent of the population, comprise 90 percent of cultivated land, and 70% of the country's livestock population, the war to eradicate absolute poverty in Ethiopia will be won or lost on the highland ecosystems[5]. An agricultural and employment based strategy should involve generation and dissemination of technologies, and institutional changes and investments required to improve agricultural productivity and to increase farm and non-farm employment incomes will be the source of growth for Ethiopia. The strategy also has the potential to lead to a poverty-focused[6] economic growth necessary to reduce food insecurity and environmental degradation. Indeed, it is consistent with current officially adopted ADLI strategy in Ethiopia.

Conceptually, an agricultural and employment based economic growth strategy has three basic elements (Mellor,1986): 1.Agricultural growth under a fixed and shrinking farmland. This requires an appropriate land-saving technology in the form of biological and chemical technologies. 2. Growth in domestic demand for food and farm

[5] This is not to suggest that the lowlands are to be ignored. But success in the highlands will also reduce poverty in the lowlands due to the dynamic relationships between the highland and lowland ecosystems. See also Teklu (2001)

[6] A poverty focused development policy involves two elements: First, is to promote the productive use of the poor people's abundant asset-labor by policies that harness market incentives, social and political institutions, infrastructure, and technology to that end. Second, is to provide basic social services to the poor in the form of health care, family planning, nutrition, and basic education. The two elements are mutually reinforcing. See *World Bank Report 1990*, and Adelman (1986)

output despite inelastic demand. The growth in food demand occurs through accelerated growth in rural employment (or increased demand for labor), made possible by indirect effects of agricultural growth itself, 3. increased demand for goods and services produced by the non-farm sector and facilitated by technology-based increase in agricultural income. These basic elements of the strategy are interactive. The strategy also requires an open trading regime favorable to agricultural exports. For example, currently farmers are producing bumper crops due to good weather. But, they are also facing a problem of low prices for their products due to weak demand. This problem can be addressed by developing export markets for farm commodities, by increasing rural incomes from farm and non-farm employment, and by promoting greater inter-regional trade that allows movement of food from surplus regions to food deficit regions of the Country[7].

The critical need for moving agriculture forward in Ethiopia is underlined by the need to increase food supply to feed a rapidly growing population, and to provide employment and income growth needed to reduce absolute poverty and food insecurity for a predominantly rural-based population. Since Ethiopia has a large pool of unskilled labor, agricultural development can relieve the growing unemployment problem. The supply of labor is a function of the labor market and the food market. Increasing employment provides the working poor with added income of which 60 to 80 percent is spent on food due to high-income elasticity of demand[8]. If food supply does not increase, a rise in employment will cause food prices to increase, reducing real income of workers, raising wages and reducing employment in other sectors of the economy (Mellor, 1986). Agricultural production also stimulates non-farm employment since increased farm incomes provide effective demand for non-farm rural enterprises.

Moreover, agricultural development makes a well known general contributions to the overall national economic development and poverty reduction by increasing the supply of food for domestic consumption, by releasing labor for industrial development and non-farm sectors, by enlarging the market for industrial (non-farm) output, by increasing the supply of savings, and by providing foreign exchange earnings (Johnston and Mellor 1961). For both microeconomic and macroeconomic reasons, no country has ever sustained rapid economic growth without first solving the food insecurity problem (Timmer, 1998). At the microeconomic level, inadequate or lack of access to food limits labor productivity and reduces investment in human capital (Fogel, 1994, Strauss, 1986). At the macroeconomic level, periodic food crises undermine political and economic stability, reducing the level and efficiency of investment required for economic growth and poverty alleviation (Timmer 1998).

There is also an important link between agricultural productivity and nutritional status of workers. Fogel (1991) provides

[7] It is noteworthy to indicate that food aid has the potential to make the food price problem worse for farmers. It has to be carefully targeted or managed to avoid adverse impact on local farm incomes and prices.

[8] It is a theoretically and empirically well established that the poor has a relatively *high-income elasticity* of demand for food or they spend a relatively large proportion of their income on food and basic necessities.

a strong evidence for the importance of increasing calorie intake to reduce mortality and to increase productivity of the working poor.

Using a robust biomedical relationship that links height, body mass, and mortality rates, he found increases in food intake among the British population in the late 18th century have substantially increased productivity and per capita income. So, the "Fogel linkages" which enhance the food security of the poor, can also contribute to long-run economic growth and poverty reduction.

A 'poverty focused' economic development policy has best chance of success if it is agricultural-led, or if it is based on increasing agricultural productivity that result in food security and the reduction in absolute poverty[9] (Adelman 1986). But, most African economies have failed to implement this strategy in the past for at least two reasons: First, there is insufficient or lack of investment in improved technologies in Africa, unlike Asia, which has invested in green revolution technologies. Technologies that are appropriate for some agro-ecologies and crops for Africa are still not on the shelf. For example, although crops such as maize and wheat have benefited from green revolution technologies, technologies for food crops such as sorghum, teff and barley are either not on the shelf or have not been adopted[10]. Thus, there is a need for successful generation and adoption of appropriate technologies for specific agro-ecological areas of Ethiopia. The second reason is the lack of an appropriate policies and institutions. The problem here is that policies and institutions are short term, discontinuous, and focused on transfers and consumption activities, instead of productive activities. There is critical need to face up to the long-term challenges of human capital investment and productive efficiency in agriculture. Given the current national commitment to agriculture and poverty reduction in Ethiopia as envisaged by the officially adopted ADLI strategy, one would expect and hope that appropriate policies would be developed and implemented in the near future.

The need to develop strong linkages within the agricultural sector as well as with the other sectors in the rural economy is evident from the experience of similar economies. The resource bases that the country has are located within the agricultural sector and its transformation to develop other sectors and to increase income of the labor force on the agricultural sector should be the priority for ADLI to be successful. The next section provides A Social Accounting Matrix (SAM) that describes the linkages in the rural sector of the Ethiopian economy.

[9] Adelman identifies two strategies to attack the problem of absolute poverty: 1, an export-oriented growth in labor –intensive manufactures and 2. Reliance on agricultural development-led industrialization (ADLI). She notes, " during the coming decade ADLI is likely to deliver more interms of less inequality and poverty. See Adelman in Lewis and Kallab (1986), p.64

[10] This point, including the technologies on the shelf and the institutional factors that impact on their successful adoption, is subject to further investigation from empirical and field studies in Ethiopia.

4. A Multiplier Analysis of Ethiopian Agriculture- SAM based Structure of the sector.

This section presents the structure of linkages of the rural/Agricultural sector based on an analytical model known as Social Accounting Matrix (SAM). SAM is a matrix that describes a qualitative and quantitative description of income flows in an economy during a specific period of time, in a square table. Each account is represented by an entry that shows rows of receipts, and columns of expenditures in a table. Taking some of the accounts as exogenous, the matrix can be used to compute the *income multipliers* that show the impact of change in those exogenous accounts on the income of the endogenous accounts[11]. In this study, SAM for rural Ethiopia is constructed using data of the First Round of Ethiopian Rural Household Survey (ERHS) conducted by the Department of Economics, Addis Ababa University in collaboration with Center for the Study of African Economies, Oxford University in 1994. The survey covered a total of 15 sample villages, with total of 1477 households. The choice of the villages was designed to cover the diversity of the communities, farming system and ecology of rural Ethiopia[12]. The list of regions, woredas (or counties) and peasant associations (villages) covered in the sample and the total value of crops are presented in Table A.2 in the Appendix.

The 15x15 matrix includes the income and expenditure of the 15 accounts, where 12 are assumed to be endogenous and the 3 are exogenous to the farm household. These accounts include the major crops as endogenous accounts. The crops are teff, wheat, maize, barely, coffee and chat. The other endogenous accounts include, consumer commodities (traded activities), livestock, factors (land and labor), households (as consumers) and enterprises. The exogenous accounts are government, capital and the foreign sector. (The complete SAM is not presented in this paper, but interested readers can request the authors to get copy of the matrix).

Analytically, total income (Y) or the row sum in each endogenous account is equal to the sum of products of the expenditure coefficient (A_n) and corresponding income plus the total exogenous income from government, rest of the world, and capital accounts (X). In this study the expenditure coefficient is the average propensity to consume of each endogenous account. It is calculated by dividing each entry by respective total expenditure (column sum)[13].

The basic SAM model can be expressed as follows:

[11] Exogenous accounts are activities external to the farm household such as government expenditures for example. Endogenous accounts are internal to the farm household decisions such as crop and livestock production activities.

[12] For the description of the survey areas and data see Beven and Pankhurst (1996), Community survey ERHS, and Dercon and Krishnan (1998)

[13] See the study by Bautista and Thomas (1997) on agricultural linkages in Zimbabwe and the details of the matrix computations.

$$Y = A_n Y + X \quad (1)$$

Where Y is a column vector (15x1) of the total income received by farm household from all sources, X is a column vector of total exogenous income injections, and A_n is the expenditure coefficient matrix, which is measure of household propensity to consume.

Solving for Y results in the following equation:

$$Y = (I - A_n)^{-1} X = M_a X \quad (2)$$

Where M_a stands for the SAM multiplier matrix. Hence, equation (2) can be used to calculate the changes in endogenous incomes associated with any change in total exogenous incomes or income injections. Each *cell* in the multiplier matrix can be interpreted to indicate the total (direct and indirect) income change in the row-account induced by exogenous unit-income injection in the column-account. (The standard limitations of SAM–based analysis based on the assumptions of the model such as absence of relative price and monetary effects and purely demand driven adjustments apply here). In this paper, the focus is on classification of activities into crops to examine the income effects of the shocks from other income sources and sub-sectors in the rural economy. The income multipliers presented here are divided into two tables, which show the multiplier matrix for the major crops (table 2) and selected other economic activities (table 3).

4.1. Crop Income Multipliers

Table 2 shows the change in income from for each crop if the exogenous income injection is made to the respective column accounts. For example, if there is 1000 Birr income injection in the livestock, factors, households and enterprises sector, the income of teff producers would increase by Birr 497, 495, 495 and 496, respectively. But, the same Birr 1000 spent in these accounts also generate more income for the other crops as shown in the livestock column of the matrix. The table shows that the crop that benefits most from the income injection is coffee followed by chat, the two dominant cash crops in the country. For instance, increasing livestock income by B1000 increases income to coffee producers by B610 as illustrated in the table. The relative weak linkage among the crops can easily be seen for the table by looking at the column of crop activities of the matrix in table 2. The entries in the main diagonal of the matrix show the income response of the same crop when there is income injection (in the form of credit and fertilizer subsidy for example) to the same crop. The table also shows that coffee and chat are the most profitable followed by teff and wheat.

Table 2. Income Multipliers of major crops in Rural Economy

	Teff	Wheat	Maize	Barely	Coffee	Chat	Other activity	Commodities	Livestock	Factors	Households	Enterprise	Total
Teff	1.479	0.479	0.479	0.479	0.479	0.479	0.479	0.534	0.497	0.495	0.495	0.496	6.870
Wheat	0.404	1.404	0.404	0.404	0.404	0.404	0.404	0.423	0.419	0.418	0.418	0.418	5.922
Maize	0.379	0.379	1.379	0.379	0.379	0.379	0.379	0.386	0.392	0.393	0.393	0.393	5.607
Barely	0.374	0.374	0.374	1.374	0.374	0.374	0.374	0.379	0.388	0.388	0.388	0.388	5.549
Coffee	0.587	0.587	0.587	0.587	1.587	0.587	0.587	0.694	0.610	0.604	0.604	0.607	8.230
Chat	0.578	0.578	0.578	0.578	0.578	1.578	0.578	0.681	0.601	0.595	0.595	0.598	8.119
Total	3.801	3.801	3.801	3.801	3.801	3.801	2.801	3.097	2.908	2.894	2.894	2.901	40.298

4.2 Income Multipliers of Other (non-crop) sub-sectors

The sub-sectors included under the income multiplier analysis in this part are commodities sector (the traded activities), livestock sector, factors of production (labor and land transactions), households as consumers, and enterprises such as small handcrafts and cottage industries of the rural economy. Here, the multipliers show that the linkage between the sub-sectors is better than the one indicated for individual crops shown earlier in table 2. Again, the linkage between crops and other activities is relatively weak as shown in the first row entries of all crops as shown in Table 3. For example a 1000 Birr injection of income to crop production will increase income earned from other activities by 924 Birr as shown in the first row of table 3 under each crop. The households and commodity traded sector are the ones that benefit the most from

income injections as shown in the fifth and second rows of table 3. This shows that middlemen (traders and "dellalas") are among the major beneficiaries of incomes shock in the rural sector. This also reveals that fact that distributive service expands relatively more than other services. This result is in line with Block's findings (1999) form the four-sector simulation model where the growth multiplier of service sector at 1.8 is larger than that of agriculture at 1.54. He also finds the multiplier for the modern sector at 1.34 and is greater than that of the traditional sector at 1.22. The enterprise sector seems to benefit the least from injections to the crop production activities or accounts. This implies that the drive towards Agriculture-Led Development Industralization (ALDI) will face challenge of week linkages between the sub-sectors due to for example a weak effective demand from the enterprise sector. (See the last row of table 3 below).

Table 3. Income Multipliers of Other institutions in Rural Ethiopia

	Teff	Wheat	Maize	Barely	Coffee	Chat	Other activity	Comm odities	Livestock	Factors	Households	Enter prise
Other activity	0.924	0.924	0.924	0.924	0.924	0.924	1.924	1.021	0.959	0.954	0.954	0.957
Commodities	3.128	3.128	3.128	3.128	3.128	3.128	3.128	4.109	3.259	3.199	3.199	3.232
Livestock	1.847	1.847	1.847	1.847	1.847	1.847	1.847	1.684	2.734	1.539	1.539	1.544
Factors	3.025	3.025	3.025	3.025	3.025	3.025	3.025	2.660	2.565	3.475	2.475	2.814
Households	6.141	6.141	6.141	6.141	6.141	6.141	6.141	6.152	6.363	6.378	6.378	6.367
Enterprise	0.389	0.389	0.389	0.389	0.389	0.389	0.389	0.396	0.364	0.344	0.344	1.346

5. The Quest for Productive and Sustainable Agricultural Technologies

The challenges of meeting food security based on appropriate technology[14] and that of slowing or reversing natural resource degradation can be and should be pursued together in Ethiopia. Indeed, successful agricultural development and sound natural resource management are complementary (World Development Report, 1994). Productivity and sustainability problems are two sides of the same agenda, which are also linked to the absolute poverty problem. Currently about half of the Ethiopian population is below the poverty line and food insecure. The goal of decreasing this level by half or to 25% below the global poverty line is achievable within the next decade if proper combination of *productive* and *sustainable* technologies and institutions are adopted[15].

Agricultural productivity, measured in terms of average (or marginal) factor productivity (land, labor, and capital), depends on technology, quantity, and quality of the factors used. A key technological issue is the type of technology farmers can use under a growing population, diminishing farmland, and land or soil degradation. Is the technology profitable or sufficiently productive to meet food security needs, and can it be sustained with the resource base of the various agro climatic zones of the Country?

In this regard, two broad technological options of agricultural intensification have been identified in the literature (Reardon, 1998). First, a traditional or a low-input sustainable agriculture (LISA) technology based on meeting soil fertility needs through application of organic matter and indigenous soil conservation techniques, and second, a combined use of LISA with farm intensification based on improved technologies aimed at meeting the goals of productivity and sustainability in agriculture. (A number of recent papers under the theme of "Sustainable Intensification of Agriculture in Ethiopia" address the

[14] An appropriate technology is based on *induced technical change* as articulated by Ruttan (1998). It involves the adoption of labor-intensive biological and chemical technology that yield increasing or land saving. But, he cautions against the lack of environmentally specific chemical and biological technologies may not be on the shelf for Africa. See Ruttan in Asefa (1988).

[15]Indeed this is a realistic goal to pursue during the next decade with proper policy and institutional environment. For example, Malaysia reduced its population below poverty from 50 % (about the same current level of poverty in Ethiopia) in 1970 to about 10 % in 1990. See *World Development Report* 1991

issue of farm intensification including some of institutional and technological requirements[16]).

Some environmentalists and agricultural scientists have been pushing LISA strategy, which alone cannot meet the goals of productivity or food security and resource sustainability goals in Africa (Low 1986). LISA has the potential to increase food production by only 1% a year, which falls short of meeting the annual increase in food demand of at least 3% or more for Ethiopia. If food security cannot be met with such a strategy, farmers are likely to engage in activities such as soil mining and clearing forests on fragile lands. Thus, rising absolute poverty and food insecurity drives natural resource degradation. Farmers driven by poverty or food insecurity engage in farm extensification strategy that is environmentally damaging (Reardon, 1998). Indeed, studies have shown that if LISA food production strategy instead of Green Revolution technologies had been pursued in South Asia since 1960s, 44 million acres of land, which are now under forest, would have been under cultivation (Tribe 1994).

This evidence suggests that biodiversity[17], which is one of the goals of sustainable natural resource management, has been enhanced in Asia by the land-saving productive green revolution technologies. In Ethiopia, there is evidence that farmers can adopt improved agroforesty and soil conservation practices under secure land tenure system (Berhanu 1998, Beyene, 1996)

Thus, the challenge is to adopt agro-ecologically focused and locally specific technological options in Ethiopia aimed at slowing or reversing resource degradation[18].

It is important to transform subsistence agriculture to science-based intensive agriculture by adopting promising indigenous practices combined with selective use of improved technologies such as inorganic fertilizer, better equipment, improved seeds, and improved soil conservation and agroforestry practices. Improved technologies and use of farm capital is the most promising path to achieve the goals of greater productivity, food security, and sustainability in most agro-climate zones (Reardon, 1998).

The ecological diversity of Ethiopia has both advantages and disadvantages in terms of developing appropriate technology. It has advantages in terms providing an opportunity for diversified cropping pattern to avoid risk. But, the task of developing and adopting appropriate technologies for the different ecological zones is challenging. The level of productivity, the pattern and determinants of crop production differ by region. The next section provides the trends in productivity and production determinants by major crops and by provinces.

5.1. Trends of Major Crops

Table 4 shows the trends of yield for major cereal crops with emphasis on the regional differences of productivity.

[16] See specifically the papers by Solomon, Beyene, Takele, Gavian and Ehui in Mulat et al editors. (1996)

[17] The issue of biodiversity is loss due to the fact that deforestation is an important area of research in the author's view.

[18] A recent article by Bekele and Holden (1998) notes, " The challenge of breaking the poverty-environment trap and initiating sustainable intensification requires policy incentives and technologies that confer short-term benefits to the poor while conserving the resource base.

One of the implications that can be drawn from the trends is the obvious dependence of the agricultural sector on weather conditions in Ethiopia. There seems to be systematic pattern of fluctuations based on rainfall and by region, even though the exact cyclical pattern of rainfall cannot be determined (Adugna, 2000). Productivity figures are also lower in recent years for barely and teff compared to that of wheat and maize. What this trend may reveal is that recent technological advances and/or incentives may the favor wheat and maize compared to teff and barely. Similar evidence using FAO data has been reported by Befekadu and Berhanu (2000), have reported that teff has the lowest productivity despite constituting the highest share in fertilizer use.

Regional productivity differences also reveal that yield levels of teff and barley declines over time. The yield level for the periods 1980-1990 and 1991-1995 also shows that these shifts in productivity and technology are a recent phenomenon, in that the yield level of teff and barley show a decline in recent years for most provinces. For instance, except for Gojjam and Gonder, crop yield level is lower in 1990-1995 compared to 1980-1990. For teff and barley the yield level is higher before 1990. The results for wheat, maize, and sorghum are mixed.

In most cases the provinces have improved level of productivity in recent years. Comparing productivity for different periods and for each crop, Harar province ranks first in teff yield both in 1980-1990 and 1991-1995 followed by Arsi and Gojjam, respectively. This finding may be surprising, since the consensus is that Arsi and Gojjam are the most productive provinces in the country. Harer also ranks first in wheat yield followed by Arsi in 1980-1990, although it lags behind Arsi in recent years. In Barely production, Arsi and Sidamo are the dominant provinces. In case of maize Gojjam follows Jimma and Arsi in 1980-1990 and 1990-1995 respectively. The regional cropping pattern in table 4 show that Arsi, Gojjam and Harar dominate the cereal crop production. But, in these three provinces, it is important to note that it is only wheat yield that consistently increases in recent years. Even maize, which is believed to have benefited from the recent technological improvements, yield has not increased until 1995. (See also the graphs in the Appendix)

Table 4. Yield of major crops by province

	ARSI	GOJJAM	GONDER	HARER	JIMA	SIDAMO	WELLO
	CerealsA	cerealsGJ	cerealsGO	cerealsH	cerealsJ	cerealsS	CerealsW
1980-1990	14.47	10.68	9.17	14.44	13.60	13.01	11.60
1991-1995	14.12	11.05	9.46	13.10	12.39	11.63	11.38
1980-1995	14.36	10.79	9.26	14.02	13.22	12.58	11.53
	TeffA	teffGJ	teffGO	teffH	teffJ	teffS	TeffW
1980-1990	9.78	8.99	8.10	11.17	9.34	7.92	8.42
1991-1995	8.35	8.91	7.60	9.39	8.31	7.71	8.64
1980-1995	9.33	8.97	7.94	10.61	9.01	7.86	8.49
	WheatA	wheatGJ	wheatGO	wheatH	wheatJ	wheatS	WheatW
1980-1990	14.34	10.30	9.25	13.89	12.03	9.19	8.87
1991-1995	14.79	12.05	10.90	13.57	12.77	11.14	12.88
1980-1995	14.48	10.85	9.76	13.79	12.26	9.80	10.12
	BarleyA	barleyGJ	barleyGO	barleyH	barleyJ	barleyS	BarleyW

1980-1990	15.50	10.06	8.76	10.66	10.13	11.56	11.33
1991-1995	14.26	9.71	9.34	11.36	11.17	10.61	11.11
1980-1995	15.11	9.95	8.94	10.88	10.46	11.26	11.26
	MaizeA	maizeGJ	maizeGO	maizeH	maizeJ	maizeS	MaizeW
1980-1990	15.04	17.20	11.73	16.43	17.60	16.98	16.90
1991-1995	18.65	16.67	11.58	13.99	16.18	16.66	14.92
1980-1995	16.17	17.04	11.68	15.67	17.16	16.88	16.28
	SorghumA	SorghumGJ	sorghumGO	sorghumH	sorghumJ	sorghumS	SorghumW
1980-1990	17.32	11.94	9.97	14.19	14.20	11.07	13.96
1991-1995	16.16	13.39	10.68	13.70	14.28	10.84	13.83
1980-1995	16.96	12.39	10.19	14.04	14.22	11.00	13.92

5.2. Determinants of Crop Production in Ethiopia

Using the time series yield data described earlier and available input information for the seven provinces and four crops, we estimated production function specified by the following regression equation:

$$Y_{it} = \alpha_0 + \alpha_1 Rain_{it} + \alpha_2 Fertilizer_{it} + \alpha_3 Oxen_{it} + \alpha_4 Labor_{it} + \varepsilon_t$$
$$i = 1,....., N \text{ and } t = 1,....., T \qquad (3)$$

ε_t is assumed to be identically and independently distributed. Y_t stands for crop yield, in this case aggregate cereals and four major cereal crops (teff, wheat, barley, and maize) are considered for analysis. In this study, *i* refers to the provinces for which data is available. These provinces are Arsi, Gojjam, Gonder, Harer, Jima, Sidamo, and Wello, t refers to the time period that span from 1980-1995.

Rain measures rainfall (in mm) taken from representative station in each province. **Fertilizer** is measured in kilograms used by the farmers in a province. **Oxen** stand for the number of draft oxen used by the farmer in a province. **Labor** is measured by the number of active labor force in a province. Since the dependent variable is the ratio of total production to area cultivated, land is not used as explanatory variable in the regression model.

Estimation is made both for individual provinces and for all provinces combined. The later is estimated using Seemingly Unrelated Regression (SURE) to take advantage of the contemporaneous correlation of the error terms of the provinces. This is based on the assumption that these provinces are affected by weather conditions and government policy similarly and hence their error terms correlate contemporaneously. In using both methods the result remains similar, hence the SURE estimation results are reported below. The regression results of the production function are presented in table 5. The results are only for factors that affect yield in each region and for each crop at statistically significant or conventional level. The result for sorghum is not reported since most of the variables turned out to be statistically insignificant.

Table 5. Production Determinants of yield by provinces*

	Cereals	Teff	Wheat	Barley	Maize
Arsi	Rainfall Fertilizer	Oxen	Rain Fertilizer Oxen	-	Fertilizer
Gojjam	Oxen Labor	Rain Labor	-	Oxen	-
Gonder	Rain	Rain Labor	Rainfall oxen	-	-
Harer	Fertilizer Oxen Labor	Fertilizer Oxen	-	-	Oxen
Jima	Fertilizer	-	-	-	Oxen
Sidama	Fertilizer	Fertilizer	Fertilizer	Fertilizer	-
Wello	Rain Labor	Rain Labor	-	Labor	Oxen

* All the determinants indicated in the table are significant at the conventional levels.

Table 5 above shows the determinants of yield differ both by province and by crop. For instance in Arsi, Harar and Sidamo, fertilizer is the major determinant or constraint of crop production, where as in Gojjam and Wello labor is the major constraint. In Gonder and Wello, rainfall is the major production determinant or constraint. The differing determinants of crop production imply the need to develop and/or adopt locally specific technologies. For example, farmers in Sidamo can significantly increase crop production by using more fertilizer, while farmers in Harer and Jima can significantly increase maize production with more oxen power and improved farm implements.

6. Institutions for productive and sustainable technologies in agriculture

Institutions in general, are the *rules of the game* that shape human interaction including economic interaction (North 1990). For an economy to grow, *incentives* must be created for people to use more efficient technologies, to save and invest, and to improve their skills, and to organize efficient markets. Such incentives are embodied in *market institutions.* But, how can society build or develop such market institutions? According a recent report[19], effective institutions are built by: 1. Designing them to complement what exists- in terms of other supporting institutions, human capabilities and available technologies, 2. Modifying and innovating institutions that work and dropping those that do not, 3. Connecting communities through open information flows and open trade or by dismantling impediments to resource mobility and trade, 4. Promoting open

[19] See *World Development Report 2002,* published by the Oxford University Press for the World Bank

competition among jurisdictions, firms, and individuals.

Moreover, economic problems such as hunger, poverty, war, and unemployment are result of institutions that provide rationale people with *incentives* to behave in a destructive rather than constructive manner (Van Den Berg, 2001). Institutions and organizations are not always the same, although they are sometimes used as such. Institutions are *rules* of the game while organizations and individuals are the *players* (Kasper, 1998). Markets are institutions that evolve and develop overtime as a form of 'institutional capital' of a country, and which must be allowed to do so with proper policies. In agriculture, institutions[20] must be developed that provide farmers the *incentives* to save and invest on farms and to adopt productive and sustainable technologies. For example, a clearly defined and secured land tenure system is a key institution that promotes incentives for farmers to adopt improved technologies.

A sustainable technology involves *farm-capital*[21] intensification that takes place in two stages. First, it involves labor-intensive application of manure and construction of traditional land improvements (planting grass strips, anti-erosion ditches, earthen bunds). Second, it requires increased use of improved soil conservation practices based on modified animal traction equipment, land saving chemical and biological technologies such as fertilizer and improved seeds. But, whether farmers can move to the second stage will depend on institutions and policies that promote agricultural profitability, and provide access to cash or credit to purchase or produce farm capital (Reardon, 1998).

In general, a successful intensification practices compatible with goals of productivity or food security and environmental sustainability requires the following conditions according to Reardon (1998): 1.public investment in the development of rural infrastructure such as feeder roads, small-scale irrigation infrastructure, and dams. 2.The development of input (labor, capital and land) markets. Improvement of input markets is necessary to reduce transaction costs and to improve the efficiency. 3. Appropriate macroeconomic policies that get "prices right" are important. Policies must make both factor and product prices favorable to farmers. The liberalization of markets for farm products since 1991 has been the right strategy, but the development of institutions that govern the development of *factor markets* (labor, capital, and land) is crucial for Ethiopia. For example, labor market policies should facilitate the free movement of labor and capital across agro-ecological regions. Since farmland is an increasingly scarce input, land markets should be allowed to emerge in order to allow for sustainable, equitable and efficient use of land[22].

[20] Johnston (1988) notes that in addition to farm level technological changes such as land improvement, improved crop varieties and training, institutional or "socially determined factors" such as agricultural research, extension, infrastructure, and appropriate macroeconomic policy environment are essential.

[21] Farm capital includes non-labor variable inputs that enhance soil fertility (both organic matter, like manure, mulch, and chemical fertilizer) and soil conservation and water-retention practices (such as terracing, tied ridging, and anti-erosion practices). See Reardon in Eicher and Staatz (1998), P. 451

[22] There is evidence of emerging rental market and informal land markets. See a recent paper by Tesfaye Teklu (2001). See also the various

Farm support institutions, and improved rural physical infrastructure such as roads that reduce the cost of transportation and complement the development of market institutions must be promoted. Farmers' capacity to save and to invest in farm intensification can be enhanced by providing access to credit and to non-farm income from non-farm employment opportunities. In most agro ecologies of Ethiopia, institutions that combine promising indigenous practices with improved technology and farm intensification approaches is required to meet the goals of productivity, food security and environmental sustainability. This will require the availability of capital that allows farmers to use chemical fertilizer, organic matter, and improved seed, in combination with increasing investments in soil conservation and small-scale irrigation technologies.

The capacity of farmers in Ethiopia to purse alternative technologies is critically conditioned by public and private investments in rural infrastructure, input and output market improvements, land markets, credit policy and promotion of non-farm enterprises such as agro-industry. The challenge is to develop innovative, cost-effective public, private and public institutions (including NGO's) that support agriculture under a favorable and macroeconomic and institutional environment (Reardon, 1998). Indeed, in absence of appropriate rural institutions, rural poverty alleviation will be just a dream, since technological packages and credit cannot reach the small farmer (Itana, 1995).

The present study is aimed at the understanding the evolution of market and non-market institutions and alternative policies that are aimed at reducing food insecurity and slowing or reversing natural resource degradation (soil erosion and deforestation) in Ethiopia. Some of the specific research questions are as follows. What are the experiences with sustainable and productive technologies that are currently on the shelf? What are the missing institutional innovations and technologies, for which crops, and in which areas? What are the institutional constraints of successful adoption of technologies by farmers? What indigenous and improved institutional and technical innovations exist and/or are needed to respond to the soil erosion and deforestation problem? How have these institutions evolved over time? For example, the Ethiopian Agricultural Research Organization (EARO)[23], with a long experience in agricultural research, has released technologies over the years. Some of the most recent ones are specifically focused on conservation of soils and forests. This paper is part of work in progress aimed at studying these experiences with emphasis on the role of institutions that affect the use of productive and sustainable technologies by farmers. It is aimed at identifying institutional constraints and promising institutions and technologies to alleviate

articles in "Land tenure and Land Policy in Ethiopia After the Derg" Dessalegn Rahmato, editor (1994). See also Gavian and Simeon (1996).

[23] EARO (formerly known us the Institute of Agricultural Research or IAR) was established in 1966 as a public agricultural research institution. For a review of experiences of agricultural technology development and transfer, including experiences with institutions of agricultural research see Mulugeta (1994). For a recent assessment of the agricultural research system, see a paper by Tesfaye (2001).

poverty, food insecurity and resource degradation in Ethiopia for the near future.

7. Concluding remarks and policy Implications

A decade after it's first report on poverty in 1990, the World Bank published a second comprehensive report on poverty[24]. The first report characterized poverty as a condition of low income and consumption resulting from low returns to labor and other assets of the poor. The second or the 2000/2001 report extended poverty to be a result of low investment in education, health, nutrition, including deficiency in the other areas of human development such as powerlessness, lack of voice, vulnerability, and fear that poor people around the world express themselves in their own words[25]. The second report also recommends three policy actions to combat poverty in general, by: 1. P*romoting opportunity*: enhancing economic opportunity for poor people by promoting poverty-focused economic growth and by increasing the productivity of their assets (land and labor-through education and health), and increasing the returns to these assets through a combined market and non-market actions. 2. *Facilitating empowerment*: making public institutions more accountable and responsive to the poor, strengthening their participation in the decision making process that affect their lives, and removing or dismantling social barriers that result from gender, ethnicity, race, religion, and social distinction and discrimination. 3. *Enhancing security*: Reducing poor people's vulnerability to ill health, crop failure, policy induced dislocations, natural disasters, and violence. The advances in each of the above three areas are complementary. Each is important in it's own right, and helps to enhance the others. While the report does not envision a simple blue print, it underscores the crucial notion that, "priorities must be made at the national level, but action and implementation must take place with local leadership and ownership reflecting local or community realities" and needs. (World Development Report 2000/01, p. VI)

The focus of this paper is more limited than one addressed by the recent report by the World Bank. The emphasis here is on the problem of rural poverty in general, and on the relevance of an agricultural based employment strategy in alleviating poverty and food insecurity in particular. The paper has explored the general problem of 'Environment-Food Security- Rural Poverty cycle', with emphasis on the need for productive and sustainable market and non-market institutions aimed at eradicating absolute poverty, food insecurity and natural resource degradation (soil erosion and deforestation). Based on data from the First round Ethiopian Household Survey conducted in 1994 and an analytical model (known has SAM), it has shown the weak nature of linkages within the agricultural/rural economy. Based on community level data of a sample of provinces, the analysis has revealed production trends, including some

[24] See *World Development Report 2002/2001: "Attacking Poverty"* published by the Oxford University Press for the World Bank, 2001, New York, N.Y. For the 1990 report see *World Development Report 100 on "Poverty" by the same publisher*.

[25] See *Voices of the Poor: Can Anyone Hear Us?* By Deepa Narayan and others, published by the Oxford University Press for the World Bank, 2000, New York, N.Y.

production determinants or constraints for selected crops by provinces.

Some policy implications can be drawn from the analysis of this paper. First, for the officially adopted ADLI policies to succeed in meeting the goal of eradicating poverty in Ethiopia, private and public investments must be made on *institutions* and *technologies* that increase crop production and improve the weak linkages within the rural economy. This will involve developing or strengthening marketing and credit institutions that provide market access and opportunities for the poor in the farm and non-farm sectors. Public and private investments must be channeled to overcome the weak linkages that exist in the rural economy particularly in agricultural crop production and non-farm sub-sectors. Public and private investments on sustainable agricultural technologies that focus on the existing potentials of each region and provinces should be made to exploit the regional *comparative advantage* and productivity gains. Public and private investments must be encouraged in agriculture and related enterprises in these regions. In other words, regions and provinces with agricultural potential should be fully supported (or not to be undermined) if the desired goal of an agricultural based economic growth or the ADLI strategy is to become a reality in eradicating poverty and food insecurity. In the other regions and provinces, with no comparative advantage in agriculture and crop production, appropriate non-farm enterprises should be developed to increase incomes and employment in these regions. Regional states or provinces should then be linked by free trade of commodities, and free mobility of labor and capital. Institutions and policies should be developed to facilitate this important process, and those that retard it should be removed. For example, this paper has confirmed the fact that Arsi is among the provinces with comparative advantage in agriculture in general and food crop production in particular. Other provinces such as Wello may, for instance, have comparative advantage in non-farm enterprises that can be developed. Economic policies should encourage such (natural) patterns of comparative cost advantage and link such provinces through free interregional trade, and mobility of labor and capital, especially by encouraging private investment based on regional cost (comparative) advantage[26]. This has been the historical process of economic growth followed by nations that succeeded in using markets and agriculture as a vehicle of alleviating poverty and achieving economic development. For example, in the United States, most food crops such as wheat and maize are produced in Nebraska, Kansas and Iowa. Other states such as Michigan and Florida generally specialize in non-farm enterprises (Michigan in Automobiles and Florida in Tourism, for example). The federal states are then linked through free interstate trade of commodities and free mobility of labor and capital resources. Such regional specialization based on cost-advantages, and investment in agriculture has fueled the historic growth

[26] This is not to undermine the need for public policy to address regions and communities that may experience extreme economic dislocation or deficiency due to external shocks such as natural disasters or war. These are legitimate areas for policies to deal with at all levels of government. But, it is crucial to point out that such pubic transfer activities cannot substitute for or address the long term problem and challenge of promoting productive investment activities aimed at economic growth and poverty eradication.

of the U.S. economy. This process has allowed the United States to achieve a successful economic development or *structural transformation* over time. Today, although only about 2 percent of the U.S. population is in the agricultural sector, the sector produces enough for the entire population as well as for exports and food aid to the rest of the world.

The paper has also argued that appropriate technologies that enhance the productivity of rural poor people's assets (such as labor and land) through improved seeds, fertilizer, and improved farm implements are also consistent with reducing resource degradation in general, or soil erosion and deforestation in particular. In other words, technologies and institutions that enhance agricultural productivity can simultaneously reduce natural resource degradation problems.

In conclusion, the challenge for eradicating absolute poverty in Ethiopia is best achieved by pursuing an economic growth strategy that transforms the currently low productivity and huge agricultural sector, where 85 percent of the population makes it's livelihood. This challenge can be met by developing private and public institutions that promote the four *prime movers* of agricultural development identified earlier in this paper: 1. Appropriate technologies- produced by public and private investments in agricultural research; 2. human capital investments and vocational skills of poor people by investment in private and public schools, training programs, on-the-job experience and health; 3. investment in infrastructure such as dams, irrigation facilities, telecommunications and roads; and 4. investments in farmer support institutions such as marketing, credit, fertilizer, and seed distribution systems. Each of the above *movers* is important and complementary. But, the analysis of this paper underscores the critical need to develop agro-ecologically or locally specific technologies to raise crop productivity, and to invest in infrastructure and in agricultural support institutions such as marketing and credit in order to overcome problems of productivity and weak linkages within the rural economy. The paper also implies that success in transforming agriculture along these lines can reduce natural resource degradation, and thereby enable Ethiopia to break out of the absolute poverty-environmental degradation-food insecurity trap.

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9. Appendix: Tables and Graphs

Table A.1. Selected Indicators of Agricultural sector in Selected Countries

	% Of crop land	% Of irrigated land of cropped land	Agri. Value added per agric. worker (1995 dollar)	Value added per hectare of agri. land (1987 dollar)	Average annual % growth: Agriculture	Average annual % growth: Industry	Average annual % growth: Service	Agric. As % of GDP
Year	1995	1996	1997	1993	1990-1999	1990-1999	1990-1999	1999
LDCs	14	25.5	.	183	2.5	1.1	4.7	27
SSA	7	4.2	379	68	2.5	1.5	2.5	18
Ethiopia	12	1.8	181*	116	2.5	6.3	6.7	49
Egypt	3	99.8	1189	2990	3.1	4.7	4.3	17
Kenya	8	1.5	228	90	1.4	1.9	3.3	27
Tanzania	4	3.8	174	..	3.6	2.6	2.5	48
Zimbabwe	8	4.7	347	41	4.3	-1.2	3.6	19
India	57	32.4	406	520	3.8	6.7	7.7	28
Brazil	8	4.8	4081	119	3	3.2	2.7	9
Belgium		3.8	34929	..	1.7	1.1	1.4	1
United States	21	12	39001	261	2.5	4.9	2.1	2

Source: Selected World development Indicators 1999/2000 and 2000/2001

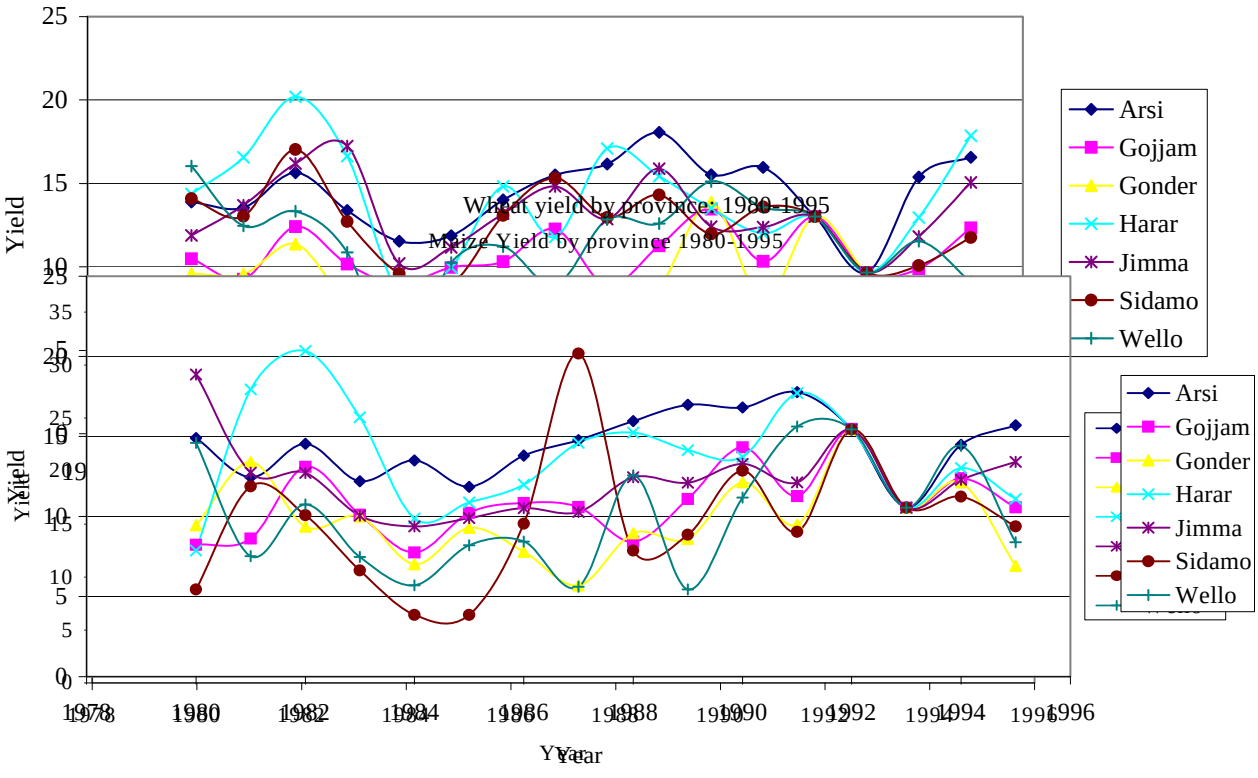
Table A.2. Value of total Crops (VTC), Sample size and Percentage of total sum by Region, Woredas and Peasant Associations

Region	Woreda	PA	Sample Size (N)	Value of total crops	% Of Total Value
Region 1	Atsbi	Hresaw	84	107.79	.0%
	Sebhassahsie	Geblen	66	4865.03	.2%
		Total	**150**	**4972.82**	**.2%**
Region 3	Ankober	Dinki	87	32547.88	1.6%
	Basso na Woraana	D.B. -Milki	62	90959.92	4.4%
		-Kormargefia	59	127571.69	6.2%
		-Karafino	38	48863.84	2.4%
		-Bokafia	25	56840.13	2.8%
	Enemayi	Yetemen	61	86830.34	4.2%
	Bugena	Shumsha	148	88992.29	4.3%
		Total	**480**	**532606.08**	**25.9%**
Region 4	Adaa	Sirbana Godeti	97	351033.49	17.1%
	Kersa	Adele Keke	97	273732.34	13.3%

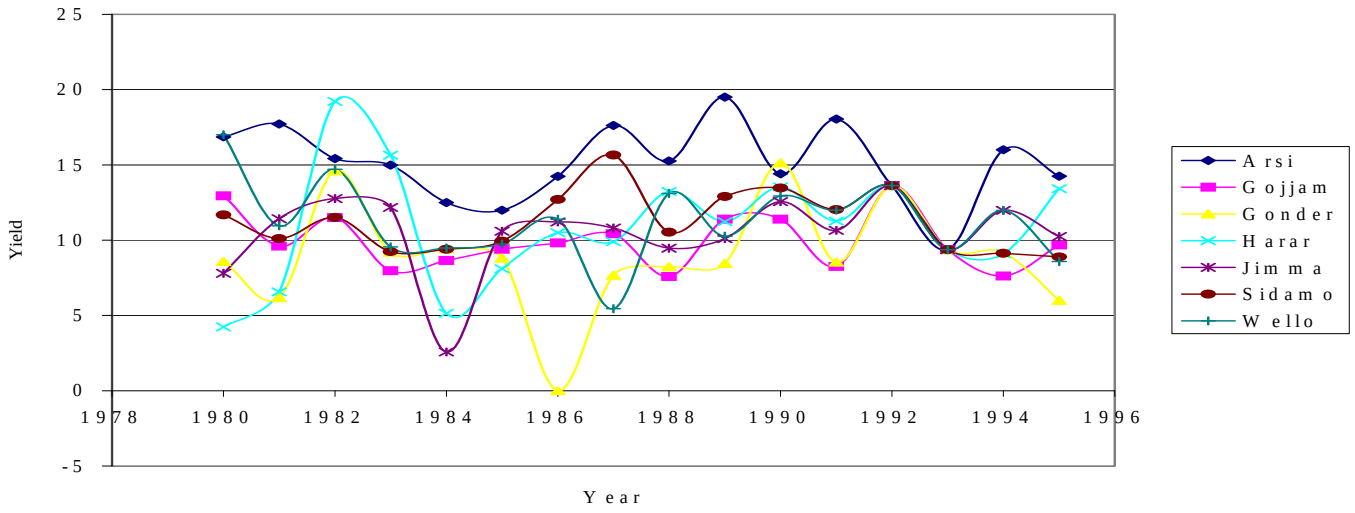
	Dodota	korodegaga	109	64607.81	3.1%
	Shashemene	Trirufe Ketchema	102	309254.35	15.0%
		Total	**405**	**998628.00**	**48.5%**
Region 7	Cheha	Imdibir	67	72681.48	3.5%
	Kedida Gamela	Aze Deboa	75	129397.44	6.3%
		Total	**142**	**202078.92**	**9.8%**
Region 8	Bule	Adado	130	204651.24	9.9%
		Total	**130**	**204651.24**	**9.9%**
Region 9	Boloso	Gara Godo	96	18457.15	.9%
	Daramalo	Doma	74	97177.50	4.7%
		Total	**170**	**115634.65**	**5.6%**
		Total	**1477**	**2058571.71**	**100.0%**

Source: First Round Ethiopian Rural Household Survey, 1994

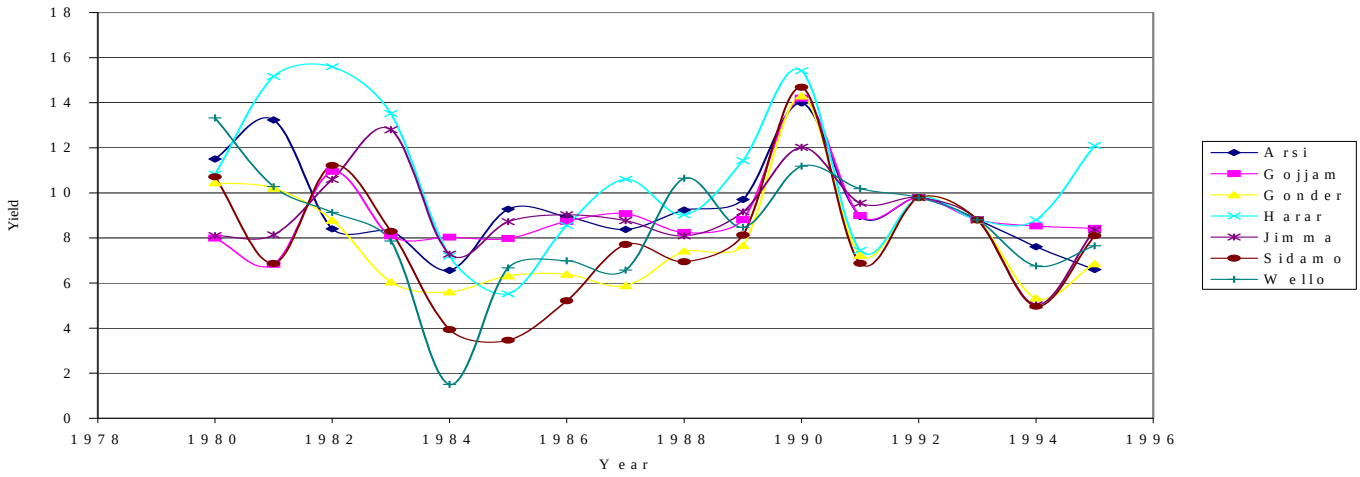
Cereals Yield by Province 1980-1995



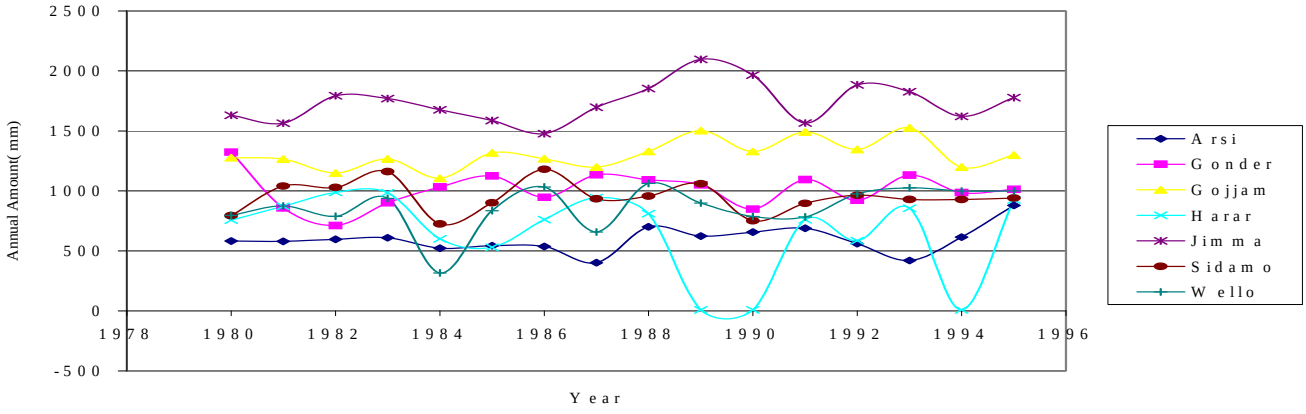
Barley yield by province: 1980-1995

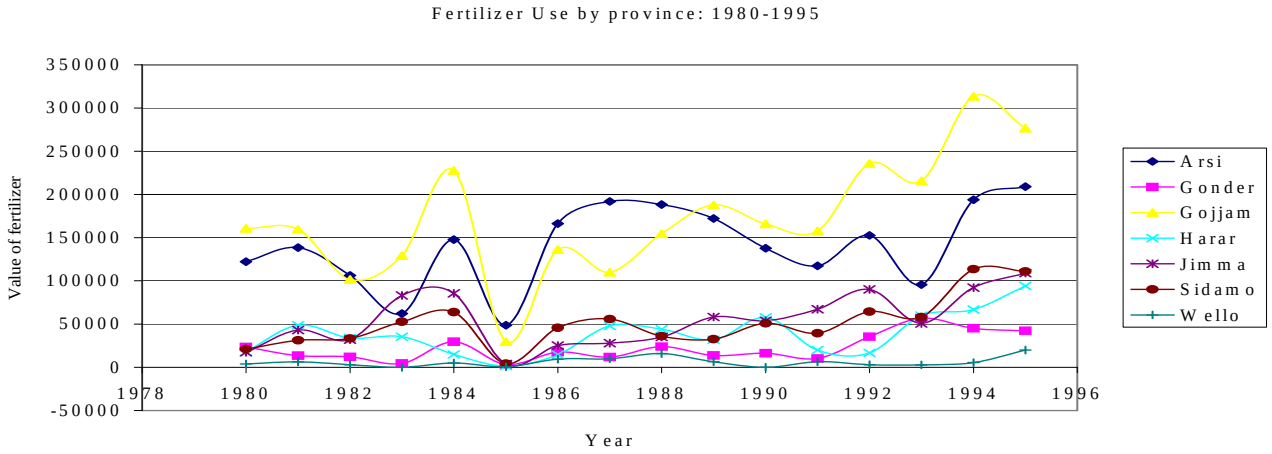


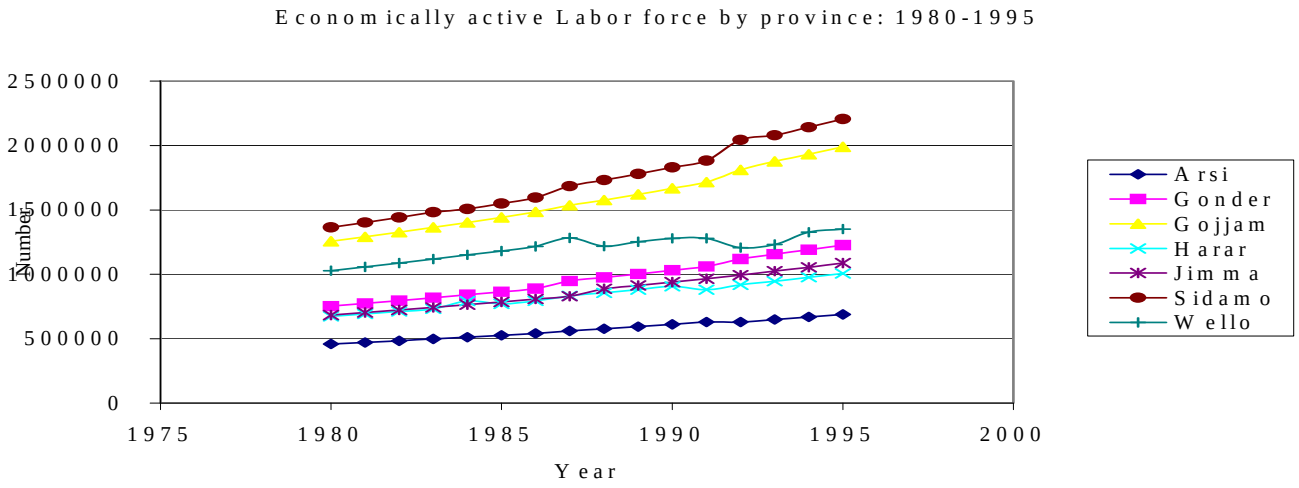
Teff yield by province: 1980-1995

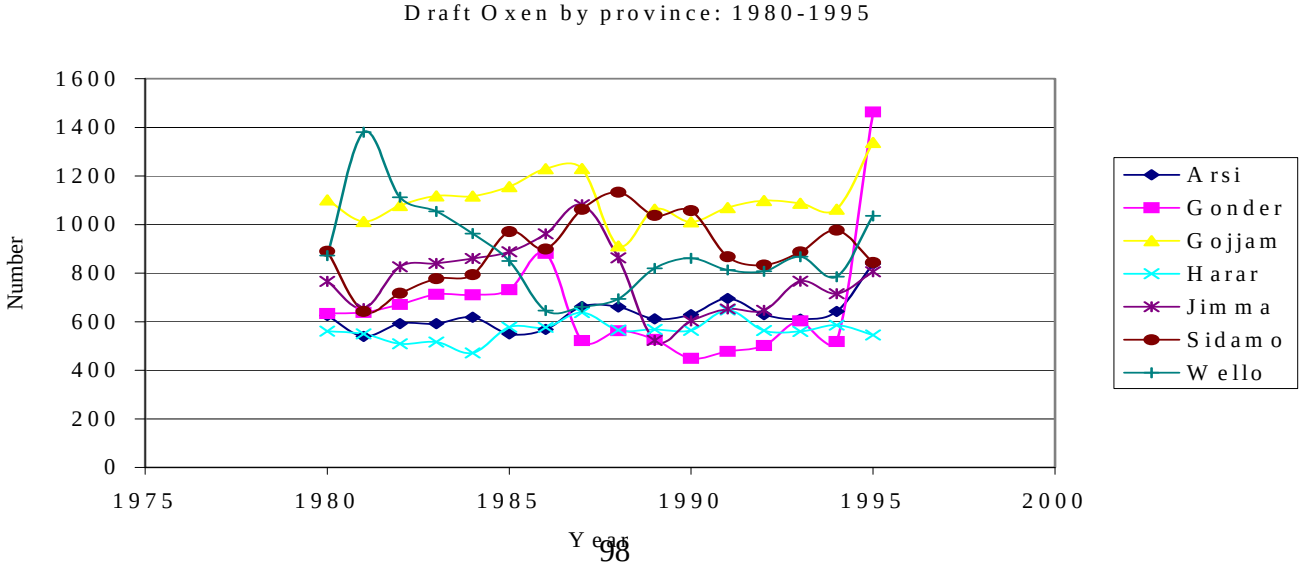


Annual average rainfall by province: 1980-1995




Fertilizer Use by province: 1980-1995
Value of fertilizer
350000
300000
250000
200000
150000
100000
50000
0
-50000
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
Year
Arsi
Gonder
Gojjam
Harar
Jimma
Sidamo
Wello


Economically active Labor force by province: 1980-1995
Number
2500000
2000000
1500000
1000000
500000
0
1975
1980
1985
1990
1995
2000
Year
Arsi
Gonder
Gojjam
Harar
Jimma
Sidamo
Wello


Draft Oxen by province: 1980-1995
Number
1600
1400
1200
1000
800
600
400
200
0
1975
1980
1985
1990
1995
2000
Year
Arsi
Gonder
Gojjam
Harar
Jimma
Sidamo
Wello