CHAPTER 2

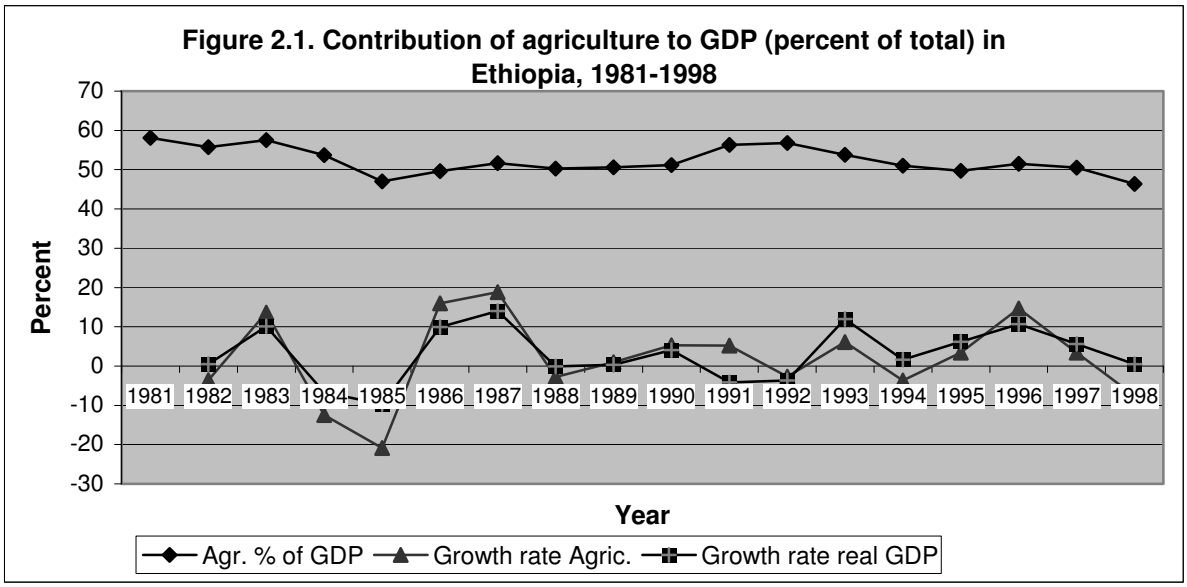
AGRICULTURE, IMPROVED TECHNOLOGY AND FOOD SECURITY IN ETHIOPIA

The purpose of this chapter is to provide background information on the role of agriculture in economic development, technology development and dissemination, and food security in Ethiopia. The first section describes agricultural production systems and government policies that have direct bearing on agricultural technology adoption. Smallholders are the most important agricultural producers in terms of area cultivated and production, and therefore, more attention was given to describing their production system and policies that are particularly important to them. However, other production systems have also been briefly analysed. Ethiopian agriculture has lived through major political changes during the past three decades (imperial, socialist and the current regimes). The policies of each of the mentioned governments to increase agricultural productivity and their impact on agricultural technology adoption are discussed. The second part of the chapter gives an overview of the status of agricultural research and extension systems in Ethiopia. It describes the constraints encountered in developing and disseminating technologies suitable for smallholder farmers and identifies problems that exist between research and extension that hindered the dissemination of improved agricultural technologies. Food availability, consumption, and food self-sufficiency issues, which are dependent on agricultural productivity, are discussed in the third part of the chapter.

2.1 Agriculture and the national economy

Agriculture is the most important sector of the Ethiopian economy. It contributes about 50% of the Gross Domestic Product (GDP), the bulk of which comes from cultivation of crops (80%) and the rest (20%) from livestock (Abinet et al, 1991). These shares did not significantly change over the years. The industrial sector is small in size contributing, on average, only about 16% of the GDP. Figure 2.1 shows the contribution of agriculture to GDP and its growth rate between 1981 and 1998 (MEDAC, 1998). The rate of growth of

agriculture was negative in seven out of 17 years. This was mainly due to severe weather fluctuations including drought in 1984 and 1987, inappropriate economic policies, low rate application of improved technologies and prolonged civil war. Apparently, this negative growth of agriculture had contributed to the reduction of GDP during that same period.

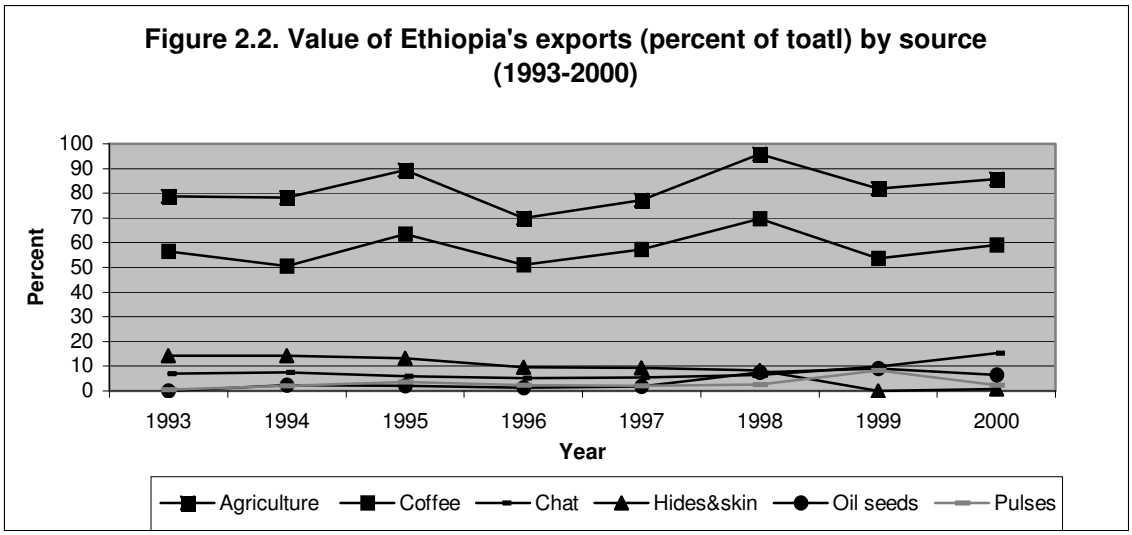


Source: MEDAC, 1998

In spite of the low productivity of agriculture, the economy of Ethiopia remains heavily dependent on agricultural exports for foreign currency. Agriculture is the major source of export revenue and accounts for 82% of the total value of exports of the country. Coffee is the major agricultural export contributing about 70% of the volume of agricultural exports and more than 58% of the total value of exports. Chat[1], hides and skin ranked second and third accounting for, on average, 8% and 7% of total exports, respectively, from 1993-2000 (National Bank of Ethiopia, 2000; Ministry of Trade & Industry, 2000). Oil seeds and pulses account for about 4% and 3% of the value of exports, respectively, but contributed better than cereals in terms of export earnings (Figure 2.2). Coffee, hides and skin have been the dominant agricultural export of the country since the 1950s. These export earnings are mainly used to finance the import of capital goods for the development of the sectors of the economy including agriculture (National Bank of Ethiopia, 2000; Ministry of Trade & Industry, 2000). Generally, sufficient efforts have not been made to diversify the

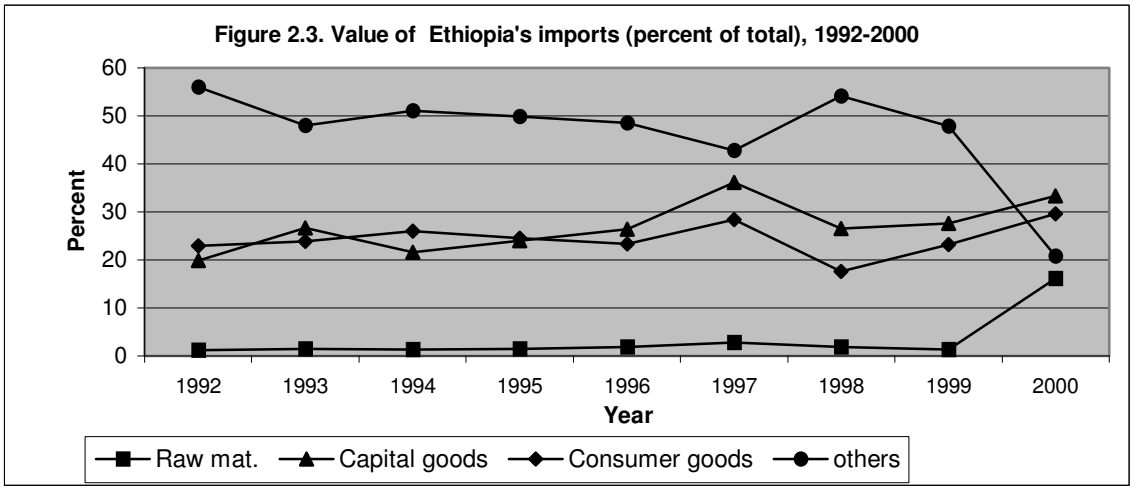
1 *Catha edulis* (Celastraceae), a bush the leaves of which are chewed as a stimulant (Bezabih Emana and Harmen Storck, 1992).

agricultural exports and the country is always at the mercy of other countries that have similar export (coffee).



Source: National Bank of Ethiopia, 2000; Ministry of Trade and Industry, 2000

On the other hand, imports of capital goods were dominant from 1992 to 1999 except for the years 1992, 1994 and 1995 where imports of consumer goods accounted for a larger share (National Bank of Ethiopia, 2000; Ministry of Trade and Industry, 2000). The share of imports of raw materials was quite insignificant during the whole period (Figure 2.3).

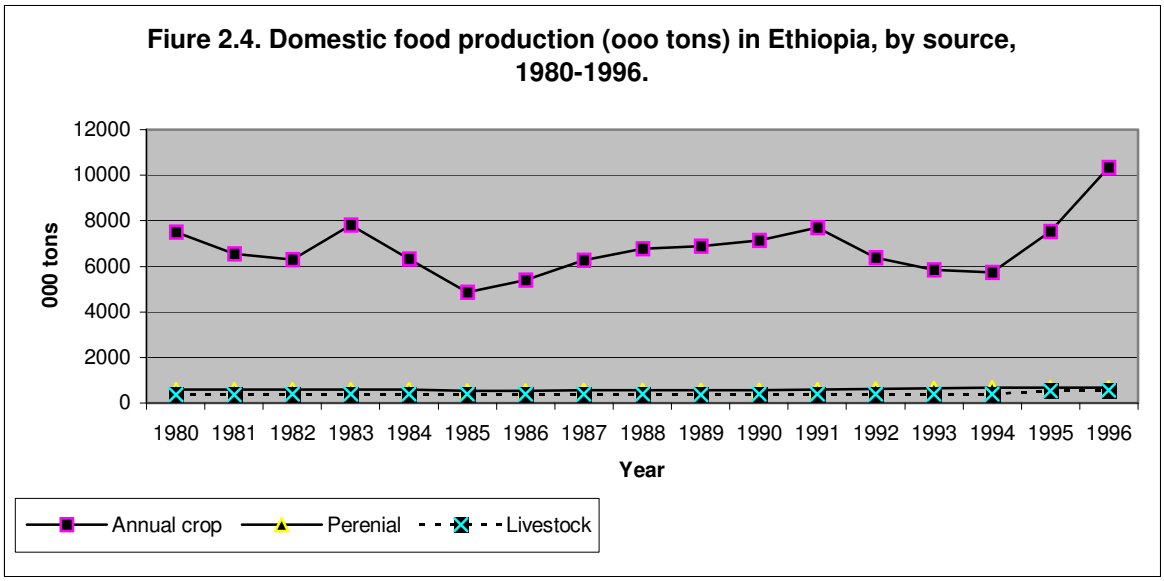


Source: National Bank of Ethiopia, 2000; Ministry of Trade and Industry, 2000

Agriculture is also the major source of employment for 90% and 89% of male and female labor, respectively, in the country. The industrial sector employs only 2% while the

services sector employs 8% and 10% of the male and female population, respectively. (ILO, 1996). Employment figures include full as well as part time workers.

Another contribution of agriculture is that it is the only source domestic food production for the growing population where about 95% of the food production comes from the smallholders' production system. Almost all of the domestic food production comes from annual crops (87%), perennial crops (8%) and livestock (5%). Figure 2.4 shows the sources of domestic food production over the years.



Source: Adapted from Debebe, 1997

2.2 The Agricultural potential of Ethiopia

Ethiopia has an area of 1.12 million square kilometres and is the ninth largest country in Africa. About 66% of the total land is potentially arable out of which only 22% is currently under cultivation and only 4% of the land suitable for irrigation is currently utilized (EARO, 2000).

Ethiopia lies within the tropics but enjoys tropical, sub-tropical, and temperate environments because of the significant altitudinal variations. Originally, Ethiopia was divided into three major agro-climatic zones:

kola, representing the warm climate zone, less than 1500 meters above sea level (masl);

weinadega, representing a moderate climate (1500 masl to 2500 masl); and

dega, which represents a cool climate, greater than 2500 masl (Stroud and Mulugetta, 1992).

Recently, the country was divided into 18 major agro-ecological zones and 48 sub-zones based on altitude, rainfall and length of the growing period (EARO, 2000). Crops and livestock production are concentrated between 1500 masl and 3500 masl where the temperature ranges from moderate (*weinadega)* to cool (*dega*).

The country is endowed with enormous water resources. The water resources of the country comprise 10 big rivers and their tributaries, and 11 lakes with sizes ranging from 20 km^2 to 3600 km^2. The irrigation potential of the country is over 3.5 million ha (FAO, 1986; Legesse, 1998). However, there are barriers, at least in the short run, to exploiting this potential. In particular, potentially irrigable lands are located in sparsely populated lowland areas where infrastructure is poorly developed.

Ethiopia has a bimodal rainfall defining two seasons. The main rainy season occurs between the months of June to September, while a shorter season with lesser amount of rain falls between February and mid-May. Crop production is mainly carried out during the main rainy season. The major crop production areas receive on average 800 mm to 1200 mm of rainfall in normal years and produce 95% of the total crop production of the country (FAO, 1986). In some parts of the highlands, shortages and uneven distribution of rainfall occur approximately once in 3 to 5 years when the amount of rainfall received may fall below 400 mm and be unevenly distributed. In general, the reliability of rainfall decreases from South to North and from West to East. The arid and semi-arid parts of the country suffer from shortages and from erratic rainfall.

With regard to its livestock population, Ethiopia stands first in Africa and tenth in the world (Pickett, 1991). According to the Ministry of Agriculture (MOA), Livestock and Fishery Resource Development Department, there are about 28 million cattle, 24 million sheep, 18 million goats, 7 million equine (horses, donkeys and mules), 1 million camels and 52 million poultry (Legesse, 1998). Unfortunately, this great potential is not well exploited.

2.3 Agricultural production systems in Ethiopia.

There are two main production systems in Ethiopia: the pastoral-nomadic system, and the mixed crop production system. The pastoral livestock production system dominates the semi arid and arid lowlands (usually below 1500 masl). These regions cover a vast area of land with a small livestock population. The crop production system can be classified into smallholders' mixed farming, producers' cooperative (PCs) farms, state farms, and private commercial farms based on their organizational structure, size, and ownership. As this study focuses only on smallholder crop agriculture, no further discussion of other systems (pastoral-nomadic and private commercial activities) is provided.

The smallholders' production system was the most dominant and accounted for more than 90% of cultivated area and production from 1980 to 1995 (Table 2.1). The major objectives of smallholder farmers' production are to secure food for home consumption and to generate cash to meet household needs (clothing, farm inputs, taxes etc). The PCs were established as a result of the past socialist government during the 1970s and 1980s to collectivise land, speed up the use of improved agricultural technologies to increase food production in the country, and provide higher income to PCs' members. The PCs mainly produced for their own consumption and to a minor extent for the market. PCs had priority to get improved inputs on credit and extension agents were based in the PCs to demonstrate improved agricultural technologies on their farms. However, despite such generous government support to PCs, their progress was very slow due to weak services offered by extension agents and PCs' leaders due to lack of experiences. Moreover, PCs did not offer higher income to their members as envisaged. Thus, there was strong resistance from smallholders to join the PCs. There were only 3741 PCs with a membership of 321,324 households or 4% of all rural households by 1989 (Stroud and Mulugetta, 1992). From 1980 to 1995, PCs cultivated 2% of the total cultivated area and produced only 1.6% of the total crop production in the country, which was the lowest of the three production systems (Table 2.1).

The state farms are the third production systems set up by the socialist regime to manage nationalized commercial farms (70,000 hectares) in 1975. Since then the government has

expanded the size and number of state farms by clearing forests and grabbing farmers' grazing lands. In 1979, the socialist government established two ministries [the Ministry of State Farm Development (MSFD) and the Ministry of Coffee and Tea Development (MCTD)] to manage state-owned farms. State farms ranged in size from 500 ha to 15,200 ha. However, in 1980 the total area cultivated by state farms ranged from 214,000 to 240,000 ha. As shown in Table 2.1 state farms cultivated only about 2% of the total land under crops and accounted for 3% of total production. State farms practiced mono cropping, were major users of improved production technologies (improved seed, fertilizers, pesticides and mechanization). The state farms have been producing for both the domestic and export markets.

Table 2.1 Crop production in Ethiopia: area and production by crop category and mode of production (1980-1995).

Crop category	Area ('000 ha)			
	Smallholders	**State farms**	**Cooperatives**	**All farms**
Cereals	9449.35	198.04	190.82	9838.21 (82)
Pulses	1632.92	6.3	29.93	1669.15 (14)
Oil seeds	458.81	17.32	14.17	490.30 (4)
Total	**11541.08 (96.2)**	**221.66 (1.8)**	**234.92 (2)**	**11997.66 (100)**
	Production ('000t)			
Cereals	10163.03	360.52	169.655	10693.21 (87)
Pulses	1356.665	3.49	17.045	1377.20 (11)
Oil seeds	221.166	7.006	3.989	232.161 (2)
Total	**11740.185 (95.4)**	**371.016 (3)**	**190.689(1.6)**	**6173.776 (100)**

Source: Estimated from CSA data (1980-1995); Figures in parentheses are percentages

2.4 Crop production in Ethiopia

The major crops in Ethiopia include cereals, pulses and oil seeds. Cereals accounted for more than 80% of the total cropland and total production between 1980 and 1996 (Table 2.2). *Tef (Eragrostis tef)* and wheat occupied 44% of the total area under major crops and contributed about 37% of the total crop production in the country from 1980 to 1996. Pulses and oil seeds accounted for the remainder.

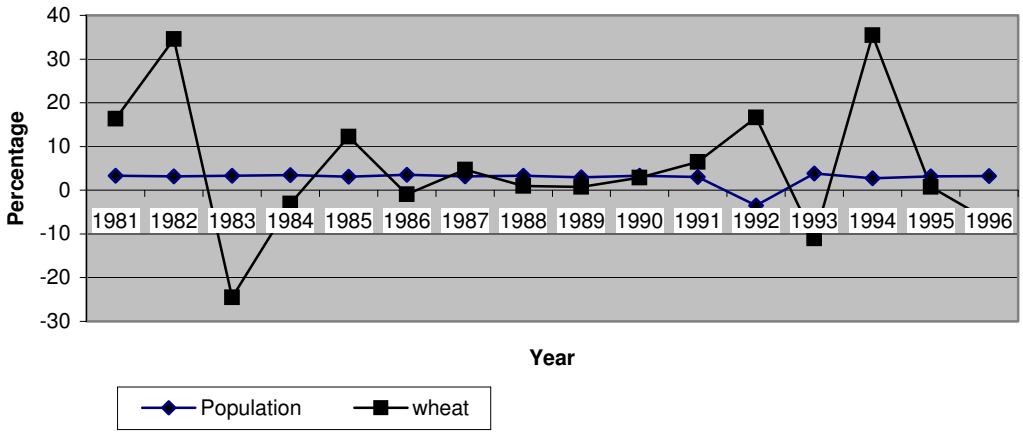
Table 2.2 Total area harvested and production of major crops in Ethiopia, 1980-1996.

Major crops	Area, 000 ha	Percentage share	Production, 000 ton	Percentage Share
Cereals	5399.481	83.19	6588.3274	88.49
Tef	1467.497	31.22	1292.5586	23.08
Wheat	615.280	13.12	750.4897	13.46
Barley	717.156	15.42	840.7215	15.46
Maize	878.229	18.68	1475.9414	25.95
Sorghum	793.265	15.40	1048.8008	18.28
Pulses	934.489	14.48	736.1408	10.75
Oil seeds	147.330	2.32	54.6700	0.76
Total	**6481.30**	**100**	**7379.1382**	**100**

Source: FAO and CSA

Ethiopia is the largest wheat producing country in Sub-Saharan Africa (Hailu et al., 1991). It used to produce a surplus and export wheat in the 1960s and 1970s (EARO, 2000). However, currently Ethiopia produces 65% of its wheat requirements since production could not cope up with population growth. For instance, wheat yield increased by only 18% while population increased by 56% from 1980-1996. Figure 2.5 presents population growth and wheat production growth rates for the same period (1980-1996). As it is clearly indicated, wheat production growth was slower than population growth in some years (1986, 1988-1989, 1995) and even negative during the drought of 1983-1984, 1993 and 1996.

Figure 2.5. Wheat production and population growth (percent of the previous year) in Ethiopia, 1980-1996



Source: Adapted from Debebe, 1997

The use of improved inputs such as improved seed, fertilizers and pesticides is generally low in Ethiopia. For instance, about 39%, 3.6% and 5.0% of the land cultivated in 2000/01 was applied fertilizers, improve seed and pesticide, respectively (CSA, 2001/02). Moreover, only about 1.3% of the area under t*ef* and only 5.4% of the wheat area was under improved varieties from 1991-2000 (Table 2.3). In terms of area fertilized and pesticide applied, wheat had a better share than t*ef* for the same period (Table 2.3).

Table 2.3 Area under improved seed, pesticide and fertilizer (000 ha), Ethiopia, 1991- 2000.

Crop type	Total area,	Improved seed		Pesticide		Fertilizer	
		Area planted	Percent	Area applied	Percent	Area	Percent
Tef	9488.04	122.67	1.29	8129.77	11.72	4857.56	51.19
Wheat	4104.03	221.11	5.39	987.97	27.4	2487.95	60.62

Source: CSA, 2001/02

Smallholders applied relatively higher rates of fertilizer on wheat (about 74 kg/ha) than on t*ef* from 1991-2000 (Table 2.4). However, these figures significantly change when the government had improved inputs use promotion programs. For instance, Table 2.5 presents area planted to improved seeds in Ethiopia in 1996 crop season where there was a strong input promotion program (Abdisa et al., 2001).

Table 2.4 Quantity of fertilizer applied on crops by smallholders in Ethiopia, 1991 -2000.

Crop type	Total area, 000 ha	Area fertilized, 000 ha	Rate, kg/ha
Cereals	6888.56	2501.98	35.3
Tef	2167.77	1175.65	53.7
Wheat	772.23	443.69	73.6

Source: CSA

Table 2.5 Area planted to improved and local varieties of major food crops in Ethiopia, 1996/1997.

Crops	Harvested area ('000 ha)	Area under improved varieties ('000 ha)	Quantity of improved seed used ('000 t)	Area planted to	
				local varieties (%)	improved varieties (%)
Tef	2396.9	92.7	2.78	96.1	3.9
Bread wheat	855.1	770.0	115.50	10.0	90.0
Durum wheat	571.1	22.8	2.28	96.0	4.0
Barley	1370.1	23.0	2.53	83.2	16.8
Maize	1951.1	1170.7	35.12	40	60
Sorghum	1750.1	420.0	4.20	76	24
Oats	71.3	71.3	71.3	0.0	100.0
Finger millet	442.0	0.0	0.0	100.0	0.0
Total cereals	**9407.7**	**2570.5**	**169.54**	**72.7**	**27.3**
Faba beans	510.4	5.1	1.02	99.0	1.0
Field peas	245.0	1.2	0.18	99.5	0.5
Chickpeas	229.2	0.5	0.04	97.6	2.4
Haricot beans	174.8	131.4	19.66	25.0	75.0
Other	247.2	0.0	0.0	100.0	0.0
Total pulses	**1406.6**	**138.2**	**20.90**	**90.2**	**9.8**
Niger seed	250.5	0.2	.002	99.0	1.0
Linseed	148.2	0.16	.004	98.0	2.0
Rape seed	21.4	0.83	.001	85.0	15.0
Ground nuts	17.4	0.63	0.005	80.0	20.0
Others	41.0	0.0	0.005	1000.0	0.0
Total oil seeds	**478.5**	**1.82**	**0.012**	**99.6**	**0.4**
Total	**11292.8**	**2710.5**	**190.45**	**76.0**	**24.0**

Source: Abdisa et al., 2001

Crop production depends on rainfall. However, the state farms either use supplementary irrigation or totally depend on irrigation for about 25% of the land under crop production. Due to unreliable amount and distribution of rainfall during the crop season and low use of improved inputs, crop yields are generally low, e.g. less than 1.2 t/ha on average (Hailu et al., 1992). Wheat and t*ef* rank the third and fifth, respectively, in terms of yield among the cereals (Table 2.6). There is a large difference between on-farms' and research centers' yields that indicates research results have not yet been achieved by producers. This is why yields of cereals, pulses and oil seeds did not exhibit remarkable growth on-farm from 1980 to 1996. However, wheat gave better yield than *tef* both on-farm and on research center farms (Table 2.6) due to better availability and utilization of more improved varieties (Table 2.5).

Table 2.6 Yield of major crops in Ethiopia, 1980-1996.

Major crops	Yield, t/ha	Minimum, t/ha	Maximum, t/ha	Research centers' yield, t/ha
Cereals	1.223	0.8806	1.4485	
Tef	0.8848	0.7042	1.4291	2.4
Wheat	1.2212	0.9578	1.5929	5.3
Barley	1.1877	0.9642	1.5151	5.5
Maize	1.6667	1.1254	1.9897	9.0
Sorghum	1.3228	0.6704	1.5802	5.0
Pulses	0.816	0.0892	1.0975	2.0
Oil seeds	0.379	0.3147	0.5190	1.3

Source: FAO and CSA

Earlier it is indicated that yields are generally low in Ethiopia due to low adoption of improved technologies. However, smallholders are relatively more productive than the other two production systems particularly in the production of pulses and oil seeds (Table 2.7). Smallholders have long experience in growing crops particularly pulses and oil seeds. In terms of cereals, small holders were more productive than producers' cooperatives and less productive than state farms due to high utilization of inputs by state farms during the period. For instance, of the total fertilizer, improved seed and agricultural credits about 50%, 79% and 85%, respectively, were directly allocated to state farms and PCs while smallholders received the remaining balance (Legesse, 1998).

Table 2.7 Yields of cereals, pulses, and oil crops by mode of production in Ethiopia, 1979/80- 1994/95.

Category	Smallholders	Producers Cooperatives	State farms
Cereals	11.50	8.60	18.05
Pulses	9.10	5.66	5.76
Oil seeds	4.84	2.97	4.54
Weighted average	10.89	7.89	16.54

Source: Estimated from CSA Statistical Bulletin (1981-1996).

2.5 Smallholders' mixed farming system

As indicated earlier smallholders dominate the agricultural production system and the total number of smallholder farmers is estimated at about seven million (MEDAC, 1999). The smallholder production system is characterized by small and fragmented land holdings, and a mixed crop-livestock production. For instance, about 62% of the smallholder households had land holdings of less than one hectare in 1996 (Table 2.8).

Table 2.8 Distribution of number of households (HH), total cropland and land area per household by size of holding in Ethiopia, 1996.

Size of holding, ha	Number of (HH), 000	Percentage of HH	Total crop land, 000 ha	Percentage of cropland	Average cropland area per HH
less than 0.1	514.01	5.92	30.10	0.34	0.06
0.1 – 0.50	2637.80	30.38	787.82	8.93	0.30
0.51 – 1.0	2260.99	26.04	1664.47	18.86	0.74
1.01 – 2.0	2159.15	24.87	3073.89	34.83	1.42
2.01- 5.0	1059.22	12.20	2950.66	33.44	2.79
5.01 – 10.0	48.75	0.56	288.82	3.27	5.92
Total	**8682.13**	**100**	**8825.06**	**100**	**1.02**

CSA: (1998)

In smallholders' production system livestock is mainly kept to supply draft power. Livestock is fed on crop residues as their main feed. Types of livestock kept on the farm include cattle, sheep, goats, horses, donkeys, mules and poultry. Cattle are kept on farms mainly for food (milk and meat), manure, and immediate cash need in addition to draft (plowing, planting and threshing). Small ruminants are frequently sold for immediate cash needs and cattle during crop failure and other unforeseen problems. Animal products are also sold to generate cash income whenever there is excess over households' self use. Pack animals (donkeys, mules and horses) are major means used to transport inputs, produce and humans in rural areas.

Farming systems' studies carried out by Hailu and Chilot (1992), Legesse et al. (1992) and Tilahun et al. (1992) revealed that smallholders give priority to staple food crop production in allocation of resources. For smallholders, food crops generally serve a dual purpose as food and cash crops. Some food crops are mainly grown for the market. Examples include t*ef* which is grown for cash in other major crop farming system (e.g., maize), and particularly white t*ef* is grown for cash while red and mixtures are grown for food in major t*ef* producing areas. The degree of the dominance of subsistence and market objective varies with location. It is clear from the above explanations that the market objectives play a key role in resource allocation in areas which are closer to big urban markets. Thus, both subsistence and market objectives of farmers have implications for technology adoption. Subsistence objectives may discourage adoption of risky technologies.

With regard to farm tools for crop production, smallholders use traditional tools and implements to perform different farm operations. For instance, land preparation is done by oxen-drawn wooden plow with a single metal chisel at the tip, *maresha*. Land preparation commences at the onset of rains, which vary from January to April. Farmers have to wait for the rains to soften the soil. Otherwise the soil is too hard to be broken by the local plough. The number of plowing depends on the type of crop grown, soil type, and number and condition of oxen during the dry season.

Most crops are planted from June to July and all crop seeds and fertilizers are broadcasted on the soil manually and covered by oxen-drawn plow. However, t*ef* is left uncovered since the seed is very small. Chickpea and rough pea are planted with the residual moisture at the end of the rainy season. The use of modern agricultural technologies on smallholders' production system is minimal with the exception of fertilizer, and to some extent herbicide in *Shewa* and *Arsi* zones. Generally, farmers use less than the recommended rate of fertilizers for all cereals. For instance, smallholders apply 26% less than the recommended rate of 100 kg/ha of DAP for wheat regardless of the location and soil type. A smaller number of farmers use improved varieties of crops in very limited areas. These technologies are either not available in sufficient amounts or on time. Most farmers feel that seeds of improved varieties are expensive, and hence hesitate to purchase the limited amount made available to them at their locality. Some farmers also have doubts

about the performance and colour of some of the improved varieties. For instance, improved wheat varieties such as *Bulk* and *Enkoy* have brown grain colour, which is not preferred by consumers for bread making and fetches lower prices.

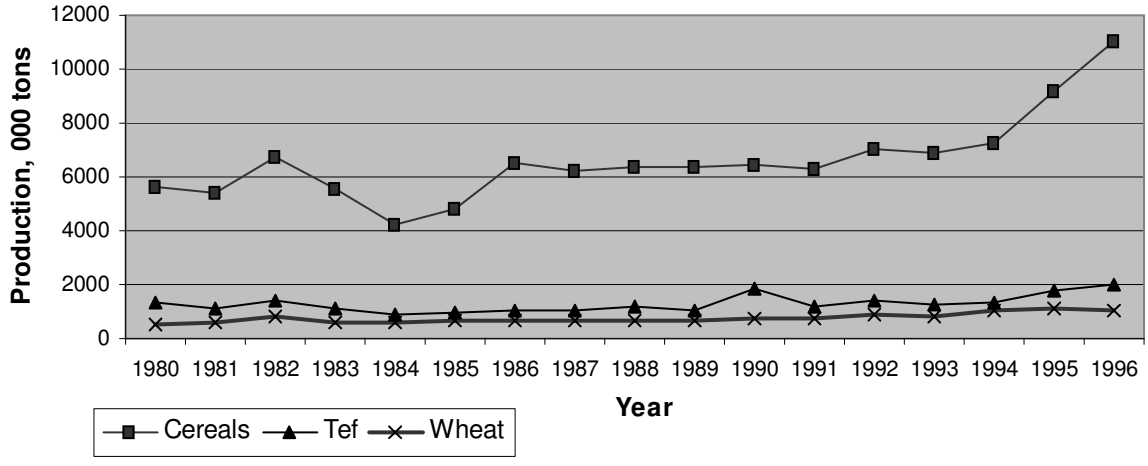
Hand weeding and use of post emergence herbicides (2,4-D) are common weed control practices in crop production. However, herbicides are sprayed only on cereals mainly on t*ef* and wheat. Pulses are rarely weeded due to overlapping of activities. Crop harvesting is from November to end of December depending on planting date and crop type. Harvesting is also done manually with a sickle and harvested sheaves are pilled near homestead until threshing. Threshing is done mainly using oxen to trample on the crops on small threshing ground, a hard surface plastered with cow dung and sun-dried. Of all the crops t*ef* is the most labour-intensive, especially for its highly demanding plowing, planting, weeding, harvesting and threshing operations.

Land is generally fallowed during the dry season and grazed. Most crop residues are fed to animals or used as building materials or fuel and hence very little is returned to the soil. Forage conservation is generally not practiced and the availability of natural grazing areas varies with altitude, rainfall and soil types. Overgrazing in some densely populated and intensively cultivated areas has contributed to soil erosion.

2.6 Trends in crop production

As indicated above, crop production generally remained almost the same for most of the years mainly due to low adoption of improved technologies. For instance, cereals, pulses and oil seeds production remained stagnant from 1986 to 1994 and increased after 1994 mainly due to increased cultivated land. Figure 2.6 depicts this trend for cereals, *tef* and wheat for the same period. The lowest production in 1984 was due to drought in that year.

Figure 2.6. Trends of cereals, *tef* and wheat production (ooo tons) in Ethiopia, 1980 - 1996



Source: CSA and FAO

2.7 Agricultural policies and their impact on agriculture

Ethiopian agriculture has lived through major political changes during the past three decades. The monarchy and feudalism era, which ended by the 1974 revolution, was replaced by a centrally planned economy (socialist regime). Consequently, rural and urban land, and large industries transferred from private, community, and church ownership to public ownership. In 1991, the present government adopted a new economic policy that promised a move away from centralized planning towards a market-oriented system in which private ownership will prevail in most sectors. Since then an adjustment and privatization programme has been underway. Moreover, Agricultural Development-Led Industrialization (ADLI) strategy was adopted to enhance food self-sufficiency and increase foreign exchange earnings, and supply of raw materials to industries (EARO, 2000). The emphasis of ADLI is on accelerating growth through increased use of improved agricultural technologies such as improved seeds and fertilizers throughout the country. The agricultural sector affected most by each of the mentioned governments' policies and the effects of these policies particularly in the adoption of improved agricultural technologies are presented in the following sections.

2.7.1 Agricultural policies during the imperial period (1950 -1973)

During the imperial period, economic policies were implemented under three consecutive five-year development plans. The First Five Year Plan (1957-1962) concentrated on infrastructure development (roads and communications) to lay the base for industrialization, while the Second Five Year Plan (1963-1968) focused on the development of manufacturing, power and improved infrastructures. With regard to agriculture, the First Five Year Plan aimed at accelerating agricultural development by promoting large-scale commercial farms where as the Second Five Year Plan (SFYP) focussed changing the predominant agricultural economy to an agro-based industry (Sisay, 1994). The SFYP in particular emphasized on diversification through commercial farming and the introduction of modern processing methods. During this period, development policies neglected the agricultural sector. For instance, during the SFYP agriculture received only 6% of the total investment expenditure and only 1% of the total investment expenditure was earmarked for the peasant sector (Cohen and Weintraub, 1975).

During the imperial period, the church[2], royal families, landlords, governors, and powerful civil and military officials owned most of the productive land. Peasants were victims of insecure tenure, exploitation and corrupt administrative and unjust judicial system. Before 1975, about 50% of farmers were share tenants and had to pay about 50% of their total production as land rent to landlords (Cohen and Weintraub, 1975). Moreover, the tenants had to provide free labour for the landlord or his local agent. There was no legal protection for tenants and they often had to bribe the landlords' agents in order to stay on the land.

To accelerate agricultural production during the First and Second Five Year Plans (1957 to 1967), the country trained about 120 extension workers (Robinson and Yamazaki, 1986), and these extension agents provided extension services only to commercial farms.

[2] The Ethiopian Orthodox church was an extensive landholder. But the size of land held by the church is not known. A study by Cohen and Weintraub (1975) estimated that up to 20% of the agricultural land of the country belonged to the church. Another study by Dessalegn (1984) estimated a figure of 10% to 12% for the period before 1975.

During the Third Five Year Plan (1968-1973), an agricultural policy aimed at improving and expanding large commercial farms and supporting agriculture of smallholders was adopted. However, policy makers still considered large commercial farms as the key to agricultural development and this bias had negative implications for technology development and adoption on smallholder farms.

2.7.2 Agricultural policies during the socialist period (1974-1990)

The 1974 Ethiopian revolution overthrew the imperial regime and replaced the military government (*Derg*) that follow socialist ideology to bring changes in the rural economy and the lives of farmers. Following the revolution the economy was restructured to create a more efficient, modern agriculture and increase production. Thus, compared with the previous regime, attention was given to agricultural development; and government expenditures on agriculture increased, and a number of policies were formulated to bring changes in the agricultural sector. However, most of these ideologically and politically driven policies were not able to bring the expected changes. Most of the policies formulated on land redistribution; development of producers' cooperatives (PCs) and state farms; villagization and resettlement; price control; and interregional trade regulations were inappropriate and resulted in distorted resource allocations. Under Ethiopian conditions, there were several policies that acted against the interests of smallholders. The impacts of these policies on smallholders are given below.

2.7.2.1 The land reform policy

During the socialist regime, there was a land reform policy in 1975 that abolished all previous land tenure systems[3], the landlord-tenant relationship and ownership of private land. The policy granted user-rights of land up to 10 ha to any individual who wanted to cultivate land (Dessalegn, 1984). This policy increased freedom of individual farmers particularly tenants and farm labourers. The land reform policy was implemented through

[3] The land tenure system during the imperial period included kinship (communal) tenures, village tenures, private tenures, church tenures, and state tenures (Cohen and Weintraub, 1975; Dessalegn, 1984).

Peasant Associations (PAs)[4] that were responsible for redistributing land according to the new principles[5] of land reform.

To what extent the land reform policy has increased agricultural production is not well known. However, from the overall agricultural performance and food shortages crisis in Ethiopia, it might be inferred that its effect was marginal. At least three factors were responsible for the failure of the land reform policy to increase agricultural production. First, in spite of being the most important economic force in the country, smallholder farmers were not given the necessary incentives to expand production. For instance, some 50%, 79% and 85%, of total fertilizer, improved seeds and agricultural credit, respectively, were directly allocated to state farms and PCs while smallholders, which produced more than 90% of total crop output received the remaining balance (Legesse, 1998). Such policies discouraged the incentives of smallholders to increase production and might have undermined the effect of land reform policy. Second, with increased population pressure, land redistribution created a new type of insecure land tenure in rural areas. In PAs where PCs were organized, relatively fertile fields were given to PCs members. This might have affected farmers' interest in investing in maintenance of land and the use of improved agricultural technologies. Third, even though tenants and farmers who have insufficient land showed greater interest in innovations to improve their production after the land reform, improved technologies were not available to them in sufficient quantity (packaging) and at reasonable prices. A study by Dessalegn (1984) indicated that the prices of fertilizers considerably increased as compared to output prices in the early 1980s. Thus, the unavailability of inputs and increments in prices might have affected the productivity of land and compromised the effect of land reform policy.

[4] PAs were organized on an average of 800 ha each. In addition to their responsibilities in land distribution, they served and still serve as grass root level organizations through which government involves the rural population in political, social and economic affairs. PAs greatly facilitate technology transfer and on-farm research activities.

[5] Land was to be allocated according to family size for individuals living in the PAs.

2.7.2.2 Producers' cooperatives expansion policies

The Ten Year Perspective Plan issued in 1984/85 indicates that the government's plan was to put 50% of total cultivated land under PCs by the end of the plan period (1994). However, the transformation of smallholder farms to PCs was much slower than envisaged in the plan. The PCs received preferential treatment in terms of access to formal credit and to modern agricultural technologies once registered under the Ministry of Agriculture (MOA). PCs used to pay 10% less for 100 kg of fertilizers and tax per hectare as compared to fertilizer prices and taxes paid by smallholders. PCs also had access to free labour as individual farmers were obliged to work up to two days per week on PCs' farms during peak agricultural periods (Kassahun et al., 1992). Moreover, PCs received preferential treatment in extension services as a development agent (DA) was assigned to PCs to render better extension services. Thus, the rate of technology adoption on the farms of PCs was relatively higher than on individual smallholdings. For instance, a study by Legesse and Asfaw (1988) in Bako area of western Ethiopia indicated that all PCs farms used fertilizer and improved maize varieties while only 34% and 50% of smallholders used improved maize variety and fertilizer, respectively, during the same period.

The most negative impact of producers' cooperative promotion policy production of the smallholder sector was when a PC was formed in a peasant association or when the number of PC members had increased, the PC members had priority in allocation of the best land as well as access to irrigation. This implies that fertile land was transferred from private smallholders to PC members and the individual farmers were allocated poor quality land. Hence, the formation of PCs had intensified the land insecurity problem for private smallholders. This might have restricted conservation and other forms of land improvement measures in the area (Legesse, 1998).

2.7.2.3 Marketing and pricing policies

Marketing and pricing policies adopted during the socialist period had a great effect on overall agricultural development and the adoption of new agricultural technologies by smallholders. The socialist government established the Agricultural Marketing Corporation

(AMC) to purchase and distribute agricultural products in 1976. The AMC was responsible to enforce uniform producer and consumer prices through out the country, provide production incentives by reducing marketing margins, and ensure adequate food supplies at reasonable prices. Grain quotas were set for individual farmers, different administrative regions and *weredas* (districts) to deliver to AMC. Interregional trade regulations were introduced and prices of grains were pan-territorially fixed by government and kept constant over time (Stroud and Mulugetta, 1992). Moreover, the activities of licensed grain traders were partially or totally taken over by AMC in most surplus-producing areas. However, the policy allowed grain traders to participate in grain marketing provided they sell 50% of their purchase to AMC at a price margin of 15% to 20% over the prices paid to farmers. At that time, the market prices were substantially higher than the fixed prices and the 15% to 20% margin was not adequate to attract traders in the light of opportunities foregone in the parallel markets. Thus, many traders inclined not to participate in legal (licensed and paying tax) marketing (Legesse, 1998).

The implications of marketing and pricing policies on the production and income of small farmers and thereby on their technology adoption decisions were negative. It is assumed that an increase in the agricultural product price increases farmer's income and raises the incentive for technology adoption, which in turn leads to higher production per unit area of land or labour. Information on the effect of different grain prices on new technology adoption is limited and the findings of these studies converge to the same conclusion. A study by Cohen and Isaksson (1988) showed that the marketing policy had a negative impact on smallholders' production and income. Another study by Franzel et al. (1992) examined the impact of fixed AMC prices and average annual market prices of output using data from on-farm fertilizer experiments. Their study showed that on average there were 63% (ranging from 21% to 140%) and 72% (ranging from 0% to 172%) responses to fertilizer use on maize and wheat, respectively. However, at AMC fixed prices, application of fertilizer was not profitable at 82% of the trial sites due to the fact that the fixed AMC price was so low that the marginal value of production even did not cover the marginal cost of fertilizer application. The study further noted that at annual average market prices of maize and wheat, application of fertilizer became profitable at 78% of the sites (Table 2.9).

Table 2.9 Impact of AMC and market prices of output on profitability of fertilizer in Ethiopia, 1984-1987.

Crop	No. of trial sites	Sites at which fertilizer is not profitable to farmers	
		At AMC fixed Price	At local market price
Maize	35	34(97%)	10(28%)
Wheat	28	16(57%)	6(21%)
Tef	9	9(100%)	0(0%)
Total	72	59(82%)	16(22%)

Source: Adapted from Franzel et al. (1992

The study concluded that the fixed low prices reduced farmers' incomes and incentives to use new technologies (Franzel et al, 1992). Another study by the World Bank (1987), assuming fixed AMC prices and based on rough estimates of fertilizer responses, indicated that the benefit-cost ratio for fertilizer use was too low to provide adequate incentives for farmers, except for maize and wheat in some areas.

In the mid 1980s, a strategy was developed to make the country self-sufficient in food production. The strategy was to concentrate resources and technology on grain-surplus-producing *weredas* (districts) and more than 100 surplus producing *weredas* were selected to implement the strategy. Technologies such as improved varieties and fertilizer were made available on credit and extension activities were strengthened in those surpluses producing *weredas*. The results of these concerted efforts were encouraging since production and yield increased in the selected *weredas*. Besides, at the aggregate level, total production was also increased in the years 1986 and 1987. However, the marketing policy in place during that time compromised the gain from these efforts. Grain trade restrictions resulted in lower prices in surplus-producing *weredas* as surpluses could not moved out to deficit *weredas*. From this analysis, it is obvious that the policy had a negative effect on the use of improved technologies in grain-surplus-producing *weredas* of the country as a decline in output price result in reduction of benefits from the technology.

2.7.2.4 Villagization and resettlement policies

During the socialist regime, villagization and resettlement programmes were undertaken in the 1980s. These programmes moved peasants from their old settlements to new sites and regions. The villagization programme moved people who typically lived scattered throughout into a village. The objectives of the villagization program were to conserve natural resources by promoting a better land-use plan, enhance extension services, give greater access to public services, and strengthen security and self-defence (Stroud and Mulugetta, 1992). By the villagization programmes, 35% to 40% of farmers were forced to move to new villages (Hansson, 1994). Potential problems with villagization were the wastage of working time in travelling to and from fields, increased attacks of crops by livestock and wildlife because of the distance of the fields from the house, overgrazing near the villages aggravated erosion and more pressure on water supplies and tree resources. Moreover, the government has lacked resources to provide the necessary services such as water. The extension workers who were used to transfer agricultural technology were assigned to implement this programme and an unhealthy relationship was created between farmers and extension workers since the programme was undertaken without consulting farmers.

On the other hand, the resettlement programme moved rural people from drought-prone areas to the western, south-western and southern part of the country, where rainfall was reliable. Initially the World Bank recommended resettlement as a solution to overcrowded areas where the resource base could no longer support the population (World Bank, 1987a). The underlying reasons for resettlement were population growth, exploitative farming practices, energy shortages, overgrazing, stagnating yields, limited off-farm employment and low economic growth (World Bank, 1987a). In 1984/85 an estimated half a million people were resettled (Sisay, 1994). As the resettlement programme was not based on detailed studies; it failed at least due to four factors. First, farmers were moved and resettled against their will and because of these forceful measures they were not interested in the resettlement scheme. Second, the implementation of the programme involved many resettles and incurred high costs, and the government failed to provide adequate supports. Third, the government had the intention of developing the resettles'

farms into PCs farms, but the resettles had no interest in collective farming. Fourth, resettles had limited participation in decisions concerning their farms. Technologies such as improved variety, fertilizer, and tractors were used on resettles' farms. However, the magnitude of participation of resettles in decision-making particularly concerning what to produce and the type and level of input to use was minimal. The authorities responsible for the implementation of the programme mainly made such decisions. Hence, the application of modern agricultural technologies was not considered as adoption decisions made by resettle farmers.

2.7.3 The post economic reform policies (1990-1995)

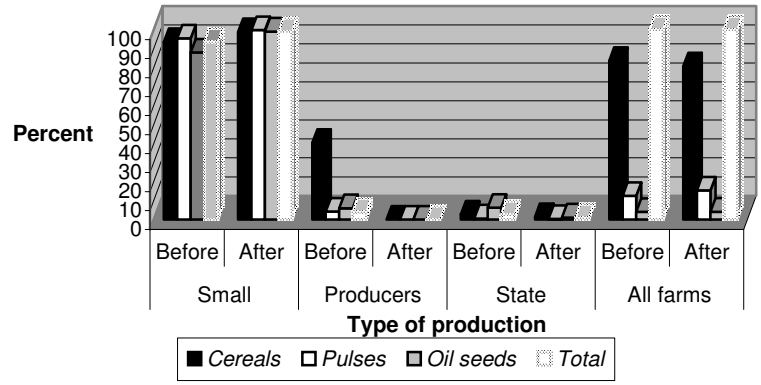
Towards the end of the socialist regime several reform measures have been undertaken since 1990, particularly the abolition of the compulsory grain quota and fixed price, and the lifting up of inter-regional trade regulations were of great importance for smallholders. Recurrent land redistribution was stopped and indefinite user right and the rights to transfer to legal heirs were given to farmers (Hansson, 1994). To make producer cooperatives and state farms viable economic units restructuring guidelines were developed. Above all, discrimination against smallholder farmers was terminated. The present government, which took power in 1991 enforced new economic reform (free market) in 1991.

Well-focused studies are not available to examine the impact of the post economic reform policies at macro as well as at micro level. To highlight the possible impact, some preliminary studies and secondary data from Central Statistics Authority (CSA) were used to compare the situations in area cultivated, production, and availability of inputs before and after the reform. A study by Hansson (1994) showed that peasant farmers increased the cultivated area by 12% to 20%[6] and agricultural production by 6% one year after the 1990 reform. As shown in Figures 2.7 and 2.8, on average, the area cultivated by smallholders increased from 93% in the pre-reform period to 99% of the total cultivated land after the reform. The area increment was mainly due to the shift from cooperative farms to private smallholder farms. Similarly, crop production increased from 93% to 98%, on average,

[6] The figures reported by Hansson (1994) do not look realistic in line with the national data reported by CSA. Using CSA data average growth rate of cultivated land over the period 1991 to 1994 was 9%.

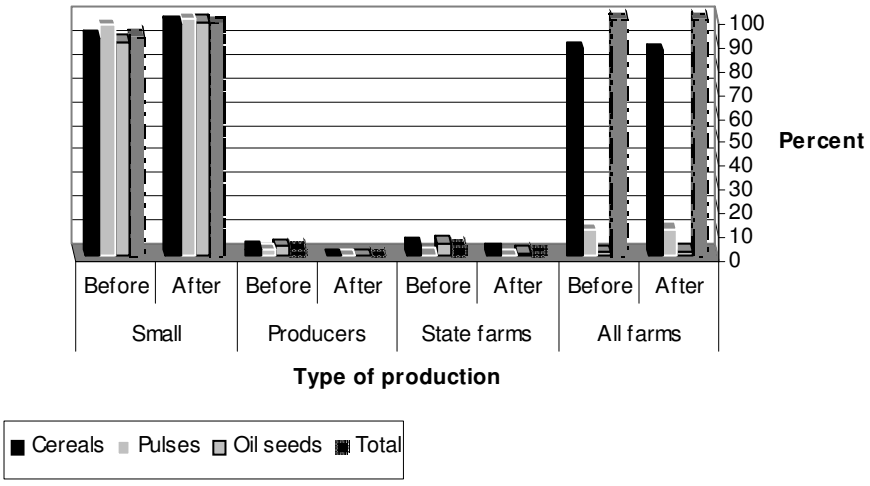
after the reform. On the other hand, the area cultivated and the amount of outputs produced by state farms dropped to 1% and 2%, respectively, in 1995. Moreover, the productivity of these farms was even worse than on smallholder farms. For instance, cereals yield of PC was 25% less than the yield obtained by smallholders. Nevertheless, a study by Eshetu (1994) showed that the performance of agriculture was greatly influenced by the weather. The study concluded that the country had two consecutive years of good rain and this may account for the considerable improvement in the performance of the agricultural sector after the reform.

Figure 2.7. Area of cereals, pulses and oil seed before and after the 1990 reform by type of production (percent of total) in Ethiopia.



Source: CSA

Figure 2.8. Crop production in Ethiopia before and after the 1990 reform by type of production (percent of total) in Ethiopia.



Source: CSA

Of the improved technologies, the availability of fertilizer and improved seed increased considerably after the reform. At the national level, the availability of fertilizer almost doubled over the period 1989 to 1995. For instance, fertilizer increased from 109,301 tons in 1989 to 210,420 tons in 1995 with an average annual growth rate of 11% (Table 2.10).

Table 2.10 Availability of fertilizer and improved seeds to smallholder farmers before and after the 1990 economic reform in Ethiopia.

Selected year	Fertilizer ('000 ton)	Improved Seed ('000 ton)	Proportion of improved seed by sub-sector	
			State farm	Smallholder
1975	13979	NA	NA	NA
1980	43287	1922	NA	NA
1984	46884	3193	80	20
1989	109301	9273	51	49
1993	135146	15586	22	78
1994	202325	17191	20	80
1995	210420	12456	23	77

Source: AISE and ESE; NA = Data not available.

Compared to the pre-reform period, the amount of improved seeds made available to farmers increased from 9,273 tons in 1989 to 12,456 tons in 1995 with an average annual growth rate of 5% due to favourable policy towards smallholders after the reform. Besides, the quantity of improved seed supplied to peasant farmers increased from around 15% in 1982 to more than 70% in 1995. Much of the seed distributed during the post-reform period, particularly after 1991, was done through safety net and rehabilitation programmes and projects. Thus, improved seed was distributed to farmers either free of charge or on loan through a revolving fund scheme with a recovery period of 3 to 5 years (Legesse, 1998).

Another change that took place after the economic reform was decentralization of extension activities and devolution of power. Approximately 3,000 to 5,000 assistant development agents (ADAs), who can speak the local language were trained and deployed over three years. This was a big achievement when compared to the number of DAs

deployed in the pre-reform period. However, the quality of ADAs was weak due to the greater emphasis attached to political outlook[7] of an individual rather than his potential technical capability in recruiting individuals for the job (Legesse, 1998).

2.8 Agricultural research and extension in Ethiopia

This section gives an overview of the status of agricultural research and extension systems in Ethiopia. It describes the process in developing and disseminating agricultural technologies; constraints encountered in developing suitable technologies for smallholder farmers and identify weak links, which exist between research and extension systems that limit the adoption of improved agricultural technologies.

2.8.1 Agricultural research in Ethiopia

To develop improved crop varieties with their cultural practices agricultural research was initiated by the Institute of Agricultural Research (IAR) currently Ethiopian Institute of Agricultural Research (EIAR). The Alemaya University of Agriculture (AUA), Addis Abeba University, Awasa College, units of the Ministry of Agriculture (MOA) and Ministry of State Farms, Coffee and Tea Development, and Regional State Agricultural Research Bureaus also undertake different types of agricultural research. IAR was a semi-autonomous public institution established in 1966 to coordinate and perform agricultural research in the country. In 1997, Ethiopian Agricultural Research Organization (EARO) was formed and it included more institutions involved in agricultural research other than ex-IAR. The mandate of EARO is to generate new technologies; to improve indigenous knowledge; to adapt foreign technologies; and to develop new scientific knowledge and information in order to increase the production and productivity of agricultural resources and ultimately improve the living standards of the farm population of the country (EARO, 2003). Since the establishment of the IAR a number of crops varieties including t*ef* and wheat, were developed and released with their respective agronomic recommendations.

[7]The assistant development agents were recruited by *wereda* administrators (elected politicians) with very little and passive participation of the responsible agricultural office and were trained for 6-9 months.

EIAR (renamed from EARO), AUA, Addis Abeba University and regional state agricultural research centers develop and release varieties. Although Pioneer Hi-Bred International has been involved in some varietal development (maize), all plant breeding has been virtually performed by the public institutions. The research programs emphasized increased *tef* or wheat production by concentrating on improved varieties with a package of cultural practices. This included the use of national and international nurseries to identify desirable genotypes, the execution of an extensive national and regional variety testing programs, the development of varieties through breeding, the coordination and execution of agronomic and crop management studies, and the multiplication and distribution of breeder and basic seed (Hailu, 1991). Special breeding, selection and crop, soil and water management programs have been designed for selected production problem areas. The areas of research included the development of varieties and crop management practices for drought and frost-prone areas, water logging vertisols and low soil fertility, specific disease or pest problems (Hailu, 1991). The target groups of the research results are producers (small-scale, private, subsistence, and resource poor farmers, medium to large-scale commercial private farmers, and the large-scale state farms) and users such as grain traders, the milling and food industry, and consumers. Before a variety is recommended for release, it must be evaluated in farmers' fields for its productivity, stability, disease resistance, and food quality. Varieties are officially released by National Variety release Committee (currently National Seed Industry Agency) after on–farm evaluation and verification. However, this procedure was sometimes violated. For instance, in 1991 Pioneer tried to produce 144 ha of hybrid maize seed and 60 ha of sunflower using improved seed that had not been evaluated and officially released in Ethiopia. As a result, the company harvested only 71.1 tons of maize seed and the sunflower even did not set seed (Hailu, 1992).

The *tef* and wheat research programs are handled by a multidisciplinary team of experts from different research and development institutions. The development of a minimum critical mass of work force, infrastructure and research facilities at major research centers has been the major efforts of the programs. Unfortunately, this is not achieved especially in the case of trained staff due to a serious brain drain and staff departure for a better pay.

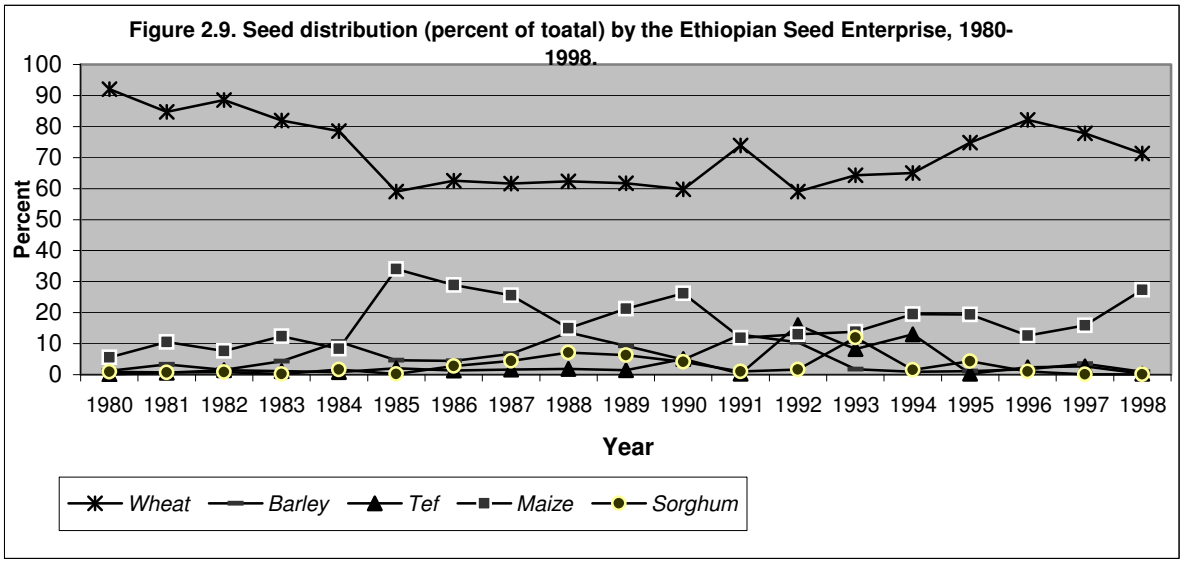
The relationship between research and extension was not formal at the beginning. The first linkage between research and extension started in 1974 in the form of IAR/EPID joint research program and discontinued in 1977. It resumed in 1980 as IAR/ADD joint research and extension program and continued until 1987. In 1985, Research and Extension Liaison Committee (RELC) were formed at the national and zonal levels to create a strong and effective linkage between research and extension (Adugna et al., 1991) and still functional.

The Ethiopian Seed Enterprise (ESE), which was established in 1979 to produce, process and market seed after release. Initially, ESE only supplied seed to state farms and producers cooperatives during the socialist regime. Now it has been given autonomous status to function as a profit making enterprise. It was the only seed enterprise in Ethiopia until December 1990, when it entered partnership with Pioneer Hi-Bred International[8] (Hailu, 1992).

ESE usually receives breeder and basic seeds from EIAR and AUA and multiplies them on its farms. It also produces seed under contractual arrangements with state farms and private producers. The enterprise maintains five processing plants, from which it distributes seed. From 1980-1998, ESE produced and distributed an average of 19,948 tons of seed per year (Hailu, 1992; Abdisa et al., 2001). Of the total seed produced, wheat has the largest share of 70.2%, maize 19%, barley 5.2%, and *tef* and sorghum each 2.8%. Figure 2.9 presents seed distribution over the years. Total seed distribution, particularly wheat was more before than after the 1990 reform. From 1980-1990, ESE distributed an average of 24,289 tons of seed while 13,980 tons was distributed from 1991-1998 which is 42% less than previously distributed seed. The reduction in seed distribution occurred when producers' cooperatives dissolved and state farms number reduced after the fall of socialist regime. Figure 2.9 also depicts that wheat seed distribution decreased from 79% to 55% after the 1984 drought while maize seed distribution increased from 8% to 34% of total seed distributed. Since 1993, ESE has increased its seed supply because of the present government's effort to promote improved seed through its extension management training plots (EMTPs). During 1995-1998, ESE distributed 55% of its seed to EMTPs, about 15%

8 The joint venture was terminated in December 1995 as part of the reform to liberalize the economy (Regassa et al., 1998).

to state farms, and about 30% to others including smallholders. In 1998, of the seeds distributed 71.3% was wheat, 27.4% maize, 0.9% barley and the remaining other crops including *tef*.



Source: Adapted from Abdisa et al., 2001

Other public agencies like *Arsi* Rural Development Unit (ARDU) of the Ministry of Agriculture (MOA) and the Ministry of State Farm Development (MSFD) had also undertaken a limited amount of seed production and distribution since the late 1960s. ARDU produced different kinds of seed for peasant farmers in *Arsi* where as MSFD produced seed to meet its own requirements.

ESE is also responsible for importing seed, to meet the local demand. Between 1986 and 1991, ESE imported nearly 3,000 tons of seed, mostly hybrid maize, malting barley and sunflower (Hailu, 1992). After establishing a joint venture with Pioneer Hi-Bred International in 1990, ESE imported more seed (Abdisa et al., 2001). Increasing seed imports may have a negative impact on national effort to develop adapted, high-yielding varieties and hybrids, on creating a sustainable seed supply that would foster self-sufficiency, and on conservation and sustainable use of indigenous germplasm (Hailu, 1992). Moreover, increased imports reflect inability of ESE to meet domestic seed demand (Abdisa et al., 2001).

ESE used to distribute seed to farmers through Agricultural Input Supply Corporation, AISCO, currently Agricultural Input Supply Enterprise (AISE). AISE distributes seed to farmers through service cooperatives (SCs[9]) and PAs through the bureau of agriculture at regional, zonal and district level. There has always been some discrepancy between the amount of seed ordered and purchased by AISCO. For instance, between 1985/86 and 1990/91, AISCO ordered about 24,688 tons of seed from ESE and purchased only about 21%, which left ESE with a large residual seed stock every year. Moreover, AISCO actually distributed only 60% of what it had purchased. This problem of seed production and distribution to farmers was caused by problems in demand assessment, the seed distribution mechanism, seed quality, and the seed price and credit system (Hailu, 1992). At present ESE distributes seed directly to SCs through district agricultural development offices. In this case the seed price of ESE should be lower than AISE because of less service costs of ESE. Formerly, AISCO charged 20 *Birr*[10] (Ethiopian currency) per 100 kg seed above the price it paid to ESE for its services (Hailu, 1992).

With regard to seed quality, there is no independent national seed quality control and certification scheme although ESE has its own internal quality control facilities. As a result, none of the commercial seed distributed by ESE is certified by independent organization. Some times farmers and development agents have disputed the purity and quality of seed supplied by ESE (Hailu et al., 1998). Besides, very few improved varieties recommended and released by the research systems have reached farmers mainly due to poor seed dissemination mechanism (Adugna et al., 1991).

The National Seed Industry Agency (NSIA) was established in 1993 to strengthen the seed industry in Ethiopia. The objective of NSIA is to increase the flow of improved seed to farmers. Generally, the contribution of the formal sector in supplying improved seed has been very low although it is improving now. As a result, most seed in the peasant sector is still produced by the farmers themselves (Hailu, 1992). Seed distributed by national and

9 SCs were established (one for every 3-10 PAs) to sell farm inputs, purchase locally produced cereals and pulses, give loan at fair interest rates, provide storage and saving services, supply basic consumer goods, educate members in socialist philosophy, supply tractor services, collect self-help contributions, provide flour milling services and promote cottage industries (Stroud and Mulugetta, 1992).

10 1 US$=8.5 *Birr*

regional research centers through on-farm testing, demonstrations and through the Plant Genetic Resources Center and community level land race conservation initiatives is minimal. However, these efforts have contributed to the distribution of recently released varieties through farmer-to-farmer seed exchange, although the distribution is limited to the immediate vicinity of the research centers (Legesse, 1998).

The most common form of seed exchange in Ethiopia is from farmer to farmer (informal seed sector). This system has a number of advantages to farmers over the formal seed sector. First, it uses indigenous structures for information flow and exchange of seeds, and this makes it more flexible than the formal sector. Second, it operates at the community level between households within a small number of communities, so farmers have easy access to seed and often know the farmer from whom they have obtained the seed. Availability is further enhanced by wide variety of exchange mechanisms such as cash, exchange in kind, barter, or transfers based on social obligations (free of charge) that are used to transfer seed between individuals and households. This is especially important for households that have limited resources to purchase seed. Third, a further benefit of the informal exchange system is that farmers are able to acquire seed in the quantities they want (Cromwell, 1996). Although farmers have access to credit, they rarely make use of this opportunity due to lack of information, unavailability, and the complicated bureaucratic procedures required to access credit.

Ethiopian farmers have been participating in seed selection and preservation for centuries and the bulk of the national seeds requirement is still met through this informal system. Of the total annual seed requirement (about 0.42 million tons), only 15% is produced by the formal sector as improved seed stock, whereas 85% is produced by the informal farmer-to-farmer exchange system as local varieties (NSIA, 1998). In 1996, of the total area under crops, 76% was planted to local varieties while 24% was under improved varieties (Table 2.5).

2.8.1.1 Improved t*ef* and wheat production technologies

To improve t*ef* and wheat production, research has been going on for more than 30 years in Ethiopia. EIAR had adopted the farming system approach to develop more appropriate technologies to farmers in 1984 (Mulugetta et al., 1992). Based on research results (on-station and on-farm), a number of recommended t*ef* and wheat technologies with their respective agronomic practices were developed and released by the EIAR and the AUA since the 1950s (EARO, 2000). These improved t*ef* and wheat technologies were demonstrated to farmers since 1986 (Adugna et al., 1991).

2.8.1.1.1 Improved t*ef* and wheat varieties

Ten improved t*ef* varieties have been released and recommended for farmers at the time of the study (Seyfu, 1993; EARO, 2000). Of these five were developed through mass selection from farmers' varieties, and the other five were obtained from the crossing program. Out of the ten varieties, *DZ-01-354, DZ-01-196* and *DZ-Cr-37* were demonstrated to farmers and were being cultivated in the study areas (Table 2.11).

Table 2.11 Improved *tef* varieties presently in use in Ethiopia.

Variety	Year released	Maturity (days)	Altitude (m)	Rainfall (mm)	Yield (t/ha)	
					on center	on-farm
DZ-01-354	1970	85-130	1600-2400	300-700	3.0-4.0	1.7-2.2
DZ-0!-99	1970	85-130	1400-2400	300-700	2.8-3.0	1.7-2.2
DZ-01-196	1978	80-113	1800-2400	300-700	2.5-3.0	1.4-1.6
DZ-01-787	1978	90-130	1800-2500	400-700	2.7-3.0	1.7-2.2
DZ-Cr-37	1984	82-90	1860-2000	134-500	2.8-3.0	1.4-1.6
DZ-Cr-44	1982	125-140	1800-2400	300-700	2.5-3.0	1.7-2.2
DZ-CR-82	1982	112-119	1700-2000	300-700	2.8-3.0	1.7-2.2
Gibbe	1993	74-98	1520-1750	550-850	2.5-3.0	1.4-1.8
DZ-01-974	1970	75-137	1500-2200	500-700	2.4-3.4	2.0-2.5
DZ-Cr-358	1995	75-137	1820-2400	350-700	2.1-3.6	2.0-2.5

Source: EARO, 2000

On the other hand, a total of 44 improved bread wheat varieties have been recommended for release at the time of this study. Of these, 14 bread wheat varieties were recommended for release between 1967 and 1974 and 36 bread wheat varieties from 1974 to 2001(Hailu

et al., 1991; EARO, 2000). However, there were 15 bread wheat varieties (Table 2.12) that were in use in addition to several obsolete varieties that tend to stay with the farmers longer (EARO, 2000). Among the obsolete varieties *6290 Bulk, 6295-4A*, and *Enkoy* are the major ones. ET-13.A2 and out of the varieties released after 1990s*, Kubsa (HAR-1685), Galema (HAR-604),* and *Wabe (HAR-710)* have been widely demonstrated to farmers with their associated cultural practices in the study areas. Under normal climatic conditions, bread wheat improved packages on the average yield 2.5 t/ha under on-farm conditions while the traditional varieties give a yield of 1.3 t/ha (Adugna et al., 1991).

Table 2.12 Bread wheat varieties presently in use in Ethiopia.

Variety	Year released	Maturity (days)	Altitude (m)	Rainfall (mm)	Yield (t/ha)	
					on center	on-farm
Dereselign	1974	144	1650-2200	300-700	na	na
K6290 Bulk	1977	128-131	1800-2200	300-700	4.0-6.0	3.0-4.0
K6295-4A	1980	128-131	1900-2400	300-700	3.5-5.5	3.0-4.0
ET-13A2	1981	107-149	2200-2700	400-700	4.0-6.0	3.0-4.5
Pavon-76	1982	120-135	750-2200	134-500	3.0-4.0	2.0-3.0
Mitike	1993	125-135	2000-2600	300-700	4.5-5.5	3.0-4.0
Wabe	1994	120-140	<2200	300-700	4.5-5.5	2.5-3.5
Kubsa	1994	120-140	2000-2600	550-850	4.5-6.0	3.0-45
Galema	1995	120-155	2200-2800	500-700	4.5-6.5	na
Abola	1997	128-131	2200-2700	na	na	na
Magala	1997	113-124	<2200	na	na	na
Tusie	1997	125-130	2200-2500	na	na	na
Tura	1999	120-149	2200-2700	na	na	na
Katar	1999	110-134	2000-2400	na	na	na
Shinna	1999	100-120	1800-2500	na	na	na

Source: EARO (2000); Tesfaye et al (2001); na = information not available at the time of the study.

2.8.1.2.2 Fertilizers

Of the several ways to increase agricultural productivity such as widespread use of improved cultural practices, efficient use of organic fertilizers and pest management techniques, the promotion of commercial fertilizer use has been the most plausible option

in Ethiopia. Commercial fertilizer plays an important role in increasing yield even without improved seeds and bridging the gap between food production and population growth. Research results show that each kg of nutrient applied can increase grain yield by more than 5 kg (ADD/NFIU, 1992). The amount of fertilizer currently applied in Ethiopia is too low to cause major ecological degradation. In fact, increased use of fertilizer reduces the expansion of cultivation of fragile lands (IFDC, 1995). However, the use of commercial fertilizer is constrained by a number of factors. For instance, technical and marketing problems have reduced the return and efficient use of commercial fertilizers. The profitability of fertilizer use is affected by three interrelated factors of yield response, fertilizer price, and output prices.

A study by Asnakew et al. (1991) on sources of nutrients showed that the best sources are urea for N and DAP for phosphorus. Fertilizer response trials have been carried out since 1966 on red and black soils. Based on several years of experimentation, 60 k g of N and 60 kg of P_2O_5 have been recommended for t*ef* and wheat (Seyfu, 1993;). However, the Bureau of Agriculture still demonstrates 64/46 kg of N/ P_2O_5 per hectare for cereals.

2.8.1.2.3 Weed control

Weeds are one of the major crop production problems in Ethiopia. To control weed damage weeding is usually done by hand. Use of herbicide is limited since herbicides have not been readily available by public agencies. The government believes there is sufficient labour on farm, which can be used for weeding although there is a shortage during peak period. Consequently, timely weeding is one of the major problems of farmers (Hailu et al, 1991). Yield losses due to weeds were 36% for wheat and 52% for t*ef* (Rezene, 1985; Birhanu, 1985). Moreover, the critical period of weed competition for wheat and t*ef* was found to be during the early crop establishment period. Optimum yield was obtained from two-hand weeding; hence, two-hand weeding (30-35 and 50-55 days after crop emergence) was recommended for t*ef* and wheat cultivation (Rezene, 1985; Birhanu, 1985).

With regard to the use of herbicides, different broad-leaf and grass herbicides (a total of 15) have been recommended to farmers. However, only 2-4,D and MCPA 50% each at the

rate of 1 l/ha were recommended to control broad leaf weeds in t*ef* and wheat production (Rezene, 1985; Birhanu, 1985).

2.8.2 Overview of extension activities

There was no formal extension service in Ethiopia prior to 1950s and new technologies were introduced through missionaries and the agricultural institutes in Jima and Ambo In 1952, formal agricultural research and extension were institutionalized under the auspices of the then Alemaya College of Agriculture (ACA). The responsibility of agricultural extension was transferred to the Ministry of Agriculture in 1963 (Tennassie, 1985). In Ethiopia research and extension are under different organizations. The Ministry of Agriculture (MOA), and the Ministry of State Farms' Coffee and Tea Development have been providing extension services to smallholders. The role of extension agents in Ethiopia includes demonstrating technologies, distributing inputs, carrying out soil and water conservation projects, villagizing farmers and promoting afforestation.

Different agricultural extension activities were undertaken in the past. The activities started as an educational service approach in the 1950s by Alemaya College of Agriculture and the service was fairly adequate particularly in the vicinity of the extension college. In the 1960s the community development approach was initiated as part of the First Five-Year plan (1958-62). Towards the end of 1960s and the beginning of 1970s the Comprehensive Package approach to rural development was introduced (e.g., CADU, WADU, ADDP). The early assessment of the comprehensive projects necessitated the development of a nationally replicable approach such as the Minimum Package Programs (MPPI and MPPII). MPPI was launched in 1971 under the Extension Project Implementation Department of the MOA. The package included limited inputs, credit and extension advices, and model farmers were used to demonstrate agricultural technologies. The MPPI was replaced by MPPII in 1980, which used peasant associations to distribute inputs and credit. Development agents (DA) in collaboration with trained farmers demonstrated the new technologies to members of peasant associations (Tennasie, 1985).

Before the termination of the MPPII in 1985, the Training and Visit (T and V) extension system was initiated in 1983. The T and V approach focused on the regular visit of contact farmers by DAs, monthly training of DAs by subject-matter specialists (SMSs) and every three months training of SMSs by researchers. From the experience of MPPI and MPPII, the Peasant Agricultural Development Program (PADEP) was launched in 1988. The objective of PADEP was to increase food production and improve farmers' productivity. This program utilized the modified T and V extension system and concentrated its programs in surplus producing *woredas* (Adugna et al., 1991).

The Sasakawa Global (SG-2000) extension approach started in Ethiopia in 1993. This program focused on demonstration of improved technologies, unlike earlier extension approaches, on larger plot size (half a hectare), timely availability of technological packages, financial self-reliance of farmers, and training of grass root level extension agents, supervisors and subject mater specialists in selected areas (Habtemariam, 1997). Following the "success" of SG-2000 Project, the government of Ethiopia launched the national extension package program, extension management training plots (EMTPs) in 1995 all over the country with more extension packages (post harvest, livestock and high income value crops). Farmers participate for a maximum of two years in the EMTPs and graduate. During their participation they get improved seed, fertilizers and herbicide on credit and on time, and technical advise from extension agents. Since the launching of EMTPS significant efforts have been made to raise the level of adoption of technological packages of t*ef* and wheat and other crops.

One of the problems that limited the development of agriculture in Ethiopia is the historically weak linkage between agricultural research and extension. This is because the two organizations are not under one umbrella, thus, are not obliged to work together. The EARO is a semi-autonomous and administered by a board whereas the extension is under the MOA. Their relationship is always on cooperation basis. Thus, extension workers are not formally involved in research. The number of forums where research information is passed to extension agents has been limited. This implies that appropriate research results may not be passed to extension agents and problems of farmers with the improved technologies may not be also communicated to researchers as feedbacks. There have been

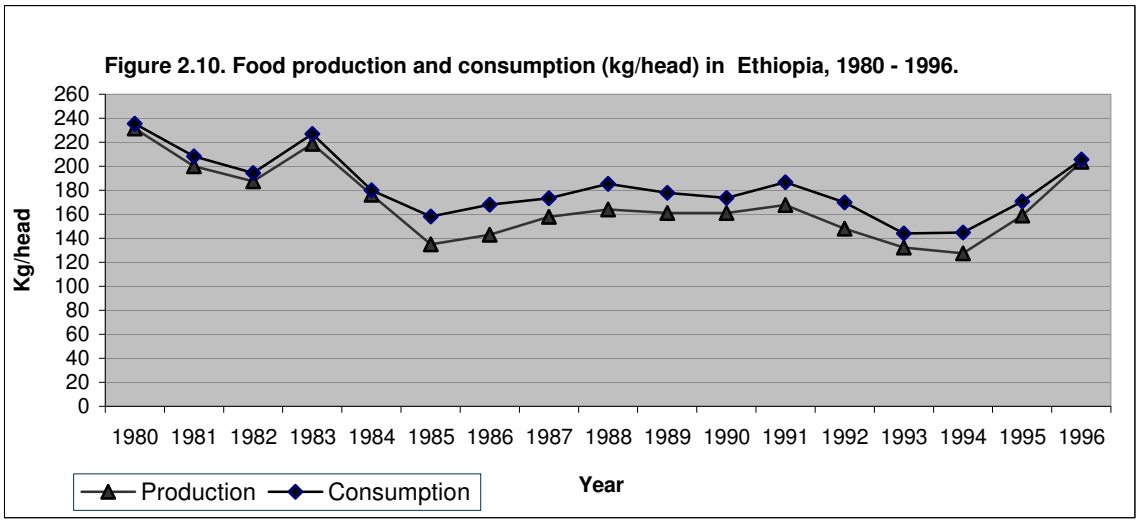
few efforts made by researchers and extension agents to improve the linkage by creating a liaison committee, Research and Extension Liaison Committee (RELC). RELC also tried to improve the linkage between researchers, extension agents and farmers. However, the outcome is not satisfactory and varies from region to region which indicate there is no clear guidance and responsibility sharing obligations. Besides, although there have been efforts to strengthen the extension units in the past, it was not adequate to establish efficient technology transfer system. Frequent reorganization, little in-service training for development agents, frequent transfer and few incentives including lack of pay raise and transportation to do their jobs have resulted in a generally unmotivated staff (Stroud and Mulugetta, 1992).

2.9 Food security in Ethiopia

In Ethiopia, food security has become an issue since the 1970s and has received considerable attention since then (Melaku, 1997). Maxwell and Frankenberger (1992) defined food security at the household level as "access to adequate food by households over time." The World Bank gave a more comprehensive definition of food security as the "access by all people at all times to enough food for an active and healthy life" (World Bank, 1986). The availability and accessibility of food to meet individual food needs should also be sustainable (Melaku, 1997). There is a difference between the concept of food security and self-sufficiency in food production. Food security implies physical and economic access to basic food at all times while food self-sufficiency is based on the need for greater independence and control of own food supply, non-tradability of some staple foods and the problems of dependence on one export crop (Hassan et al, 2000).

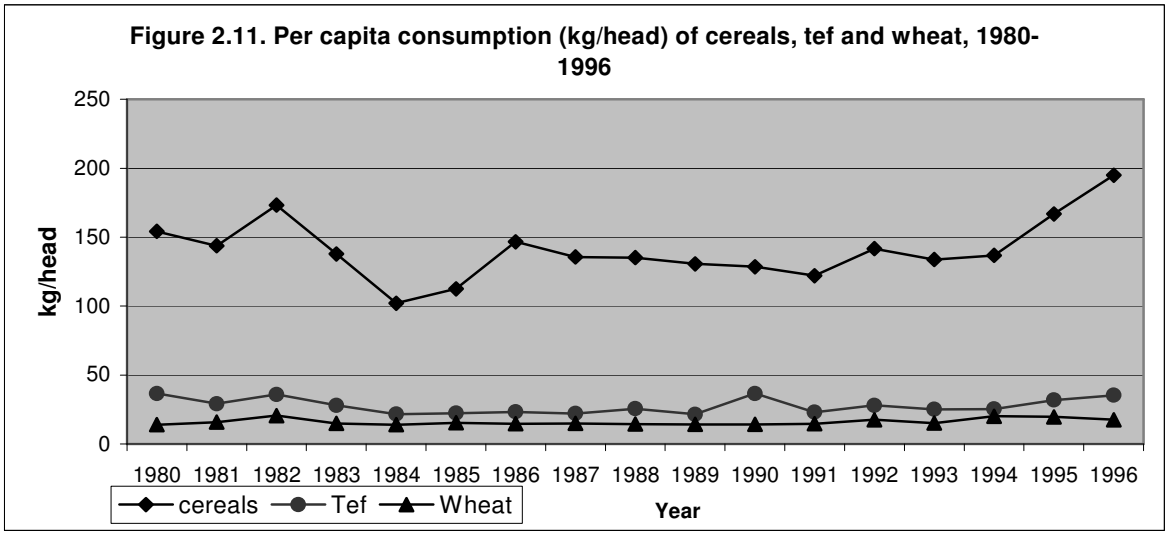
For a country like Ethiopia, food security is a high priority. However, domestic food production and supply have consistently been below the requirements mainly due to low productivity of the agricultural system resulted from insufficient use of improved technologies such as improved seeds, fertilizers, and herbicide. Consequently, Ethiopia is not able to feed its rapidly growing population. Figure 2.10 presents per capita production and consumption based on 225 kg/head/year, which is equivalent to 2100 kilocalorie (Kcal) recommended for an average individual (Debebe, 1997). The production was

estimated without considering yields losses both at the field and storage due to lack of data. As it is clear from Figure 10, domestic food supply from agriculture (crop and livestock) was not sufficient to feed the population. In fact, it was only in 1980 where production meets the required consumption. The situation was particularly bad during the drought years of 1984-87 and 1993-94. For instance, in 1985, per capita food production dropped by 23% due to the drought while population increased by 3.1% from 1984. This forced per capita consumption to fall below the required level due to unavailability of food. The 1985 and 1993 consumption level (158 and 144 kg/head/year, respectively) was even lower than the minimum recommended level (182 kg/ head) for an average individual.



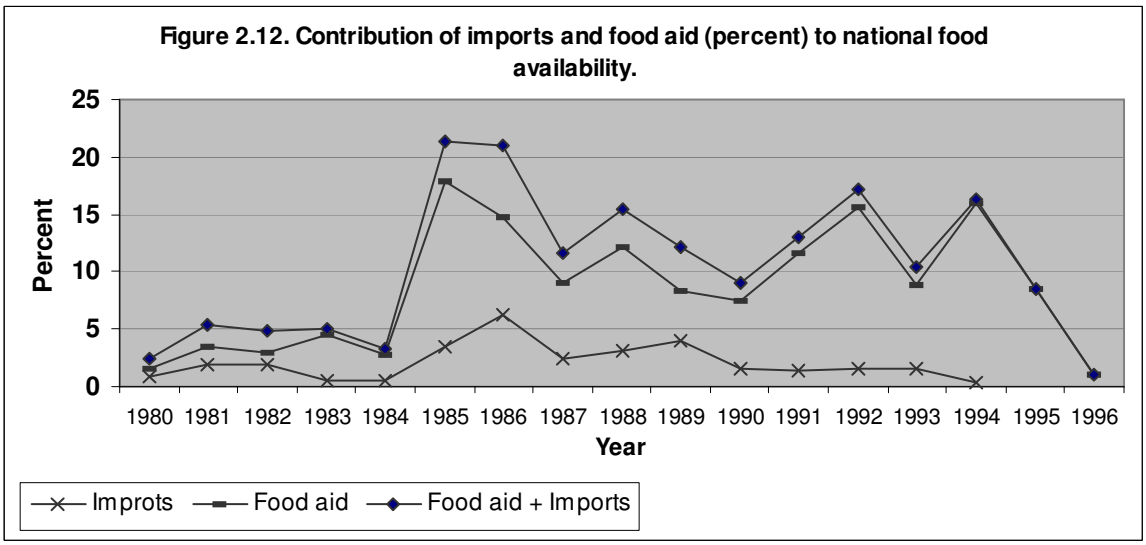
Source: Adapted from Debebe, 1997.

Cereals are the major staple food accounting for 69% of the calories in Ethiopian diet (Stroud and Mulugetta, 1992). *Tef (Eragrostis tef)* is the main staple food (Seyfu, 1987). *Tef* and wheat contribute 20% and 11%, respectively, of per capita cereals consumption (Debebe, 1997). The average per capita cereals, t*ef* and wheat consumption were 141 kg, 28 kg and 16 kg per head per year, respectively. The shares of cereals, *tef* and wheat in food self-supply during 1980-96 were 87%, 16% and 9%, respectively. Figure 2.11 shows per capita consumption of cereals, t*ef* and wheat over the years.



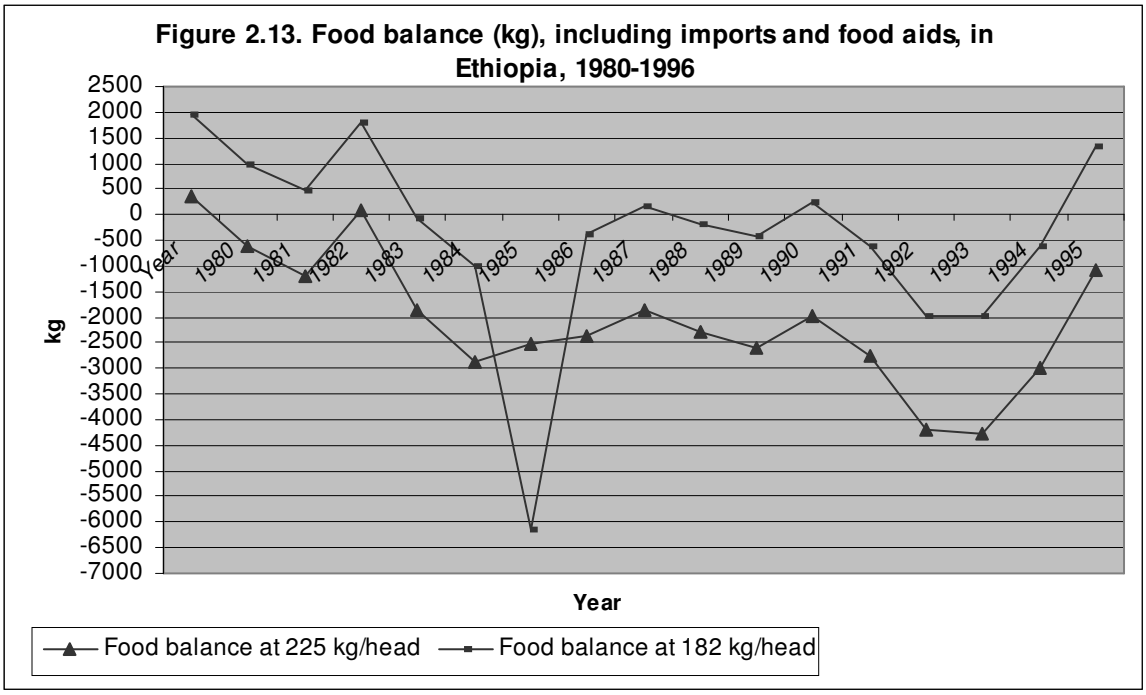
Source: Adapted from Debebe, 1997

It is clear from Figure 2.10 that the country had to import food to feed its growing population when it has the foreign exchange and look for food aid otherwise. Food aid has been the most important source of households' food security in rural Ethiopia. Annual food aid varies from 200,000 to 1,200,000 metric tons since 1980. The number of people who received food aid also increased from 2.5 million in 1987, 7.85 million in 1992, and 7.7 million in 2000 (Devereux, 2000) to 14 million in 2003. Ethiopia had imported up to 6% of its domestic food production from 1980 up to 1996 and received up to 16% of its domestic food production as food aid (Debebe, 1997). Food imports and food aid reached up to 21% of Ethiopia's agricultural production especially after the drought years (Figure 12).



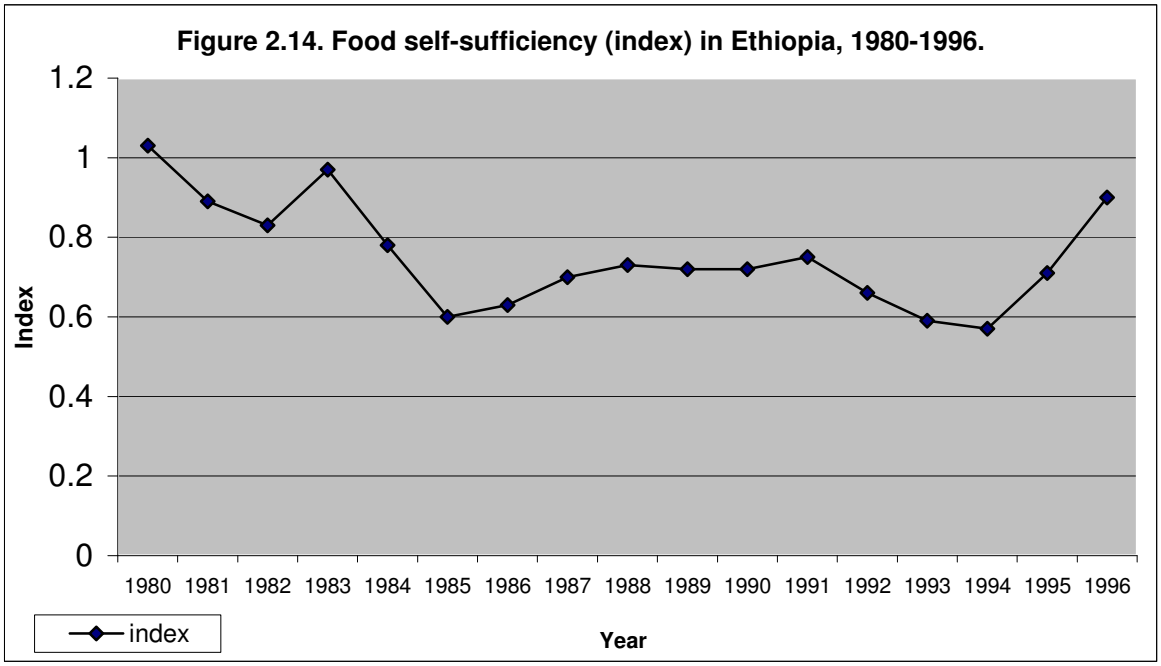
Source:Adapted from Debebe, 1997

One of the reasons for food shortages is unbalanced food production and population growth. For instance, total domestic food production from 1980 to 1996 increased by only 2.2 % per annum while the level of per capita food production dropped by about 12% for the same period due to rapid population growth (2.8% per annum). As a result there have always been food deficits during that period except in 1980 and 1983, even with food aid and imports (Figure 2.13). Moreover, domestic food production could not meet the requirements of the population even with the lowest calorie intake of 1700 kcal per person per day in most of the years during 1980 to 1996 (Figure 2.13).



Source: Adapted from Debebe, 1997

On the other hand, the food self–sufficiency index measured as the ratio of domestic food supply to domestic demand was less than one for all periods indicating food deficit except in 1980 (Figure 2.14).



Source: Adapted from Debebe, 1997

The above anal yses call for a systematic effort to alleviate the food insecurity in Ethiopia. This can be achieved by promoting the use of improved inputs in all major production areas. Improvement in crop production can be achieved by efficient (not rationing) allocation of improved inputs to productive regions and efficient distribution of outputs from surplus areas.