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Agricultural Market Performance and Determinants of Fertilizer Use in Ethiopia

By

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1. INTRODUCTION

Ethiopia has a population of 55 million (1995), the second largest in sub-Saharan Africa. Growing at a rate of 3 percent per annum, the population is expected to double by the year 2010. The level of urbanization is very low, with only 15 percent living in the urban areas. Close to 50 percent of the total population is reported to be under the age of 14 years, implying a very high dependency ratio.

One immediate effect of the population pressure has been diminishing farm size. In 1995/96, about 63 percent of farming households had less than 1 ha of holdings. Less than 1 percent of the farmers owned holdings greater than 5 ha and these were likely to be concentrated in the sparsely populated areas with low agricultural potential (CSA, 1996).

With declining farm size, it becomes increasingly difficult to practice traditional soil-fertility restoring techniques (e.g.fallowing and crop rotation) and maintain households' livelihoods from the land. As noted by Boserup and others, rising population density typically causes a transition from fallow-based systems to permanent cultivation. To maintain yields under these conditions, farmers must add supplementary nutrients using increased quantities of organic and chemical fertilizers. Although the use of fertilizer has increased in Ethiopia in recent years, there is ample evidence that most farmers are not adequately compensating for the loss of soil nutrients caused by more intensive cultivation (Mulat, 1996). In many densely populated areas, farmers plant cereal after cereal to meet their subsistence requirements with little or no application of commercial or organic fertilizer. Although the benefit of chemical fertilizer is known by many, only 31% of the farmers in the country used commercial fertilizer in 1995/96 and just 37% of the cultivated area was treated (CSA, 1996). The picture for organic fertilizers is not any more encouraging. Because of fuelwood scarcity, rural households have been forced to divert animal dung from its traditional role as soil nutrient to direct burning for fuel (Senait, 1997). Crop residues and other by-products are used as animal feed, thus aggravating soil degradation and erosion. Uncontrolled deforestation of the natural vegetation cover, high stocking rate, farming practices with little concern for conservation and poor soil management practices have resulted in low and stagnating yields. Coupled with diminishing farm size, the generally stagnant yields have resulted in sharply declining labor productivity (measured by output per agricultural la bor) and poverty[1].

Agricultural development strategies need to effectively reduce the key constraints to growth. Hayami and Ruttan (1984), for instance, noted that the constraints imposed on agricultural development by an inelastic supply of land can be offset by advances in biological technology, while the constraints imposed by an inelastic supply of labor can be offset by advances in mechanical technology. The ability of a country to achieve growth in agricultural productivity and output depends on its ability to make an efficient choice among alternative paths of

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[1] See for instance, Yibeltal Gebeyehu, 'Population Pressure, Agricultural Land Fragmentation and Land Use: A Case Study of Dale and Shashemene Weredas, Southern Ethiopia, in Dejene Aredo and Mulat Demeke (eds.), Ethiopian Agriculture: Problems of Transformation , Proceedings of the Fourth Annual Conference on the Ethiopian Economy, Addis Ababa, 1995.

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technical change. In this regard, declining farm size does not necessarily translate into underemployment and poverty in Ethiopia if a transition is made to intensive land use and/or rapid growth in non-farm employment.

Recognizing the seriousness of the soil fertility problems in Ethiopia and the necessity of improving agricultural productivity and food security if general economic growth is to occur, the present Federal Democratic Republic of Ethiopia has undertaken a broad based Agricultural Development-led Industrialization (ADLI) strategy. The strategy concentrates on accelerating growth through focusing on the supply of fertilizers, improved seeds and other inputs. Although food production began to improve after 1994, the country is still facing widespread chronic and transitory food insecurity in some areas of the country.

The objective of this research is to examine how the fertilizer sector in general, and farmers' demand for fertilizer in particular, have evolved since the introduction of fertilizer sector reforms in Ethiopia. There is much debate in the agricultural development literature about whether fertilizer use in Africa is constrained primarily by poor input distribution systems, by farmers' lack of knowledge concerning the benefits and correct use of fertilizer, or by lack of effective demand because the product is simply not profitable enough. In our research we have looked at each of these issues in an effort to understand the relative importance of the different constraints and how well current policies are addressing the problems. In doing this, we attempt to identify additional policy measures needed to sustain expanded use of fertilizer and thus enhance food security in Ethiopia.

The data for the study come mainly from three major sources: (1) the Agricultural Survey carried out by the Central Statistical Office (CSA) for the year 1995/96 season; (2) the Food Security Survey (1995/96) conducted by the CSA in collaboration with the Grain Market Research Project of the Ministry of Economic Development and Cooperation; and (3) the fertilizer Trial conducted during the period of 1989 to 1991 by the Ministry of Agriculture (MOA) and the National Fertilizer and Inputs Unit (NFIU). In addition, observations from several field visits were used to corroborate findings obtained from data analyses.

Production functions have been used to analyze profitability and identify profit maximizing fertilizer application rates. Regression models using wereda-level data have been estimated to identify the most important factors influencing fertilizer adoption and total quantity used.

After presenting a brief review of aggregate national statistics on farm size, yields, and fertilizer use patterns, we examine recent progress in the development of fertilizer and agricultural credit markets (the supply side of the subsector). We then turn to a review of recent evidence on fertilizer profitability and other factors such as household characteristics, agroecological conditions, and choice of crop mix that shape farmers' demand for fertilizer. In Section 5, we present the results of a econometric selection model to identify factors determining whether fertilizer is used in a given wereda as well as factors determining the intensity of fertilizer use in weredas where fertilizer has been adopted. We conclude with a discussion of implications for the design of future agricultural programs and policies.

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2. RECENT TRENDS IN ETHIOPIAN AGRICULTURE

As mentioned in the introduction, most analysts agree that population growth is decreasing farm size per capita and compromising the traditional system of regenerating soil fertility through use of fallows. Table 1 presents the distribution of farm size for the 1995/96 cropping season. Almost 40% of farms are less than 0.5 hectares and about 60% are less than one hectare. Any farm over 5 hectares is in the largest 1% of farms. If farm families are to feed themselves and produce a marketable surplus with less land per capita, they need to adopt farming techniques on a sustainable basis in order to increase yields per hectare.

Table 1: Distribution of Holding Size.

Landholding (ha)	Number of households (000)	Cumulative (%)
under 0.1	634.56	7.45
0.10 - 0.50	2556.94	37.47
0.51 - 1.00	2166.35	62.91
1.01 - 2.00	2029.56	86.74
2.01 - 5.00	1060.84	99.2
5.01 - 10.00	62.28	99.93
10+	5.94	100

Source: CSA, Agricultural Sample Survey 1995/96, Vol. IV, Report on Crop Land Utilization, Bulletin No. 152, 1996

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Table 2 presents the trends in average yields since 1980 for seven of Ethiopia's principal food crops. One notes a fair amount of inter-annual fluctuation in yields, due primarily to climatic variability. There is no evidence of the type of steady growth in yields per hectare needed to feed a national population that is growing at 3% per year, although there is some evidence of a recovery in yields during the early 1990s. A simple linear regression of yields(1980 to 1995) as a function of time showed that the coefficient (of the time variable) was insignificant, suggesting stagnant yields for all the major crops but wheat, which registered a positive growth rate. Even maize, which has been the engine of agricultural growth in much of Eastern and Southern Africa due to breakthroughs in variety development, does not exhibit yield levels in the 1990s that outpace what was realized in the early 1980s.

Table 2: Yield of Major Crops in Quintal per Hectare.

YEAR	Cereals	Teff	Barley	Wheat	Maize	Sorghum	Pulses	Oil Seeds
1980	11.82	9.63	13.20	11.04	12.37	14.58	11.59	5.11
1981	11.59	8.14	11.92	10.03	17.90	14.63	10.49	3.65
1982	13.41	9.81	13.14	12.64	19.90	15.37	12.27	4.78
1983	11.62	8.28	10.21	10.40	18.52	13.22	9.71	3.84
1984	8.68	6.76	10.42	9.88	11.32	6.70	6.77	3.66
1985	9.43	7.41	9.83	9.58	11.25	10.68	6.39	3.43
1986	11.59	8.09	11.20	11.09	16.53	12.85	9.15	3.88
1987	12.08	8.17	12.15	11.50	19.05	11.53	7.63	4.11
1988	12.28	8.84	11.43	12.26	18.45	13.87	9.07	3.54
1989	13.14	8.59	13.75	12.84	19.59	13.34	10.56	4.00
1990	13.65	14.29	12.92	14.35	12.75	13.71	14.22	12.89
1991	10.27	8.70	1.25	13.83	16.44	13.01	8.91	4.18
1992	13.43	10.04	13.20	15.93	18.53	14.84	8.23	3.34
1993	12.94	9.05	15.15	13.74	16.54	15.80	7.38	3.80
1994	10.71	7.04	9.64	13.31	15.15	12.66	8.82	3.43
1995	9.84	8.36	10.57	12.20	19.83	0.00	9.78	4.99

Source: Dejene Aredo, The Determinants of Cropping Pattern and Agricultural Productivity in Ethiopia 1980 - 1995, Department of Economics, AAU (mimo), 1997.

Given the average farm size of about 1 hectare for for a family with approximately 5 persons, cereal yields in the range shown in Table 2 (800 to 1300 kilograms per hectare, with the exception of maize that goes as high as 2000 kgs/ha.) are, at best, barely adequate for feeding household members.[2] This leaves little room for the 60% of households with less than one hectare of land to sell much to meet the needs of urban consumers and cereal deficit farm families.

Chemical fertilizers are recognized as one of the key means for increasing yields per hectare. Table 3 illustrates patterns of fertilizer use during the 1995/96 meher cropping season. Most fertilizer is used in four regions: Oromiya, Amhara, Southern, and Tigray. Average national doses are about 35 kilograms/ha when users and nonusers are considered, while average doses applied by users only are 95 kilograms/ha. These application rates are relatively high compared to past experience in Ethiopia, but they are far below the nutrient needs of the heavily-cropped Ethiopian soils which have been under cultivation for centuries.

[2] Given grain requirement of 215 kg/person per year, a family of 5 household members rougly requires 1075 kg per year for food alone. Since part of the harvest may need to be sold (to meet other needs and obligations (e.g. tax) in the market and part of retained for seed, the output level of many farmers is certainly inadequate.

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Table 3: Characteristics of Fertilizer Use in Ethiopia, 1995/96 Meher Season.

Region/crop	Cultivated area (000 ha)	% Area Fertilised	Dose (kg per hectare)	
			Total	Users only
Tigray	437	21	11	51
Teff	88	22	19	87
Barley	87	24	17	69
Wheat	85	19	17	88
Maize	45	49	1	2
Sorghum	96	9	-	-
Amhara	2,380	30	22	75
Teff	882	41	33	81
Barley	296	16	10	66
Wheat	259	25	28	112
Maize	290	51	26	5
Sorghum	472	1	-	-
Oromiya	3,034	47	47	100
Teff	941	66	81	123
Barley	385	41	32	78
Wheat	470	68	83	121
Maize	700	33	16	50
Sorghum	452	11	7	58
Southern	609	38	47	126
Teff	160	52	62	120
Barley	52	35	45	131
Wheat	58	83	12	155
Maize	195	33	84	123
Sorghum	140	-	16	-
National	6.653e+21	37522951367	35572362214	9.511e+13
Teff				
Barley				
Wheat				
Maize				
Sorghum				

Source: CSA, Agricultural Practices, Bulletin No. 152, 1996

In the past, attempts to increase crop yields included the comprehensive and minimum package projects initiated in the late 1960s and 1970s and the Peasant Agricultural Development Project (PADEP) launched in the 1980s. The basic aim was to promote agricultural development by concentrating inputs, credit and marketing services and

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building infrastructure in geographically delimited areas. Integrated rural development projects were considered as the most effective tools to bring about maximum impact within a short period of time.

Within the framework of ADLI, a new system of agricultural extension, known as the Participatory Demonstration and Training Extension System (PADETES), was launched in 1994/95. The system tries to merge the extension management principles of the Training and Visit (T & V) system with the technology diffusion experience of the SG 2000.[3] The major elements of the extension package are fertilizer, improved seeds, chemicals and better cultural practices for the main cereal crops (teff, wheat, maize, barley, sorghum and millet). In addition, a series of measures have been introduced since November 1991, progressively liberalizing fertilizer supply and marketing. Very recently (February 1997), fertilizer subsidies have been removed and retail prices deregulated.

In spite of the various efforts, agricultural intensification in general, and fertilizer consumption in particular, are not progressing as rapidly as desired. In the rest of this paper, we examine the diverse factors that are constraining fertilizer adoption and application rates, in view of helping policy makers design sustainable programs that promote agricultural intensification through the use of chemical fertilizers.

3. MARKET DEVELOPMENT AND THE SUPPLY OF CREDIT

Fertilizer demand is heavily influenced by the market structure and credit availability. The recent economic reform has liberalized the fertilizer market and allowed the participation of the private sector with the aim of improving distribution and consumption. Attempts have been made to improve the supply of fertilizer credit. However, there is not enough competition in the fertilizer market, particularly at the regional/local level, and the last two years have been characterized by an over-supply which is costly (in terms of high storage and interest rate charges) to everyone involved (public and private sector firms and farmers). The latest developments in the market structure and credit are briefly reviewed below in order to throw light on the implications of the ongoing reform for demand and profitability.

3.1 The Structure of the Fertilizer Market

Up until 1992, the fertilizer market was entirely controlled by the state owned parastatal named the Agricultural Input Supply Corporation (AISCO), now renamed as the Agricultural Input Supply Enterprise (AISE). Consistent with the new economic policy, the Government designed the New Marketing System (NMS) for fertilizer in 1992 with the main objective of liberalizing the fertilizer market and creating a multi-channel distribution system. The liberalization permitted the private sector to engage in the importation and

[3] The centrepiece of the SG 2000 is farmers' half-hectare demonstration plots, utilizing improved seeds, improved management practices, and fertilizer types and seed rates as recommended by the National Fertilizer Input Unit of the Ministry of Agriculture.

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distribution of fertilizer, hence ending the monopoly power of AISCO[4]/AISE. AISE started by appointing its own wholesalers and retailers.[5] Only two firms have joined the market for fertilizer import and distribution since the 1992 reform. In 1993, the Ethiopian Amalgameted Limited (EAL) became the first private company to import and set up its own fertilizer supply network. Its market share in the total import increased to 27.9% in 1996 (Table 4).[6] The second firm, owned by the Amhara Regional Government, started operation in 1994 under the name, Ambassel Trading House Private Limited Company. It is mainly a wholesale and distribution agent of AISE and collects its supplies from Assab. In 1996, the company was appointed as the sole distributor and wholesaler of AISE in the Amhara region. It was also allocated foreign exchange by the Government to import fertilizer in 1996. EAL and Ambassel together accounted for 35.1% of total fertilizer imports in 1996 (Table 4).

Table 4: Fertilizer Import by Firm.

	1995		1996		1997	
	Imports	Share (%)	Imports	Share (%)	Imports	Share (%)
AISE	232219	81	219574	64.8	160000	100
EAL	55400	19	94669	27.9	0	0
Ambassel	-	-	24337	7.2	0	0
Total	287619	100	338780	100	160000	0

Source: National Fertilizer Industry Agency (1997).

Each of the three importers/distributors has its own dealer network. AISE and its network of distributors, wholesalers and retailers covered nearly the whole country. With 1 distributor (Ambassel), 103 wholesalers, 901 retailers and 860 service cooperatives in 1996, AISE's operation is the largest in the country. The network of Amalgameted included 230 direct sales centers, 1,285 private retailers and 550 service cooperatives. Ambassel operated with 94 direct sales centers, 120 private retailers and 385 service cooperatives in 1996. Among the major distributors/wholesalers that joined the market in 1996 and 1997 are Dinsho (owned by the Oromiya Regional Government) and Guna (owned by the Tigray Regional Government).

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[4] AISCO was established in 1985. Between 1978 and 1984, the Agricultural Marketing Corporation (AMC), State-owned parastatal, was the sole importer and distributor of fertilizers.

[5] In 1992, 7 wholesalers and 114 private retailers were registered in some parts of Shewa, Gojam, Arsi and Hararghe.

[6] The firm did not import in 1997 because of large unsold stock from the previous year. Only AISCO imported fertilizer in 1997 (Table 4).

Consistent with the Government's liberalization policy, a total of 229 AISE's marketing centers have been phased out. The transfer has already been made in the Amhara region, with Ambassel taking over nearly all the centers in the region. In the Oromiya region, most of the AISE's centers in East Shewa, West Shewa, North Shewa and Arsi were taken over by Dinsho in 1996. In other regional states, AISE carries out its operations on its own (direct sales to farmers) and/or through its private wholesale and retail agents.

Access to fertilizer is thought to have improved as a result of the input market liberalization. However, the full benefit the reform has yet to be realized because of various limitations in the marketing system. There are at least four major problems associated with the existing structure of the fertilizer market which seem to have affected demand directly or indirectly: (i) uncompetitive retail markets; (ii) uneven playing field and excess supply; (iii) principal-agent relationship; and (iv) regulation of prices.

First, limited participation by small-scale wholesalers and retailers has made the fertilizer market uncompetitive and inaccessible. For instance, about 80% of AISE's sales in 1997 was through distributors/wholesalers (mainly Ambassel, Dinsho and Guna). The share going to retailers, individual farmers and the non-peasant sector was 15, 2 and 3%, respectively (AISE, 1997). In the case of Ambassel, direct sales to farmers and service cooperatives accounted for 52 and 39% of the total sales, respectively, in 1997. Small wholesalers accounted for only 3% of the total sales of the company. The remaining (5%) was sold to state farms. In 1997, most sales of EAL were directed to the large distributors such as Ambassel, Dinsho and Guna which also carried out the retailing operations.

Retailing by the large firms imply that sales or retail outlets are few and concentrated in the towns and along the major roads, and the terms and conditions of sales are not sufficiently flexible. It is often expensive and sometimes unmanageable for the large distributors to maintain several sales centers within a given wereda and provide sales service throughout the year. Often the companies do not have the capacity to sell fertilizer on flexible terms (e.g on the basis of informal credit arrangements or exchange for grain). A more efficient, flexible and a wider distribution of fertilizer can only be ensured if local traders are allowed to participate fully. Among the major reasons for the lower rate of participation were the manner in which credit is allocated (see section 3.2 below) and the removal of subsidy and the unattractive wholesale price fixed by the government. For most of the small private wholesalers and retailers, adding adequate retail margin on the wholesale price meant making fertilizer even more expensive or limited demand for the input. The large distributors/wholesalers sold at the wholesale price direct to the service cooperatives and farmers group. The latter sold to their members at the wholesale price plus some transport cost.[7]

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[7] The amount charged by the service cooperatives and farmer groups for the service provided (buying fertilizer from distributors) varies from place to place. But the cost of transport and perdiems for the delegates who make the purchase is included in the charge. For instance, each farmer paid ... birr to the service cooperative in the district of Ada (Debre Zeit) in 1997.

Second, excess supply was a serious constraint in 1996 and 1997 and the problem was more serious for some than for the other firms. In 1996, for instance, AISCO and Ambassel sold 72.9 and 75.3% of their total supply, respectively. The performance of both firms was well above EAL which was able to sell only 29.2% of its supply.[8]

In 1997, AISE sold only 46% of its total supply. With 69% sales (relative to total supply), the performance of EAL improved significantly over the previous year. The company sold fertilizer to other distributors such as Ambassel and Dinsho at dumping prices to get rid of its unsold stock from last year. The performance of the other dealers, namely Ambassel and Dinsho, was much better, selling over 87% of the total made available for sale.[9] Table 5 shows the performance of sales for each importer/distributor.

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[8] Overall, only 59.4% of the total amount made available was actually sold in 1996, WITH. about 164,932 tons of fertilizer left unsold in 1996.

[9] Overall, unsold stock amounted to 113,936 tons in 1997 and fertilizer consumption declined by 18.5% over the previous year (Annex I).

Table 5: Sales Performance by Importer/Distributor in Tons (1996 and 1997).

Importer	Total Available* (tons)			Total sales (tons)			Percent sold (%)		
	DAP	Urea	Total	DAP	Urea	Total	DAP	Urea	Total
1996									
AISCO	153537	46994	200531	120155	26045	146200	78.3	55.4	72.9
EAL	95669	33785	129454	33553	4212	37765	35.1	12.5	29.2
Ambassel**	61799	14797	76596	46543	11141	57684	75.3	75.4	75.3
Total	311005	95576	406581	200251	41398	241649 a	64.4	43.3	59.4
1997									
AISE	96165	57700	153865	57613	13050	70663	60	23	46
EAL	42946	23694	66640	36195	9512	45707	84	40	69
Ambassel	50169	13657	63826	45457	12809	58266	91	94	91
Dinsho	22301	9684	31985	20387	7613	28000	91	78	87
Guna	2187	1726	3913	2002	1656	3658	92	96	93
Total	213769	106461	320229	161654	44640	206294			

Source: NFIA

* Total available includes import plus carry-over stock from the previous year

** Includes imports of AISCO sold to Ambassel

a This amount is different from the amount reported in 1997 by Tibebu Haile (see Annex I).

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The firms with huge carry over-stock incur considerable additional costs in the form of storage and interest charges. The extra cost may be covered by the firms themselves or passed on to the farmers. In any case, failure to sell the available supply implies serious uncertainty, besides the financial problems. Sales uncertainty can also impede free entry into the fertilizer market and constrain investment in market infrastructure.

Apart from inadequate forecasts of demand, the excess supply is attributed to the tendency of some firms becoming regional or local monopolies. For instance, Ambassel is progressively dominating the market in the Amhara region. The firm supplied about 99% of the total fertilizer sold to farmers, state farms, private commercial farms, research centres, etc. in the region in 1997. The sales by EAL accounted for less than 1% of the total distribution in the region (Table 6). The market structure for fertilizer in the Amhara region is apparently a monopolistic one. EAL blames lack of level playing field for the monopolistic tendencies and its poor performance in the region. According to EAL, all credit sales are directed to Ambassel in the Amhara region.

Table 6: Fertilizer Sales by Region and Importing Companies as at August 31, 1997 (All Figures in Tons).

Region	AISE		EAL		AMBASSEL		DINSHO		GUNA		TOTAL			%of the total regional share
	DPA	UREA	DAP	UREA	DAP	UREA	DAP	UREA	DAP	UREA	DAP	UREA	TOTAL	
Tigray	2032	1477	3012	2255	-	-	-	-	2002	1656	7046	5388	12434	6.03
Amhara	-	-	417	9	43563	11516	-	-	-	-	43980	11525	55505	26.91
Oromiya	27117	6113	25427	4137	-	-	20387	7613	-	-	72931	17863	90794	44.01
Somali	-	-	-	-	-	-	-	-	-	-	-	-	-	
Benishangul G.	70	75	-	-	-	-	-	-	-	-	70	75	145	0.07
SNNPR	23133	2764	4653	141	-	-	-	-	-	-	27786	2905	30691	14.88
Gambella	-	-	-	-	-	-	-	-	-	-	-	-	-	
Harari	-	-	434	-	-	-	-	-	-	-	434	-	434	0.21
AddisAbeba	1	2	1750	792	-	-	-	-	-	-	1751	794	2545	1.23
DireDawa	-	-	502	578	-	-	-	-	-	-	502	578	1080	0.52
Sub-total	52353	10431	36195	7912	43563	11516	20387	7613	2002	1656	154500	39128	193628	93.86
Others	5260	2619		1600	1894	1293					7154	5512	12666	6.14
G.Total	57613	13050	36195	9512	45457	12809	20387	7613	2002	1656	161654	44640	206294	100

Note 1. EAL's distribution in Tigray is assumed to be sold as there is no information obtained regarding the actual sales.

2. Sales figures refer to sales to farmers, private commercial farms and research centers etc. It doesn't include sales to other importing companies or distribution

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In Oromiya, fertilizer was sold by three suppliers, namely AISE, EAL and Dinsho in 1997. With a market share of 36.6% in the case of AISE , 32.6% for EAL and 30.8% for Dinsho, the fertilizer market in Oromiya appears more competitive than the Amhara region. Nonetheless, there is no competition at local level since the three firms often operate in different localities. The local authorities direct all credit sales to Dinsho in weredas where the company operates. Dinsho faces no threat of competition from AISE as the former is largely recognized as wholesale agent of the latter (except in rare cases like dumping by EAL in 1997). Credit sales by AISE are approved in places where Dinsho or AISE has no presences. Hence, fertilizer buyers in a given wereda do not have the opportunity of choosing among dealers in the region. The market is rather characterized by local monopoly dealers. Likewise, the fertilizer market in SNNPR was dominated by AISE as it accounted for 84.4% of the total sales in 1997. The rest, 15.6%, was supplied by EAL.

Third, fertilizer distribution is characterized by the principal-agent relationship between importers and wholesalers/retailers. Distributors, wholesalers and retailers are not in a position to call on several suppliers and obtain the best possible deal. They operate as commission agents of the importers and are therefore unable to establish themselves as fully independent and competing operators. If the plan to introduce licensing of fertilizer dealers/agents by the government becomes effective, dealers will have the opportunity to buy the input from importers/distributors of their choice. This will widen distribution network and attract new entrants into the market.

Finally, fertilizer demand is also affected by regulated prices. Although retail prices have been deregulated (since February 1997), the wholesale price is still fixed by the government. Late announcement of the wholesale price in 1997 resulted in delays for the belg season. More importantly, fertilizer sales do not start until the price for the year is announced by the government. For many farmers, fertilizer sales start long after they have sold their grain, not when their cash constraint is less binding. The market is expected to improve with the deregulation of the wholesale fertilizer prices by December 31, 1997.

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3.2 Credit

Fertilizer sales are largely financed through credit in Ethiopia. It is estimated that close to 80% of the annual off-take is covered by credit from the banks.[10] Historically, fertilizer demand goes up and down with changes in the supply of credit.[11]

Because of massive default, the Agricultural and Industrial Development Bank of Ethiopia (AIDB) sharply reduced its supply of fertilizer loan in the early 1990s. The loss was

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[10] For instance, 2,098,830 qt of DAP and 432,690 qt of urea were sold in 1996. Assuming farmers pay some 25% of the total cost in the form of down-payment, the financial requirement for the transaction can be estimated as 376,482,825 birr. The banks extended 298,965,000 or 79.4% of the requirement in the same year.

[11] See for instance, KUAWAB/DSA, Fertilizer Marketing Survey, Vol. 1, USAID/Ethiopia, Addis Ababa, April 1995.

absorbed by the state and the bank, renamed as Development Bank of Ethiopia (DBE). DBE was granted afresh start in 1992.[12] The Transitional Government of Ethiopia (TGE) also revised the 1988 Rural Credit Policy of the National Bank of Ethiopia (NBE). which made input loans a close preserve of AIDB[13]. In 1994, the Commercial Bank of Ethiopia (CBE), with 150 branches, became involved in the extension of agricultural credit along with the Development Bank of Ethiopia (DBE) (35 branches) the former AIDB. Loan recovery improved somehow after the disastrous record of the early 1990s. CBE, for instance, reported a recovery rate of ..%? and 83%? in 1995/96 and 1996/97, respectively. DBE also reported a recovery of 95% and 87% during the same period (Table 7).

Table 7: Loan Recovery by Region ('000).

Region	1995/96				1996/97			
	Disbursed.	Collected	Outstanding	Rec. Rate	Disbursed.	Collected	Outstanding	Rec. Rate
DBE	**56869**	**56708**	**3267**	**95**	**130364**	**124329**	**18772**	**87**
Tigray	1252	1206	216	85				
Oromiya	28790	28956	1557	95	63799	58245	13203	82
Amhara	25688	25332	1472	95	37632	39351	15891	99.9
SNNP	1138	1213	23	98	28917	25721	5549	82
Reg. 14	-							
Reg. 13	-				16	13	4	75
CBE	**221130**	**222522**	**19694**	**91.8**	**242096**	**214585**	**43295**	**83**
Tigray	2093	1826	415	81.4				
Oromiya	28559	30203	1184	96	179053	152505	39832	79
Amhara	150228	149790	14034	91.4	30250	31904	-	100
SNNP	36870	37035	3972	90.3	29226	27765	2295	92
Reg. 14	3380	3668	90	97.6	3568	2411	1168	67
Reg. 13								

SOURCE: DBE and CBE

[12] Poor credit recovery (54% in 1990, 37% in 1991 and 15% in 1992) resulted in outstanding loans of about 140 million birr.

[49] The financial sector reform raised interest rates from 6% in 1992 to 11-12% in 1993, 14-15% in 1994, and 15-16% in 1995 and 1996. The NBE directive of 1994 (NBE/INT3/94) allowed the banking sector to set its own lending rates, but fixed the maximum at 15%.

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3.2.1 Fertilizer Loan Administration

The improvement in loan recovery over the last two years was largely due to the administrative measures taken by the regional authorities to enforce repayment. Farmers with overdue loans are threatened with fines and imprisonment to enforce repayment. The power of the local governments was further consolidated when a new credit system was introduced in 1996/97. The responsibility of credit disbursement and collection was transferred from the banks to the regional governments. The regional governments estimate their fertilizer credit requirements and sign a loan agreement with the banks. The regional councils in turn advance the money to Service Cooperatives (SCs) and farmer groups. However, different procedures have been applied in processing fertilizer loan by the regions.[14]

In the Amhara and Southern regions, the processing and administration of the credit is the sole responsibility of the regional governments. The regional states borrow the input credit directly from the banks and rely on its own administrative machinery and peasant organizations to disburse and collect the loan. To be eligible for credit, a farmer must have repaid all his/her prior loans. The Input Coordination Unit at the peasant association (PA) level screens farmers who apply for credit and gives its recommendations in writing to the service cooperatives[15]. The service cooperatives collect similar recommendations from its member PAs and submits its application for credit to the Wereda Agriculture Bureau. In the absence of SCs the PAs or group of farmers directly submit their demand to the Agriculture office. The Bureau makes its own screening and then submits aggregated credit requests to the wereda ICU which reviews and decides each proposal against the credit made available (by the regional council) for the wereda. Once approved, the wereda administration nominates the supplier of the inputs and advises the wereda Finance Bureau. The Finance Bureau and the cooperatives sign a loan agreement and the cooperatives deposit up to 25% of the fertilizer price (collected from the farmers) in the form of down-payment. The signing results in the issuance of a delivery order by the Finance office which the cooperatives use to collect their stock from the supplier. The loan including the accrued interest on maturity date is repaid by the regional states as per the agreement concluded.

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[14] The only exception is Tigray where a largest part of the fertilizer credit, estimated at about 16 million birr per annum is met through the funds made available by the Relief Society of Tigray (REST). The credit is processed through REST's Savings and Credit Stations. The terms of credit included 10 to 25% down-payment and the market (bank) lending interest rate is charged on the balance.

[15] In 1995, the Input Coordination Unit (ICU) was established at all levels to coordinate the distribution of all farm inputs. The ICU at the regional, zonal and wereda levels were expected to facilitate loan disbursement and collection by the banks. Representatives from the administration, finance bureau, banks, suppliers and MOA form the committee of the ICU. The committee at the wereda level is chaired by the chief administrator who often plays a key role in the whole process of credit supply and collection.

In Oromiya, the Regional Government concludes the loan agreement on behalf of the borrowers with the banks but the processing and administration of the loan is handled by the banks themselves. The cooperatives or peasant associations apply to the banks for credit with a supporting letter from an authorized wereda official. The banks process the application and issue input delivery order. Dinsho is nominated as the supplier firm in areas where it operates. The Regional Government is responsible for timely loan repayment and in case of default is liable as a guarantor.

3.2.2 Constraints in the Credit Market

Although credit repayment has improved under the new arrangement and the volume of credit supply has been increasing in recent years, it appears that the approach suffers from some serious limitations with important implications for fertilizer demand. The system has resulted in direct intervention by the government in the financial market. Credit allocation and collection procedures have deviated from the principles of normal banking operations, leading to distortions, delays in sales and unnecessary strains on the farmers as well as on the administration and extension staff.[16] The allocations of loans are not only bureaucratic but also contrary to market principles. For the most part, only firms favored by the authorities are nominated as suppliers: mainly Ambassel in the Amhara region, Dinsho in Oromiya and AISE (together with its wholesale agents) in the Southern. Administrative measures applied to enforce repayment can also be harsh and inconsiderate of the farmers' circumstances. For instance, collection begins immediately after harvest in all areas. All farmers are forced to bring their produce to the market at the same time (to pay their fertilizer debts, taxes, etc.). As a result, supply exceeds demand and prices fall sharply whenever farmers are pressed for repayment. The system does not accommodate the need of farmers who want to incur additional interest costs with the aim of gaining from higher prices later during the year.

The penalties for all those who failed to repay immediately after harvest may include the sale of assets (e.g oxen or other animals) by the authorities (together with policemen). Farmers may develop a negative outlook towards fertilizer loans and become more risk-averse. Another commonly practiced measure is to withhold fertilizer credit to SCs with defaulting members during the next season. Such decisions of withholding credit sales until all members of a given service cooperative have paid their debts is likely to cause unnecessary delays and penalize too many non-defaulting farmers.[17]

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[16] Other regular development or social activities of the regional bureaus are likely to be adversely affected by the increased work load. Extension and other staff of the agriculture bureau are required to devote a good part on their time of loan disbursement and collection, instead of development activities. Delays in processing loan applications by the local authorities (finance bureaus and others) has also negatively affected timely distribution of fertilizer in parts of the Amhara and Southern region. (See for instance, Itana Ayana, Agricultural Inputs Credit Performance Since 1994 and Plans for 1997, Paper presented at the National Fertilizer Workshop, 15 - 18 October, 1996). The staff of wereda finance bureaus have limited time and experience in loan disbursement and consider the assignment as additional burden.

[17] The measure of withholding credit, for instance, resulted in considerable delays in the case of the Oude service cooperative located some 55 km south of Addis Ababa along the highway connecting the

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Realizing that the marketing and the credit delivery systems are among the major factors in the smooth operation of the market, the government intends to introduce the so called coupon system with the objective of allowing farmers to purchase farm inputs from suppliers of their choice and creating a more competitive distribution network (Tibebu Haile, 1997) . This would mean that the choice of suppliers will not be left to the local government officials. But the absence of a viable farmer organization for the delivery and recovery of rural credit is likely to continue constraining fertilizer distribution in the country.

The absence of an effective peasant institution for credit delivery is the other major problem associated with the existing credit system in Ethiopia. A typical service cooperative has over 5 to 6 member peasant associations or over 1000 member households. It is simply too large to provide effective screening of borrowers, generate reliable demand information, and/or exert any form of peer pressure on members to make timely repayment of debts. Weak cooperatives are also the main reason for the government intervention in the credit market and diversion of valuable extension time to administrative affairs. Hence, the effort to restructure service cooperatives into smaller groups needs to be stepped up.

Finally, unlike other types of loans, fertilizer credit is not insured. The loan is expected to be paid regardless of the harvest. There are no provisions to help those requesting even the postponement of repayment for the next season. The sale of critical assets like oxen becomes unavoidable in situations of crop failure. Access to credit alone may not induce fertilizer use where the risk of production is high. Resource poor farmers could be discouraged from using or applying sufficient quantities of fertilizer so long loans are not insured.

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4. OPTIMUM RATES OF APPLICATION AND FERTILIZER PROFITABILITY

One of the major factors affecting demand for fertilizer is profitability. As shown below the profitability of officially recommended levels of fertilizer use has declined in recent years because of changes in both input and output prices.

4.1 Recommendation Rates

Fertilizer use in Ethiopia started with low rates of application. For over two decades, the Ministry of Agriculture (MOA) recommended 100 kg DAP (mainly phosphorous fertilizer) per hectare in most places. The research recommendation that 50 kg of urea (nitrogenous fertilizer) applied along with the 100 kg DAP was largely ignored during this period except in a few major teff producing areas. This was logical given that larger farm sizes permitted fallowing and crop rotations in which nitrogen fixing pulses and oilseeds were rotated with

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capital with Nazreth. Fertilizer sales began 15 to 20 days after the optimal planting time for wheat and teff. The farmers believe that it is not logical to penalize 1,122 farmers (drawn from 6 peasant associations) just because a handful of individuals failed to make the necessary payment.

cereals. Consequently, about 90% of the fertilizer import was in the form of DAP with the balance 10% taking the form of urea.

Higher application rates were recommended to farmers after the four-year experiments (1988 to 1991) of the Agricultural Development Department / National Fertilizer and Inputs Unit (ADD/NFIU). The results of these experiments showed that farmers needed to apply a significantly larger amount of both nitrogen and phosphorous to maximize their return. The optimum rates recommended by ADD/NFIU vary by crop type and region but a larger (relative to the recommendation of MOA) amount needed to be applied in each case. In the case of teff, for instance, farmers in Shoa needed to apply 64 kg N and 57 kg P_2O_5 or 91 kg of urea and 124 kg of DAP per hectare (215 kg in total) to get optimum results in 1992. The rates for wheat for the same area (Shoa) were higher: 76 kg N and 60 kg P_2O_5 or 114 kg of urea and 130 kg DAP (a total of 244 kg). It should be noted the economic optimum rates calculated using the same prices (1992) and quadratic equation used by NFIU, gave a much higher figures than these rates . For instance, the optimum rate (1992) for teff in Shoa was calculated as 110 kg urea (19.6% higher than ADD/NFIU) and 169 kg DAP (36.3%) (total 279 kg/ha) (See Annex III)[18].

Drawing mainly on these results, the new recommendation rate for the major cereals, which was being popularized first by the SG 2000 project in Ethiopia and later by the new extension program of the government, has been set at 100 kg of urea and 100 kg of DAP per hectare for most areas. Considering the trials of ADD/NFIU and the limited opportunities for fallowing and crop rotation, the higher rates of application are justified. The fact that the current cultivation practices do not incorporate crop residues into the soil also mean that higher doses of fertilizer are required to grow crops.

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4.2 Trends in profitability and rates of application

In order to assess the trends in fertilizer profitability, the value cost ratio (VCR)[19] has been calculated for the years 1992 (the year immediately after the grain market liberalization) and 1997 (after the removal of the fertilizer subsidy) using the optimum rates suggested by ADD/NFIU (Table 8). The results demonstrate that fertilizer profitability has sharply declined between 1992 and 1997. Across the country, the VCR for teff declined by 55%, i.e. from 3.74 in 1992 to 1.69 in 1997 (Figure 1). The sharpest fall was observed in the case of maize: its VCR declined by 67% (Figure 2). A decline of 48, 47 and 41% was observed for wheat, barley and sorghum, respectively.

In general, the ratio fell below the critical threshold of 2 for 70.8% of the sites/crops in 1997, compared to none in 1992. Among the five crops, only barley came out with a VCR

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[18] ADD/NFIU defined economic optimum rate (EOR) as the point on the yield response curve where the last birr invested in an input will provide the farmer a net return of one birr. It appears that the Unit was mistaken in the calculation EOR.

[19] The value cost ratio (VCR) measures the return framers receiving from investing on fertilizer. It is generally believed that farmers would like to see a 100% return or a VCR of 2 in order to make the necessary investment decision.

greater than 2 across the country and for all sites in 1997. Wheat was the next more profitable crop, with a VCR of 1.95 across the country (and with 2 out of 4 sites attaining a VCR greater than 2). The lowest profitability was observed in the case of maize (1.41) followed by sorghum (1.57). The VCR was 1.69 in the case of teff, and the minimum teff price must increase by 19.2% over the harvest season price of 1997 in Shoa to ensure the desired level of incentive (VCR of 2). In general, barley, wheat and teff appeared more profitable than maize and sorghum.

In practice, many farmers tend to reduce their rate of fertilizer application following higher fertilizer prices (relative to output prices). Indeed, the optimum rate calculated using the grain and fertilizer price showed that application rates must decline significantly if farmers have to apply input levels that maximize return (Annex III). Compared to 1992, the rate of urea and DAP application in the case of teff farmers in Shoa must be reduced by 21.8% and 31.4%, respectively in 1997. The results show that recommended rates may need to change in line with changing market conditions especially if there are no input subsidies or if price stabilization measures are non-existent.[20]

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[20] As neither farmers nor government knows ahead of time what output prices will be in liberalized markets, perhaps what is needed is for the extension services to provide farmers with examples of a range of application rates/returns based on different price scenarios -- then the farmers can decide what they think the price will be and invest in fertilizer accordingly.

Table 8: Value Cost Ratio Based on NFIU Trial Data

	N	P2O5	Fert. cost 1997	incremental yield with fert.	Output Price, 1997	VCR 1997	VCR 1997 *1.2	Fert. cost, 1992	Output Price 1992	VCR 1992	Min Out. Price	Change %
1	3	4	5	6	7	8	9	10	11	12	13	13/7
Teff												
Shewa	64.00	57.00	515.86	641.00	1.35	**1.67**	2.01	211.67	1.22	**3.69**	1.61	19.67
Gojam	57.00	56.00	480.48	592.00	1.35	**1.66**	1.99	197.26	1.22	**3.66**	1.62	20.69
Arsi, Bale	45.00	47.00	390.54	473.00	1.35	**1.63**	1.95	160.39	1.22	**3.60**	1.65	22.78
Other	12.00	42.00	222.60	195.00	1.35	**1.18**	1.41	91.98	1.22	**2.59**	2.28	69.75
ATC	57.00	53.00	468.42	590.00	1.35	**1.69**	2.03	192.25	1.22	**3.74**	1.59	18.06
Wheat												
Shewa	76.00	60.00	581.68	1091.00	1.12	**2.09**	2.51	238.52	0.88	**4.03**	1.07	-4.37
Gojam	62.00	47.00	466.70	997.00	1.12	**2.38**	2.86	191.33	0.88	**4.59**	0.94	-16.04
Arsi, Bale	66.00	72.00	585.12	826.00	1.12	**1.57**	1.89	240.36	0.88	**3.02**	1.42	27.06
Other	47.00	52.00	419.60	716.00	1.12	**1.90**	2.28	172.38	0.88	**3.66**	1.17	5.12
ATC	67.00	59.00	537.34	940.00	1.12	**1.95**	2.34	220.47	0.88	**3.75**	1.14	2.54
Barley												
Shewa	56.00	59.00	488.06	963.00	1.03	**2.03**	2.43	200.45	0.79	**3.80**	1.01	-1.30
Arsi, Bale	56.00	69.00	528.26	1199.00	1.03	**2.33**	2.80	217.15	0.79	**4.36**	0.88	-14.20
Other	44.00	67.00	466.46	1061.00	1.03	**2.34**	2.80	191.97	0.79	**4.37**	0.88	-14.38
ATC	59.00	64.00	521.60	1129.00	1.03	**2.22**	2.67	214.26	0.79	**4.16**	0.92	-10.03
Maize												
Shewa	56.00	55.00	471.98	1325.00	0.53	**1.48**	1.77	193.77	0.65	**4.44**	0.71	35.44
Gojam	80.00	90.00	720.20	1932.00	0.53	**1.41**	1.69	295.90	0.65	**4.24**	0.75	41.74
Welega, Kefa, Illubab	90.00	90.00	765.00	1855.00	0.53	**1.28**	1.53	314.10	0.65	**3.84**	0.82	56.81
GamuGofa, Sidamo	46.00	64.00	463.36	1212.00	0.53	**1.38**	1.65	190.60	0.65	**4.13**	0.76	45.37
Other	55.00	19.00	322.78	594.00	0.53	**0.97**	1.16	131.83	0.65	**2.93**	1.09	106.62
ATC	60.00	64.00	526.08	1410.00	0.53	**1.41**	1.69	216.08	0.65	**4.24**	0.75	41.87
Sorghum												
Shewa	24.00	54.00	324.60	759.00	1.04	**2.44**	2.92	133.86	0.72	**4.08**	0.86	-17.91
Hararghe	0.00	49.00	196.98	248.00	1.04	**1.31**	1.57	81.83	0.72	**2.18**	1.59	52.45
Other	39.00	70.00	456.12	809.00	1.04	**1.85**	2.22	187.88	0.72	**3.10**	1.13	8.22
ATC	34.00	67.00	421.66	636.00	1.04	**1.57**	1.89	173.77	0.72	**2.64**	1.33	27.25

ATC = Across the country

Agricultural producers may not need to reduce their application rates nor do they require government support (in the face of rising input costs) if good weather (like the year 1996/97) resulted in a higher yield response without being accompanied by a fall in grain prices. The implications of a 20% increase in yield response were thus assessed and the results showed that the VCR can approximate the critical threshold (VCR of 2) in the case of teff (Table 8). The threshold is exceeded in the case of barley and wheat but not in the case of maize and sorghum if good weather resulted in a 20% increase in yield response.

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By the same token, improved technological packages would have a similar yield-raising effect, i.e. offset the higher input prices. On the other hand, bad years such as 1997/98 would create considerable strain on farmers and may seriously jeopardize repayment of fertilizer loan.

Among the main reasons for the declining profitability are the rising fertilizer prices relative to output prices[21]. Fertilizer prices have sharply increased in recent years because of devaluation, removal of subsidies, uncompetitive fertilizer market and poor infrastructure (Annex I).The major factors contributing to the relatively lower grain prices are inadequate road and storage facilities, uncompetitive output markets, weak market information service and limited expansion of the non-agricultural sector.[22]

In spite of the decline in the level of profitability, fertilizer use in the country has continued to increase (for most of the years since 1992) (Annex I). At least two main reasons can be given for this. First, although farmers are unable to get a return of 100% (VCR = 2) or more (as in the years just before the devaluation), fertilizer is still profitable (not allowing for the risk of crop failure) with a return of (at the 1997 prices) 69% for teff, 95% for wheat, 122% for barley, 41% for maize, and 51% for sorghum. In view of the continuous cultivation system (due to shortage of land), fertilizer use may be viewed as profitable even though the rate of return has fallen below 100%. In the absence of alternative options to restore soil fertility, farmers have no choice but continue to invest on chemical fertilizers, although the return is inadequate to protect them against the various risks[23]. Second, the negative effects of the high fertilizer prices may have been offset by other factors including the market liberalization (which improved access), improved access to credit and the ongoing intensive extension effort.

Nonetheless, there is no guarantee that demand for fertilizer will continue to rise. In deed, there are indications that demand may stagnate or even decline unless corrective measures are taken. For instance, sales have fallen far short of supply in the last two years (see section 2 above). More importantly, fertilizer demand actually declined (by 18.5%) in 1997. This can be attributed to problems mentioned above (inefficient marketing, weak credit delivery system, and low profitability) and bad weather. It is also evident that these are not the only factors affecting demand. In this regard, it becomes imperative to look into the different factors affecting fertilizer sales or demand in Ethiopia. The next section attempts to identify these factors and assess their relative contributions.

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[21] Grain Prices were extremely low immediately after the 1996/97 harvest.

[22] See also Mulat Demeke, et al. Promoting Fertilizer Use in Ethiopia: The Implications of Improving Grain Market Performance, Input Market Efficiency, and Farm Management, 1997.

[23] As indicated above, valuable assets are sold to pay for fertilizer cost whenever crop failures occur. As indicated by KUAWAB/DSA (1995), many farmers sell livestock to pay for fertilizer even in normal years.

5. IDENTIFYING AND EVALUATING THE RELATIVE IMPORTANCE OF FACTORS INFLUENCING FERTILIZER CONSUMPTION

The Ethiopian government has three parallel goals with respect to fertilizer policy: (1) to increase the number of adopters, (2) to increase the application rates of those adopting, and (3) to improve the nutrient balance of fertilizer applied (i.e. increase nitrogen relative to phosphate).

In this section of the paper we provide insights that should help the government improve the design of policies to meet the first two goals. Specifically, we identify a range of factors that differentiate fertilizer users from non-users and then look into the factors that influence the intensity of fertilizer use (i.e. kilograms applied per hectare). In both cases, we quantify to the maximum extent possible the relative importance of these factors, thereby helping the government to identify areas of intervention likely to have the greatest impact on fertilizer demand.

Fertilizer decisions are made at the household level, so it is imperative to understand the set of factors influencing household decisions. To accomplish this we present a wide range of descriptive statistics on variables that explain fertilizer use and non-use by households as well as differences in the intensity of use. Some analysis concerns the entire nation, while other analysis focuses on the principal fertilizer-using regions.

Further analysis has been made at the wereda-level. This is an important complement to the household analysis because it helps us to separate factors that are household-specific from those that are related to residence in a particular wereda. The wereda level analysis also provides useful information for targeting government interventions as it is often easier to target a program to a geographic entity rather than to a particular type of household. In the wereda-level analysis we limit ourselves to the four regions where one would expect farmers in most weredas to be consuming fertilizer (Oromiya, Amhara, Southern, and Tigray).

Similar questions were asked at the household and for wereda-level analysis. Among the key questions addressed are: Why do some households or weredas in the higher fertilizer-use regions use no fertilizer at all? Why is average use per hectare higher in some households/weredas than in others? Are these differences strictly due to agroecological factors or are there other factors such as access to markets, credit, and infrastructure that need to be addressed?

In the household and wereda descriptive analysis, we look at the relationship between fertilizer use and the determining factors on a variable by variable basis. While such an approach is informative and provides us with a number of hypotheses about how each variable affects fertilizer use, the world is more complex. Each of the individual factors can be interacting with the other factors and it is important to understand how everything fits together to form a composite picture that more closely resembles reality. To accomplish this objective we developed a multivariate model using wereda-level data. The model looks at: (1) factors that determine whether a wereda (i.e. the aggregate behavior of all

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households in the wereda) uses fertilizer or not, and (2) factors that determine the intensity of use within the fertilizer-using wereda.

We begin this discussion with a brief review of the studies in Ethiopia to be followed by a section identifying the broad categories of factors that influence fertilizer use. We then turn to our analysis of the data, using the best available data (a combination of our own surveys and secondary data) to test the statistical relationship between these variables and observed fertilizer use. Finally we present and interpret the results of the multivariate model of fertilizer use at the wereda level.

5.1 A brief review of factors influencing fertilizer adoption and intensity of use

Fertilizer or adoption decisions are made at the household level, so it is imperative to understand the set of factors influencing household decisions. Several studies have shown that the decision to use fertilizer is influenced by various factors in Ethiopia. Itana (1985), for instance, showed that literacy, farm size, unavailability of cash for down payment, price of farm inputs and adequacy of rainfall were the most important determinants agricultural technology adoption. Mulugeta (1995) also identified that access to credit, herbicide use, timely availability of fertilizer, farm size and oxen are the most important determinants of fertilizer adoption. More or less similar results were also obtained Chilot, Shapiro and Mulat (1996). However, Teressa (1997), while drawing the same conclusions with respect to several variables, obtained a negative relationship between land size and fertilizer use. Asmerom and Alber (1994) also arrived at the conclusion that the use of fertilizer in North West and Central Ethiopia does not depend on farm resources such as capital and land to any significant degree. The main reason for these inconsistent results, at least for some important variables, may be attributed to differences in the area of study, smallness of the sample size and misspecification of the model.[24] The relevance of the results beyond the districts of the study may also be limited.

The area coverage of the study by Crooppenstedt and Mulat (1996) is probably the largest so far. All the main fertilizer consuming regions, namely Oromiya, Amhara, Southern Region and Tigray, were included in this. Attempts were also made to examine the impact of the ratio of output prices to fertilizer prices. The results showed that literacy status of the household head, access to all-weather road, access to banks, extensions services, and availability of labor play an important role in fertilizer adoption. The study also indicated that amount of fertilizer used (intensify of use) is influenced by several factors including previous experience with fertilizer, supply conditions, liquidity, oxen owned by the household, and the ratio of the price of the main crop to the cost of fertilizer. However, the study failed to include farm size, cropping pattern and rainfall in the analysis.

The implications of improving the performance of grain and input marketing on the profitability of fertilizer use was analyzed by Mulat, Ali and Jayne (1997). Evidence suggests that the existing system of fertilizer distribution in Ethiopia has resulted in high

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[24] For instance, some variables such risk factors, financial liquidity, agronomic circumstances (influencing response to fertilizer application), cropping pattern, etc. were not included in the model.

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fertilizer prices and lower grain prices. The study concluded that fertilizer profitability will significantly improve if the markets are made more competitive and efficient. The study, however, did not look into the implications of changes in profitability levels for fertilizer adoption. By way of conceptualizing the factors influencing fertilizer adoption and intensity of use, the factors influencing fertilizer demand have been grouped into the following seven categories.

i. **Profitability:** The profitability of fertilizer is among the major determinant of fertilizer use. Farmers will not be persuaded to adopt fertilizer unless its profitability is sufficiently high. The major factors influencing profitability are: (a) the price of output; (b) cost of fertilizer; and (c) the response of output to fertilizer application. The response rate itself is a result of the interaction of a large number of agronomic (largely controllable) and natural (uncontrollable) factors. The agronomic factors include land preparation, type of crop planted (cropping pattern), seed variety, seeding rate, planting time, method of fertilizer application, soil and water management, control of weeds insects, and balanced nutrient use. According to FAO (1987), incremental output to fertilizer application may decline by as much as 20 to 50% due to inappropriate crop variety, untimely planting and unbalance nutrient use. Among the uncontrollable variables are climate and soil type.

ii. **Risk factors:** There are numerous risks and uncertainties associated with crop production and marketing. Some of the most important risks under the Ethiopian farming conditions are moisture stress and drought, excess rains, hailstorms, flooding, frost, crop pests such as army worm and grasshoppers and abnormal weed infestation. Some areas are characterized by a very high coefficient of both inter- and intra-year variability. Low and fluctuating output prices together with a sudden rise in input prices and delays/unavailability constitute marketing risks. High risk conditions imply that farmers are less inclined to invest on fertilizer.

iii. **Human resources:** The quantity and quality of human resource possessed by a peasant household may be measured by the amount of family labor, educational background, age and gender of the household head. A positive relationship between education and fertilizer use, for instance, may signify the contribution of education to greater access to information. A larger family labor supply could also mean better cultural practices, leading to a more efficient/profitable use of fertilizer. Female-headed households are often underprivileged and may have discriminated access to other resources, hence they may be less likely to use fertilizer.

iv. **Extension services:** Farmers' attitude towards technology adoption is influenced by extension services. Many studies have shown that people who have adopted innovations have frequent contact with change agents. The skill of the extension agents and the extent to which the agent understands and accepts the farmer perspective has considerable influence on adoption.

v. **Household assets and capital:** Amount of land under cultivation, number of draft animal and other livestock owned are among the most important assets and capital in the

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rural sector. Households with less resources are expected to have a different attitude towards risk than those more resources. Resource-poor farmers may not afford the risk that they might not get any yield increase by applying fertilizer in a dry year. Shortage of oxen could also mean poor land preparation and failure to plant at the right, thus discouraging farmers from buying fertilizer, and also lowering the output response to fertilizer use.

5.2 Descriptive Analysis

Tables 9 shows the proportion of households using chemical fertilizer by region. Nationwide, 31.2% of the households used fertilizer in 1995/96. The vast majority (close to 70%) of the farming population did not make use of any chemical fertilizers. However, the percentage of non-users varies markedly within regions: 60% in Oromiya, compared to 71% in Southern region, 76% in Amhara and 79% in Tigray. Note also that on a national basis, the largest percentage of households using chemical fertilizer are in Oromiya.

Table 9: Percent of Households Using Chemical Fertilizer by Region and Nationwide in Ethiopia

Region	Within Regions		Total Percent	Nationwide percentage use
	Percent of households not using fertilizer	Percent of households using fertilizer		
Tigray	78.7%	21.3%	100%	4.6%
Amhara	76.3%	23.7%	100%	23.3%
Oromiya	60.0%	40.0%	100%	49.8%
SNNPR	70.8%	29.2%	100%	22.3%
Average	68.8%	31.2%	100%	100%

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The proportion of weredas using fertilizer (defined as weredas reporting households who use fertilizer - regardless of the number involved) is larger than the proportion of user households (Table 10). As a whole, the use of fertilizer was reported by 69 % of the weredas under consideration. The proportion of user weredas was larger for Tigray (77%) and Oromiya (75%) than for Amhara (61%) and Southern region (62%). The result indicates that fertilizer was more widely distributed than what may be inferred from the proportion of user house-holds. Fertilizer has been introduced in a larger number of weredas but the number of user households is not proportionately large, especially in Tigray.

Table 10: Percent of Weredas Using Chemical Fertilizer by Region and Nationwide in Ethiopia

Region	Within Regions		Total Percent	Nationwide percentage use
	Percent of households not using fertilizer	Percent of households using fertilizer		
Tigray	22.6%	77.4%	100%	11.2%
Amhara	38.8%	61.3%	100%	22.8%
Oromiya	25.5%	74.5%	100%	48.8%
SNNPR	38.3%	61.7%	100%	17.2%
Average	31.1%	68.9%	100%	100%

In order to get an even clearer picture, user and non-user weredas have been identified by region and zone (Table 11). The result shows that the variations across zones are very distinct. For instance, the proportion of weredas using fertilizer ranges from 0% in Wag Himra to 91% in West Gojam in Amhara. User weredas are also small in number in North Wello (13%) and South Wello (31%), North Gondar (36%) and Oromiya zone (40%). Most weredas in the more drought-prone areas (former Wello and North Gondar) do not use fertilizer. In Oromiya, a 100% use rate was found in West Shoa, East Shoa and Arssi, as compared to just 14% in Borena and 33% in West Hararghe. Over 50% of the weredas use fertilizer in the other zones. The variation across zones is more pronounced in SNNPR: fertilizer distribution is concentrated in four zones Hadiya (100%), Kembata Alaba Timbaro (100%), Guraghe (88%) and Sidama (88%) and Yem special wereda (100%). There are no user weredas in the other special weredas and many of the small zones. The distribution of fertilizer by zone is more uniform in Tigray, over 70% for all cases (Table 11).

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Table 11: Percentage of Weredas Using Chemical Fertilizers By Region and Zone

Region	Zone	Percentage of Weredas Using Fertilizer
Tigray	Tigray West	.83
	Tigray Centre	.73
	Tigray East	.71
	Tigray South	.80
Amhara	Gonder North	.36
	Gonder South	.75
	Wello North	.13
	Wello South	.31
	Shewa North	.79
	Gojjam East	.79
	Gojjam West	.91
	Wag himira	.00
	Agawawi	.67
	Oromia zone	.40
Oromiya	Wellega West	.59
	Wellega East	.88
	Illubabor	.72
	Jimma	.91
	Shewa West	1.00
	Shewa North	.79
	Shewa East	1.00
	Arssi	1.00
	Harerge West	.33
	Harerge East	.58
	Bale	.78
	Borana	.14
SNNPR	Gurage	.88
	Hadiya	1.00
	Kembata Alaba	1.00
	Sidama	.88
	Gedeo	.50
	Omo North	.47
	Omo South	.50
	Shekicho	.33
	Kaficho	.13
	Bench	.00
	Maji	.00
	Yem Special Wereda	1.00
	Amaro Special Wereda	.00
	Burji Special Wereda	.00
	Konso Special Wereda	.00
	Derashe Special Wereda	.00

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A number of reasons may be given for the observed variations in fertilizer use. This section is about the factors that led to the observed variations.

i. Fertilizer Profitability:

The proxy variables used for fertilizer profitability were cropping pattern, use of complementary inputs, average rainfall and altitude. Fertilizer use rate was hypothesized to be higher in the case of more profitable crops, usage of complementary inputs, higher rainfall and higher altitude areas.

The relationship between fertilizer use and area cultivated per crop by region of Ethiopia is shown on Table 12. For the entire sample, the share of teff in household total area cultivated is larger for fertilizer user households (26%) than nonusers (17%). Fertilizer users in Amhara and Oromiya tend to have a larger percentage of their household cultivated area under teff. The difference is significant in all regions but Tigray. Wheat is also popular among fertilizer users, with significantly higher percentages of area cultivated (among users) for the entire sample as well as for Amhara, Oromiya and SNNPR. The situation with respect to maize is mixed: although its cultivated percentage share is slightly higher among fertilizer users for the overall case (by 2%), Amhara (3%) and SNNPR (4%), it is less popular among users in Oromiya. Sorghum, coffee and chat are less common among users. For instance, fertilizer users for the overall sample allocated 8% of their land to sorghum as compared to 18% in the case of nonusers. Significant difference was observed for all regions except Tigray.

The preference for teff and wheat production among users is partly related to profitability. As shown in Section IV, these crops are more profitable than sorghum or maize. But other factors, such as relatively more stable and high prices may also carry more weight in the decision to fertilize teff. The lower preference for sorghum can be attributed to its lower profitability and drier ecological conditions in areas where the crop is a predominant crop and fertilizer use is not highly profitable.[25]

The proportion of households using improved seeds, pesticides, and irrigation is generally very small. These practices are also more common among users than noun-users. For instance, fertilizer-using weredas have a larger percent of farmers using improved seeds and pesticides in all regions but Amhara. Overall, some 4% and 17% of the farmers in user weredas reported using improved seeds and pesticides, respectively. By contrast, only 2% and 3% of the households in the non-user weredas made use of improved seeds and pesticides, respectively. User seem to realize that fertilizer profitability is higher when used with complementary inputs, though these are not widely available. Irrigation is also slightly more common among users than non-users but the difference is not statistically significant in all cases.

For the entire sample, a greater amount of rainfall is reported by fertilizer-using weredas than non-users, but the difference is signficant only for Amhara. Adequate rain is associated with more adoption of fertilizer. On the other hand, more rain is observed for non-users in SNNPR. Fertilizer use may have been discouraged by too much rain in this region.

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[25] The actual area planted to each crop rather than the percent allocated give similar results.

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A higher altitude was also observed in the case of weredas that use fertilizer and the difference was significant for the entire sample, SNNPR and Oromiya. Higher altitudes seem to provide The difference however is not statistically significant for Amhara and Tigray. Ferilizer-using weredas are alos only in the case of .. Higher rains (not leading to excess situation) and higher altitudes imply better growing conditions, thus encouraging fertilizer use.

Table 12: The Relationship Between Fertilizer Use/Non-Use and Household Relative Area Cultivated Per Cereal Crop By Region of Ethiopia

CROP:	Teff		Maize		Wheat		Barley		Sorghum		Millet	
	Non-User	User	Non-User	User	Non-User	User	Non-User	User	Non-User	User	Non-User	User
REGION	Mean values in the table are for household share of cultivated area devoted to each crop by user and non-user of fertilizer.											
Tigray												
Mean	.19	.20	.08	.09	.22	.18	.19	.22	.16	.13	.06	.10
Sig Dif												-.04*
Amhara												
Mean	.21	.36	.09	.13	.08	.10	.15	.07	.21	.09	.03	.07
Sig Dif		-.15***		-.03***		-.02*		+.08***		+.12***		-.04***
Oromya												
Mean	.14	.26	.21	.17	.06	.14	.09	.09	.19	.09	.02	.01
Sig Dif		-.12***		+.03**		-.08***				+.10***		+.007**
SNNPR												
Mean	.13	.18	.13	.18	.02	.11	.07	.06	.15	.04	.00	.00
Sig Dif		-.04**		-.04**		-.09***				+.10***		
TOTAL												
Mean	.17	.26	.14	.16	.07	.13	.11	.09	.18	.08	.02	.03
Sig Dif		-.09***		-.02**		-.06***		+.02***		+.10***		-.008**

Source: Calculated from CSA and FS survey data, 1995/96.

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ii. Production Risks:

The degree to which farmers are constrained by risk factors in using fertilizer is assessed using proxy variables such as percent of households which received food aid at least once during 1991-1995 and percent of households reporting crop damage in 1995/96. Overall, 45% of the households in the non-user weredas received food aid, compared to 30% in fertilizer user weredas.

iii. Human Resources:

For the overall sample, the literacy rate among the fertilizer user group was 7% higher than among nonusers and the difference was statistically significant. The results generally confirm that literacy has positive influence on fertilizer adoption. But it should be noted that although the percentage of literate household heads was larger in the users group for all regions but Tigray, the difference was large enough to be statistically significant only in the case of Amhara.

No significant difference was observed between the two groups with respect to age. Fertilizer adoption does not seem to be affected by whether the farmer is young or old. Similarly, experience in farming (measured by the number of years the respondent has been

operating as a farmer) is not significant for any of the regions. The significance of the experience variable for the overall sample, however, does suggest that users have slightly longer experience in farming than non-users.

The evidence does not support the argument that female headed households have fallen behind their male counterparts in terms of fertilizer adoption. For the entire sample, the percentage of female heads in the users group was 15% compared to 13% for nonusers and the difference was not statistically significant. The same insignificant difference was obtained for Amhara and Oromiya. However, the pattern was inconsistent in the case of Tigray and SNNPR: significantly larger percent of female headed households among users group in SNNPR but smaller in Tigray.

iv. Extension Services:

Overall, about 59% of the households in the fertilizer using category know about the new extension program (NEP), compared to only 43% in the non-using group. The difference is statistically significant for all regions but Tigray. A similar statistically significant difference was observed with respect to whether or not the household has participated in NEP. For the entire sample, 12% of the households in the user group participated, as opposed to only 3% in the non-user group. The difference was particularly large, 20%, in the case of Tigray, perhaps an indication that the extension program is the most important factors in the adoption of fertilizer in the region[26].

v. Household Assets and Capital:

Household assets are represented by the number of livestock owned (TLU) and capital by farm size and traction animals in this study. The results are consistent with the argument that resource base is an important determinant of fertilizer use. Results demonstrates that lack of resource is a serious constraint to fertilizer use. Fertilizer using households on the average own 5 tropical livestock units (TLU), as opposed to 3.65 in the case of nonusers. This difference (in favor of users) is true for the overall sample and for all regions except SNNPR. With respect to the number of TLU per capita, the difference is less pronounced but it is still statistically significant in Oromiya and for the overall sample.

A similar marked distinction between users and non-users was observed with respect to capital, proxied by ownership of traction cattle. On the average, fertilizer users owned 1.52 draft cattle, while nonusers owned only 0.99. The difference is more conspicuous in the case of Oromiya (.84) and Amhara (0.54). Fertilizer users in Tigray also owned 0.30 more traction cattle than nonusers. However, no distinction was observed between the two groups in SNNPR.

For the entire sample, users have 9% more traction households than nonusers. The differences (in percent of traction households for users and nonusers) ranged from 1% in Amhara to 14% in Oromiya and SNNPR. Access to traction animal is positively associated

[26] In Tigray, fertilizer adoption is not related to most other variables.

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with fertilizer use in all regions except Tigray where no difference between users and nonusers was found. Overall, the use of draft animals is very high (87%) for the survey regions; the percentage ranges from a low of 69% in SNNPR (where farm size is the smallest) to a high of 99% in Tigray. While many small farmers in SNNPR manually cultivate/dig their farm (true for enset areas), such practice seems to be non-existent in the north, particularly Tigray. In the absence of own draft animals, farmers may not be able to practice critical cultural practices on time. Hence they may be discouraged from using fertilizer as they are unable to efficiently utilize the input.

Table 13 examines the relationship between farm size and fertilizer use. Farmers who used fertilizer in Amhara and Oromiya cultivated more total land (.75 to 1 hectare more) and more land per person (0.15 hectares more per person) during the meher season of 1995/96 than farmers who did not use fertilizer. These are large differences given that average farm size for the overall sample is only 1 hectare. In Tigray and SNNPR, on the other hand, there is no statistically significant farm-size difference between users and non-users. But the overall sample results are similar to those for Amhara and Oromiya, which have the largest number of weighted observations.

The result that non-users cultivate smaller land than users contradicts the argument that intensification is higher on smaller farms (to compensate for land shortage). The reason may be found in the nature of smaller farm in Ethiopia. Households with very small plots seldom produce enough grain to meet their families' consumption requirements.[27] Such families (unless they rely on *enset* as in SNNPR or food aid in Tigray[28]) are likely to be dependent on the market for their food. Some families (e.g. poor families with no oxen or family labor) may largely rely on income earned from rented-out or sharecropped land and retain only a small plot which is planted without fertilizer. Others are more likely to be involved in various non-farm activities and wage employment (e.g food for work) to survive. Even with fertilizer many may not be able to produce for the market. They may be reluctant to invest their cash income on fertilizer (instead of buying food from the market) because of the risk involved. Poorer households often tend to be more risk-averse than better-off farmers. Households with more animals tend to have a better financial and traction capacity and are more likely to withstand the risk of crop failure (for they can pay fertilizer debts by selling animals). Our result imply that declining farm size can act as a barrier to technology adoption.

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[27] Since the average yield of cereals is about 10 quintals, farmers with small holdings, say 0.5 ha, can only manage to produce 5 quintals which is hardly enough to feed a family of 5 or 6 mouths

[28] See for instance Daniel C. Clay, et al., Improving Food Aid Targeting in Ethiopia: A Study of Food Insecurity and Food Aid Distributions, GMRP/MEDAC, 1997, forthcoming.

Table 13: Comparison of Mean Values of Land Access Indicators for Farmers Using and Not Using Fertilizer[29] During 1991-1995 Period

Region		Meher Hectares Cultivated (CSA Measure)		Meher Hectares Cultivated Per Person (CSA Measure)	
		Non-User	User	Non-User	User
Tigray					
	Mean	.96	1.10	.22	.21
	Sig Dif				
Amhara					
	Mean	1.09	1.92	.24	.37
	Sig Dif		-.83***		-.13***
Oromya					
	Mean	.97	1.74	.20	.33
	Sig Dif		-.76***		-.13***
SNNPR					
	Mean	.61	.62	.12	.12
	Sig Dif				
Total	Mean	.93	1.50	.20	.29
	Sig Dif		- .09***		-.57***

Source: Analysis of CSA and Food Security 1995/96 survey data (N=2597).

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[29] Fertilizer use category is based on FS variable which equals 1 if fertilizer was used at least once during the period 1991/2-1995/96, and equal to zero otherwise. The same definition has been used for the rest of the tables Observations are weighted using the adjusted weight variable standardized by the mean value of the weights for the 2597 cases of data retained after cleaning.

5.3 Changes in the Level of Fertilizer Use

Among the 823 respondents replying that they had either increased or decreased quantities of fertilizer used over the last five years (1991/91 - 1995/96), 477 increased and 346 decreased. Looking at the results by region, we find that Tigray was the only region where decliners outpaced advancers (27 decreased and 24 increased). Farmers reporting increase in the amount of fertilizer use were further asked about their first and second most important reasons for this decision. The first and second responses (if offered by the farmer) were combined to create and an index in which all first responses were given a weight of 2 and all second responses a weight of 1. The results for the frequencies of the index are given in Table 14.

Table 14: Reasons for Increasing Fertilizer Use from 1991/92 - 1995/96

Reasons for Increasing Quantity of Fertilizer	Frequency of Combined Weighted Responses
Declining soil productivity	634
Success in using on farm	515
Improvement in availability	137
Increase in credit availability	21
Other	14

Source: Calculated from 479 first responses and 379 second responses to Question Q6.1 in FS 1995/96 survey.

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Overall, declining soil productivity is the most important reason for increasing the level of fertilizer use. It seems that the natural process of continuous cultivation without replenishing soil nutrients is the major factor driving farmers to increase fertilizer use. Hence programs to stimulate adoption may need to be focused in areas where farming practices have shifted to intensive or continuous cultivation resulting from population pressure or shortage of land.

The next very important reason in increasing fertilizer quantities is farmers' ability to correctly use fertilizer. Success in using fertilizer seems to be followed by increased application of fertilizer. Bad experience, especially in the initial stages, may serious constrain adoption. It is thus important to have good extension programs to make sure that farmers are successful with their initial forays into intensification with fertilizer. Among the other less important reasons for increasing use rates are improved availability of both the input and credit supply.

The most important reason for reducing fertilizer use levels during the period 1991/92 - 1995/96 was the increase in the cost of fertilizer (Table 15). Some farmers seem to have failed to withstand the sharp decline in profitability (Section IV) and decided, as expected, to reduce application rates.

Table 15: Reasons for Decreasing Fertilizer Use During 1991/92-1995/96

Reasons for Decreasing Quantity of Fertilizer	Frequency of Combined Weighted Responses
Increase in the cost of fertilizer	379
Reduction in availability	183
Decrease in credit availability	81
Failure in use of fertilizer	66
Improved soil productivity	17
Other	63

Source: Calculated from 341 first responses and 208 second responses to Question Q6.2 in FS 1995/96 survey.

The availability issue comes out more strongly on the 'decrease' side than on the 'increase' side. It is the second major reason for using less amount of fertilizer than in the past. Perhaps the lesson here is that one needs to build fertilizer distribution networks in a manner that insures their survival, rather than implementing programs with broad geographic coverage that cannot be sustained. It is also important to note that some farmers have reduced their consumption of fertilizer due to reduced availability of fertilizer and lack of success in using the input.

5.4 Factors Affecting the Use of Fertilizer by Farmers

This section reports the results of wereda-level econometric analysis of factors affecting whether or not fertilizer was used in the wereda, and the level of fertilizer used per hectare by households in the wereda. A total of 361 weredas were included, based on data collected from the CSA Agricultural Survey and the GMRP Food Security Survey, both covering the 1995/96 crop year. A selectivity model was used to address this issue; methodological details will be reported in a subsequent report. In this section, we focus on the model results and policy implications. As a prelude to the analysis, a large set of potential variables were examined through descriptive correlation analysis. The set of variables explored were:

DOMAIN: Categorical domain-level variables were constructed to examine how average fertilizer use (kg per hectare) in the 361 weredas varied according by domain. There are 21 domains covered in the analysis.

AVGRF5: Amount (mm) of rainfall per year in the wereda, based on a five-year historical average.

AVGELEV5: Average elevation of the wereda.

SCMEMB_2: Percent of households in the wereda that are members of a service cooperative. It is hypothesized that this variable may affect households' access to credit, since the large majority of households relying on credit must belong to a farmer group in order to obtain it.

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CROPDMG: Percent of households reporting crop damage from animals in the wereda. This variable was included due to widespread reports by farmers that fertilizer use is uneconomic even in some productive areas because of crop damage by wild animals.

NUMDISTC: Number of fertilizer distribution centers in the zone.

TOTBAN_W: Numbers of development banks and commercial bans in the wereda.

PCFEMHHH: Percent of female-headed households in the wereda.

PCLITHHH: Percent of households in the wereda in which the head is literate.

AVFRMSIZ: Average farm size per household in the wereda

KNOEXT_1: Percent of households in the wereda that have knowledge of the Government's New Agricultural Extension Program (a proxy for interaction with extension agents).

SORG: Categorical variable taking a value of 1 if the main cereal crop produced in the wereda is sorghum.

TEFF: Categorical variable taking a value of 1 if the main cereal crop produced in the wereda is teff.

WHT: Categorical variable taking a value of 1 if the main cereal crop produced in the wereda is wheat.

PERFA5_1: Percent of households in the wereda receiving food aid in the past 5 years.

TLU: Average amount of livestock owned by households in the wereda.

Basic descriptive statistics on each of these variables is presented in Table 16. There were only 312 valid cases (weredas) in which data was available for all variables.

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Table 16: Descriptive Statistics on Key Variables Hypothesized to Affect Average Fertilizer Use in Ethiopia

Variable	Mean	Std. Dev.	Minimum	Maximum
AVGRF5	1207.33	367.39	0	2100.0000
AVGELEV5	2076.67	461.27	1000.00	3500.0000
SCMEMB_2	32.86	34.13	0.00	100.0000
PCLT10P	77.55	33.35	0.00	100.0000
CROPDMG	69.80	25.39	0.00	100.0000
NUMDISTC	14.50	8.59	0.00	45.0000
TOTBAN_W	0.29	0.61	0.00	3.0000
PCFEMHHH	0.17	0.09	0.00	0.5800
PCLITHHH	0.23	0.1316	0.00	0.6400
AVFRMSIZ	1.10	0.62	0.11	3.5600
KNOEXT_1	51.75	35.52	0.00	100.00
SORG	0.34	0.30	0.00	1.00
TEFF	0.48	0.58	0.00	1.00
WHT	0.12	0.68	0.00	1.00
PERFA5_1	33.42	39.01	0.00	1.00

Each of these variables was included in the selection model to begin with. A second model was specified after dropping a small number of variables that were shown to be statistically unrelated to wereda-level fertilizer use. The final set of variables estimated in the probit part of the model (i.e. factors determining whether or not households in the wereda used fertilizer) was Di (domain-level categorical variables, with the Tigray domain being incorporated into the constant), AVGRF5, AVGELEV5, AVGFRMSIZ, SCMEMB_2, PCLT10P, CROPDMG, NUMDISTC, TOTBAN_W, AVGFRMSIZ, PCFEMHHH, PCLITHHH, TLU, KNOEXT_1, HASORG, HATEFF, HAWHT, and PERFA5_1. The final set of variables estimated in the continuous portion of the model were: a constant, AVGRF5, AVFRMSIZ, TLU, AVGELEV5, SCMEMB_2, PCLT10P, CROPDMG, NUMDISTC, TOTBAN_W, PCFEMHHH, PCLITHHH, KNOEXT_1, SORG, TEFF, WHT, PERFA5_1.

Of the 312 valid weredas included in the model, there were 101 in which none of the households sampled used fertilizer, and there were 211 weredas in which the average fertilizer use was greater than zero. Of the 101 weredas in which average fertilizer use was zero, the model predicted correctly in 68% of the cases. For the 211 weredas where average fertilizer use was greater than zero, the model predicted correctly in 89% of the cases. The model results are contained in Table 17.

The results indicate that many of the statistically important factors affecting whether or not households in the wereda used fertilizer were related to access to fertilizer, credit, and extension services. The variables representing number of fertilizer distribution centers and

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distance from markets were both highly significant and positively related to the use of fertilizer in a given wereda. The results also indicate that the number of commercial and development banks in the wereda was moderately important and positively related to the use of fertilizer. Also, the variable proxying for interaction with extension agents positively and significantly increased the probability that fertilizer was used in a given wereda.

The dominance of teff in production patterns was also found to be an important determinant of fertilizer use. This is consistent with information presented earlier that teff area receives a large portion of the total crop area that is fertilized. Sorghum area was found to have a negative but not strongly significant impact on the probability of fertilizer use in a given wereda. Lastly, the percentage of female-headed households was positively related to the probability of fertilizer use. It is not immediately clear why this result would be obtained, and research is continuing to uncover other potentially omitted effects that could be correlated with the prevalence of female-headed households at the wereda level.

Perhaps surprisingly, neither rainfall, elevation, average farm size, nor livestock assets significant affected whether or not fertilizer was used in a given wereda.

Strong domain-level effects also influenced whether or not fertilizer was used in a given wereda. Since Tigray was modeled as the base region, results are presented relative to this region. The results indicate that after controlling for the predetermined variables entered into

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Table 17: Selectivity Model Results with Probit Selection Rule

ML Estimates of Selection Model	
Maximum Likelihood Estimates	
Dependent variable	KG_HA
Number of observations	312
Iterations completed	39
Log likelihood function	-1376.715
LHS First 30 estimates are probit equation.	

Variable	Coefficient	z=b/s.e	significance level
Probit portion			
Constant	-3.2457	-2.564	0.01034
D3	-1.3998	-1.903	0.05709
D4	-1.3625	-1.952	0.05092
D5	-1.9344	-2.061	0.03926
D6	-1.5495	-2.837	0.00455
D7	-1.5793	-2.331	0.01974
D8	-0.2198	-0.316	0.75170
D9	-0.4903	-0.674	0.50022
D10	-0.48940	-0.582	0.56034
D11	0.32098	0.625	0.53176
D14	-0.91186	-1.080	0.28012
D15	-0.30617	-0.478	0.63271
D16	0.77125	0.881	0.37825
D17	0.18054	0.232	0.81689
AVGRF5	0.17669E-03	0.333	0.73899
AVGELEV5	0.35819E-03	1.171	0.24178
AVFRMSIZ	0.26845E-02	1.374	0.21956
SCMEMB_2	0.38678E-02	1.035	0.30090
PCLT10P	0.57848E-02	1.786	0.07405
CROPDMG	-0.16554E-02	-0.323	0.74632
NUMDISTC	0.80275E-01	2.776	0.00551
TOTBAN_W	0.30329	1.498	0.13414
PCFEMHHH	2.6739	2.414	0.01576
PCLITHHH	1.7521	1.701	0.08895
TLU	0.12893	0.421	0.67366
KNOEXT_1	0.75034E-02	2.251	0.02437
SORG	-0.34960E-01	-1.091	0.27513
TEFF	0.16310	3.591	0.00033
WHT	0.34364E-01	0.996	0.31925
PERFA5_1	-0.49136E-02	-1.234	0.21715

CCRDA

Continuous model (using inverse Mills ratio)

Variable	Coefficient	z=b/s.e	significance level
Constant	224.23	2.308	0.02100
AVGRF5	-0.527E-01	-1.638	0.10149
AVFRMSIZ	0.298E-02	2.304	0.03956
TLU	0.481E-01	1.673	0.10896
AVGELEV5	-0.205E-01	-0.820	0.41229
SCMEMB_2	-0.188E-01	0.297	0.94912
PCLT10P	0.879E-01	0.246	0.80538
CROPDMG	0.11890	0.283	0.77703
NUMDISTC	0.23220	0.158	0.87464
TOTBAN_W	20.525	1.485	0.13754
PCFEMHHH	-177.63	-1.323	0.18574
PCLITHHH	-5.469	-0.646	0.51809
KNOEXT_1	0.12089	0.373	0.70878
SORG	-3.4263	-1.404	0.16045
TEFF	1.3334	1.047	0.29514
WHT	0.88232	0.455	0.64929
PERFA5_1	-0.25159	-0.778	0.43684
Sigma(1)	95.357	21.093	0.00000
Rho(1,2)	-0.20489	-0.665	0.50606

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the probit stage of the model, the following areas had significantly (10% level) less likelihood of using fertilizer, relative to Tigray: North and South Gondar, East and West Gojjam and Agewawi, North Wello and Wag Hamra, South Wello, Oromiya Zone and North Shewa, and East and West Wollega. These results should not be construed that fertilizer use is higher in Tigray than these areas, but rather that *after controlling for other variables entered into the model,* there are unexplained residual differences in fertilizer use between Tigray and these other domains. Two other domains were found to have relatively large number of weredas in which fertilizer was used relative to the base region, after controlling for other factors: these are Hadyia, Gurage and Kembata, as well as East and West Hararge.

Many of the variables that were statistically significant in explaining whether or not fertilizer was used in a given wereda become relatively unimportant in explaining the intensity of fertilizer use across weredas (average kg used per hectare in the wereda). There are differences in the set of factors explaining whether or not fertilizer is used and the intensity of fertilizer use. The most important factor explaining the quantity of fertilizer used per hectare is average farm size. As farm size increases, so does the intensity of fertilizer use. This is consistent with results presented earlier showing a strong correlation between farm size and fertilizer dose (kg applied per hectare). This positive association may be due to several factors: larger farms may generate more cash to purchase fertilizer without dependence on credit programs. The credit-related constraints on fertilizer use are underscored by the fact that 80% of fertilizer use in the country is financed on credit. The results also show that the amount of livestock ownership is positively related to fertilizer use intensity. This is most likely because livestock ownership

is correlated with draft animal ownership, which is found to be important in facilitating fertilizer use in many countries of Africa (see Dione 1990).

Again, variables such as rainfall, elevation, and membership in service cooperatives were not statistically associated with intensity of fertilizer use. A major conclusion from this wereda-level model is that while we have identified a number of important factors explaining whether or not fertilizer is used in a given wereda, these factors do not appear to have a great effect on the intensity of fertilizer use. We are currently investigating in more detail the determinants of fertilizer use and intensity among households to uncover potentially cost-effective strategies for promoting fertilizer use in Ethiopia.

Summary of econometric findings:

- Access to fertilizer, credit, and extension services are of major importance in determining whether fertilizer is used in a given wereda. The following variables were positively associated with weredas where fertilizer was used: number of fertilizer distribution centers, average distance of households from markets, number of commercial and development banks in the wereda, and interaction with extension agents.

- Major teff producing areas were also found to be positively related to fertilizer use at the wereda level. Sorghum area was associated with a negative but not strongly significant impact on the probability of fertilizer use in a given wereda.

- For reasons that are not entirely clear, the percentage of female-headed households was positively related to the probability of fertilizer use.

- Perhaps surprisingly, neither rainfall, elevation, average farm size, nor livestock assets significant affected whether or not fertilizer was used in a given wereda.

- Strong domain-level effects also influenced whether or not fertilizer was used in a given wereda. The highest use of fertilizer by zone, after accounting for other included variables, is Hadyia, Gurage and Kembata, as well as East and West Hararge.

- The most important factor explaining the *quantity* of fertilizer used per hectare is average farm size. As farm size increases, so does the intensity of fertilizer use.

- The amount of livestock ownership is positively related to fertilizer use intensity.

- Variables such as rainfall, elevation, and membership in service cooperatives were not statistically associated with intensity of fertilizer use.

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6. SUMMARY AND CONCLUSIONS.

This study has examined how the fertilizer sector evolved since the introduction of the policy reforms in Ethiopia with a view to assessing the implications for enhancing fertilizer use in the country. The results indicate that the full benefit of the reform has not been realized because of various constraints in the marketing system and institutional issues. Fertilizer retailing is carried out by the large distributors/wholesalers with limited number of sales outlets. As a result, the distribution system at the local level has not encouraged a more flexible and a wider availability of the input. Often the market in each wereda, zone or region is controlled by a single firm, thus giving rise to a monopolistic market structure.

Because of an uneven playing field, some firms are unable to sell their fertilizer stock during a given season. Failure to sell supplies may create serious uncertainty, besides the considerable financial costs created. Sales uncertainty can impede free entry into the fertilizer market and constrain investment in market infrastructure.

Fertilizer sales do not start until the price for the year is announced by the government. Late announcement of the wholesale price in 1997, for instance, resulted in delays in sales for the belg season. Moreover, sales start long after farmers have sold their grain, not at a time when their cash constraint is less binding.

At the root of the marketing problem is the inefficient credit system. Since 80% of fertilizer sales is on credit, distortions in the credit market have serious implications for the use of fertilizer and farm productivity. Fertilizer credit is administered by local government officials. It is often alleged that there can be a lack of experience, and bureaucratic and sometimes unscrupulous procedures applied in this setting. Suppliers are often nominated by the authorities approving the loan. Administrative measures applied to enforce repayment have exacerbated the marketing problems. The practice of forcing all farmers to pay immediately after harvest can result in a seasonal market oversupply and relatively low grain prices. Harsh penalties on defaulters with genuine problems can induce negative attitudes towards technology adoption and reinforce risk-averse behavior. There are no provisions to protect farmers against the sale of critical assets like oxen in situations of crop failure.

Much of the inadequacies in the credit market are attributed to lack of an effective rural institution for credit delivery. Service cooperatives are too large to ensure repayment through peer pressure. The main reason for the government intervention in the credit market and diversion of valuable time of extension workers to administrative affairs (related to fertilizer loans) can also be attributed to lack of effective credit institutions.

Another important factor militating against expanded use of fertilizer is the sharp decline in its profitability. The return to fertilize use declined sharply between 1992 and 1997. The VCR for teff, for instance, declined by 55%, i.e. from 3.74 in 1992 to 1.69 in 1997. The decline amounted to 67% in the case maize and 48% for wheat. The ratio fell below the critical threshold of 2 for 70.8% of the sites/crops in 1997, compared to none in 1992. The main reason for the declining profitability is the rising fertilizer price relative to output price.

CSRDA

It is evident that the sharp decline in profitability has not led a proportionate decline in fertilizer consumption. It seems that in the absence of alternative options to restore soil fertility, farmers have no choice but continue to invest on chemical fertilizers, although they know that the return is inadequate to cover the risk involved.

Given the recent decline in fertilizer consumption and the shortfall of demand behind supplies, it becomes imperative to examine the determinants of demand. The results of this study have shown that fertilizer use is influenced by variables associated with profitability, financial liquidity, human resources, access to markets, household assets and extension services. A descriptive analysis of the different factors affecting chemical fertilizer use indicated that user households or user weredas tend to allocate more land to some crops like teff (fetches relatively higher prices) and less land to crops such as sorghum. Although the proportion of households using improved seeds, pesticides, and irrigation is generally very small, these practices are more common among fertilizer users than non-users. Users realize that fertilizer is more profitable when used with complementary inputs. Fertilizer adoption is also lower in weredas that faced crop damage and required food aid.

The literacy rate among the users group was 7% higher than among nonusers and the difference was statistically significant, suggesting that literacy has a positive influence on fertilizer adoption. Interaction with extension agents is also higher among fertilizer user groups.

The fact that lack of resources can be a serious constraint to fertilizer use was confirmed as fertilizer using households on the average own 5 tropical livestock units (TLU), as opposed to 3.65 in the case of non-users. User groups also owned more draft cattle. The difference between users and nonusers was equally pronounced with respect to farm size: farmers who use fertilizer cultivate more land than farmers who did not use fertilizer. The higher resource base and the larger the size of cultivated land, the higher are the chances that a household will use chemical fertilizer.

Access to credit is among important determinants of fertilizer use. User weredas (as opposed to non users) have better access to bank (as measured by the number of banks in a wereda) and have more households that are members of service cooperatives. A higher rate of adoption was also associated with weredas with more distribution centers in a wereda and better access to market places.

The results of the regression analysis (selection model) also indicated that many of the important factors indicated in the descriptive analysis were confirmed as affecting whether or not households in the weredas used fertilizer. The statistically significantly factors were: access to fertilizer, credit, and extension services, area under teff cultivation, number of fertilizer distribution centers and distance from markets. The number of distribution centers and area under teff are highly significant explanatory variables. The results also indicated that there are significant regional or zonal factors affecting fertilizer adoption.

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Many of the variables that were statistically significant in explaining whether or not fertilizer was used in a given wereda become relatively unimportant in explaining variations in the intensity of fertilizer use across weredas (average kg used per hectare in the wereda).

The most important factors explaining the quantity of fertilizer used per hectare are average farm size and the amount of livestock owned. As farm size increases and the number of animals owned goes up, so does the intensity of fertilizer use. Households with adequate resource base may generate more cash to purchase fertilizer (to buy the input on cash or pay for down payment) or they may be less risk-averse compared to resource-poor farmers.

A number of policy implications can be drawn from this study.

First, the reform process needs to include measures that would effectively allow full participation of the private sector all levels. In particular, measures are required to increase the number of small, private sector, retailers so as to increase the number of distribution centers or retail outlets and make the retail market truly competitive. Fertilizer dealers must also be able to get fertilizer from whichever supplier is offering lower prices and more favorable terms. In this regard, implementing the plan to license wholesalers and retailers by the government, instead of the current practice (each importer and distributor appointing its own wholesaler and retailers or principal-agent relationship), deserves particular attention. This, together with the planned deregulation of the wholesale prices (December 31, 1997), is expected to widen and deepen the distribution network at the local level and increase demand.

Second, farmers would benefit from the reform only when there are as many dealers as possible to take part in the importation and distribution of fertilizer. Any practice that may be viewed as discriminatory could discourage entry or limit the number of participants and discourage investment in storage and other infrastructure by the private sector. National, as well as local government officials must be committed to the principles of free market operations.

Third, the system of credit allocation needs to be improved to allow farmers to purchase fertilizer from retailers of their choice. Supply conditions and terms of sale would remain unresponsive to farmers' interest and liable to corruption if suppliers are nominated by a third party, the local authorities. The introduction of a coupon system, as suggested by NFIA, is expected to help level the playing field and create a favorable environment for a more competitive marketing system.

Fourth, although restructuring service cooperatives has been on the agenda of the government for quite sometime, the progress so far is hardly encouraging. Fertilizer loan disbursement and collection will continue to constrain supplies available from a range of distributors, unless effective cooperative institutions- with the power to exert peer pressure to enforce repayment - are created. Such institutions are also required to allow extension agents to use their time for extension purposes.

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Fifth, the number of weredas without bank branches is quite significant. The analysis has shown a link between fertilizer use and the number of banks operating in a particular wereda. Efforts aimed at increasing the number of bank branches through various methods such as introducing mobile banking services, rural credit schemes, involving private banks, etc. could have a positive impact on demand.

Sixth, complementary inputs such as technology research to develop improved crop varieties , improved seeds and chemicals, as well as improved farmer management practices are necessary to make fertilizer more profitable and enhance demand at given input and output prices. Measures that improve the effective supply of these inputs are expected to have a positive impact on fertilizer consumption.

Seventh, a favorable impact on fertilizer demand is also expected from measures aimed at building the asset base of poor farmers. Loans for oxen and other animals (with proper consideration for feed and veterinary service) need to be expanded along with the effort to expand fertilizer use.

Finally, crop failure is a major factor that makes investments in fertilizer a risky venture. In the absence of any protection in the form of crop insurance or government guarantees, farmers are forced to sell assets such as oxen, leading to decapitalization. There may not be an easy solution to tackle this problem, but it is high-time that studies on how best to tackle the problem be initiated. Further research is also required to investigate the determinants of fertilizer use intensity.

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Annex 1: Quantity and Price (nominal) of Fertilizer Distributed to the Peasant Sector (1971 - 1996)

Year	DAP			Urea			Total (000 tons)
	(000 Tons)	Price		(000 Tons)	Price		
		Unsu/ed	Subsidized		Unsu/ed	Subsidized	
1971	811	38.00		136	30.00		947
1972	1,744	38.00		303	32.00		2,047
1973	7,666	42.00		710	32.00		8,376
1974	12,413	44.00		667	40.00		13,080
1975	13,209	50.00		770	50.00		13,979
1976	33,636	48.00		1,409	40.00		35,045
1977	32,535	48.00		1,455	40.00		33,990
1978	32,217	55.00		1,717	55.00		33,934
1979	48,277	64.00		3,010	65.00		51,287
1980	40,742	85.00		2,545	85.00		43,287
1981	29,668	116.30		1,444	83.90		31,112
1982	30,255	89.00		1,418	69.70		31,673
1983	42,047	81.40		3,008	63.70		45,055
1984	42,147	81.40		4,737	63.70		46,884
1985	22,296	81.40		1,823	63.70		24,119
1986	74,345	81.40		8,918	63.70		83,263
1987	88,336	79.80		8,995	63.70		97,331
1988	85,232	81.40		11,441	63.70		96,673
1989	99,186	96.60		10,115	80.90		109,301
1990	92,302	88.80		12,808	75.10		105,110
1991	79,790	91.00		10,489	77.30		90,279
1992	135,467	107.10		17,191	95.30		152,658
1993	99,560	176.20	149.70	35,587	156.10	132.4	135,146
1994	176,737	182.60	143.30	25,588	105.40	131.1	202,325
1995*	202,311	258.00	178.00	44,411	248.00	168.0	246,722
1996*	209,883	256.87	200.00	43,269	246.87	190.00	253,152
1997**	161,654			44,640			206,294

Source: Compiled from various including Alemayehu Bekele. 1992 **Fertilizer Marketing in**

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* Actual sales as quoted from Tibebu Haile, Fertilizer Imports, Distribution and Sales 1996, (Paper presented to the National Fertilizer Workshop, Oct. 15 - 18, 1996, Ghion Hotel, Addis Ababa).

** As at August 31,1997

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Annex II: Fertilizer Loan Disbursement (1983-1997) (000' Birr)

	Disbursement		
Year	AIDB	CBE	Total
1983	27,835	-	27,835
1984	33,866	-	33,866
1985	42,134	-	42,134
1986	30,106	25,462	56,178
1987	1,713	37,531	39,244
1988	21,246	-	21,246
1989	35,106	-	35,106
1990	72,177	-	72,177
1991	44,395	-	44,395
1992	35,594	-	35,594
1993	14,819	2,506	17,325
1994	29,030	158,287	187,317
1995	51,836	221,130	272,966
1996*	56,869	242,096	298,965
1997*	43,880	185,275	119,155

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Source AIDB Research and Planning Division; The Government of Ethiopia, Integrated Use of Inputs and Distribution Mechanism, Dec., 1994; and Itana Ayana, Agricultural Inputs and Credit Performance Since 1994, and Plans for 1997, (Paper presented at the Notional Workshop, 15-18 October, 1996).

* CBE and DBE, Report presented at the Second Annual National Fertilizer Workshop, October 1-3, 1997, Ghion Hotel, Addis Ababa

Annex III: Optimum rates of fertilizer application by region and by crop type

	No. Of trials	NFIU calculation at 1992 prices				Own calculation at 1992 prices				Own calculation at 1997 prices			
		N		P2O5		N		P2O5		N		P2O5	
		Nutrient (kg)	Urea (qt.)	Nutrient (kg)	DAP (qt.)	Nutrient (kg)	Urea (qt.)	Nutrient (kg)	DAP (qt.)	Nutrient (kg)	Urea (qt.)	Nutrient (kg)	DAP (qt.)
Teff													
Shewa	537	64.00	0.91	57.00	1.24	81.27	1.10	77.81	1.69	60.66	0.86	53.37	1.16
Gojam	227	57.00	0.76	56.00	1.22	73.66	0.99	72.44	1.57	53.16	0.71	52.73	1.15
Arsi, Bale	55	45.00	0.58	47.00	1.02	58.36	0.75	61.42	1.34	41.71	0.53	43.86	0.95
Other	57	12.00	-0.10	42.00	0.91	69.08	0.88	73.30	1.59	-1.10	-0.33	35.92	0.78
ATC	876	57.00	0.79	53.00	1.15	72.14	0.97	70.37	1.53	53.43	0.73	50.25	1.09
Wheat													
Shewa	212	76.00	1.14	60.00	1.30	93.92	1.38	77.58	1.69	78.00	1.17	61.45	1.34
Gojam	42	62.00	0.95	47.00	1.02	74.06	1.13	56.89	1.24	63.14	0.96	48.22	1.05
Arsi, Bale	252	66.00	0.82	72.00	1.57	99.86	1.29	103.57	2.25	67.34	0.83	75.10	1.63
Other	33	47.00	0.58	52.00	1.13	63.71	0.82	66.72	1.45	48.25	0.59	53.87	1.17
ATC	539	67.00	0.95	59.00	1.28	85.48	1.21	76.48	1.66	68.12	0.96	60.86	1.32
Barley													
Shewa	48	56.00	0.72	59.00	1.28	84.76	1.22	73.18	1.59	59.75	0.78	61.30	1.33
Arsi, Bale	129	56.00	0.63	69.00	1.50	79.08	1.03	80.92	1.76	58.95	0.68	70.65	1.54
Other	21	44.00	0.39	67.00	1.46	.	.	.	.		.	.	.
ATC	198	59.00	0.74	64.00	1.39	83.08	1.16	75.87	1.65	61.88	0.79	65.74	1.43
Maize													
Shewa	129	56.00	0.75	55.00	1.20	69.71	0.96	65.58	1.43	43.39	0.56	45.11	0.98
Gojam	62	80.00	0.97	90.00	1.96	102.61	1.22	118.34	2.57	63.57	0.75	74.05	1.61
Welega, Kefa, Illu	24	90.00	1.19	90.00	1.96	600.82	9.02	475.18	10.33	153.55	1.71	191.22	4.16
Gamu G., Sidamo	27	46.00	0.46	64.00	1.39	62.06	0.69	77.28	1.68	30.46	0.22	51.91	1.13
Other	20	55.00	1.03	19.00	0.41	113.87	0.75	202.91	4.41	E.	E	E	E
ATC	262	60.00	0.76	64.00	1.39	74.84	0.97	77.09	1.68	45.26	0.55	50.98	1.11
Sorghum													
Shewa	14	24.00	0.06	54.00	1.17	.	.	.	.	.	.	.	.
Hararghe	12	0.00	-..42	49.00	1.07	104.76	0.87	165.68	3.60	29.34	-0.11	87.61	1.90
Other	18	39.00	0.25	70.00	1.52	71.04	0.71	97.72	2.12	48.53	0.38	78.81	1.71
ATC	44	34.00	0.17	67.00	1.46	70.36	0.56	114.33	2.49	44.69	0.27	82.84	1.80

ATC = Across the country

CRDA