RESEARCH WITH FARMERS

Lessons from Ethiopia

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Preface

Agriculture is the mainstay of the Ethiopian national economy, accounting for over 40% of the national gross domestic product, over 90% of the national foreign exchange earnings and over 85% of the national labour force. Despite its great importance as well as potential, agriculture remains unproductive. Although a host of factors account for the low agricultural productivity, the availability and use of improved agricultural technologies constitute the major limitations to date.

Experiences from the developed countries as well as from some of the developing countries clearly show that modern agricultural technologies play a crucial role in raising agricultural productivity. It was in light of this truth that the Ethiopian government took tentative steps to organize a national research scheme some three decades ago. Over the years, the national research organizations have carried out numerous experiments to identify technologies that may contribute to increased productivity of crops and livestock under various agro-ecological conditions. It is sad to note that these technologies have contributed very little to raising agricultural productivity, especially in the small-scale farming sector that accounts for over 95% of the cultivated land and over 90% of the total production in Ethiopia.

This state of affairs raised the obvious need for reassessing the research objectives, goals and strategies of the national research system. A cursory glance shows that adoption of agricultural technologies by farmers is minimal. The reason for this could be traced to (1) the inadequate availability of 'appropriate' technologies, (2) farmers' unawareness of the technologies that have been identified for their areas, (3) unavailability of the necessary inputs and supplies as and when needed by producers and (4) policy issues that discourage technology adoption.

It is with these circumstances in mind that the Institute of Agricultural Research (IAR), as the organization responsible for national agricultural research, recast its organizational structure and resource distribution to address this pressing issue. Besides strengthening its agricultural economics research programme, it also created a new division to address the linkages between technology generation and

within the reach of farmers they are not encouraged to apply for loans. Loans are used for oxen or equipment or for developing infrastructure like grain stores.

Nearly all fertilizer supplied to small farmers is sold on credit through their PAs. If more than 5% of a PA's fertilizer debt is not repaid then credit is not extended to it the following year (personal communication with MOA staff). Moreover, farmers who are unable to settle their overdue debts on the previous year's loans are not allowed to receive a new loan (Awoke and Hailu 1986). If farmers have a poor season they can neither repay past loans nor obtain credit to allow them to increase production in the next season.

Weaknesses in research and extension programmes are also problems limiting maize production. In recent years many measures have been taken to improve and make the research and extension systems effective. However, they are still inadequate to the task of developing appropriate technologies and making them available to producers. There is a lack of a strong and well-coordinated research–extension linkage at the grass roots. For example, in some areas research and extension make contradictory recommendations, which clearly has a negative effect on the dissemination of research findings. The Research and Extension Liaison Committee has been established by IAR and MOA to bridge this gap. It is hoped that the committee will strengthen the linkage between research and extension.

Other socioeconomic constraints on maize production as identified through various surveys conducted by IAR's farming systems research teams include seasonal labour shortage and inadequate transportation and marketing facilities.

Conclusion

The growth in maize production in Ethiopia has been mainly due to the expansion of the area under the crop. This expansion has, however, declined substantially over the last 15 years and growth in production can now be expected to come mainly from increases in yields, which are generally low.

The majority of maize producers are small farmers who scarcely use any of the well-known yield-increasing technologies. These technologies such as improved seeds and chemical fertilizers will have to be made available to farmers in a timely and affordable manner. Lack of draught power is also a major constraint to maize production, a constraint that can be relaxed through provision of credit for the purchase of oxen.

Marketing infrastructure such as roads, transportation facilities and storage is essential for increasing maize production. At present the majority of peasant producers have limited access to these facilities. If peasant farmers are expected to increase their maize production through the adoption of modern technologies, improvements in infrastructure will have to be coupled with a lucrative incentive structure. Sustained increase in maize production will arrest the slowly declining self-sufficiency in maize for consumption.

Chapter Fifteen

Constraints to Increasing Wheat Production in the Smallholder Sector

Hailu Beyene, Steven Franzel and Wilfred Mwangi

This chapter examines constraints to increasing wheat production in Ethiopia, focusing on the smallholder sector, which accounts for 76% of total wheat production. First the role of wheat in the Ethiopian economy is outlined and production trends are assessed. Next production practices, marketing and utilization are discussed. Finally constraints to increasing production are presented. Most of the farm-level data presented are assembled from diagnostic surveys of five wheat-producing areas:

- Kulumsa, Arsi Region (Chilot *et al.* 1989, Chapter 11)
- Sinana, Bale Region (Alemayehu and Franzel 1987)
- Holetta, Western Shewa Region (Hailu and Mohammed 1986)
- Inewari, Northern Shewa Region (Hailu and Chilot 1989, Chapter 7)
- Sendafa-Aleltu, Northern Shewa Region (Hailu and Chilot 1989, Chapter 7)

The surveys were conducted by multidisciplinary teams of the Institute of Agricultural Research in collaboration with local extension staff. In addition, we also draw upon data from the Institute of Agricultural Research's on-farm wheat trials. As was true with the previous chapter, this one shows how data from several different surveys can be assembled in a manner useful for policy makers, planners and organizations serving the wheat subsector.

Role of Wheat in Ethiopia

Ethiopia is sub-Saharan Africa's largest producer of wheat, accounting for 57% of its 1.06 million hectares. However, Ethiopia's wheat yields over the period 1983–87 averaged only about 1.24 t/ha, as compared to 1.76 t in the rest of sub-Saharan Africa (FAO production data from annual yearbooks). This is partly explained by the fact that wheat is a traditional crop in Ethiopia, grown using traditional durum varieties and practices, whereas in most other countries it is of

recent introduction and is grown using improved varieties and technology.

Table 2.1 shows that wheat ranks fifth in area and production and fourth in yield per hectare among Ethiopia's principal cereals. Over the years 1979 to 1987, wheat area averaged 646 000 ha and production averaged 716 000 t (CSA 1987, 1989a,b).

The most important wheat-growing areas of Ethiopia are the highlands of the central, southeastern and northwestern regions of the country. Wheat is found at altitudes ranging from 1700 to 2900 m; rainfall in these areas is bimodal and varies from 600 to 2000 mm. Most wheat is produced during the main rainy season, June to September, although some is produced during the light rains, March to May. Virtually all wheat is produced under rainfed conditions.

The two major wheat species grown in Ethiopia are durum wheat (*Triticum durum* L.) and bread wheat (*Triticum aestivum* L.). Durum wheat is indigenous and Ethiopia is considered one of the centres of genetic diversity. Bread wheat has been introduced relatively recently. Durum wheat accounts for two-thirds of the country's total wheat area (Tesfaye 1987).

Production Structure and Trends

Wheat is grown by three types of farms in Ethiopia: smallholders, state farms and producer cooperatives. Smallholders farm 82% of the total wheat area, producing 76% of the total wheat harvest (Table 15.1). State farms, accounting for 10% of the area and 17% of wheat production, produce only bread wheat. Producer cooperatives account for 8% of the wheat area and 7% of production. Yields average 2.0 t/ha for state farms and 1.1 t/ha for smallholder and producer cooperatives.

Table 15.2 summarizes trends in wheat area, production and yields over the 37-year period from 1948–50 to 1985–87. From 1948–50 to 1961–63, both area and yields increased, resulting in increased production. Over the period 1961–63 to 1979–81, both area and production declined. However, wheat yields increased, mostly caused by the rapid increase in cultivation by state farms, which grow

Table 15.1. Wheat area, production and yield by farm type, main season 1986†

Sector	Area		Production		Yield
	'000 ha	%	'000 t	%	(t/ha)
Smallholders	526.49	82.4	585.2	76.3	1.11
Producer cooperatives	49.3	7.7	53.1	6.9	1.08
State farms	63.1	9.9	129.1	16.8	2.04
Total	638.9	100.0	767.5	100.0	

Source: CSA 1987

† main-season wheat production accounts for 99% of total wheat production

Table 15.2. Annual growth rates in wheat area, production and yield in Ethiopia

Period	Area (%)	Production (%)	Yield (%)
1948–50 to 1961–63	0.67	2.34	1.67
1961–63 to 1970–72	−1.38	0.31	1.69
1970–72 to 1979–81	−3.43	−0.56	2.87
1979–81 to 1985–87	0.72	3.58	2.86
1948–50 to 1985–87	−0.89	2.61	3.50

Source: FAO production data from annual yearbooks

Table 15.3. Wheat consumption, self-sufficiency and food aid in Ethiopia (annual averages)

Period	Total wheat consumed ('000 t)	Per capita wheat consumption (kg)	Growth rate per capita wheat consumption*	Self-sufficiency (%)	Wheat imports received as food aid (%)
1961–63	644	25	–	99	–
1970–72	699	22	−1.30	94	85†
1979–81	879	23	0.23	71	–
1985–87	1500	33	5.47	53	85‡

Source: FAO production data from annual yearbooks

* figures show the growth rate in per capita wheat consumption compared to the previous period

† for the years 1972–76

‡ for the years 1983–87

bread wheat and use a higher level of technology and thus achieve higher yields. Over the period 1979–81 to 1985–87, wheat area and yields increased, resulting in a 3.58% annual growth rate in production. These increases were also largely attributable to increases in area and yield on the state farms.

Per capita wheat consumption stagnated over the period 1961–63 to 1979–81 and then increased dramatically in the 1980s (Table 15.3). The big increase in wheat consumption has been as a result of (1) food aid during and following the 1984 famine, (2) subsidized bread prices that have encouraged wheat consumption and (3) the high population growth rate. Whereas Ethiopia had been self-sufficient in wheat production in the 1960s, by 1985–87 the country was producing only half of the total wheat consumed. Total wheat imports amounted to over 700 000 t, about 85% of which was received as food aid. Increased wheat production can play an important role in reducing Ethiopia's food deficit.

Wheat in the Smallholder Farming System

Production practices

Table 15.4 shows the importance of wheat in five selected smallholder wheat-growing areas. In four of these areas, wheat is grown primarily for food; in the Sinana area its primary role is as a cash crop. In the five areas, wheat is grown by over 85% of the farmers and occupies 24% to 39% of the cultivated area. Average wheat area per farm ranges from 0.71 ha to 1.0 ha.

Table 15.5 shows the wheat types and varieties used in six wheat-growing areas. Improved varieties are found in all six areas but are the most important in only one area, the Kulumsa highlands. All improved varieties shown in the table

Table 15.4. Importance of wheat in selected wheat-growing areas of Ethiopia

Area	Major crops (in order of importance by area)*	Farms growing wheat (%)	Total area cultivated per farm (ha)	Wheat area per farm (ha)	Wheat as % of farm area
Holetta	T, W, B, F	85	2.61	0.71	27
Inewari	W, T, F, L	100	2.16	0.71	33
Sendafa-Aleltu	W, T, C, L	100	3.44	0.81	24
Kulumsa	B, W, P, F	93	2.20	0.86	39
Sinana	B, W, P	85	4.00	1.00	25

Source: Alemayehu and Franzel 1987, Hailu and Chilot 1989, Chilot *et al.* 1989, Hailu and Mohammed 1986

* B = barley, C = chickpea, F = faba bean, L = lentil, P = field pea, T = tef, W = wheat

Table 15.5. Wheat types and varieties grown by farmers

Area	Types	Varieties
Holetta	bread	Kenya, Enkoy*
Inewari	durum, bread	Gonde, Enkoy,* Laketch,* Gojam, Enat-Sende, Manze
Sendafa-Aleltu	durum, bread	Gebre, Enkoy,* Laketch,* Israel
Kulumsa (highlands)	bread	Enkoy,* Israel
Kulumsa (mid altitude)	bread	Israel, K6295-4A, Dashen,* Enkoy*
Sinana	bread	Wolandi, Enkoy*

Varieties are listed in order of area planted

* improved varieties; some of the local varieties, e.g., Kenya and Wollendi, probably descend from improved varieties released by development projects many years ago

are bread wheat. Although improved durum wheat varieties exist, they are not widely grown in any of the six areas.

Wheat production practices vary from location to location as shown in Table 15.6. In most areas, wheat is planted only once per year at the onset of the main rainy season. In some areas, such as Sinana, wheat is also planted during the short rainy season, using a different field from that used for main-season wheat.

For main-season wheat, land preparation commences at the onset of the rains, which varies between January and April. The main reason for not starting earlier is that the soil is too hard to plough with the local plough, the *maresha*, which is made from wood and has a metal blade for breaking the soil. In most areas, a pair of oxen is used for land preparation; however, in Inewari, horses are also used. The number of ploughings depends on the onset of the rains, the strength of the draught power and the nature of the soil. Wheat fields are ploughed on average two to five times before planting.

The time of planting ranges from mid-June to August, depending on the varieties used, the soil type and the level of rainfall. For example, in the Holetta area on red soils, wheat is planted in June. In Inewari and Sendafa-Aleltu, where soils are black and prone to waterlogging, wheat is planted in August. Research shows that optimum planting dates vary across areas and that late planting tends to reduce yields by as much as 34% (Getinet 1985).

In most areas, farmers broadcast their wheat seed on flat soil and then use animal-drawn ploughs to cover it. In Inewari after broadcasting their seed, farmers make furrows with ploughs and broadbeds by hand. But in Sendafa-Aleltu farmers plough to construct ridges, broadcast their seed and plough again to cover the seed. Both methods are used to alleviate waterlogging (Chapter 7).

Table 15.6. Wheat production practices in different areas of Ethiopia

	Land preparation				Fertilizer use*			
Area	Method	No. of ploughings	Planting time	Planting method	Farmers using(%)	Av.rate (kg/ha)†	Weeding method	Harvest time
Holetta	oxen	2–4	June	flat	30	40	HW/herb.	Nov–Dec
Inewari	oxen/ horses	2–3	Jul–Aug	BBF	100	50–75	HW	
Sendafa-Aleltu	oxen	3–4	Jul–Aug	ridges/ furrows	75	50–75	none	Dec–Jan
Kulumsa	oxen	3–5	June	flat	100	90	HW/herb.	Nov–Feb
Sinana	oxen	3–4	Mar–Apr/ July	flat	10	NA	none	Aug/Jan

Source: Alemayehu and Franzel 1987, Hailu and Chilot 1989, Chilot *et al.* 1989, Hailu and Mohammed 1986

* most of the fertilizer used is diammonium phosphate; a few farmers also use urea

† average rate for farmers using fertilizer

HW = handweeding; herb. = herbicides; BBF = broadbeds and furrows; NA = not available

Most farmers use local varieties; farmers say that although improved varieties give higher yields when used with fertilizer, without fertilizer they perform poorly. In Vertisol areas, improved varieties are also said to be more susceptible to waterlogging than local varieties. Therefore, those who use improved varieties tend to allocate a portion of their field for local varieties as a risk-avoiding measure. Semi-dwarf varieties, which tend to be higher yielding than the farmers' taller local varieties, account for only 10% of the total wheat area.

The number of farmers using fertilizer ranges from 10% to 100% depending on the area (Table 15.6). The most commonly used fertilizer is diammonium phosphate (18/46 N/P_2O_5); in some areas urea (46 N) is also available. Farmers' rates of application for the former range from 50 to 125 kg/ha (9/23 to 23/58 N/P_2O_5 kg/ha); the nationwide recommended rate according to the Ministry of Agriculture is 41/46 kg/ha N/P_2O_5. Farmers' fertilizer rates depend on the availability of fertilizer and the fertility of the soil. The quantity of fertilizer supplied to farmers is generally less than the supply they are willing to purchase. Fertilizer use in wheat production is low relative to that in other countries. For instance in 1985, on average only 11 kg nutrients/ha were used in Ethiopia compared to Zimbabwe's 279 (CIMMYT 1989). Manure is not used because fields tend to be far from the homesteads and because priority for manure use is given to other crops.

Wheat tends to be weeded later than is recommended, either because activities overlap during the appropriate weeding time (Holetta) or because farmers need weeds for livestock feed (Inewari). Most farmers in Sendafa-Aleltu and Sinana do not weed at all; they claim that it is not necessary and that they lack time. In both areas, farmers plough their wheat fields three to four times, claiming that frequent ploughing reduces weed infestation. Many farmers in the Holetta and Kulumsa areas use herbicides (2,4-D) to control broadleaf weeds; they remove grass weeds by hand.

The time of harvesting main-season wheat varies between November and February, depending on altitude, sowing date and type of variety used (early versus late maturing). Harvesting is done manually using a sickle. Harvested wheat is piled and threshing begins once all the wheat and other crops are harvested. Threshing is done by using animals, mainly oxen, to trample the grain on a small threshing ground, a hard surface made of sun-dried dung and soil.

Marketing and Utilization

Most smallholders grow wheat primarily for food; surplus production above household needs is sold. Farmers store wheat in local stores made of mud and plant material plastered with cow dung. These stores may be kept in the house or outdoors. Rodents were reported to be a problem in Holetta and Kulumsa; weevils damage wheat in Holetta.

Rural households use wheat for preparation of local bread (*dabo*), boiled grain (*nifro*), roasted grain (*kolo*), porridge (*genfo*) or as a component of pancake (*injera*). Wheat straw is used for roof covering and for animal feed although it is said to be inferior to straw of other major cereals. In urban areas, wheat bread prepared in bakeries is sold at subsidized prices and is a popular snack food. Urban dwellers also eat homemade bread as a breakfast food.

Farmers sell their wheat through three channels: service cooperatives (SCs), private traders and consumers. Until March 1990 farmers in many areas were required to deliver a quota of wheat to their SCs. SCs then sold the grain to the Agricultural Marketing Corporation (AMC), which distributed the grain to consumers, bakeries and state organizations. Typical quotas were 100 to 200 kg, and farmers were paid for the quotas at official prices, which were fixed and uniform throughout the country and over seasons. These official prices were usually below local market prices, which vary according to supply and demand. For example, at six markets over the period 1985–87, local wheat prices on average were 2.3 times higher than the fixed official prices (RRC 1990).

In 1990, the system of quotas and fixed prices was ended. AMC's role following the change in policy has not been clarified. The quota system is described in Chapter 16.

Farmers also sell wheat to private traders and consumers at local market prices. Until 1988, private grain trade was banned in Arsi and strictly controlled in other wheat-producing areas. In 1988, private traders were permitted to buy, transport and sell grain as long as they sold half of their purchases to AMC at fixed official prices. Reports from Arsi in 1988 were that significant quantities of wheat were moving through private marketing channels to Addis Ababa. In March 1990, traders were permitted to buy, move and sell grain without having to sell a portion to AMC. The impact of this change in policy is not yet known.

Improved inputs such as improved seed and fertilizer are distributed to farmers through their service cooperatives. They are not generally available in the parallel markets. Herbicides, however, are not often available through SCs but are available in limited quantities in the parallel markets at much higher prices.

Constraints to Increasing Production

Principal constraints to increasing production are categorized into two groups, technical and socioeconomic. The constraints are not listed in order of importance since the ranking of problems varies from area to area.

Technical constraints

Low soil fertility

Low soil fertility, including deficiencies of nitrogen and phosphorus, has been noted as a major problem in four of the five wheat-growing areas where diagnostic surveys were conducted. Soil fertility was a secondary problem in Sinana, where

cultivation has begun relatively recently. In these surveys assessment of the soil fertility problem was based on researchers' observations of soils and crops and on farmers' opinions.

These findings are supported by data from farmer-managed on-farm wheat fertilizer trials at 28 sites between 1984 and 1987. The yield response ranged from 0 to 197% and averaged 72%. Fertilizer use was found to be profitable at 79% of the sites (Chapter 16). On-farm wheat trials conducted in 1988 and 1989 also established the profitability of fertilizer on wheat in the Kulumsa, Sinana and Adet areas (Amanuel *et al.* 1990b).

Fertility problems are aggravated by farmers' cultivation practices. In all five areas, farmers practise continuous cultivation; land is not fallowed. Crop rotation is not frequently practised. For example, in Sinana cereals account for about 90% of the cultivated area; thus, there is almost no rotation with oilseed crops or pulses. Pulses and oilseed crops are more common in Holetta, and most farmers rotate their crops.

Weeds

Weeds are reported to be a major problem in the Holetta and Kulumsa diagnostic surveys, based on researchers' observations and farmers' opinions. In Kulumsa, the problem appears to be increasing. Bengston (1983) reported that weed densities in farmers' wheat fields in Chilalo Awraja increased from 710 to 1400 weeds/m^2 between 1967 and 1980. One of the main causes of the problem is the high infestation of weed seeds in farmers' wheat seed; in 1986 in Arsi region, 41% of farmers' seed samples contained over 600 weed seeds/kg (MOA/SEAD 1987a).

Weed damage is aggravated by an overlapping of activities at the time of weeding; for example, in Holetta during wheat weeding in August, farmers are also preparing land for planting tef. The optimum period for weeding is the farmers' busiest time of the year in both Holetta and Kulumsa. As a result, farmers are often unable to effectively control weeds.

It should be noted that in areas where farmers do not weed wheat, weeds may not be a problem. For example, weed control experiments on wheat in the Sinana area indicate that weeding was not economic at many of the sites (Dereje *et al.* 1990). Farmers at these sites were able to control weeds by repeated ploughings and by using higher than recommended seed rates.

Pests and diseases

Stem and leaf rust are the principal disease problems on durum wheat; principal diseases affecting bread wheat are stripe rust and *Septoria tritici.* Rusts were reported to be an important problem in the Kulumsa and Holetta areas. In the Holetta area in 1985, 53% of the farmers reported it. Aphids are the principal insect problem on wheat; aphids are a high priority problem in Sinana, especially during the main season. The problem is aggravated by late planting; late-planted wheat is more susceptible to moisture stress and thus to aphid attack (Alemayehu and Franzel 1987). Seed gall nematode is a major problem in Kulumsa. Wild animals are also an important problem affecting wheat in Holetta. The principal problem there is wild pigs, which feed on awnless wheat.

Varieties

Many of the local durum wheat varieties have low yield potential, tend to be weak strawed and have low resistance to diseases and lodging (Tesfaye 1987). Farmers claim that improved varieties respond well to fertilizer but that in the absence of fertilizer, they yield less than local varieties. Improved varieties also tend to be less susceptible to waterlogging and drought.

Other constraints

Other constraints of medium importance or specific to selected areas include:

- Poor seedbed preparation, largely a result of the shortage of oxen, weak oxen, the dry-season feed shortage and poor-performing ploughs. Poor seedbed preparation results in thin crop stands and leads to severe weed infestation.
- Waterlogging of soils is an important problem on Vertisols at Inewari and Sendafa-Aleltu, where farmers use ridges and broadbeds. Because of it farmers are forced to plant late, nutrients are leached from the soil and yields are reduced.
- Climatic problems also affect wheat production. Rainfall distribution is often poor in Sinana, and frost may injure wheat in Sinana and Holetta.

Socioeconomic constraints

Improved inputs not available

Research has shown that use of improved seeds, fertilizers and herbicides can increase wheat production. Farmers have shown great interest in using such inputs. However, state farms and producer cooperatives receive priority in their allocation. Among smallholders, these inputs are not available in sufficient quantity to meet the demand. In some areas, PAs ration fertilizer among farmers.

Several other problems also limit the use of improved inputs. First, the supply of credit to smallholders is very small, since most agricultural credit is allocated to state farms and producer cooperatives. The Agricultural and Industrial Development Bank extends credit for fertilizer to farmers in some areas through their service cooperatives. However, if less than 95% of a PA's fertilizer debt is repaid then credit is not extended to any farmer in the PA the following year (Legesse *et al.* 1990). Moreover, farmers are not permitted to purchase herbicides or improved seed on credit.

Second, timeliness is also a problem concerning inputs; fertilizer often arrives in an area long after the optimal planting time. Third, inputs are sometimes not available in the form farmers need them. For example improved seed is available only in 100-kg bags; it is thus not possible for a farmer to buy a small quantity for testing.

Seasonal labour shortage

In two of the five wheat-producing areas, Kulumsa and Holetta, seasonal labour shortage was an important problem and in the three other areas, a medium-priority problem. In Holetta and Kulumsa most crops are planted at the same time. This results in a shortage of labour during the peak seasons of weeding and harvesting. The most important crop in Holetta, tef, is usually planted about one month later than wheat. Important labour overlaps between the two crops still occur; the weeding time for wheat coincides with land preparation and planting of tef. Seasonal labour shortages at weeding time cause yield losses in both areas as wheat is weeded late. Farmers report that when herbicides are available, there is no shortage of labour at weeding time. But most farmers in most years lack access to herbicides.

The labour bottleneck at harvesting is especially problematic because some varieties are prone to shattering; if harvesting is delayed, late rainfall may damage the crop.

Draught power shortage

Because of the shortage of draught power, land preparation is often poor and is not completed on time. This problem is exacerbated by unavailability of dry-season feed, which makes the oxen very weak. Poorly prepared land leads to poor plant establishment, heavy weed infestation and low yields.

Land shortage

The shortage of land limits wheat production, especially in Inewari, Holetta and Kulumsa. At the latter two sites, it has also been aggravated by the expansion of producer cooperatives, which were allocated land from smallholder areas.

Low prices

Low fixed prices have also been an important constraint on smallholders in two ways. First, they reduce farm income, reducing farmers' ability to invest in their farms. Second, they discourage the use of improved inputs such as fertilizer and improved seed. For example, data from on-farm fertilizer trials on wheat from 1984 to 1987 show that at fixed official prices fertilizer was profitable at only

43% of the 28 sites where trials were conducted. Using local market prices, fertilizer became profitable at 79% of the sites (Franzel *et al.* 1989). Now that the system of fixed prices has been abolished, higher wheat prices should promote the use of improved inputs and facilitate increased production. However, experience from other countries has shown that if improved inputs and other complementary services (credit, extension, marketing, etc.) are not available, improved prices alone are not likely to lead to an increase in production (Ghai and Smith 1987).

Conclusion

Recent trends show that the growth rate of wheat consumption in Ethiopia has far exceeded the growth rate in production. Given the high demand for wheat and the high rate of growth in population, Ethiopia's wheat deficit will continue to be large in future years. There is very little land left in the highlands for extending the area cultivated. Therefore, increases in wheat production will have to come from intensifying cultivation, that is, increasing yields per hectare.

There is great potential for increasing yields in the smallholder sector, which accounts for 76% of production. Results from on-farm trials have shown a high response to improved inputs, especially improved varieties and fertilizers. However, these inputs are not available in sufficient quantities or when needed. The ending of grain quotas and low official prices in 1990 has removed a major constraint to wheat production. However, to improve production, improved access is required to inputs, technologies and services.

Principal technical constraints to increasing wheat production include low soil fertility, weeds, diseases and the low yield potential of existing durum wheat varieties. Chemical fertilizers, though expensive, show high returns at the farm level. Herbicides have great potential for controlling weeds, alleviating labour shortages, reducing the cost of weed control and increasing yields. Improved varieties are needed that resist disease, respond better to improved inputs and are acceptable to farmers.

A sustained effort is therefore needed to develop technologies that are appropriate and profitable for small farmers in order to solve these problems. The newly formed wheat team in the Institute of Agricultural Research should lead the effort to develop new wheat technologies. Close liaison is also required with other support services of the agricultural sector, e.g., the Ministry of Agriculture, the Agricultural Input Supply Corporation, the Ethiopian Seed Corporation and the Agricultural and Industrial Development Bank.