FORTY YEARS OF RESEARCH EXPERIENCE
Debre Zeit Agricultural Research Center
1955–1994

DEBRE ZEIT AGRICULTURAL RESEARCH CENTER
ALEMAYA UNIVERSITY OF AGRICULTURE
DEBRE ZEIT, ETHIOPIA
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Editor:
Efrem Bechere

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DEBRE ZEIT AGRICULTURAL RESEARCH CENTER
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The Debre Zeit Agricultural Research Center (DZARC) is the oldest research station in the Country. It was established in the mid-50s as a satellite experiment station for the then Alemaya College of Agricultural and Mechanical Arts (now Alemaya University of Agriculture). During the last three and half decades, the Center has conducted multidisciplinary research programmes on cereals, legumes, horticultural crops, poultry, dairy animals and animal feed. It had also additional responsibilities for conducting ecoregional research on socio-economics, soil management, livestock etc.

From 1976-84, DZARC came under the Addis Ababa University during which time the Center's additional responsibilities included formal Diploma training of middle-level manpower. In 1985, DZARC was again placed under the Alemaya University of Agriculture and terminated the training programme. Today, DZARC is a top-level agricultural research Center, strategically located to cater to its mandate crops: tef, durum wheat, chickpea and lentils and its other research activities on poultry, dairy, horticultural crops and forestry. Its surroundings have variable agro-climatology representing the different agro-ecological zones in the country. The soil types at Debre Zeit (black and light) are also representative of the majority of the soil types where its mandate crops are grown. Further, the Debre Zeit area has a crop-livestock system-based agriculture.

DZARC carries out various research activities on its mandate crops in breeding, crop protection (pathology, entomology and weed control), agronomy, soils and socio-economics. Research on livestock basically focuses on dairy, poultry, forage crops and nutrition. In horticulture, research is conducted on onions, shallots and grapevine. Attempts are underway to revive the endod research in conjunction with the Institute of Patho-biology of the Addis Ababa University. The Center disseminates research results through its Outreach programme. DZARC serves as a practical training center for farmers, technicians and graduate students.

The Center carries out its research activities from its substations at Debre Zeit, Akaki, Chefe Donsa, Bichena, Koka, Alem Tena, Enewari and Dhera. It conducts demonstration trials throughout the country in collaboration with other organisations.

Throughout the years, the Center has released several improved varieties of bread wheat, durum wheat, tef, chickpea and lentils with improved packages. These varieties are widely grown around the country today and have substantially increased the yields of these crops per unit area. For the next cropping season alone, eight durum wheat, three tef, three chickpea and three new lentil varieties are under verification and consideration for release by the National Variety Release Committee.

The Center staff currently number 69 or 11 PhD, 11 MSc, 8 BSc, 13 Diploma and 26 Certificate holders. Senior staff spend about 75% of their time on research and the
remaining 25% on teaching. They serve as advisors and internal examiners for graduate students of the School of Graduate Studies of the Alemaya University of Agriculture.

The Center collaborates with national organisations, namely the Institute of Agricultural Research, the Plant Genetic Resource Center/Ethiopia, the Addis Ababa University, the Ethiopian Seed Enterprise, the Ministry of Natural Resource Development and Protection and the Ministry of Agriculture. It also has strong connections with international organisations like the International Maize and Wheat Improvement Center (CIMMYT), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Center for Agricultural Research in the Dry Areas (ICARDA).

This publication highlights the Center's research activities of the past four decades. While the whole story can not be told in full in these pages, we do hope that readers will see at a glance, and appreciate, the Center's research activities and achievements made during the period under review.

Efrem Bechere (PhD)
Vice-President for Research and Development
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INTRODUCTION

Wheat (Triticum sp.) is one of the most important cereal crops in Ethiopia. It ranks fifth both in area planted and amount produced after tef, maize, sorghum and barley. Wheat occupies about 700,000 ha with a national average yield of less than 10 quintals/ha. Both tetraploid (Triticum turgidum L.) and hexaploid wheat (Triticum aestivum) are grown. The former are indigenous and cover about two-thirds of the wheat area under production. The cultivars grown are landrace cultivars composed of mixtures of several morphotypes (agrotypes) and subspecies. Durum or macaroni wheat (Triticum durum Desf.) is the predominant tetraploid wheat species. It is traditionally grown on heavy black clay soils (Vertisols) of the highlands between 1800–2800 metres above sea level. In contrast, hexaploid or bread wheat (Triticum aestivum L.) was probably an introduction during the early 1920s by the Portuguese or the Italians. It has wider adaptation and higher yield potential than durum or macaroni wheat.

The wheat programme at the Debre Zeit Agricultural Research Center was started in 1955 by the agronomy staff of the College of Agriculture and Mechanical Arts (now Alemaya University of Agriculture) and included both bread wheat and durum wheat. The basic objectives of the programme were:

1. to select or develop wheat varieties with high yield and disease resistance, and
2. to determine agronomic practices that improve the productivity of wheat.

To facilitate the study, wheat varieties were introduced initially from USA, Kenya and from Paradiso Experiment Station in Eritrea. The varieties consisted of hard red spring, durum and soft wheats. These were tested at Debre Zeit and Alemaya along with the Ethiopian wheat landrace cultivars. Based on superior yield performance in 1958, two bread wheat varieties, namely Kenya 1 and Kenya 5 were released to farmers for general cultivation, for the first time. Later, the two varieties played a key role in the identification of Arsi, Bale and Shashemene as potential areas for production of bread wheat in Ethiopia.

In 1964, a wheat-testing programme was initiated at MOA's seed multiplication farm near Kulumsa in Arsi by the agronomy staff of the Debre Zeit Agricultural Research Center who commuted from Debre Zeit. The multilocation testing programme was intensified with the establishment of IAR in 1966 through use of IAR's research stations as testing sites and thus cover more areas of the country. In the meantime, contacts increased with international research organisations: FAO, USDA, CIMMYT, ALDA (now ICARDA) and national research programmes of Kenya,
Turkey and Australia to acquire wheat materials for testing. Through the initiation of IAR, a National Crop Improvement Committee was formed in 1967 to organise and coordinate all research activities at a national level. As a result of the coordinated yield trials which followed, wheat varieties with wider adaptation and higher yield were identified for release to farmers (Table 1). Initial seed increase of the varieties was carried out at Debre Zeit while large-scale seed multiplication was done at MOA’s seed multiplication farm near Kulumsa. In addition to the selection of wheat varieties, the development of improved agronomic practices for different agroclimatic conditions has been an integral part of the research.

Upto 1974 the Debre Zeit Agricultural Research Center was responsible for the coordination of the national wheat programme. In spite of the fact that durum wheat has been the major type of wheat grown in the country, more research emphasis was given to bread wheat. This was not only due to the superiority in yield performance shown by bread wheat to durum wheat at the time but also due to the government’s interest to boost bread wheat production in the country so as to reduce imports.

ACHIEVEMENTS

1. Based on superior yield performance, wider adaptation and other agronomic characters shown in repeated testing during the period 1955–74, a number of high-yielding varieties were released to farmers for general cultivation throughout the country (Table 1). It is worth noting that all varieties released were bread wheat introductions from Kenya except Laketch and Sonora 63 which were from CIMMYT Mexico and Derrselign (CI 8154 Fr2) from USA. Most of the varieties have played a key role in increasing wheat production in the country.

2. Cultural practices, which allow the expression of genetic potential of the high-yielding varieties, have also played a vital role in increasing the productivity of wheat in the country. Paramount among these are proper time of planting, rate of seeding, weed control, rate and method of fertilizer application. Although recommendations may vary from one region to another the planting of improved durum wheat varieties 2–3 weeks earlier than the normal used for the landraces has in general been found to be more beneficial. Similarly, a seeding rate of 150 kg/ha is recommended for the high-yielding varieties as compared to 100 kg/ha for the landraces.

   Durum wheat growing mostly on heavy black soils (Vertisols) has shown the best response from a combination of NP fertilizers. Hand-weeding, at least once at late tillering stage, or the use of 2,4-D at 4-leaf stage at the rate of 1 litre/ha has been found to control most weeds.

3. The Debre Zeit wheat research programme, not only was a pioneer in introducing improved varieties of bread wheat into the country but also was in the forefront in collecting and preserving indigenous wheat landraces before they became extinct.
<table>
<thead>
<tr>
<th>Variety</th>
<th>Source (origin)</th>
<th>Year of release</th>
<th>Ear type</th>
<th>Chaff colour</th>
<th>Grain colour</th>
<th>Days to maturity</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya 1</td>
<td>Kenya</td>
<td>1958</td>
<td>Beardless</td>
<td>White</td>
<td>White</td>
<td>115-130</td>
<td>100-125</td>
</tr>
<tr>
<td>Kenya 5</td>
<td>Kenya</td>
<td>1958</td>
<td>Bearded</td>
<td>Red</td>
<td>Red</td>
<td>115-130</td>
<td>100-125</td>
</tr>
<tr>
<td>Yaktana 54</td>
<td>Kenya/CIMMYT</td>
<td>1967</td>
<td>Bearded</td>
<td>Red</td>
<td>Red</td>
<td>120-140</td>
<td>100-130</td>
</tr>
<tr>
<td>Kentana–Frontana</td>
<td>Kenya/CIMMYT</td>
<td>1967</td>
<td>Beardless</td>
<td>White</td>
<td>Red</td>
<td>115-130</td>
<td>100-125</td>
</tr>
<tr>
<td>Supremo-Kenya</td>
<td>Kenya/CIMMYT</td>
<td>1967</td>
<td>Beardless</td>
<td>Red</td>
<td>Red</td>
<td>115-130</td>
<td>100-130</td>
</tr>
<tr>
<td>Frocor (Y + X K +)</td>
<td>Kenta/CIMMYT</td>
<td>1967</td>
<td>Bearded</td>
<td>White</td>
<td>Whiter</td>
<td>100 110</td>
<td>90-110</td>
</tr>
<tr>
<td>Laketch</td>
<td>CIMMYT</td>
<td>1970</td>
<td>Bearded</td>
<td>Red</td>
<td>White</td>
<td>110-125</td>
<td>75-100</td>
</tr>
<tr>
<td>Salaino</td>
<td>Kenya/CIMMYT</td>
<td>1973</td>
<td>Beardless</td>
<td>White</td>
<td>White</td>
<td>120-140</td>
<td>100-120</td>
</tr>
<tr>
<td>Derrcelevin (CI 8154Fr^2)</td>
<td>USA</td>
<td>1974</td>
<td>Bearded</td>
<td>White</td>
<td>Red</td>
<td>110-125</td>
<td>80-110</td>
</tr>
<tr>
<td>Sonora 63</td>
<td>CIMMYT</td>
<td>1975</td>
<td>Bearded</td>
<td>White</td>
<td>Red</td>
<td>110-115</td>
<td>75-100</td>
</tr>
</tbody>
</table>
The wheat samples that were collected and maintained were later handed over to the Plant Genetic Resources Center/Ethiopia soon after it was established in 1976.

CURRENT WHEAT BREEDING ACTIVITIES

Soon after the revision of the national wheat research programme by the National Crop Improvement Committee in 1975, the Debre Zeit Agricultural Research Center took the responsibility for the improvement of durum wheat in the country. The bread wheat improvement programme became the responsibility of the Holetta Research Center. The main objective of the Durum Wheat Improvement Programme is to develop varieties with the following characteristics: stable and high yield; tolerance to frost and drought; resistance to leaf, stem and stripe rusts and septoria; resistance to insect (aphid and leaf beetle) and improved nutritional and grain quality. Other agronomic characters such as stiff straw, tolerance to waterlogging, early maturity and good tillering capacity also receive due consideration in the breeding work. Also the development of improved agronomic practice is an integral part of the research.

In Ethiopia, durum wheat is grown under varying agro-climatic, edaphic and disease conditions. Consequently, the identification of varieties with wide adaptation and high stable yield has been rather difficult. This means that to increase the productivity of durum wheat in the country, specific varieties must be developed for specific conditions or areas. To this end, programmes are already in progress to develop varieties with tolerance to the waterlogged soil conditions of Chefe Donsa and Bichena, and tolerance to drought at Dhera.

On the other hand, the multilocation testing strategy has been found to be effective in assessing the consistency of relative cultivar performance as well as for identifying genotype which combine desirable agronomic traits; e.g. resistance to diseases, tolerance to drought, waterlogging, frost etc. The other strategy that has been in use since 1978 is the "off-season nursery system" of growing two generations in a year, that is, regular and off-season. Apart from advancing generations, the system allows the screening of wheat materials against leaf and stem rusts in both seasons at Debre Zeit, a recognised "hot-spot" area; it also speeds up the multiplication of promising lines.

New improved varieties of durum wheat are being developed through: 1) selection from indigenous wheat landraces; 2) introduction and selection, and 3) hybridisation.

Selection from indigenous landraces

Since Ethiopia is the center of genetic diversity for durum wheat, there is an excellent opportunity to select from the heterogeneous landrace populations and pure line agrootypes possessing genetic variability in a breeding programme. The aim is to further improve the landraces through hybridisation with exotic varieties and to develop composites containing high-yielding genetic lines (agrootypes) for immediate use by farmers. Since 1986, this aspect has been under investigation in a Tetraploid Wheat
Improvement Project in Developing Countries. This is a project funded by SAREC. The results obtained so far have been very encouraging.

In 1966–67, two landrace cultivars, namely Arendeto (DZ 04–118) and Marou (DZ 04–688) were developed by mass selection and released to farmers in Yerer–Kereyu Awraja. The landrace utilisation scheme will continue in cooperation with the Plant Genetic Resources Center/Ethiopia.

**Introduction and selection**

The acquisition of durum wheat germplasm from abroad in the form of nurseries and segregating populations, testing and selection under Ethiopian conditions has been a key factor for the improvement of durum wheat varieties in the country. The major sources of introductions have been CIMMYT and ICARDA, although FAO and USDA were also major contributors. During the 20-year period from 1974 to 1994, five varieties, namely Cit 71, Gerardo, Ld 357, Boohai and Foka were released for general cultivation (Table 2). Of these, Ld 357 was an introduction from USA while the remaining four were from CIMMYT/Mexico. Several advanced lines have also been selected and used as parents in the crossing programme.

**Hybridisation**

Durum wheat hybridisation at Debre Zeit Agricultural Research Center started in 1974. Since then numerous crosses with various objectives, involving locally adapted varieties and high-yielding exotic types, and between landraces and exotic types have been made in attempts to recombine desirable traits into single genotypes. The early generations required screening and selection under heavy disease pressure followed by yield testing. Although two-way crosses were common in the early stages, back-crossing the F₁ to one of the parents (top-crossing) has been found to be more useful. Initially, a strict pedigree method was used to handle the segregating population. This procedure has been effective in identifying disease resistance as well as in the selection of consistently high-yielding combinations across locations. As a result, a modified bulk method has been in use since 1986 where selections are bulked in early generations (F₃ and F₄) and individual plant selection is started in advanced generation (F₅). Comparative yield trials identify the outstanding lines. For the first time, a high-yielding durum wheat variety called Kilinto was released to farmers from the local hybridisation programme in 1994. More advanced lines from the programme are scheduled for release.

**STAFF DEVELOPMENT THROUGH THE YEARS**

Staff development at the Debre Zeit Agricultural Research Station in the past 40 years (1955–94) has been marked by leadership of qualified agronomists and breeders with PhDs. They were assisted by Graduate and Technical Assistants, who themselves were holders of BSc degrees, diplomas and certificates in agriculture.
Table 2. Agronomic characteristic of durum wheat varieties released between 1966 and 1994.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Source (origin)</th>
<th>Year of release</th>
<th>Ear type</th>
<th>Chaff colour</th>
<th>Grain colour</th>
<th>Days of maturity</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arendento (DZ 04-118)</td>
<td>Ethiopia</td>
<td>1966</td>
<td>Bearded</td>
<td>Golden</td>
<td>White</td>
<td>ML</td>
<td>MT</td>
</tr>
<tr>
<td>Marou (DZ 04-688)</td>
<td>Ethiopia</td>
<td>1967</td>
<td>Bearded</td>
<td>White</td>
<td>Amber</td>
<td>Late</td>
<td>MT</td>
</tr>
<tr>
<td>Cocorit 71</td>
<td>CIMMYT</td>
<td>1976</td>
<td>Bearded</td>
<td>White</td>
<td>White</td>
<td>Early</td>
<td>Short</td>
</tr>
<tr>
<td>Gerardo = Gerardo VZ 466/61-130 x Gill &quot;S&quot;, cm 9605</td>
<td>CIMMYT</td>
<td>1976</td>
<td>Bearded</td>
<td>Brown</td>
<td>Amber</td>
<td>ML</td>
<td>Short</td>
</tr>
<tr>
<td>Ld 357 (Cl 8155)</td>
<td>USA</td>
<td>1979</td>
<td>Bearded</td>
<td>Brown</td>
<td>White</td>
<td>ML</td>
<td>MT</td>
</tr>
<tr>
<td>Boohai = Ci 71/Candeal II, CD 3862</td>
<td>CIMMYT</td>
<td>1982</td>
<td>Bearded</td>
<td>White</td>
<td>Amber</td>
<td>ME</td>
<td>Tall</td>
</tr>
<tr>
<td>Foka = Ci 71/Candeal II, CD 3369</td>
<td>CIMMYT</td>
<td>1993</td>
<td>Bearded</td>
<td>White</td>
<td>Amber</td>
<td>ML</td>
<td>Tall</td>
</tr>
<tr>
<td>Kilinto = Illumilo/Inrat 69/Boohai/3/Hora/Gerardo/4/Cit 71, DZ 918</td>
<td>Ethiopia</td>
<td>1994</td>
<td>Bearded</td>
<td>White</td>
<td>Amber</td>
<td>ML</td>
<td>Tall</td>
</tr>
</tbody>
</table>
MSc- and BSc-degree holders and a number of Technical Assistants gained practical experience before departing abroad for further studies. Several have returned to Debre Zeit and are still serving giving the Programme the essential continuity which has resulted in the release of eight durum wheat varieties.

**The period prior to 1960**

Formal wheat observation and variety testing at Debre Zeit Agricultural Research Center, then known as Bishoftu Agricultural Experiment Station, was initiated in 1955 by an American agronomist (Oklahoma State University Contract), Mr. Ben R. Jackson. Mr. Jackson was a staff member of the Alemaya College of Agriculture and Mechanical Arts (now Alemaya University of Agriculture). At the end of his tenure in 1958, he was succeeded by another agronomist, Mr. Merhejhause, who took over the wheat experiments at Debre Zeit while operating from Alemaya.

**The period between 1960 and 1970**

In 1960, for the first time, a graduate of the Alemaya College of Agriculture, Ato Tesfaye Tesemma, was stationed at Debre Zeit to take care of the wheat programme. When he left for the US in 1961 for MSc training, Ato Woudeneh Taddese replaced him and run the wheat programme for a year before he too left for the US to do graduate studies. Ato Asrat Felleke, a former graduate of Alemaya and agronomist with MSc degree from the US joined the programme. By the time Ato Asrat left for the US for further studies in 1964, Ato Tesfaye Tesemma was back from the US with MSc degree. He served the programme till he left for the US in 1970 for his doctorate.

Ato Aklilu Abebe and Ato Taye Wolde-Mariam were Technical Assistants and worked in the wheat programme during this period.

**The period between 1971 and 1980**

Ato Zewdu Oumer was in charge of the wheat programme until Dr. Tesfaye Tesemma returned in 1993 from a study leave in the US and continued the programme along with two Technical Assistants. A Graduate Assistant, Ato Efrem Bechere, and a Technical Assistant, Ato Demissie Mitiku, joined in 1976 while Ato Tilahun Atanafu, another Technical Assistant, joined in 1978. Ato Taye Wolde-Mariam, Technical Assistant left the programme in 1980.

**The period between 1981 and 1990**

The wheat programme continued to expand under Dr. Tesfaye Tesemma’s leadership. Ato Efrem Bechere with MSc degree (1979) and Ato Demissie Mitiku with BSc (1985) were back and working full time. Ato Efrem served the programme till 1985 when he finally left for the US for PhD training. In the mean time, Ato Getachew Belay (BSc) and W/o Kimia Mohammed (MSc) joined the programme in 1982 and 1987, respec-
tively. After working in the programme for four years, Ato Getachew left for Sweden in 1986 and returned with MSc degree in 1988. W/o Kimia quit the programme in 1990.

The Technical Assistants who served in the programme during the period were Ato Aklilu Abebe (1955-86), Ato Aleme Dejene (1985-90), Ato Gebeeychu Wolde-Semayat (1980-83), and Ato Tilahun Atanafu (since 1978).

The period between 1991 and 1994

Dr. Tesfaye Tesemma continued to lead the wheat programme with Ato Getachew Belay and Ato Demissie Mitiku. In 1992, they were joined by Dr. Efrem Bechere while Ato Getachew left for Sweden in 1993 for training leading to PhD degree. In 1993, a Graduate Assistant Ato Bennet Gashawbeza and three new Technical Assistants, namely Tsehay Bekele, Chuchu Kebede and Amha Yacob joined the programme. This brought the number of Technical Assistants in the programme to four including Ato Tilahun Atanafu.

Thus, the research staff in the wheat improvement programme has been steadily increasing in number over the years. The substations at which wheat experiments were handled also increased to six. It is envisaged that both will continue to increase as new wheat areas are covered.

INFRASTRUCTURE

Upon the takeover of the infrastructure of the Research Center by the Management Institute in 1985, the offices of the Wheat Improvement Programme moved into the poultry house which had two compartments. These it used until 1994. Presently, it has moved into a new laboratory building which has seed-storage and office facilities. It also has a 20 x 20 m lath-house (wire-house) which has been constructed with financial aid from CIMMYT and the German Volunteer Service, to facilitate crossing and the advancement of generations at least twice a year without fear of bird damage.

FUTURE OUTLOOK AND PRIORITIES

Durum wheat will continue to be an important crop in Ethiopia. At present, since production does not meet demand, more effort should be made to increase the productivity of the crop per unit area of land. Therefore, the objective of the Durum Wheat Improvement Programme will continue to be the development of new varieties which are superior to the ones currently grown by the farmers. However, improved varieties alone are not adequate to increase yield: they must go hand-in-hand with the agronomic practices that provide the best environment for the expression of the genetic potential.

In Ethiopia since durum wheat is grown under variable agro-ecological conditions, there should be more emphasis on developing specific varieties to satisfy specific
conditions or areas. This way the development of durum wheat varieties that will be suitable to naturally waterlogged areas and drought-prone areas would receive due consideration.

Ethiopia is rich in genetic diversity of durum wheat. Therefore, effort to utilise the indigenous landraces in breeding programmes will be encouraged.

Figure 1. A Field day at the Akaki substation, October 1994.
TEF IMPROVEMENT PROGRAMME
Hailu Tefera and Mulu Ayele

Tef (Eragrostis tef) is one of the unique indigenous food crops of Ethiopia that was domesticated centuries ago, perhaps before the introduction of wheat and barley in the country. It has played a major role in Ethiopian agriculture since ancient times. Its better performance under stress environments relative to the world's popular cereals, high consumer preferences and high market prices are some of the reasons why many farmers keep growing it.

Data for 11 years (1979/80–1989/90) indicated that on the average tef occupied annually 1.34 million hectares of land and was followed by maize, barley, sorghum, wheat and millets with 0.92, 0.89, 0.84, 0.64 and 0.19 million hectares, respectively (Central Statistical Authority, 1987; 1990; 1993). The same source showed that annually 1.13 million tonnes of tef were obtained.

Tef research was first started at the Jimma Agricultural and Technical School (now the Jimma Junior Agricultural College) in 1956. The research was transferred to the Debre Zeit Agricultural Experiment Station (now the Debre Zeit Agricultural Research Center) in 1960. The research work was started by collecting tef samples from different parts of Ethiopia. The Center has, since then, been responsible for tef research and has developed some improved varieties and their agronomic practices. Literally, all released varieties in the country at the moment have been developed at this Center.

OBJECTIVES

To increase the productivity of the crop through genetic improvement and other agronomic practices, the Tef Improvement Programme has set out the following objectives:

1. Development of high yielding as well as lodging and disease-resistant cultivars of tef for low, mid- and high-altitude regions of Ethiopia by selection from landrace populations and segregating populations and subsequent testing of these in multi-location yield trials

2. Improvement of agronomic practices, e.g. seed-bed preparation methods, seeding practices, plant nutrition, cropping system, harvesting and threshing practices

3. Generation of basic information in the areas of genetics, breeding and physiology; e.g. moisture-stress physiology, which would accelerate the attainment of objectives stated in (1) and (2) above.
ACHIEVEMENTS

1960–69

To isolate superior genotypes from landraces about 462 accessions were collected in the first decade of tef research. A big effort was made to identify better-yielding cultivars through mass selection and as a result the popular tef varieties DZ–01–354, DZ–01–196 and DZ–01–99 were released towards the end of this decade for large-scale production.

DZ–01–354 and DZ–01–99 have a wide range of adaptation in the country. The yield potential of DZ01196 was not comparable to DZ–10–354 and DZ–01–99 but owing to its excellent seed quality it was distributed to farmers. These varieties yield 1522 q/ha under farmers’ condition.

1970–79

A total of 1138 landrace accessions were collected during this period from Shewa, Wello, Wollega, Arsi, Sidamo, Gojam, Gondar and Tigray. The total accession number was increased to 1600. The mass selection procedure was pursued to identify better performing varieties from the germplasm accessions. Consequently, the variety DZ–01–787 was released for large-scale production in 1978. This variety had equal yielding ability compared to DZ–01–354 but its resistance to rust was better than DZ–01–354 and other varieties.

From the mutation breeding work that started in 1972, appropriate doses of radiation and mutagenic chemicals were determined. Gamma ray dose of 150 Krad, X-ray dose of 130 Krad, and ethyl methane sulphonate dose of 2.5–4.7% were recommended for mutation breeding in tef.

Tareke Berhe discovered the artificial crossing technique of tef in 1974. The first tef hybrid was produced in December 1974 using the contrasting lines DZ–01–186 and DZ–01–44 which have adequate genetic markers. The main impediment to a successful crossing till this time was the failure of researchers to detect the early morning anthesis (6:30 – 8:30 a.m.) of the tef florets. Emasculation of the three anthers from the floret in the afternoon followed by pollination the next morning when anthers were ready to dehisce was found to be the best technique of crossing. This procedure is currently followed and gives a reliable hybrid seed. A total of 325 single, double, three-way and multiple crosses were made in 1975, 1976 and 1977.

Recommendation on cultural practices of tef were also produced during this period. Pertaining to sowing dates, July 815 and July 1522 were found to be appropriate for light soils and black soils (Vertisols), respectively, around Debre Zeit. Similarly, a seeding rate of 25 kg/ha for light soils and 30 kg/ha for black soils was recommended. Regarding fertilizer rate, 40 kg/ha N and 26 kg/ha P have been recommended for light
soils whilst 60 kg/ha N and 26 kg/ha P have been recommended for black soils (Vertisols).

1980–89

During the period under review, germplasm collection activity continued and total acquisition rose to around 2000. These materials were characterised for morpho-agronomic traits. Three varieties of tef from the hybridisation programme were released for different tef-growing regions. The variety DZ–Cross–44 was released for Holetta, Indibir and their vicinity while DZ–Cross–82 was released for Jimma and its vicinity in 1982. The variety DZ–Cross–37 or Tseday, as named by farmers, was released in 1984 for low and mid-altitude environments. This variety is suitable for multiple cropping systems and for drought-prone low-rainfall areas while its earliness and good-seed quality makes it widely accepted in low-rainfall areas. Currently, seed demand for this variety is very high.

In an attempt to test the adaptation of improved varieties to new areas not addressed by the regular yield-testing programme, a variety adaptation trial was initiated in collaboration with the Agricultural Development Department of the Ministry of Agriculture at the beginning of this phase. The trials showed that some of the improved varieties were suitable for one or more new test localities in administrative regions like Gojam and Gondar. These same trials also indicated that grain yields could even triple by using improved agronomic practices alone, using farmers' local cultivars. Therefore, where improved varieties were lacking, application of improved agronomic practices made an impact on grain yield. Clearly, this was one of the best options to increase tef productivity in the short run.

In addition, the proper date for harvesting a late variety of tef was determined at this time for Vertisols around the Debre Zeit area: harvesting 12 weeks after heading was found to be appropriate for DZ–01–354, a late variety.

1990–94

A germplasm catalogue was produced for over 2000 pure lines initially characterised in the late 1980s. One variety, DZ–Cross–255 (or Ghibie) developed at Debre Zeit was released for Jimma and Asasa area in 1993, making eight, the total number of varieties released to that date (Table 3). These varieties are all under production today. Four cultivars (DZ–01–112, DZ–01–1445, DZ–01–974 and DZ–Cross–358) are ready for verification and approval by the National Variety Release Committee (NVRC). Additional information on the genetics and drought physiology of tef were generated during this period. Tef varieties released by the Centre are listed in Table 3.
Table 3. Varieties of tef (Eragrostis tef) released for large-scale production since the beginning of tef research at Debre Zeit Agricultural Research Centre.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year released</th>
<th>Production area</th>
<th>Experimental yield (q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DZ-01-354</td>
<td>1970</td>
<td>High-altitude areas</td>
<td>18-28</td>
</tr>
<tr>
<td>DZ-01-196</td>
<td>1970</td>
<td>Mid- and high-altitude areas of Debre Zeit and its surroundings</td>
<td>16-24</td>
</tr>
<tr>
<td>DZ-01-99</td>
<td>1970</td>
<td>Mid- and high-altitude areas</td>
<td>18-28</td>
</tr>
<tr>
<td>DZ-01-787</td>
<td>1978</td>
<td>High-altitude area</td>
<td>18-29</td>
</tr>
<tr>
<td>DZ-Cross-44</td>
<td>1982</td>
<td>Holetta, Indibir and their surroundings</td>
<td>21-30</td>
</tr>
<tr>
<td>DZ-Cross-82</td>
<td>1982</td>
<td>Jimma and its vicinity</td>
<td>15-22</td>
</tr>
<tr>
<td>DZ-Cross-37</td>
<td>1984</td>
<td>Asosa; low- and mid-altitude areas around Debre Zeit, and as a catch-crop in many areas</td>
<td>15-27</td>
</tr>
<tr>
<td>DZ-Cross-255</td>
<td>1993</td>
<td>Jimma, Awasa and their surroundings</td>
<td>16-27</td>
</tr>
</tbody>
</table>

CURRENT ACTIVITIES

Research on numerous projects on breeding and agronomy of tef are under study at present to develop better cultivars for various production environments along with their agronomic practices. The breeding activity is based upon exploiting the existing variation in tef germplasm through selection and further tests in several locations for several years. In addition, gene recombination is employed by intraspecific hybridisation to isolate superior individuals from segregating populations.

Studies on the establishment of appropriate population density and sowing date for four maturity groups of tef at different altitude zones are also in progress. The effect of antilodging growth-regulator chemicals on tef is being studied.

Furthermore, experiments are in progress on the effects of drought and waterlogging on the performance of tef.
FUTURE OUTLOOK

The tef crop has been subjected to less scientific scrutiny than other cereals. Emphasis should therefore focus on basic and applied research on its genetics/breeding, agronomy, physiology and various disciplines. The crop is primarily grown by subsistence farmers in various regions of the country. Hence, research on tef should focus on high, mid- and low-altitude areas representing various social and economic environments of tef-growing areas.

Genetics

More information is needed on the genetics of the crop to understand the gene action and inheritance pattern of useful traits. For better genetic gain, heritability and interrelationships of traits must be studied under various environments. The development of genetically improved varieties must continue by selection from the landraces and segregating populations.

Agronomy and physiology

In the areas of agronomy and physiology, the short-term strategies are the refinement of the already recommended cultural practices and development of new packages for production in new environments. Some problem areas of interest are seeding practices, land preparation methods for waterlogged and droughty environments and proper harvesting dates. Long-term research in these fields will include studies on cropping systems, crop rotation, minimum tillage and agronomic aspects of mechanisation (e.g. testing planting and harvesting implements designed for other small-seeded and lodging-susceptible crops). Studies to understand the physiological, morphological and biochemical basis of drought and waterlogging tolerance will also be conducted. Other long-term studies will also include comprehensive studies on the utilisation aspects of the crop both for food and feed (e.g. assessment of nutritive value, development of various recipes, improvement of food-processing methods etc).

STAFF DEVELOPMENT

Staff members who worked on the breeding/agronomy, crop protection, taxonomy, physiology and agricultural economic aspects of tef since 1960 are listed in the Appendix.

INFRASTRUCTURE DEVELOPMENT

1960–79

The Tef Improvement Programme had a good office–laboratory complex, glasshouse and lath-house. Besides its 100-ha holding at the Debre Zeit main research centre, the programme had use of sites in its vicinity and in other parts of the country. These other
sites belonged mainly to the Debre Zeit Agricultural Research Center, the Institute of Agricultural Research and the Ministry of Agriculture.

1980–89

From 1984 onwards, the research work was carried out without use of a proper office, laboratory or glass-house facilities. This was because of the takeover of same by the Ethiopian Management Institute, which started its operation on the previous holdings of the Debre Zeit Agricultural Research Centre.

1990–94

Up to July 1993, research was conducted and coordinated from a small ex-poultry pen. The programme moved into the newly built office–laboratory complex in July 1993. A new glass-house and cold store under construction are about to be completed. These facilities should enable the research work to show more progress in the future.

Figure 2. An improved variety of tef under demonstration at a Field Day at the Akaki substation (October 1994).
Chickpea (Cicer arietinum L.) and lentils (Lens culinaris Medik) are amongst Ethiopia’s important cool-season food legumes. They have been in cultivation since ancient times.

Chickpea in Ethiopia is cultivated to a large extent between 1400–2300 m above sea level where the mean annual rainfall ranges from 700–2000 mm. Geographically, this agro-ecological zone coincides with the distribution of Vertisols and chickpea production regions.

Lentils are grown between 1400 and 3000 m above sea level. They are grown during the months of July–November, the main rainy season, while chickpea is grown during September–January on receding moisture. These crops are very important in a subsistence farming situation since they are grown in rotation with cereals. They form an integral part of the diet for the majority of the rural population and the poor sector of the urban population. The crops are the main source of protein to the former while for the latter they are a reliable and cheap supply of plant protein. Chickpea and lentils are grown in rotation with cereals in most parts of Ethiopia. As such they have helped maintain soil fertility and productivity through their ability to fix atmospheric nitrogen. Among the four major cool-season food legumes in Ethiopia, chickpea and lentils have a prominent place in terms of hectarage and production. Up to 1974, chickpea was the number one pulse crop followed by faba bean (Vicia faba L.), lentils and field pea (Pisum sativum L.) After 1974, faba bean has been the leading food legume crop in both acreage and production. At present, chickpea and lentils rank second and fourth, next to faba bean, in terms of production and acreage.

More than one-third of the total chickpea area and about half of the total chickpea production in Africa is in Ethiopia. Of the total area under production to lentils in Africa, about half of it is in Ethiopia. Globally, Ethiopia is at present the tenth lentil-producing country in the world and the top producer in Africa. Ethiopia is among the important chickpea and lentil producing countries in the world, yet the yield of these two crops has remained very low (ton/ha), the major reasons being:

1) The inherently low yield potential of the existing landraces
2) Susceptibility of landraces to frost, waterlogging and terminal drought
3) Poor cultural practices
4) High year-to-year instability in yield because of susceptibility to diseases
5) Poor protection measures against diseases and pests.
A coordinated national research programme on highland pulses was started during the early 1970s as a result of the action of the National Crop Improvement Committee (NCIC). Since then, the Debre Zeit Experiment Station of the Addis Ababa University (now under Alemaya University of Agriculture), in collaboration with Chilalo Agricultural Development Unit (CADU), coordinated the research on four major highland pulses (chickpea, lentils, faba bean and field pea). In 1976 the research activities were divided between Alemaya University of Agriculture (AUA) and the Institute of Agricultural Research (IAR): Chickpea and lentils research became the responsibility of AUA (Debre Zeit) while the IAR assumed the research responsibility for faba bean and field pea. Since 1978, the National Chickpea and Lentils Improvement Programme has been coordinated from Debre Zeit (89° 44' N latitude and 38° 55' E longitude, 1900 m altitude, 45 km south-east of Addis Ababa). It has four subcenters in Shoa Administrative Region, viz. Akaki (2200 m.a.s.l.), Chefe Donsa (2400 m.a.s.l.), Koka and Alem Tena (1650 m.a.s.l.) representing different agro-ecological zones. Besides these, research centers of IAR and ADD sites are used for multilocation trials.

Programme objectives

The overall objective of the Chickpea and Lentil Improvement Programme is to contribute towards increased agricultural productivity and ensure sustainability of production, thereby increasing the availability of food and improving the economic and social wellbeing of the people. More specifically, the programme aims to:

1) evaluate germplasm from which further genetic improvement can be made
2) conduct breeding in order to develop high yielding and stable cultivars
3) develop and integrate management of diseases and insect pests
4) develop appropriate cultural practices for different genotypes and agro-ecological zones
5) develop cultivars with multiple resistance to various diseases, and
6) disseminate technical information through research reports and other publications.

MAJOR ACHIEVEMENTS

Collection and evaluation

Since 1977, 439 chickpea and 242 lentil landraces have been collected by the staff of ICRISAT, ICARDA and Debre Zeit Agricultural Research Center (DZARC) and their accessions evaluated at DZARC by PGRC/E and DZARC staff. In addition, more than 600 chickpea and 4000 lentil accessions and segregating populations have been introduced from ICRISAT and ICARDA out of which a large number of promising materials have been identified.
Breeding

Based on the results of years of national yield trials (NYT) on chickpea and lentils, some outstanding varieties were identified for their high-yield potentials. These varieties were multiplied and distributed to farmers. The varieties released, their area of adaptation and agronomic recommendations are given in Tables 4–6.

Table 4. Released chickpea varieties and their areas of adaptation.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year of release</th>
<th>Area of adaptation altitude (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DZ-10-04</td>
<td>1974</td>
<td>1800–2300</td>
</tr>
<tr>
<td>DZ-10-11</td>
<td>1974</td>
<td>1600–2000</td>
</tr>
<tr>
<td>Dubic</td>
<td>1978</td>
<td>1800–2300</td>
</tr>
<tr>
<td>JG-62 x Radhy</td>
<td>1985</td>
<td>1800–2300</td>
</tr>
<tr>
<td>Mariye</td>
<td>1985</td>
<td>1800–2300</td>
</tr>
<tr>
<td>DZ-10-16-2</td>
<td>1994</td>
<td>1800–2300</td>
</tr>
</tbody>
</table>

Table 5. Released lentil varieties and their areas of adaptation.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year of release</th>
<th>Area of adaptation altitude (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL-142</td>
<td>1980</td>
<td>1650–2200</td>
</tr>
<tr>
<td>R-186</td>
<td>1980</td>
<td>1800–2400</td>
</tr>
<tr>
<td>NEL-358 (Chalew)</td>
<td>1985</td>
<td>1850–2450</td>
</tr>
<tr>
<td>NEL-2704</td>
<td>1994</td>
<td>1600–2200</td>
</tr>
</tbody>
</table>

CURRENT RESEARCH ACTIVITIES

Emphasis is on the development of high yielding and stable chickpea and lentil varieties for different agro-ecological zones. The following major activities are being carried out:

1. Evaluation of local and exotic chickpea and lentils accessions for tolerance to biotic (disease and insect pests) and abiotic (drought, waterlogging and frost) stresses.
2. Conduct multilocation yield trials at different agro-ecological zones and identify stable, promising chickpea and lentil materials for release.

3. Carry out crossing work for various objectives, mainly for transferring disease-resistant genes to high-yielding and susceptible varieties.

4. Development of appropriate cultural practices, seeding rates, planting date, seedbed practice etc for different varieties in various agro-ecological zones.

5. Carry out research on entomological, pathological, weed and soil management problems of the crops.
Figure 4. *A demonstration field of chickpea varieties at Akaki substation*

Agronomy

Some agronomic studies conducted at the Debre Zeit Agricultural Research Center are summarised in Table 6.
Table 6. Agronomic recommendations for chickpea and lentil crops.

<table>
<thead>
<tr>
<th></th>
<th>Chickpea</th>
<th>Lentils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting date</td>
<td>Early August to early September</td>
<td>End of June to Mid-July</td>
</tr>
<tr>
<td>Seeding rate</td>
<td>65–85 kg/ha</td>
<td>50–65 kg/ha (small-seeded)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–75 kg/ha (large-seeded)</td>
</tr>
<tr>
<td>Spacing</td>
<td>10 cm between plants and 30 cm between rows</td>
<td>5 cm between plants and 20 cm between rows</td>
</tr>
</tbody>
</table>

Figure 5. Experiment on sowing date for lentils.
STAFF DEVELOPMENT

During the first decade from 1970–79, nine nationals and expatriates laid the groundwork and initiated important research on chickpea and lentils. The next decade saw an increase of staff to 16, of whom more than half had their first to third degrees. The period from 1990 to 1994 again saw staff increase to 21. Dr. Geletu Bejiga has been Team Leader since 1980. Staff consisted of breeders, agronomists, pathologists, entomologists, soil scientists, and technical and field assistants. Six staff were able to further their studies on study leave. The staff list is given in the Appendix at the end of this publication.

INFRASTRUCTURE

The Chickpea and Lentils Improvement Programme has an office and laboratory complex at Debre Zeit Agricultural Research Center. The newly established greenhouse at Debre Zeit is expected to facilitate the screening of a large number of chickpea and lentil materials.

FUTURE OUTLOOK

The focus of research of the Chickpea and Lentil Improvement Programme will be in the following areas:

1. Develop stable and high-yielding cultivars of chickpea and lentils for:
   a) lowland regions (< 1800 m.a.s.l.)
   b) medium altitudes (1800 to 2300 m.a.s.l.)
   c) highlands (> 2300 m.a.s.l.)

2. Develop drought-tolerant cultivars of chickpea and lentils

3. Produce genetic stock for resistance to wilt, root-rots and Ascochyta blight in chickpea and lentils

4. Develop frost-tolerant cultivars of chickpea and lentils

5. Develop rust-resistant cultivars of lentils

6. Identify source of tolerance to waterlogging in chickpea and lentils, and incorporate into adaptable genotypes

7. Screen for tolerance to major insect pests like Heliotis armigera (in chickpea) and aphids (in lentils)

8. Develop cultivars with multiple resistance to various diseases of chickpea and lentils.
Though the Debre Zeit Agricultural Research Center was established in 1953, socio-economics research was not launched until the Department of Agricultural Economics was established in 1976. The establishment of the Department was, however, preceded by two Programmes: namely Seed Multiplication and Outreach which were established in 1974/75. In later years these became the prominent programmes of the Department. The principal concept underlying the establishment of the Department is that all agricultural research has to be accompanied by socio-economic research for effective dissemination of research outputs to the farming community.

Until 1987 the emphasis of the Department was on seed multiplication of improved seeds of tef, wheat, chickpea and lentils and demonstration of improved technologies of these crops. In addition to the above activities, the Department started conducting production cost studies, collecting market prices of major crops and carried out socio-economic surveys and related studies. In 1987, the Department was reorganised and its research scope broadened. In 1988, it embarked upon Farming Systems Research (FSR) incorporating farmers' participation in technology generation and transfer.

Objective

The overall objective of the Department is to improve farmers' standard of living through the generation, popularisation (promotion) and adoption of appropriate technologies.

Approach

The Department encourages and employs a multidisciplinary-team approach. It works closely with agronomists/breeders, pathologists, soil scientists etc. It also collaborates with national and international research organisations like CIMMYT, ICRISAT, IAR, MOA etc.

ACTIVITIES AND MAJOR ACHIEVEMENTS

Farm management and seed multiplication

The section produces basic seeds of wheat, tef, chickpea and lentils on 122 hectares for seed multiplication. It used to manage 43 ha of research farm which is currently managed by an independent unit, namely the Research Field Operation Unit. This Unit
also provides farm machinery services and advice to neighbouring government organisations.

The Department has five old tractors of which three are functional. These are used for plowing and discing. There is also one computer and one vehicle (4 WD) at its disposal.

The section’s production record for the 17-year period from 1976/77 to 1993/94 shows the following: 1009.46 tonnes of wheat (Boohai, Enkoy, Dereselign, Gerardo, Cocorit71), 925 tonnes of tef (DZ-01-196, DZ-01-354, DZ-01-99, DZ-01-787 and Cross-37), 313.57 tonnes of chickpea (DZ-10-11, Dubie and Mariye) and 13 tonnes of lentils (EL-142 and Chalew) (Table 7).

Table 7. Improved seed multiplied and distributed to the Ethiopian Seed Corporation, farmers, government and non-government organisations during 1976/77 to 1993/94 (quintals).

<table>
<thead>
<tr>
<th>Year</th>
<th>Wheat</th>
<th>Tef</th>
<th>Chickpea</th>
<th>Lentils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>284</td>
<td>503</td>
<td>312</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>272</td>
<td>190</td>
<td>257</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>453</td>
<td>522</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>600</td>
<td>580</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>670</td>
<td>430</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>680</td>
<td>520</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>1000</td>
<td>850</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>350</td>
<td>250</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>300</td>
<td>245</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>250</td>
<td>300</td>
<td>71</td>
<td>10</td>
</tr>
<tr>
<td>1986</td>
<td>848</td>
<td>704</td>
<td>9.5</td>
<td>23.5</td>
</tr>
<tr>
<td>1987</td>
<td>480</td>
<td>416</td>
<td>94.34</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>909</td>
<td>575</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>921</td>
<td>383</td>
<td>689</td>
<td>20</td>
</tr>
<tr>
<td>1990</td>
<td>625</td>
<td>658</td>
<td>140</td>
<td>51</td>
</tr>
<tr>
<td>1991</td>
<td>520</td>
<td>610</td>
<td>170</td>
<td>15</td>
</tr>
<tr>
<td>1992</td>
<td>480</td>
<td>524</td>
<td>80</td>
<td>8</td>
</tr>
<tr>
<td>1993</td>
<td>452.65</td>
<td>591.95</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>10094.65</td>
<td>8851.95</td>
<td>3124.84</td>
<td>132.50</td>
</tr>
</tbody>
</table>

Source: Department of Agricultural Economics, DZARC.
About 65% of the seeds produced (of wheat, tef, chickpea and lentils) were annually supplied to the Ethiopian Seed Corporation, while the remaining was distributed to farmers and agricultural organisations or was used for seedstock on-farm.

**Farming systems and outreach**

The Unit diagnoses the production circumstances of farmers, their practices, problems, objectives and preferences. It carries out on-farm evaluation of agro-technologies of wheat, tef, chickpea and lentils, and demonstrates and popularises the on-farm validated agro-technologies. To effectively execute such studies, the Department has worked out its plan and strategies based on high-, mid- and low-altitude zones of the country.

The unit has demonstrated improved technologies of wheat, tef and chickpea in many parts of the country. It has surveyed the farming systems of Ada, Akaki and Tullu Bollo and has identified the major production constraints; it has verified herbicides, insecticides and other technologies.

The demonstration work carried out at Ada, Lume and Akaki from 1976 to 1988 has shown that improved packages of wheat, tef, chickpea and lentils outyielded the local package by about 110%, 71%, 67% and 60%, respectively.

A survey conducted in Ada, Lume and Gimbichu woredas in 1990/91 indicated that 94% of farmers grew improved wheat varieties.

**Socio-economic studies**

Although this Unit has received less emphasis, nonetheless, it is responsible for undertaking marketing studies, project evaluations and other rural development issues. The Unit has already generated relevant information on the performance of training and visit extension system, and socio-economic factors affecting fertilizer demand in Ada and Lume woredas. The Unit is collecting and compiling information on prices of major cereals like wheat, tef, chickpea and lentils crop from Debre Zeit market.

**ORGANISATIONAL STRUCTURE AND STAFFING OF THE DEPARTMENT**

The following three operational units help the Department to realise its objective:

1. Farm management and seed multiplication
2. Farming systems research and outreach
The Department has three MSc and three BSc degree-holding staff. These staff are also involved in teaching courses for undergraduate students at Alemaya University of Agriculture. The Department also has four technical assistants. The staff situation since the establishment of the Department is shown in the Appendix.

FUTURE OUTLOOK

The Department is planning to expand its sphere of activity. Towards this end, it is going to increase its staff to meet its manpower needs. It has plans to increase its research facilities and refine research strategy but limiting itself to relevant and comprehensive research projects. The Department would be generating useful and scientific reports and involve itself in development-oriented projects in order to popularise research outputs of the Center to the ultimate users. The Department will continue its close cooperation with national and international research institutions and standardise its socio-economic research. Major areas of operation planned are as follows:

1. Farming systems survey, on-farm technology evaluation and technology transfer
2. Adoption studies of agro-technologies
3. Marketing studies
4. Impact studies
5. Livestock on-farm research
6. Gender-related issues
The Crop Protection Department of Debre Zeit Agricultural Research Center was established in 1976 with the primary aim of conducting relevant research programmes that basically complement the improvement of crops in yield and quality. The main focus of research is on studying the effect and control mechanisms of diseases, insect pests and weeds of crops that would eventually lead to an increase in agricultural productivity. In essence, the Department is to carry out research in crop pathology, entomology and weed sciences that basically address the problems of farmers throughout the country.

OBJECTIVES

General

1. To conduct research on diseases, pests and weeds of tef, durum wheat, chickpea and lentils

2. To generate new innovations to supplement crop production techniques

3. To disseminate to the farming community technological innovations produced in integrated pest management systems

4. To provide relevant data and research output for implementation in rural development projects

5. To generate material for instruction purposes

6. To assist graduate students in sharing experimental techniques and to provide them with other advice as necessary

7. To provide advisory services to extension workers and the farming community

8. To search for appropriate control measures for diseases, pests and weeds.

Specific

Pathology

1. To monitor disease outbreak through regular surveillance on mandate crops and others
2. To identify and screen new sources of resistance to diseases
3. To monitor changes in the virulence of pathogens
4. To study the mode of inheritance in disease resistance
5. To provide basic information on host-parasite relationships
6. To conduct seed-health testing and to detect seed-borne diseases
7. To provide in-service training and short courses in pathology
8. To investigate the usefulness of various disease management systems.

**Entomology**
1. To monitor insect pest types and development at regular intervals
2. To screen crop varieties for resistance to insect pests
3. To study the ecological distribution of insects and pests in space and time
4. To investigate the biology of the pests
5. To provide basic information on insect-host relationships
6. To evaluate the various pest-control strategies
7. To provide in-service trainings and short courses in entomology.

**Weed science**
1. To make inventories of weed flora
2. To evaluate the influence of weeds on the productivity of crops
3. To investigate the effect of various weed-control methods
4. To monitor changes/shifts in weed flora at frequent intervals
5. To provide in-service training and short courses in weed science and weed control.

**RESEARCH STRATEGY**

The major research thrust of the Department is more on applied and adaptive research and less on basic and strategic research. It focuses mainly on generating practical
knowledge and development of efficient production systems specifically applicable to climatic and soil factors.

In striving to realise its overall objectives, the Department undertakes core research programmes laid out under the following strategies of operation:

1. Identification of biotic and abiotic factors responsible for low productivity of crops

2. Evaluation of massive germplasm materials on durum wheat, tef, chickpea, lentils and other additional crops such as grapevine, garlic and shallot, for their capability to withstand disease, pests and weeds

3. Monitoring and surveying of diseases, pests and weeds in the country

4. Investigation of an appropriate integrated pest-management systems, by evaluating all possible components of crop-protection methods


ACHIEVEMENTS

The Crop Protection Department has the following achievements to its credit:

1. Identified insect pests, diseases and weeds associated with mandate crops and other crops in different areas of the country

2. Screened a large collection of wheat, tef, lentils and chickpea germplasm, for assistance against diseases and insect pests

3. Screened commercially available pesticides (insecticides, herbicides and fungicides) against insects, weeds and diseases

4. Performed studies on the biology of plant pathogens and insects

5. Performed studies on cultural control measures against diseases and insect pests

6. Provided advisory services to farmers, extension workers and gardeners in and around Debre Zeit

7. Conducted some basic research and generated practical knowledge

8. Worked closely with durum wheat and pulse breeders on the new varieties released.

The following were the major topics of research in the past seven years (1987–94):

a. Chemical screening (against insects, diseases, weeds)
b. Cultural control measures (largely on tef and wheat)
c. Host resistance screening
d. Pest/pathogen biology
e. Seasonal influence
f. Loss assessments in the three disciplines
g. Surveys of diseases, insect pests and weeds
h. Seasonal distribution of grasshoppers.

CURRENT RESEARCH PRIORITIES

A. Insect pests
   1. Grasshoppers and crickets
   2. American bollworm
   3. Pea aphid
   4. Storage pests

B. Diseases
   1. Wheat stem rust
   2. Wheat leaf rust
   3. Septoria leaf blotch
   4. Septoria glume blotch
   5. Bacterial blight
   6. Seed mycoflora
   7. Wilt root-rot
   8. Viruses
   9. Rust
   10. Basal rot
   11. Garlic rust

C. Weeds
   1. Broad-leaved weeds
   2. Grass weeds
These criteria for priority determination were based on: 1) surveillance reports, 2) research extension linkage committee reports (RELC), and 3) potential damages. The mode of operation was as follows:

1. Surveillance of problem areas concerned: a) field surveys – farmers, b) RELC reports, and c) demands of farmers

2. Loss assessment (based on the extent of damage)

3. Evaluation of control measures concerned a) host resistance, b) cultural control, c) biological control, and d) chemical control

4. Study of damaging agencies included a) epidemiology, b) biology, c) seasonal distribution, and d) pathogen/pest variability.

5. Generating information or innovations for implementation. A number of publications and annual reports have been produced before and after the establishment of the Department.

**STAFFING**

The Department's research staff includes by discipline, plant, crop, pulse and cereal pathologists; crop entomologist and a weed scientist. Some of these started working at the Center even before the establishment of the Department at Debre Zeit. A detailed staff list is available in the Appendix.
REVIEW OF RESEARCH IN ANIMAL SCIENCES
Daniel Keftasa, Alemu Yami, Teshome Shenkoru
and Yalemeshet Wolde-Amanuel

The programme was started in 1956 with research on poultry. Dairy research followed in 1971. Research on forage crops was being carried out as an extension of the programme at Alemaya.

The major objectives of the research programmes involved assessments, evaluations, studies and recommendations, and training and advisory services. Assessments of dairying characteristics of local and cross-bred cattle under different management practices were a major objective. An equally important objective was utilisation assessment of non-conventional feed resources and the development of feeding techniques for different classes of animals raised for their milk, meat or egg production. Other objectives were as follows:

1. To evaluate and select different exotic poultry breeds
2. To study adaptation, agronomic and feeding values of different exotic and local grasses, herbaceous legumes and multipurpose trees and assess the possibilities of integrating them into the cereal-based cropping systems
3. To develop packages of recommendations for extension purposes. These involved the management of different classes of animals under different agro-ecological conditions
4. To help train postgraduate students, and
5. To give advice to development workers.

ACHIEVEMENTS

From studies and observations carried out over a period of years, the Department of Animal Sciences has been able to put forth a number of recommendations, which are discussed in the following paragraphs.

Among the indigenous breed of cattle, Boran, Fogera and Barka have been found to be most suitable for cross-breeding with exotic dairy cattle. Fifty per cent F1 Boran x Holstein crosses are recommended under current farming systems and management practices for most medium-highland conditions.
Among a number of poultry breeds tried out under local conditions, the White Leghorn has been found to be superior for high egg production, disease resistance and overall adaptability. Over half a million improved chickens have been distributed to neighbouring farmers and large-scale commercial farms. The current development of poultry industries in the country, particularly within and around Debre Zeit town, has been the outcome of research on poultry at Debre Zeit Agricultural Research Center.

So far three formulae of chick starter ration, two growers’ ration and three layers/breeders’ ration have been developed. Green alfalfa at 5% inclusion rate has been found to improve egg quality.

Figure 6. Chicken experiment for egg production at the Center.

Over 500 forage germplasm have been evaluated and the following species have been recommended for use under medium-highland environments:
1. **Annual forage crops:** vetch, oats, clovers, fodder-beet
2. **Herbaceous legumes:** Desmodium, alfalfa, Napier grass
3. **Perennial grasses:** Rhodes grass, panicum, Napier grass
4. **Multipurpose trees:** sesbania, leucaena, lucerne.

Different management requirements of each species and their suitability for different cropping systems (intercropping, crop rotation, relay cropping and sequential cropping) have been studied.

Studies conducted on different cereal straws and grain legume haulms revealed that there were clear variations between genotypes. They are further influenced by the environment under which they are grown. Different improvement techniques such as supplementation by urea, molasses, mustard cake and forage legumes have shown to increase the utilisation of crop residue by beef cattle and sheep. This resulted in increased intake, higher digestion, better feed-use efficiency, faster growth rate and improved economic benefits to farmers.

**CURRENT ACTIVITIES**

The major focus is on (1) improving the feed resource base for livestock, and (2) the development of feeding systems from locally available materials. This latter is mainly for mixed croplivestock production systems of the central highlands in forage and pasture crops agronomy. Thirdly, the focus is on integration of herbaceous and tree legumes with cereal-based cropping systems.

Research on poultry focuses on development of management practices both for egg and meat-type chicken.

**Some research areas in progress:**

1. Effect of different management systems on yield, persistency and nutritional value of different annual forage crops.
2. The economics of different livestock feed production systems.
3. The value of different leguminous forage species in cereal-based cropping systems of the central highlands through intercropping, crop rotation and sequential cropping.
4. Genetic and environmental effects on the nutritional value of cereal straws.
5. Assessment of the nutritional value and digestibility characteristics of different crop by-products followed by developing techniques for improving their nutritional value by supplementing with industrial by-products and forage legumes.
7. Development of livestock management packages (breeds, feeds, feeding-system technologies) and their verification on-farm to make them available for extension use.

**FUTURE CHALLENGES**

The Department of Animal Science will continue its present research into the future, and take up new challenges. Among research areas scheduled are the following:

1. To develop inexpensive feeds and feeding systems based on locally available resources (native grass, crop residues, industrial by-products and introduced forages) for milk and meat production

2. To strengthen studies on integration of forage legumes into the current cereal-based production system through inter-cropping, crop rotation, soil conservation and agroforestry systems

3. To study forage seed production techniques

4. To undertake on-farm evaluation and demonstration of proven technologies such as management of F1 50% cross-bred dairy cattle, crop-residue based ration formulations, performance of exotic and cross-bred chickens and improved forage crops for different environments

5. a) To upgrade the native chicken through different methods of cross-breeding with exotic breeds.

   b) To distribute and monitor the performance of improved chickens at smallholder level.

**INFRASTRUCTURE**

**Dairy cattle research**

The Department has the following facilities available for its operation:

<table>
<thead>
<tr>
<th>Facility</th>
<th>Capacity for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barn</td>
<td>100 cows</td>
</tr>
<tr>
<td>Pen</td>
<td>17 calves</td>
</tr>
<tr>
<td>Pen</td>
<td>6 cows</td>
</tr>
<tr>
<td>Pen</td>
<td>17 experimental calves</td>
</tr>
<tr>
<td>Recovery pen</td>
<td>9 cows</td>
</tr>
<tr>
<td>Barn</td>
<td>30 heifers</td>
</tr>
<tr>
<td>Milking parlour</td>
<td>5 cows</td>
</tr>
</tbody>
</table>
Beef cattle

There is one feeding barn for 112 beef animals. There are at present eight fistulated bulls on experiment.

Sheep

The sheep facilities are a barn with 200-sheep capacity and 20-sheep capacity metabolic crates.
Figure 8. In vivo experiment on a fistulated bull.

Figure 9. Sheep feed experimentation in metabolic crates.
Poultry Facility
- Brooding room
- Broiler house
- Layer house
- Three incubators
- Three hatcheries

Forage and pasture crops

The Department has use of 25 ha for large-scale production and three hectares for experimental purposes. In addition, the Department has one nutrition laboratory and one dairy processing unit at its disposal.

MANPOWER

Thirty-three staff with various levels of education currently run the Department.

<table>
<thead>
<tr>
<th>Staff on</th>
<th>PhD</th>
<th>MSc</th>
<th>BSc</th>
<th>Technical Assistants</th>
<th>Field Assistants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy cattle research</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Poultry research</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Animal nutrition research</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Forage and pasture crops research</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>22</td>
</tr>
</tbody>
</table>

A detailed staff list by name is available in the Appendix.
The Soils and Plant Nutrition Section was initially established in 1981 as a result of the need to teach soil science courses to diploma students of the then Junior College of Agriculture. Although the Section is relatively young compared to other research disciplines, it has, nevertheless, achieved remarkably in the 13-year period since its establishment (see discussion under Achievements).

OBJECTIVES

The Section has the following major objectives:

1. To identify, prioritise and carry out research on soil nutrient problems that influence the yield of teff, durum wheat, chickpea and lentils in the central highlands of Ethiopia and some other important locations in northern Shoa and Gojam.

2. To prepare a recommendation package for fertilizer use for crops grown in the region’s major soil types

3. To study and recommend better land and soil management options for optimum crop yield

4. To study and recommend better cropping systems that would help farmers to optimise yield, and attain soil and crop productivity on sustainable basis

5. To assist graduate students in their specialist research towards the investigation of nutrient-use efficiency and dynamics, thereby fulfilling AUA’s mandate

6. To give advisory service to extension workers and development agents based upon research findings.

FACILITIES

The Section has a modest laboratory equipped with modern scientific equipment that are useful for soil physico-chemical analyses and plant nutrient determinations. Some of these include atomic absorption spectro-photometer, flame photometer, kjeldahl apparatus, glass stills, furnace, centrifuge, shakers, infiltro-meters, instrument for the determination of particle size distribution etc. The range of these apparatus is increasing from time to time through grants being obtained as a result of collaborative projects.
In addition, assembly and erection of a modern glass-house obtained through external research grant is nearing completion.

Figure 10. Fertilizer experiment on durum wheat at Akaki substation.

ACHIEVEMENTS

A number of useful activities were completed during the past decade. Some of the prominent ones include the following:

1. Physico-chemical characterisation of major soils of Shoa region

2. Nitrogen and phosphorus response studies including identification of the optimum rate, time of application, and type of fertilizer for teff and durum wheat grown on major soil types

3. On-farm verification studies involving the improved Vertisol management technological package
4. Improved cropping systems (such as forage legume undersowing with wheat, sequential cropping of legumes with tef and wheat, double-cropping on Vertisols etc)

5. Studies on the dynamics of phosphorus on important soils of the central highlands

6. Studies of moisture relations with soil physical conditions on Vertisols

7. Analysis of determinants of fertilizer demand in farming systems of Ada and Lume regions of the central highlands.

**PUBLICATIONS**

Upto 1984, staff were engaged in full-time teaching; hence the reason for no publications at this time. Publications which appeared since then are those of the Center staff who contributed research results conducted at DZARC or are collaborative. Some are PhD and MSc thesis extracts. The list appears under *Publications* at the end.

**CURRENT ACTIVITIES AND FUTURE PLANS**

At present, Section staff are engaged, to a great extent, in the extension of components of the improved Vertisol management technology to a watershed level, based upon experience and results obtained from research plots in the field. In addition, erosion and run-off studies are also being conducted in collaboration with partners participating in the Joint Vertisol Management Project for the immediate future. Emphasis will be on the following problems:

1. Studying nitrogen and phosphorus nutrient-use efficiency and crop genotype x nutrient interactions for cereals (teff, wheat) and legumes (chickpea and lentils).

2. Studying mechanisms of adaptation of crops (teff, wheat, chickpea and lentils) to low phosphorus supply on Vertisols

3. Economic optimum analysis of fertilizer recommendations on crops.

**MANPOWER STATUS**

The Section staff had training opportunities locally and abroad. Staff qualifications at present are as follows:

**PhD** 2 One staff member is pursuing studies abroad leading to a PhD degree.

**MSc** 2 One senior staff is serving in the Transitional Government on secondment basis.

**BSc** 1
Irrational exploitation of natural forests in Ethiopia has resulted in shortage of firewood, exposure of soils to water and wind erosion, degradation of the habitat of wildlife and gradual extinction of natural springs. The current environmental crisis in Ethiopia which, for the most part is a man-made phenomenon, has many causes. Some of these are overexploitation of natural resources compounded by disturbance of the ecosystem of productive areas, and impediment of natural regeneration of trees and shrubs. Hence the solution to this wide and complex problem is to accelerate forest development in all sectors with the help of basic and applied forest research. This is how we can and must meet the steadily increasing demand for wood and forest products by an ever-increasing population. The demand also arises from a higher living standard.

In view of the above facts, the Forestry Research Programme was established at Debre Zeit Agricultural Research Center in 1979. The staff of three work from a one-room office. In addition, there is a small nursery office, a seed store and a tool store for use by the Forestry Research Programme.

**OBJECTIVES**

The objectives of the Centre's forestry research are fourfold; namely:

1. to undertake basic forestry research which deals with the establishment of seed orchards and the selection of species and ecotypes as sources of seed for future forestry activities

2. to run a forest nursery research dealing with tree seed technology and silviculture

3. to undertake the transfer of forest research extension technology to farmers and development agents, and

4. to undertake professional consultancy, teaching and providing advisory service to the public.

**ACHIEVEMENTS**

Adaptability trial of tree species (arboretum or seed orchard)

The performance of 18 tree species in the nursery and in the field have been studied for the past ten years. Yearly growth in height and diameter, seed-bearing periods and
other occurrences were recorded. At present eight tree species have been identified from which seeds can be obtained and put to different uses.

**Improvement of germination energy of Acacia albida**

Out of the eight treatments expected to break the hard seed-coat dormancy, the simplest technique; i.e. soaking seeds in boiling water for six minutes was found to give the highest (85 per cent) germination energy.

**Adaptability trial of Simmondsia chinensis (Jojoba)**

The Section obtained 160 jojoba seeds from the US in 1987 and tested 80 seeds in the nursery for their germination energy. The germination was good but the seedlings showed chlorotic symptoms. However, when seedlings reached plantable size, 25 were planted at the Center and 25 seedlings were planted on a site between Modjo and Nazareth. Five of the seedlings planted at the Center survived but the remaining died.

**Community forest development**

An acacia plantation, developed on the north-eastern hillside of the town of Dukem, is doing quite well.

**Survey on forest development and utilisation in Ada region of central Ethiopia**

A research project, launched recently in collaboration with the Department of Agricultural Economics, gives basic information on the status of forest resources and corresponding socio-economic conditions in the forest resources of Ada and Lome-Bora region.

**Extension and consultancy services**

A total of 650,045 tree seedlings were distributed and sold to individuals and organisations in the region. The Forestry Research Unit also gave consultancy service to various government agents and individual farmers.

**Meteorology service**

The Forestry Research Unit has been responsible for collecting and compiling weather data for the Centre.

**CURRENT ACTIVITIES**

Currently the Forestry Research Unit handles research activities under three titles:
1. Arboretum establishment including tree adaptability trials
2. Survey on development and utilisation of forest resources in Ada region, and
3. Evaluation of multipurpose tree species as animal feed.

Figure 11. Forest nursery at the Debre Zeit Agricultural Research Center.

STAFF DEVELOPMENT

The Forestry Research Unit had a staff of three until recently: Ato Adugna Zerihun, MSc (Forester), Ato Betre Alemu (BSc), and a new BSc graduate. Ato Adugna Zerihun was Assistant Professor at AUA and head of the Forestry Research Unit at Debre Zeit till his retirement in September 1994. The new BSc recruit joined the Forestry Research Unit in September 1994. Ato Betre Alemu who was Assistant Lecturer at AUA, left in July 1994 for advanced studies abroad.
FUTURE RESEARCH PRIORITIES

1. Adaptability trial of tree species for agroforestry practices for different soil types

2. Community forestry development research

3. Selection of tree species for soil conservation

4. Studies on management system for woodlot development on graded land

5. Adaptability trial of tree species for Ada region

6. Research on nursery techniques

7. Arboretum developmental programme for preserving tree species

8. Research on cropping

9. Spacing trial for some tree species

10. Date of planting trials for tree species

11. Studies on seed-treatment techniques

12. Determination of seedling size for field planting.
Asfaw Zelleke

Ethiopia is bestowed with favourable climatic conditions and fertile soils for the production of almost all vegetable crops known to science. However, the use of vegetable crops in the Ethiopian diet is insignificant.

Cognisant of this fact, the Debre Zeit Agricultural Research Center had focused on carrying out research and extension work using different varieties of vegetable and fruit crops, spices, medicinal and ornamental plants since the early 1950s. The main thrust of the research programme at Debre Zeit Research Center was the introduction of different vegetable and fruit crops in order to improve the cereal-based diet of the Nation at large. Thus, research undertakings of special merit are categorised into four groups of research periods: 1950–60, 1960–70, 1970–80 and 1980–94. (See under Research on Vegetable Crops, Major Achievements and Grapevines.)

**RESEARCH ON VEGETABLE CROPS**

Research on horticultural crops from mid- to end of 1950 was on adaptation trials of introduced varieties of vegetable crops.

During the period from 1960 to 1970, research on horticultural crops reached its climax. Two factors contributed to this fact: (1) the growing interest in vegetable crops by consumers, and (2) the assignment of a resident horticulturist at the Center.

The main thrust of the research during this time was on varietal trial and cultural practices. The results of the investigations on different vegetable crops are briefly summarised below.

Vegetables, especially uncooked types, have been somewhat limited in Ethiopian diets. The major vegetable crops used for research were tomato, potato, pepper, eggplant, carrot, lettuce, and shallot/garlic.

**Tomato (Lycopersicon esculentum)**

The research at the Center consisted of varietal trials including some of the outstanding varieties developed in Europe and in the US. Experimental plantings included over 30 varieties. Unfortunately, excepting some varieties such as Moneymaker and Rutegers which reached the growers, none of the other varieties were officially released to growers because of the continuous inclusion of new varieties in the trial every year.
Potato (Solanum tuberosum)

Potato is a popular vegetable crop in Ethiopia. It has been cultivated for a long time and is well established in the diet of the people. It is well adapted to most farming regions. However, the high-altitude region is the principal producing area. Experimental projects at Alemaya include crossing and selection of introduced pure lines. Superior varieties were released to growers after verification trials on farmers’ fields in different agro-ecological zones.

Pepper (Capsicum annum)

In the late 1960s research on chilli pepper centered on the collection and study of local types, including black pepper, along with the introduction of new types from the US and Mexico. Unlike the chillies, Sweet Bell pepper is not commonly used in the Ethiopian diet. However, many varieties of the sweet pepper were tested at the Center. Of those tested, "California Wonder" variety was the most preferred by consumers and its seeds were eventually released to local growers.

Eggplant (Solanum melongena)

The Center studied three varieties of eggplant in the late 1960s and tested consumer preferences on the local markets. It was found very popular.

Carrot (Dacaus carota)

The Center introduced varieties considered to be the most desirable which it eventually introduced into the school garden programme of the extension services.

Lettuce (Lactuca sativa)

A large number of varieties performed well in trials at the Center. However, documents are not available on varieties released to growers.

Shallot/garlic/onion (Allium)

The genus Allium is of paramount importance to the Ethiopian diet. Shallot and garlic are used in the preparation of mixed spices in addition to other uses. This makes them an important component of the diet. Varietal trials have been conducted on shallot, garlic, onion, leek and asparagus (indigenous to Ethiopia).

Since 1986, a number of local shallot and garlic germplasms collected from different parts of the country are being characterised and evaluated for resistance/tolerance to disease, yield, growth and other agronomic characteristics. As a result, promising materials will be recommended along with their respective improved cultural practices in the near future.
RESEARCH ON FRUIT AND OTHER CROPS

Research on fruit crops has been carried out at the Debre Zeit Agricultural Center to determine the kind of fruit crops best adapted to the climate of Debre Zeit and other areas with similar climatic conditions. The contribution of the research results to better health conditions through improved nutrition is believed to be greater than a direct contribution to the economy. In view of this fact, effort was made to conduct research on some tropical and subtropical fruit crops at the Center since the early 1950s. These include:

Citrus

Oranges, grapefruit, mandarine, lemon, lime: The leading varieties of these crops were planted at the Center during the early years of operation. The varieties grown on own root, were secured from Closeburn Nursery in Kenya. The overall performance of the selection was reasonably well at the Center. However, tree growth was slow. Also the trees did not develop the quality of fruits grown elsewhere at lower altitudes.

Other crops

Banana (Musa spp.): Four hybrid types of banana were planted at the Center even though the fact that the climate, soil etc were not ideal for commercial banana production. Thousands of young plants were distributed to farmers of the area.

Papaya (Carica papaya) is grown widely in Ethiopia. The Center conducted research on it and found it did moderately well. The demand for young seedlings by the growers was considerably great.

Guava (Psidium guava): Several cultivars of guava were grown at the Center. The trees produced a good yield although bird damage was heavy. Guava is especially important to Ethiopia because of the high vitamin C content of the fruit.

Fig (Ficus carica): There are many species of Ficus which are indigenous to Ethiopia. The cultivated fig does well in many parts of the country, and the early research at the Center showed that the fig was favourable for home orchard production.

Mango (Mangifera indica) is grown in many regions of the country. Research on mango at the Center showed that its rate of growth was very slow but a good quality fruit was produced.

MAJOR ACHIEVEMENTS

A number of varieties of Dwarf banana (Cavendish), apple, watermelon, eggplant, lettuce, potato, cabbage, beet, carrot, cauliflower and others were introduced, evaluated and released.
Intensive research on disease resistance, yield and quality of local and exotic accession of *Capsicum* had initiated the establishment of the Ethiopian Spice Extraction Company which is based on the production of the varieties from the farmers’ garden. The years 1970–80 marked an era of endod and enset research at the Center. Particular achievements were recorded on endod, enset and tomatoes during 1970–80 and on grapevines, shallot/garlic during 1980–94 as discussed below:

**Endod (Phytolaca dodecandra)**

The serendipital discovery of *endod* (by others outside the Center) as effective molluscicide highlighted the significance of its use as a detergent in rural Ethiopia. The chemical extract of *endod* was found to be useful in the control of snails which is a potential host of schistosome. The discovery provided the impetus for the establishment of a large-scale collection of *endod* at the Center. Thus, in collaboration with the Institute of Pathobiology of the Addis Ababa University, the Center initiated in the early 1970s research on agrobotanical studies of *endod*.

Berries and cuttings of different cultivars were collected to domesticate the plant for large-scale production. High-yielding *endod* cultivars with high molluscicidal potency were selected.

**Enset (Enset ventricosum)**

In the case of *enset*, the main thrust was on basic and applied research which focused on classifying and selecting for high food and fiber yield, early maturity, and bacterial wilt resistant clones of enset. Over 88 different clones from various parts of the country were collected at the Center. The findings of this research are a clear contribution to scientific knowledge of the crop and a solution to its production problems.

**Tomatoes**

Research on some vegetable crops was also carried out. Different varieties of tomatoes were tested for their yield and acceptance by the consumers.

Staking and urea-dressing combination treatments increased the yield of six tomato varieties (Casqpie Rouge, Indian River, Best of All, VF No. 36, Purdue 1361, and VF No. 11) more than the other treatments did. In regard to consumer preference Purdue 1361, VF No. 11, Money Maker and Roma certified were more acceptable than the rest of the varieties included in this trial. Substantial yield increase was obtained by increasing manure application from 20 to 160 t/ha.

**Grapevines**

The period 1980–94 brought about dramatic changes in the direction of the research activities of the Section. It was the period during which research projects on *endod* and *enset* phased out. In turn a new venture on grapevine research gained momentum. In
this regard the performance of the existing local cultivars collected from Guder vineyards was studied. At the same time, a large collection of exotic varieties was introduced from Europe and the USA collaborative programme was established between the Center and the Horticultural Development Corporation of the Ministry of State Farms Development.

The experts from the Debre Zeit Agricultural Research Center made significant contributions in (1) the selection and establishment of new vineyard sites for the Corporation; (2) providing technical advice and in-service training to all its employees working on grapevines; and (3) providing different varieties of planting materials of grapevines imported from abroad.

Fruiting units have been identified for four local cultivars. Chemicals for effective control of powdery mildew and downy mildew have been identified. At present, about 140 cultivars of grapevines are being evaluated for their adaptability and response to some cultural practices at mid-altitude.

Figure 12. Netch Debulbul variety grapes under experiment at the Center.
Shallot

Bulb placement effects on growth and yield of shallot were studied and side-ridge placement of shallot bulbs was found to be superior on the two soil types than the remaining bulb-placement methods tried at Debre Zeit.

Ornamental plants

Different kinds of ornamental plants have been propagated and distributed to the public and governmental organisations.

Awards

The Center was recognised for its research achievements by the Royal Horticultural Society of The Netherlands, as one of its affiliated societies. The Center also received three awards: Silver (1962), Bronze (1967) and Bronze (1969) for vegetables, roses and tomatoes, respectively.
Shallot and garlic

The Debre Zeit Agricultural Research Center is a pioneer for collection, characterisation, and evaluation of shallot and garlic germplasms. Various research activities are being carried out on these crops, since they are important vegetable crops in the Ethiopian diet. Varieties of superior quality which show resistance to diseases will be made available to growers.

Figure 14. An improved shallot variety.
Figure 15. *Promising varieties of garlic.*

Grapevines

The first official grapevine introduction and plantation was made at Debre Zeit Agricultural Research Center. Grapevine research activities will be extended and carried out at Guder and Dire Dawa areas in the near future.

Endod

Seed production, breeding and other agrobotanical studies will be carried out at the Center in collaboration with the Institute of Pathobiology of the Addis Ababa University.

STAFF

A staff list by name, qualification/position and years served is available in the Appendix.
PUBLICATIONS

WHEAT BREEDING RESEARCH

Journals


Getachew Belay, Tesfaye Tesemma, Demissie Mitiku and Efrem Bechere. Effect of soil type on the performance of durum heat lines. (Submitted for publication in EJAS).


Tesfaye Tesemma, Getachew Belay, Demissie Mitiku and Efrem Bechere. Yield assessment of durum wheat lines with and without application of fertilizers. (Submitted for publication in EJAS).

**Proceedings and workshop presentations**


Bulletins


Book chapters


Thesis


Efrem Bechere. 1987. *Inheritance of resistance to physiologic races 15B (Culture TLM) and 56 (Culture MBCT) of stem rust (Puccinia graminis F. sp. Triticii) in six durum wheat (Triticum durum desf.) cultivars*. PhD thesis, Oklahoma State University, Stillwater, Oklahoma.


Tesfaye Tesemma. 1963. *The effect of selected fertilizer treatments upon forage sorghum on sandy soil*. MSc thesis, New Mexico State University, New Mexico, USA.

Tesfaye Tesemma. 1973. *Analysis of yield and related traits in a diallel cross of winter wheat with reference to long and short photoperiod treatments*. PhD thesis, Oklahoma State University, Stillwater, Oklahoma, USA.

**TEF IMPROVEMENT PROGRAMME**

Publications on tef, produced since 1963, by the staff of the Alemaya University of Agriculture (formerly the College of Agriculture and Mechanical Arts) and by the staff of the University working elsewhere are listed below:

**Journals**


**Bulletins**


**Chapters of Books**


**Theses**


Tareke Berhe. 1981. *Inheritance of Lemma color, seed color and panicle form among four cultivars of tef (Eragrostis tef [Zucc.] Trotter)*. PhD thesis, University of Nebraska, Lincoln, Nebraska, USA.


**Proceedings and workshop presentations**


CHICKPEA AND LENTIL IMPROVEMENT PROGRAMME

Journals


Bulletin


Newsletters


Proceedings


**Theses**


**DEPARTMENT OF AGRICULTURAL ECONOMICS**

**Journals**

Proceedings and workshop presentations


Books and chapters of books


PROGRAM REVIEW IN CROP PROTECTION DEPARTMENT

Journals


**Bulletins**


**Chapters of books/Manuals**


**Newsletters**


**Proceedings and workshop presentations**


**DEPARTMENT OF ANIMAL SCIENCES**

**Journals**


**Proceedings and workshop presentations**


Bulletin


SOILS AND PLANT NUTRITION SECTION

Journals


**Newsletters**


**Proceedings and workshop presentations**


**Books and chapters of books**


Students’ theses assisted/supervised by Section staff


**FORESTRY RESEARCH UNIT**


Adugna Zerihun. 1991. Ten years' forest research results at Debre Zeit Research Center (Submitted for publication)

Adugna Zerihun. 1994. Weather data compilation (196592) for Debre Zeit Research Center (Submitted)

HORTICULTURAL CROP IMPROVEMENT PROGRAMME

Journals


Bulletins


Zemedu Worku, Gugssa Endeshaw and Bekele Tullu. 1969. Feasibility studies of tomato production in Debre Zeit Area. Experiment Station Bulletin 61. College of Agriculture, Haile Selassie I University, Debre Zeit, Ethiopia. 54 pp. (Eng. & Amharic)

Proceedings and Workshop Presentations


Reports


Dereje Ashagari. 1980. Some studies on bacterial wilt of enset and prospects of its control.


**Book**


**Theses**


APPENDIX

STAFF OF THE DEBRE ZEIT AGRICULTURAL RESEARCH CENTER

Names are repeated where staff have worked in different departments. Effort has been made to make the list and dates as complete as possible.

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<td>Efrem Bechere</td>
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Crop Protection Department

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Animal Science Department

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1. Currently on study leave.
2. Teaching and research staff at (now ex-) Junior College of Agriculture.
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<td>BSc</td>
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<td>Alemu Yami</td>
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<td>Bekele Sisay</td>
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<td>Berhanu Wagaw</td>
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<td>Daniel Keftasa</td>
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<td>Dawit Zekiros</td>
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<td>Esthete Dejene</td>
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<td>Goshu Makonnen</td>
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<td>Kelachor</td>
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<td>Kirubel Kora</td>
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<td>Lydia Bach (Mrs.)</td>
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<td>Michael Blumme</td>
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<td>Teklay Nigussie</td>
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<td>Telahun Sahilu</td>
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<td>Teshome Shenkoru</td>
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<td>Dipl.</td>
<td>Poultry Scien.</td>
<td>1956–79</td>
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<td>Yalemeshet W/A</td>
<td>MSc</td>
<td>Animal Nutritionist</td>
<td>1993</td>
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**Horticultural Crops Improvement Programme**

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<th>Name</th>
<th>Qualification</th>
<th>Discipline/Position</th>
<th>Duration</th>
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<tr>
<td>Asfaw Zelleke</td>
<td>BSc, MSc, PhD</td>
<td>Viticulturist &amp; Section Head</td>
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<tr>
<td>Dessie Getahun</td>
<td>BSc</td>
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<tr>
<td>Getachew Tabor</td>
<td>BSc</td>
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<td>n.a.</td>
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<td>Goshu Letta</td>
<td>n.a.</td>
<td>Field &amp; Lab.</td>
<td>n.a.</td>
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<tr>
<td>Mesfin Amcha</td>
<td>BSc, MSc, PhD</td>
<td>Res. Assist.</td>
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<tr>
<td></td>
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<td>Breeder</td>
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</table>
MILESTONES

1953

The Debre Zeit Agricultural Research Center is established. Other names it went under since its establishment are: Branch Experiment Station, Bishoftu Agricultural Experiment Station, Central Experiment Station and Experiment Station.

1955

The wheat programme at the Debre Zeit Agricultural Research Center is started and includes research on both bread wheat and durum wheat. Research starts with formal wheat observation and variety testing by Mr. Ben R. Jackson, an American agronomist from Oklahoma State University, and other agronomy staff members of the Alemaya College of Agriculture and Mechanical Arts (now Alemaya University of Agriculture).

1956

Poultry research programme starts at the Debre Zeit Agricultural Research Center.

1964

1. In 1964, a wheat-testing programme is initiated at MOA’s Seed Multiplication Farm near Kulumsa in Arsi by the agronomy staff of the Debre Zeit Agricultural Research Center who commuted from Debre Zeit.

2. A wheat-testing programme is initiated at MOA’s Seed Multiplication Farm near Kulumsa in Arsi by the agronomy staff of the Debre Zeit Agricultural Research Center commuting from Debre Zeit.

1966

The Institute of Agricultural Research (IAR) is established.

1967

Through the initiation of IAR, a National Crop Improvement Committee is formed to organise and coordinate all research activities on a national level.

1971

Dairy research programme starts at the Debre Zeit Agricultural Research Center.
1974/75
Seed Multiplication and Outreach is established. Later it becomes part of the Department of Agricultural Economics.

1976
1. The Department of Agricultural Economics is established.
2. The Crop Protection Department is established.

1976/84
DZARC came under Addis Ababa University and included formal training of middle-level manpower leading to Diploma level in crop and animal sciences, and socio-economics.

1979
The Forestry Research Programme is established.

1981
The Soils and Plant Nutrition Section is established.

1984/85
DZARC lost most of its facilities (offices, laboratories, part of research field etc.) to the Ethiopian Management Institute. The Center was again placed under the Alemaya University of Agriculture.
<table>
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<th>ACRONYMS</th>
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<td>AAU</td>
<td>Addis Ababa University</td>
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<td>AUA</td>
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<tr>
<td>CIMMYT</td>
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<td>DZ</td>
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<td>Debre Zeit Agricultural Research Center</td>
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<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations (Italy)</td>
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<td>HSIU</td>
<td>Haile Selassie I University</td>
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<td>IAR</td>
<td>Institute of Agricultural Research</td>
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<td>ICARDA</td>
<td>International Center for Agricultural Research in Dry Areas (Syria)</td>
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<td>ICRISAT</td>
<td>International Crops Research Institute for the Semi-Arid Tropics (India)</td>
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<td>IDR</td>
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<td>ILCA</td>
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<td>MOA</td>
<td>Ministry of Agriculture</td>
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<td>RELC</td>
<td>Research and Extension Liaison Committee</td>
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<td>USDA</td>
<td>United States Department of Agriculture</td>
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