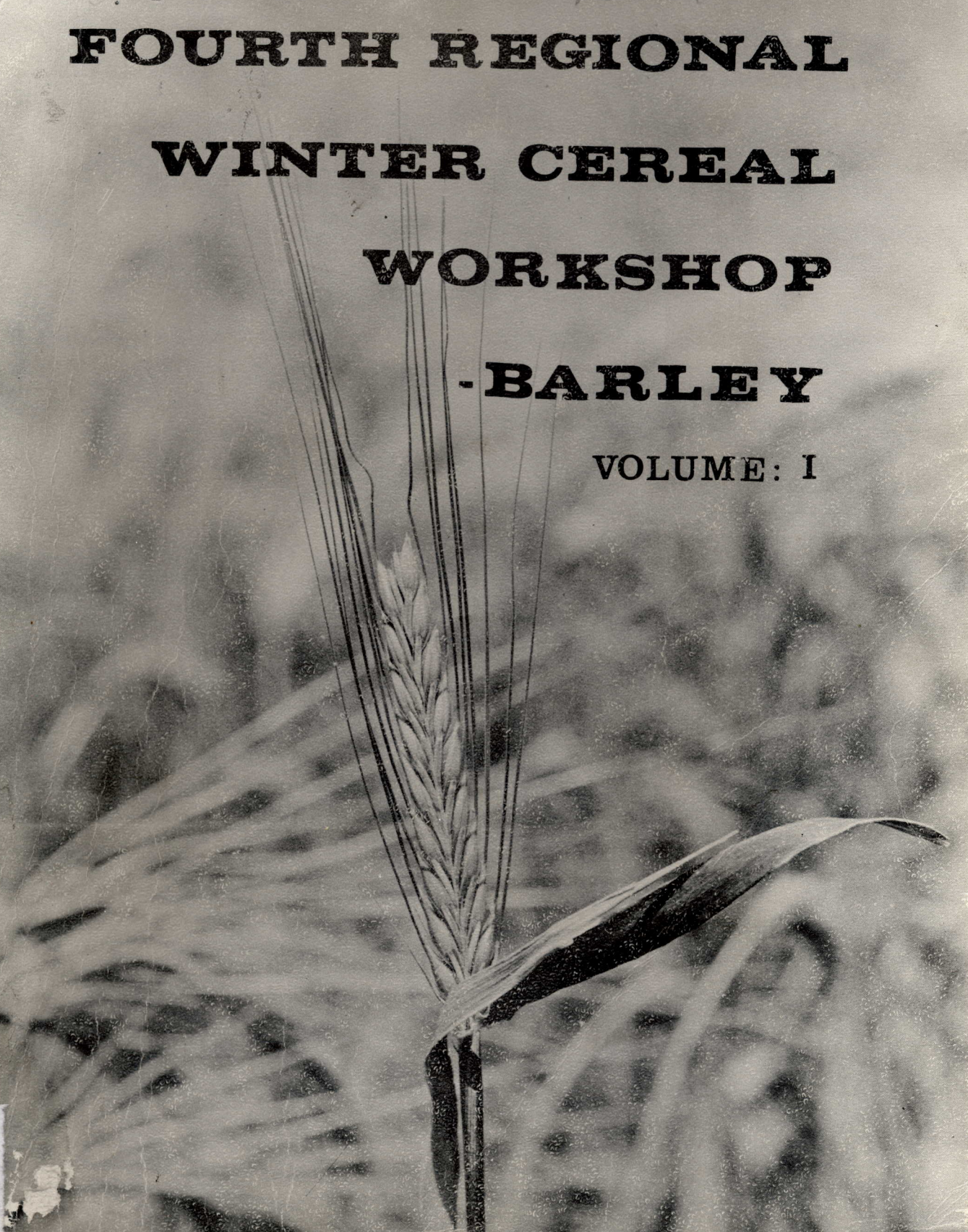
# FOURTH REGIONAL WINTER CEREAL WORKSHOP -BARLEY

VOLUME: I



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AMMAN - JORDAN

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# BARLEY : Volume I

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# BARLEY WORKSHOP

## FOREWORD

Human use of barley goes back to the dawn of history. This staple grain has been an essential part of the staff of life for man and beast for thousands of years, and has contributed more than is often appreciated to the development of civilization as we know it today.

Barley traditionally was the energy food of the masses. Significantly, it was barley loaves that provided the basis for the miraculous feeding of the multitude in New Testament times. Of equal significance is the fact that in modern times an index of social progress is the extent to which barley is disappearing from human diet to be replaced by wheat.

The trend is currently active and change is so rapid that the status of barley in the Mediterranean area at the present time is largely unassessed as far as human life-styles and national agricultural programs are concerned. There is need for an up-to-date appraisal of the role and importance of barley in the countries of North Africa and Western Asia.

This need is fully appreciated by the staff of the International Center for Agricultural Research in the Dry Areas (ICARDA), which was established in January 1977 to improve food production in the Mediterranean lands and associated countries. ICARDA was set up under the aegis of the Consultative Group for International Agricultural Research, and prominent in the mandate given to it by CGIAR is responsibility to carry out research on improvement in barley. For such research to be effective, benchmarks are needed to enable progress to be measured and signposts are required to mark the way for future activities.

The Barley Workshop described below was held in Amman, Jordan, in April 1977, to establish the benchmarks and signposts to which reference has just been made. About 120 scientists from more than 40 countries met for five days at the University of Jordan to discuss the present status of barley production and use; to assess the problems affecting its cultivation; and to advise on the strategy and methods for future research. The results of these discussions form the report to which this is a foreword.

It should be emphasised that the Workshop has established the continuing value of barley in many countries of the world. This report constitutes a major contribution for such a vitally important crop, which remains supreme in its ability to tolerate drought conditions and to accept levels of salinity and soil infertility that rule out the cultivation of wheat.

While it is true that its direct use as human food has declined over the centuries, it is also true that barley's use for animal production in various forms makes it of ever-increasing importance in societies where the consumption of animal protein is rising year by year. Added to this is the little publicized growth of the brewing industry in the developing countries which sets new standards of quality and quantity of demand.

The future of barley is assured and this report provides a much-needed and suitably authoritative basis for research by ICARDA and other similar institutions and national programs in the years to come.

Harry S. Darling
Director-General - ICARDA

# INTRODUCTION

The publication of the Proceedings of the Fourth Winter Cereal Workshop held in Amman, Jordan, from 24-28th April, 1977, is a continuation of a series which had its origins in Beirut, Lebanon, in 1972. The First Workshop was concerned with three main subject areas: diseases, reviewing the status of Septoria, tritici and yellow rust (Puccinia striiformis) in the region; agronomy, and the status of agronomic research in the area; and, a review of the known sources of resistance to Septoria and yellow rust. The Second Regional Wheat Workshop in Ankara, Turkey, in May 1974, was concerned with tillage and cultural practices for wheat under low rainfall conditions. The Third Regional Wheat Workshop was held in Tunis, Tunisia, in 1975, and focused on the subject of durum wheat improvement, weed control, crop rotation with annual forage and legumes, and seeds.

The philosophy behind the Workshops has been to provide a forum for the exchange of information for active cereal research workers in this area of the world. The Workshops have usually been scheduled every two years and the topics covered have been those currently in need of attention. The Workshops have been a stimulus to the presentation of the most recent research results which could be used by fellow colleagues.

The Fourth Workshop in this series designated Barley as an appropriate and opportune subject. The current Workshop has drawn from a much broader base than previously because of the smaller number of workers in this region, and the additional support and interest provided from sources other than the traditional ones of FAO of the United Nations, the Rockefeller Foundation, the Ford Foundation and CIMMYT. Additional support and funding for this Workshop has been provided by the Montana State University-United States, Agency for International Development (AID) and the International Center for Agricultural Research in the Dry Areas (ICARDA). The barley research group at Montana State University initiated the idea of a conference on barley in the Middle East. The original suggestion was for the conference to be held in Lebanon in 1976, but the civil war during this period forced a postponement of these plans.

With the Regional Workshop scheduled for 1977 the merging of the two programs into a collaborative effort seemed to make a great deal of sense. The topic of barley, with all of its production potentials and problems, was a relevant one and a subject needing attention. The convening of the Barley Workshop in the Middle East also provided barley research workers from all areas of the world with an opportunity to become familiar with the newest International Agricultural Research Center, ICARDA.

One of the major responsibilities of ICARDA is the production and improvement of small grain cereals in the Middle East Region. The mandate includes a primary responsibility for the development of barley germplasm. Together with CIMMYT (International Maize and Wheat Improvement Center - Mexico) the establishment of ICARDA should strengthen the research and production needs in this region and other areas of the world.

The development of the program for the Barley Workshop was drafted by staff members from CIMMYT, ICARDA and Montana State University. The Ministry of Agriculture, Government of Jordan, and the Faculty of Agriculture, University of Jordan, graciously extended an invitation to act as the hosts for the Workshop. It should be mentioned that the efforts of our hosts were invaluable and without their active efforts this Workshop would not have been possible. All of us extend a special appreciation to the local organizing Committee for arranging such a delightful and beneficial stay in Jordan.

We were honored to have His Royal Highness, the Crown Prince, present the Welcome Address and officially open the conference. We regret that we are not able to record and include his stimulating address in the proceedings.

As in any large gathering, a number of changes are required depending upon the circumstances prevailing at the time. Thus the schedule of the program is not identical to the one originally presented by the organizing committee.

During the process of arranging the papers and reports it became obvious that the amount of information presented was substantial and of two distinct types. For this reason it was decided that two volumes would better serve the interests and needs of barley researchers. In the first volume we have collected together the country reports and abstracts that refer to the production and usage of barley and which illustrate its current importance. While in the second, we have attempted to group together those papers which review the current state of knowledge on barley research and production methods and work. Needless to say, some papers fall somewhere in between these guidelines. The Editors assume the responsibility for modifying some papers and any inadequacies thereby introduced. Hopefully our efforts have been accurate and beneficial. For any errors or oversights we humbly apologize. The publication of these two volumes is a joint undertaking by ICARDA and CIMMYT. A special word of appreciation needs to be extended to Mrs. Nada Khattar who typed, re-typed and helped in so many ways to get the proceedings published. Without her we would still be editing.

The Editors
Aleppo, Syria
January, 1978.

# THE POSITION OF BARLEY IMPROVEMENT IN THE WORLD SITUATION

The reports presented during the course of this Workshop by over 30 different countries have provided a good overview of the position of barley in the world, with regard to its production, utilization, improvement and problems.

In general, barley is used primarily as an animal feed in most of the countries represented. It is also used to a varying degree for human consumption in these countries but it is generally less important as a human food in most. The use of barley for malt production is becoming increasingly popular throughout the world. Overall then barley consumption is high in many countries and it is becoming increasingly important to direct research towards production improvement. This is illustrated in Figure 1 which shows countries where barley is an important commodity and demand substantially exceeds domestic production.

It appears that, until recently anyway, barley has been treated very much as an inferior crop, especially if compared with wheat. This has been mainly due to the minimal encouragement, in terms of price support, given by governments, and the almost total lack of improved varieties and practices available to the producers. This situation has been made worse by the recent strides that have taken place in wheat variety and production improvements. These have caused a dramatic increase in the yield and production of wheat whereas Barley yields have remained relatively static for some time (Table 1). As a result, wheat production has become increasingly favoured, leading to a continuing decline in the area and production of barley (Table 2).

The majority of the barley crop is produced in the more marginal areas with poor soil conditions, erratic rainfall and traditional techniques while in the richer, more advanced agricultural areas, farmers favour wheat production. Under these marginal conditions barley can survive and yield where it would be totally uneconomic to produce wheat. It thus has a considerable comparative advantage here; an advantage which until recently was hardly exploited at all due to inadequate and outmoded cultural practices and negligable incentives to production increase.

However, it appears that there is an increasing awareness amongst many of the countries represented that there is a large reservoir of unexploited potential existing in barley. Increasingly, barley improvement programs are expanding and becoming autonomous from the wheat breeding efforts of which they have traditionally been a part. Many governments are also beginning to give much more incentive to farmers to increase barley production.

Improved varieties with high yield potentials, yield stability, disease resistance and adaptation to harsh environments are resulting from a considerable increase in the volume of research work at both the regional and international levels. This material and other locally developed varieties are now figuring highly in the work of most of the national research efforts cited. Although there are still many problems to be solved in the development of suitable varieties for the wide range of conditions in the region the continuing and expanding efforts of researchers in this field are beginning to be reflected in an increased acceptance of barley as an economic alternative to wheat in some areas.

Much more cooperation and an international pooling of resources is required to enable barley to capitalise on its newly found respectability and make a real contribution towards increasing the food production and standard of living of many of the more marginal agricultural areas of the world.

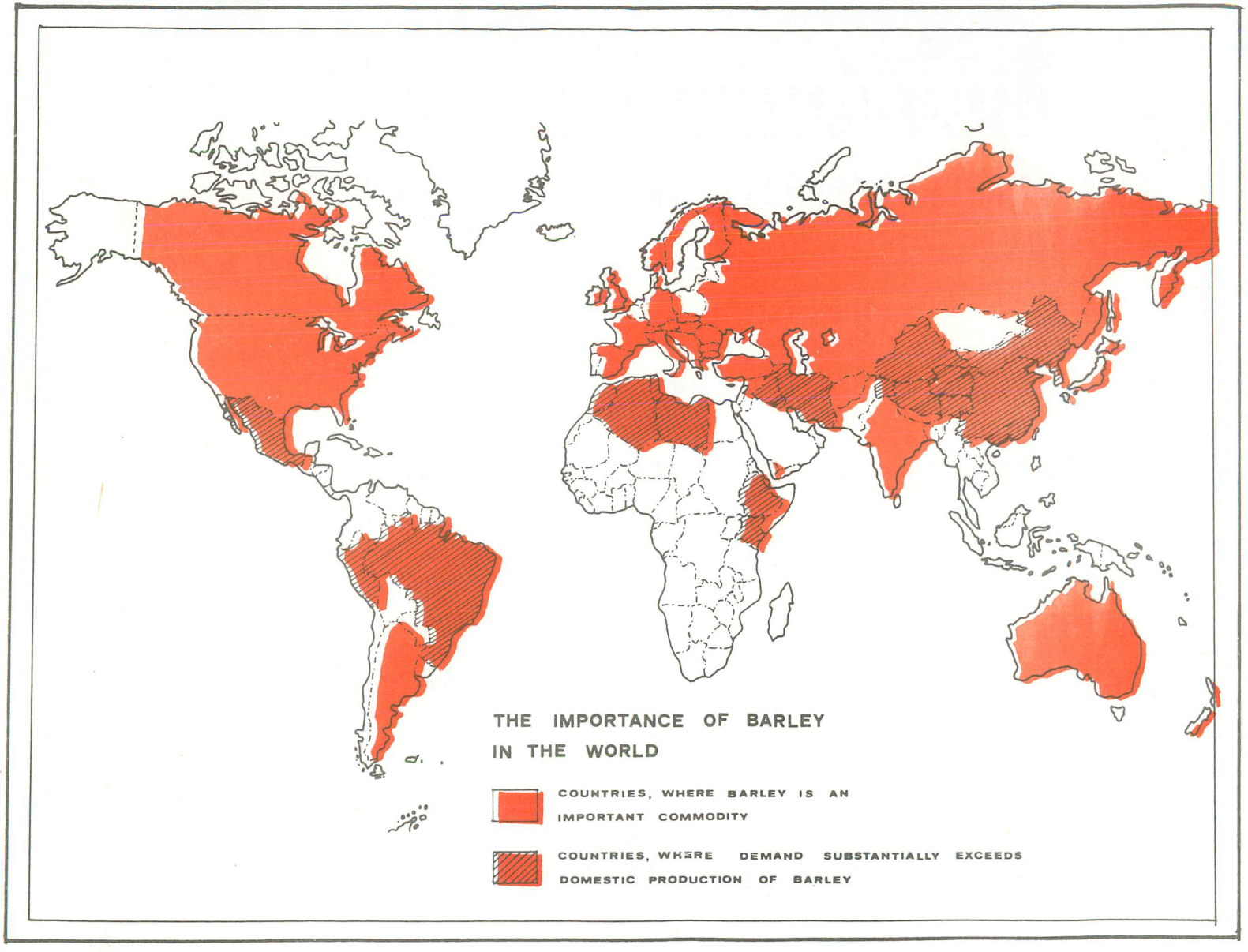

THE IMPORTANCE OF BARLEY
IN THE WORLD
COUNTRIES, WHERE BARLEY IS AN IMPORTANT COMMODITY
COUNTRIES, WHERE DEMAND SUBSTANTIALLY EXCEEDS DOMESTIC PRODUCTION OF BARLEY

Table 1. A Comparison of Wheat and Barley Production Patterns Throughout The Region - 1975/76

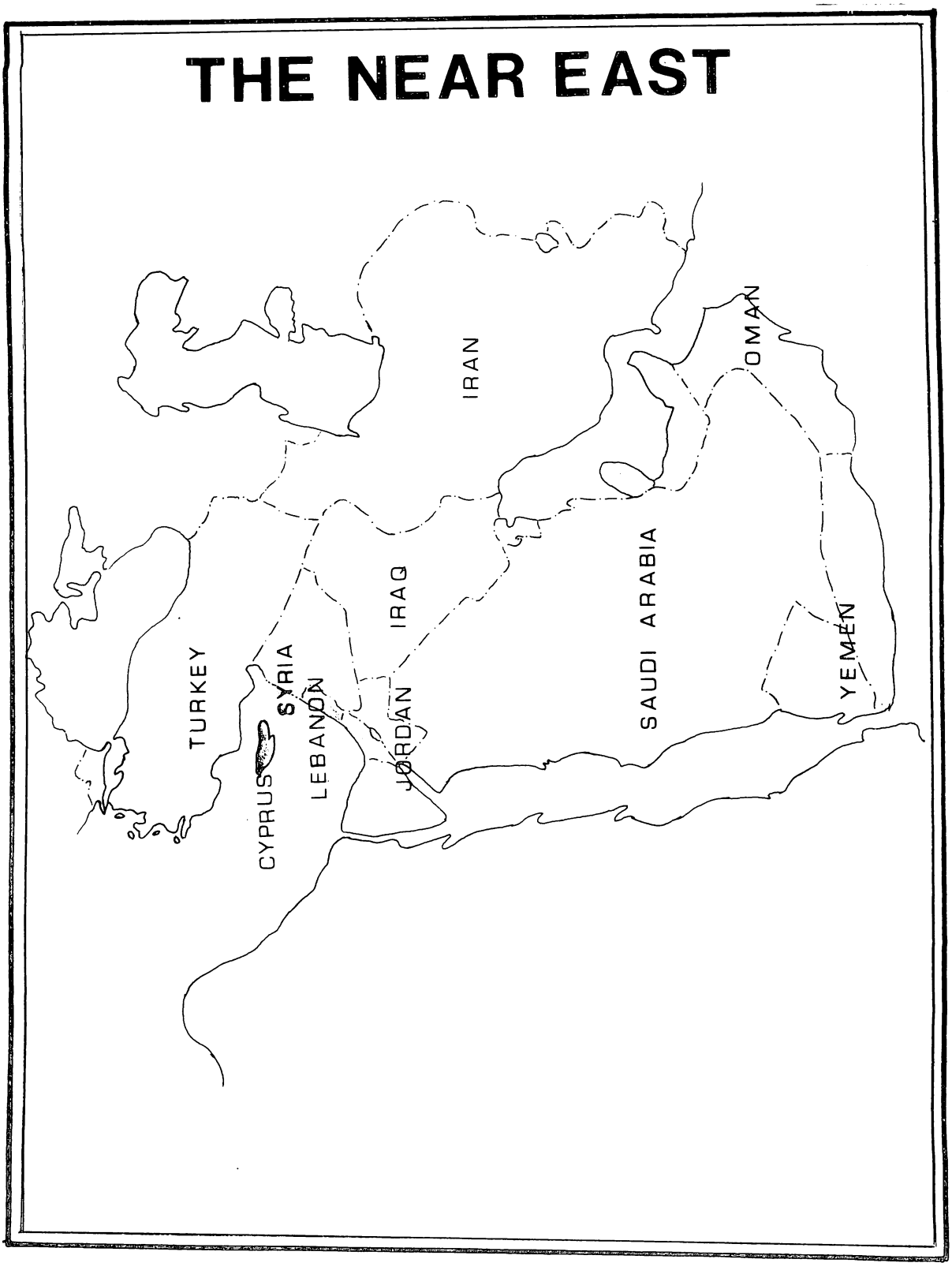
| Country | Area (1000 ha) | | | Production (1000 mt) | | Yield (Kg/Ha) | |
|---|---|---|---|---|---|---|---|
| | Total | Barley | Wheat | Barley | Wheat | Barley | Wheat |
| Afghanistan | 7,844 | 325 | 2,440 | 369 | 2,678 | 1,133 | 1,097 |
| Algeria | 6,240 | 750 | 2,200 | 500 | 1,300 | 667 | 591 |
| Bangladesh | 11,000 | 25 | 150 | 17 | 215 | 684 | 1,433 |
| Cyprus | 365 | 87 | 80 | 81 | 81 | 1,157 | 1,013 |
| Egypt | 2,720 | 34 | 376 | 99 | 1,984 | 2,946 | 3,447 |
| Ethiopia | 13,000 | 818 | 706 | 829 | 681 | 986 | 965 |
| France | 17,027 | 2,717 | 4,117 | 10,012 | 18,906 | 3,686 | 4,592 |
| Greece | 2,780 | 398 | 920 | 950 | 2,351 | 240 | 256 |
| India | 160,610 | 2,930 | 18,107 | 3,150 | 24,235 | 1,075 | 1,338 |
| Iran | 15,580 | 1,281 | 5,000 | 826 | 4,100 | 645 | 820 |
| Iraq | 4,848 | 719 | 1,513 | 516 | 1,166 | 931 | 770 |
| Italy | 9,290 | 224 | 3,712 | 559 | 9,695 | 2,499 | 2,612 |
| Jordan | 1,132 | 50 | 150 | 35 | 135 | 700 | 900 |
| Kenya | 1,454 | 30 | 100 | 45 | 140 | 1,500 | 1,400 |
| Korea | 2,241 | 731 | 75 | 1,576 | 165 | 2,156 | 2,216 |
| Lebanon | 240 | 10 | 50 | 10 | 70 | 1,000 | 1,400 |
| Libya | 2,377 | 422 | 115 | 173 | 70 | 610 | 609 |
| Morocco | 7,400 | 2,000 | 1,900 | 2,050 | 1,900 | 1,025 | 1,000 |
| Nepal | 1,980 | 26 | 240 | 25 | 225 | 962 | 938 |
| Pakistan | 19,385 | 205 | 6,113 | 140 | 7,629 | 682 | 1,248 |
| Portugal | 596 | 104 | 500 | 91 | 630 | 875 | 1,260 |
| S.Arabia | 811 | 12 | 130 | 18 | 175 | 1,500 | 1,346 |
| Spain | 4,925 | 3,262 | 2,863 | 6,728 | 4,354 | 2,063 | 1,521 |
| Sudan | 7,844 | 211 | 240 | 161 | 270 | 763 | 1,125 |
| Syria | 5,546 | 700 | 1,350 | 655 | 1,500 | 936 | 1,111 |
| Tanzania | 15,192 | 3 | 40 | 4 | 4 | - | 1,071 |
| Tunisia | 4,510 | 438 | 1,214 | 330 | 1,150 | 755 | 947 |
| Turkey | 25,543 | 2,625 | 8,500 | 4,500 | 13,000 | 1,714 | 1,529 |
| Yemen (A.R.) | 1,200 | 170 | 60 | 200 | 71 | 1,176 | 1,183 |
| Yemen (Dem.) | 252 | 1 | 15 | 0.5 | 15 | 417 | 1,000 |
| Yugoslavia | 7,381 | 330 | 1,843 | 754 | 6,283 | 2,406 | 3,409 |

(Date provided for the Barley Workshop)

Table 2. The Changes in the Pattern of Barley Production Over the Period Between 1961/65 and 1974/76

| Country | 1961 - 65 | | | 1974 - 76 | | |
|---|---|---|---|---|---|---|
| | Area (1000ha) | Yield (kg/ha) | Prod. (1000Mt) | Area (1000ha) | Yield (kg/ha) | Prod. (1000Mt) |
| Cyprus | 69 | 1243 | 86 | 64 | 1423 | 93 |
| Afghanistan | 350 | 1082 | 379 | 350 | 1114 | 388 |
| Bangladesh | 28 | 549 | 15 | 25 | 648 | 16 |
| India | 2998 | 864 | 2590 | 2825 | 1023 | 2901 |
| Iran | 990 | 800 | 792 | 1431 | 873 | 1263 |
| Iraq | 920 | 925 | 851 | 554 | 934 | 516 |
| Jordan | 85 | 735 | 62 | 40 | 501 | 22 |
| Korea Rep. | 726 | 1584 | 1150 | 709 | 2279 | 1616 |
| Lebanon | 13 | 968 | 13 | 7 | 1007 | 8 |
| Pakistan | 186 | 632 | 118 | 195 | 697 | 137 |
| Saudi Arabia | 9 | 1046 | 10 | 14 | 1571 | 22 |
| Syria | 740 | 877 | 649 | 960 | 812 | 770 |
| Turkey | 2791 | 1235 | 3447 | 2621 | 1640 | 4310 |
| Yemen AR. | 141 | 1000 | 141 | 180 | 1268 | 228 |
| Yemen Dem | 1 | 2255 | 3 | 1 | 1938 | 2 |
| Algeria | 811 | 587 | 476 | 758 | 718 | 558 |
| Egypt | 52 | 2614 | 137 | 39 | 2798 | 110 |
| Ethiopia | 1612 | 820 | 1323 | 1053 | 829 | 867 |
| Kenya | 12 | 1281 | 15 | 20 | 1557 | 31 |
| Libya | 350 | 248 | 87 | 300 | 569 | 171 |
| Morocco | 1627 | 808 | 1316 | 1991 | 1134 | 2279 |
| Sudan | 1 | 754 | | | 1063 | |
| Tunisia | 507 | 286 | 145 | 358 | 624 | 220 |
| Greece | 184 | 1349 | 248 | 404 | 2360 | 953 |
| Nepal | 23 | 1077 | 25 | 28 | 869 | 24 |
| Portugal | 125 | 486 | 61 | 105 | 842 | 89 |
| Spain | 1420 | 1379 | 1959 | 3176 | 1814 | 5765 |

Source: FAO Production Yearbook, 1976.


THE NEAR EAST
IRAN
OMAN
TURKEY
SYRIA
IRAQ
SAUDI ARABIA
YEMEN
LEBANON
JORDAN
CYPRUS

# BARLEY PRODUCTION IN CYPRUS

By

A. Hadjichristodoulou*

The area under cultivation in Cyprus is approximately 440,000 ha. An estimated 57% of this area is occupied by field crops, mainly winter grain cereals which are grown on 150,000 ha. Of this 70,000 ha. are occupied by barley and 80,000 ha. by wheat.

Annual production of barley varies greatly with variations in rainfall and on average it is around 81,000 tons. Though it is used exclusively for feeding purposes, it cannot satisfy the needs of the expanding livestock industry, and on average an additional 130,000 tons are imported each year.

The varieties Athenais occupies 90% and Attiki 10% of the total area under barley. Most of the barley is grown in the plains, below 800m altitude but some fields in the hilly areas up to 1,500m are also sown with barley (Fig. 1). Sowing starts in November with the beginning of the rainy season and harvesting is May-June. The winters are mild, with minimum temperatures around 0-5°C. For this reason, though varieties in Cyprus are of spring type, they are sown in the winter. Barley yields are reduced by low rainfall and by its unfavourable distribution during the growing period. Most of barley is grown in areas of average annual rainfall ranging between 300 and 400 mm.

In the past, barley was grown after fallow; crop residues and vegetation in the fallow year were grazed by sheep and goats before cultivations started for seed bed preparation. Now, there is a tendency to reduce fallow by introducing other rotation systems. An estimated 40% of total barley area is sown after fallow, 25% after a legume or cereal forage crop and 35% after barley or wheat grain crop, with increased N fertilizer rate. Normal N fertilizer rates are around 30 to 40 kg N/ha.

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* Agricultural Research Institute, Nicosia, Cyprus.

In addition to grain production, barley is the main dry land crop used for grazing or hay making. It is used either in pure stands or in mixtures with legumes (Hadjichristodoulou, 1973). The common practice for hay making is to cut barley at the 50% heading stage, but recent studies showed that dry matter yield, digestible dry matter yield and protein yield are higher at the milk stage of grain fill (Hadjichristodoulou, 1976a). A new high hay yielding variety, 628, was selected from a large number of introduced lines (Hadjichristodoulou, 1976b). This variety which is more productive than Athenais, is presently used for hay production. Optimum seed rate for forage barley was found to be around 180 kg/ha., twice the normal seed rate for grain production (Hadjichristodoulou, 1975).

The main insect causing significant damage to barley crops is the leaf miner, (Syringopais temperatella Leaderer). The chemical BHC effectively controls this pest (Serghiou, 1975).

A series of studies were conducted on insects attacking stored grain and a number of chemicals were recommended for its protection (Iordanou, 1976).

## Barley Research Work in Progress

### 1. Breeding

Three research workers (Dr.A.Hadjichristodoulou, Mrs. Athena Della and Mr.C.Josephides) assisted by six technicians are working on barley improvement.

(a) Grain yield. The aim is to develop new, high yielding, drought resistant varieties. Introduction of new lines and screening under local conditions has not so far produced a better variety than Athenais. The hybridization programme is expanding mainly through crossing Athenais with selections from crosses between Athenais early genotypes and with other promising varieties. The most advanced lines of this programme are under evaluation in yield trials. A screening program aims at selecting lines insensitive to sowing date.

(b) Nutritional quality. The aim is to increase protein content and lysine content of grain by mutation and hybridization. Promising selections from the mutation programme are evaluated in yield trials (M-). Also Athenais was crossed with the Hiproly

(CI3947) and the Riso mutants No.1508 and No.7 to increase protein and lysine contents of the grain of Athenais. The best $F_5$ lines with 10-20% higher protein content and DBC are evaluated in yield trials.

(c) Forage barley. Athenais was crossed with hooded lines to develop hooded barley for hay making as hay from hooded barley is more palatable than from awned barley. The best selections from this cross produced in 1976 more dry matter and digestible dry matter than the best awned hay variety 628. Furthermore, by crossing Athenais with early genotypes some early lines with rapid growth were selected and are being tested for early grazing in winter.

(d) Diseases. Rust and net blotch are the main barley diseases. Mildew infestations were also recorded in certain years. However, the natural incidence of diseases has been very low in recent years. The last rust epidemic was recorded in 1969.

2. Rotations and Cultural Practices

Two research workers are involved in the improvement of rotation systems and cultural practices (Mr.Th.Samios and Mr. J.Photiades) assisted by two technicians. The main aim of this work is to find optimum rotation systems and to develop methods for better utilization of available water from rainfall.

(a) Rotations. Barley grown after fallow gave lower grain yields than after woollypod vetch. Barley grown after barley but with increased nitrogen fertilizer rate (47 kg N/ha) gave equal yields as barley after woollypod vetch fertilized with 40 kg N/ha. Barley after barley, but with the low N fertilizer rate (40 kg N/ha) and barley after barley cut for hay gave lower yields (similar to those of barley after fallow).

(b) Sowing with the Press drill in uncultivated fields gave similar yields as sowing with conventional drill in cultivated fields. There is a saving of 30 kg seed/ha and no cost for land preparation when sowing with a Press drill.

(c) Comparison of methods of preparation of fallow land and sowing techniques showed that deep chiselling in autumn followed by shallow chiselling in spring combined with sowing with a conventional drill was the best among treatments tested.

3. Weed Control.

One research worker (Mr. P. Americanos) assisted by one technician is working on chemical control of wild oats in cereals.

4. Insect Control.

Two research workers (Dr. C. Serghiou and Mr. N. Iordanou) assisted by three technicians are working on insect control of barley, both in fields and in stores.

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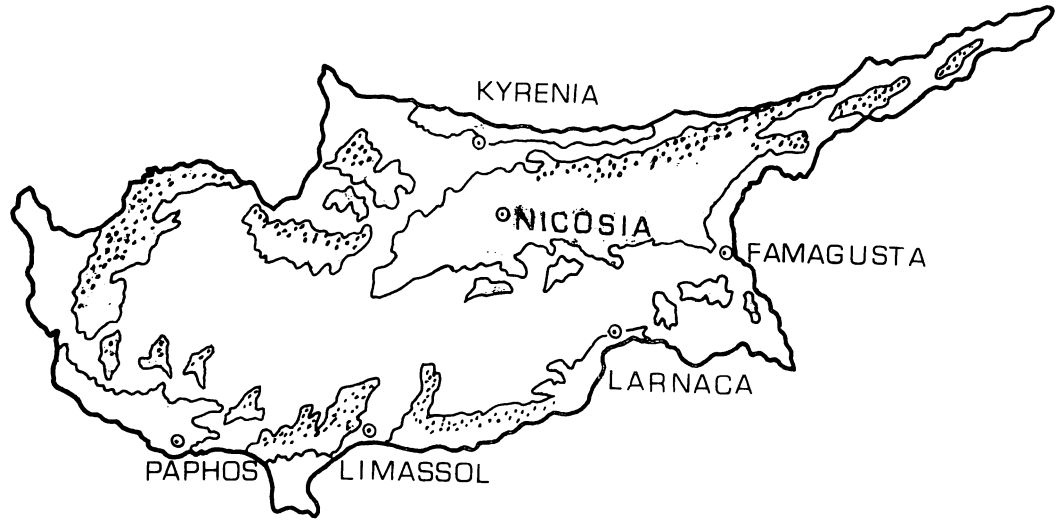
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BARLEY

BARLEY . CAROB OR OLIVE TREES

FIG. 1. REGIONS IN CYPRUS WHERE BARLEY IS GROWN

# IRAN COUNTRY REPORT

By

B. Sadri and B. Payman*

## Introduction

Some 9 million hectares of annual crops are grown every year in Iran. Of these, wheat covers some 5-6 million hectares and barley 1.5 million hectares. About one third of the area is irrigated (wheat 2 and barley 0.5 million hectares) and the rest is cultivated under rainfed conditions. The majority of rainfed barley is grown in the northeast and north western part of the country.

The total production of barley in the last season was about 1.5 million tons, meaning an average of one ton per hectare. (In irrigated land 1.69 and in rainfed condition 0.68 t/ha.). The optimum sowing date varies in different parts of the country; in cold areas, it begins from September 20 and in warm regions it begins from November 20 and with a duration of one month.

The normal harvesting time in warm regions starts from the first day of May and in cold areas almost two months later.

## The Factors Influencing Barley Production

As has been mentioned above $\frac{2}{3}$ of the area is under rainfed conditions, so obviously the most limiting factor is the amount of precipitation and its distribution. In the dryland farming regions proper cultural practices are not used. Some farmers sow the seed in dry soil in the fall, others wait for the first rain to prepare the seed bed and then sow the seed. The germination is very much dependent upon the first rain in the fall and so if the first rain comes late the crop is late planted (a frequent occurrence).

---

* Seed and Plant Improvement Institute,
Wheat and Barley Research Project,
Karaj, Iran

The amount of annual rainfall varies from 200 to over 600 mm. On the basis of the amount of rainfall, the rainfed barley acreage can be roughly classified as follows:

Areas having over 500 mm of rain 10%
Areas having over 400-500 mm of rain 15%
Areas having over 350-400 mm of rain 30%
Areas having over 350 mm of rain 45%

The rotation system in rainfed areas is mostly barley-fallow barley or barley-fallow, fallow-barley.

Uses:

It is estimated that 90% (percent) of barley produced is utilised for feeding, and the rest is used for brewery and other uses. In the past, when the price of barley grain was lower than wheat, some villagers used to blend barley flour with wheat flour, but nowadays the price of barley is almost equal and this is not done anymore.

We are not self-sufficient in barley production and every year, we import about 100,000 to 200,000 tons of grain for feeding and brewery purposes.

Breeding and Evaluation Programs

Barley breeding and testing along with wheat breeding is carried out in 22 stations throughout the country. Karaj is the central station for breeding work. For five years crosses have been made at this station, and $F_2$ materials are sent to other main stations for selection. Each year an average of 100 simple crosses, double crosses, top and back crosses are made at Karaj, depending on the objective of the cross.

The main objective of these crosses is the incorporation of high yield with disease and lodging resistance, earliness, shattering resistance and winter hardiness for cold areas.

In general, the pedigree method with individual plant selection is being applied in the breeding program. In addition to other comparative yielding trials, a uniform regional barley yield trial including 20 varieties is carried out every year at all the stations.

The principal varieties of barley are Zarjo, Goharjo for cold region and Gorgan 4 for Caspian region, Sina and Eram for warm region.

# BARLEY PRODUCTION IN IRAQ

By

Shamoon Issa Bekou*

Agriculture is the second most important sector of Iraq's economy; oil being the first. Over 50% of the population, directly or indirectly, depends on agriculture for its sustenance. The total area of the country is about 43.4 million hectares; with an estimated arable area of about 12 million hectares. The total land actually cultivated is about 7.5 million hectares; of which about 3 million hectares are cropped annually. About 45-50% of the cultivated area is rainfed and the rest irrigated by canals, pumps, wells and springs.

## Climatic Conditions and Factors Influencing Barley Production

The climate of Iraq ranges from arid to semi-arid and the rainfall varies from 50 mm in the southern desert areas to about 1,000 mm in northern hilly and mountainous areas. Almost all the rainfall is received during the winter and spring months. In the North all winter cereals, including barley, depend entirely on rainfall, the amount and distribution of which varies from year to year and from region to region.

Thus, the only crop rotation being followed in the North in regard to barley is: Barley-Fallow. While in the South it is being rotated with all the other winter or summer crops and legumes. Barley in central and southern Iraq is usually given the less fertile land. An important factor in this is its ability to withstand salinity more than any other winter crop.

## Area and Production

Wheat and Barley are the major field crops, followed by rice, cotton, pulses, maize, sorghum, millets, linseed, sesame, sugar beat, lentils, vetch, tobacco, soybeans and peanuts. Table 1 shows the area, production and yield of the main field crops in Iraq (Average 69/70-73/74).

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Table 1.

| Ser. No. | Crop | Area (000)H | % of Total | Production (000)T. | % of Total | Yield (K/H) |
|---|---|---|---|---|---|---|
| 1. | Wheat | 1439 | 65.4 | 1396 | 58.7 | 955 |
| 2. | Barley | 545 | 24.8 | 618 | 26.0 | 1116 |
| 3. | Rice | 87 | 4.0 | 237 | 10.0 | 2710 |
| 4. | Maize | 9 | 0.4 | 16 | 0.7 | 1654 |
| 5. | Sorghum | 6 | 0.3 | 6 | 0.3 | 1148 |
| 6. | Millets | 3 | 0.1 | 3 | 0.1 | 933 |
| 7. | Total Cereals | 2089 | 95.0 | 2276 | 95.8 | 1047 |
| 8. | Sesame | 15 | 0.7 | 11 | 0.5 | 686 |
| 9. | Linseed | 7 | 0.3 | 5 | 0.2 | 745 |
| 10. | Pulses | 53 | 2.4 | 39 | 1.6 | 733 |
| 11. | Cotton | 35 | 1.6 | 46 | 1.9 | 1299 |

From the above table, it is evident that cereals account for about 95% of both the cropped area and total production. Within the cereals, wheat and barley are the most important crops. Together, they occupy about 90% of the area and contribute about 95% of the production of the main crops. Individually, barley occupies 24.8% of the area and contributes 26% of the production. Barley ranks second to wheat, both in acreage and production, but excells both wheat and total cereals in yield per hectare.

In regard to its geographic distribution and production in the country, Table 2 gives area, production and yield in the three main zones of Iraq.

About 42% of barley crop is grown under rainfed conditions in the North and contributes about 32% of the production of the rest of the area. About 58% is grown under irrigation (mostly on partially or moderately saline soils) and due to better yields contributes about 68% to the production.

With regards to Iraq's position in the Near East Region, area, production and yield of this crop in the various barley growing countries of the region are given in Table 3 (Average 69/70 to 73/74).

Thus Iraq stands 4th in respect of barley area in the region; 3rd in respect of production and 7th in respect of yield. Turkey stands 1st both in respect of area and production; followed by Iran

and Syria in area; Iran and Iraq in production. In respect of yield, Yemen Democratic Republic is first, followed by Egypt, Saudi Arabia and Turkey.

Table 3. Production and Yield

| Country | Area (000/H) | % of N.E. | Production (000/T) | % of N.E. | Yield Kg/H | % of N.E. |
|---|---|---|---|---|---|---|
| Egypt | 35 | 0.58 | 93 | 1.49 | 2653 | 254.36 |
| Libya | 207 | 3.43 | 101 | 1.61 | 497 | 47.65 |
| Afghanistan | 324 | 5.37 | 367 | 5.86 | 1131 | 108.44 |
| Cyprus | 78 | 1.29 | 73 | 1.17 | 928 | 88.97 |
| Iran | 1341 | 22.21 | 938 | 14.98 | 961 | 66.25 |
| Iraq | 545 | 9.02 | 618 | 9.87 | 1116 | 107.00 |
| Jordan | 47 | 0.78 | 21 | 0.34 | 417 | 39.98 |
| Lebanon | 7 | 0.12 | 7 | 0.11 | 926 | 88.78 |
| Saudi Arabia | 18 | 0.29 | 26 | 0.42 | 1465 | 140.46 |
| Syria | 753 | 12.47 | 365 | 5.83 | 548 | 52.54 |
| Turkey | 2531 | 41.91 | 3475 | 55.51 | 1372 | 131.54 |
| Yemen A.R. | 152 | 2.52 | 172 | 2.75 | 1126 | 107.96 |
| Yemen D.R. | 1 | 0.02 | 4 | 0.06 | 2936 | 281.50 |

Uses and Consumption of Barley

Barley forms an important feed for livestock and a part is also used for brewing (malting); the demand for both is increasing. In Central and Southern Iraq, where barley is irrigated, it is usually cut or grazed by animals. This is done mainly to avoid lodging. In the North, in years of low production, the price of barley rises so much that it becomes very close to that of wheat. In order to have a real idea of the status of the crop in the country, it is interesting to follow its production/consumption for the past 16 years. (See Table 4).

It may be seen from Table 4 that the area under barley fluctuated around one million hectares up to 65/66, then decreased slightly up to 68/69, after which it showed a sudden shrinkage. The yield showed an upward trend making up the loss to some extent. The production dwindled from about one million tons in the early sixties to about half a million tons in early seventies (except for 71/72 year due to ideally favourable rainfall season). Further,

Iraq was exporting barley up to 69/70; after which it became an importer due to both reduction in area production and the increased demand for feed and the malting industry. According to some estimates the future demands are expected to reach one million tons by 1980.

Table 4.

| Year | Area (000/H) | Product. (000/T) | Consumpt. (000/T) | Export (000/T) | Import (000/T) | Yield Kg/H |
|---|---|---|---|---|---|---|
| 1960/61 | 1041 | 911 | 864 | 47 | - | 876 |
| 1961/62 | 1189 | 1125 | 786 | 339 | - | 948 |
| 1962/63 | 1218 | 947 | 904 | 43 | - | 776 |
| 1963/64 | 1098 | 623 | 598 | 25 | - | 568 |
| 1964/65 | 1097 | 806 | 678 | 128 | - | 736 |
| 1965/66 | 1169 | 832 | 682 | 150 | - | 712 |
| 1966/67 | 785 | 736 | 725 | 11 | - | 937 |
| 1967/68 | 903 | 992 | 941 | 41 | - | 1098 |
| 1968/69 | 845 | 963 | 881 | 82 | - | 1140 |
| 1969/70 | 672 | 682 | 609 | 73 | - | 1014 |
| 1970/71 | 396 (dry year) | 432 | 680 | - | 248 | 1092 |
| 1971/72 | 726 | 980 | 960 | 20 | - | 1350 |
| 1972/73 | 464 | 462 | NA | NA | NA | 995 |
| 1973/74 | 519 | 533 | NA | NA | NA | 1026 |
| 1974/75 | 567 | 437 | NA | NA | NA | 770 |
| 1975/76 | 576 | 579 | NA | NA | NA | 1007 |

Crop Improvement Efforts

The improvement of this crop has been restricted to introduction from abroad. The major problems of the conventional tall types are low yield, severe lodging, disease susceptibility, rachis-breaking and shattering at harvest. Baladi-265, introduced from Egypt in 1939, has been the local variety grown in the irrigated areas and Black 2-rowed under rainfed conditions. Later many promising exotic selections from collection and varietal trials, were put to large scale tests against the local varieties. Since 1970/71 the scope of varietal selection has been greatly enhanced through expanded varietal/advanced line procurement from abroad, both directly or through FAO and other international agencies.

Recently, a national crossing program has been started in order to improve the local varieties through crossing with the promising exotics. The good performers in the screening nurseries and small scale tests are then compared in large scale National trials at a number of stations in different agro-climatic regions for further selection leading to release. Under irrigation, Numar, Giza 120, CM67, Arivat and Giza-121 have performed very well. Of these, Numar had been released as a feed barley. Arivat has done well, both under irrigation and rainfed conditions and has also been released as a dual purpose variety (for feed and brewing). Of the two-rowed types (preferred for brewing), A-16, Beecher, Clipper and Weah have shown promising results but need further testing for final selection. Crossing, screening, selection and testing work continues in cooperation with the other Regional and International agencies in order to obtain high yielding good quality types of barley.

Since barley is taken to be a poor land crop, sown mostly on partially saline or marginal lands, not much agronomic work has been carried out. The crop is generally grazed under irrigation (60% of the barley area) before allowing it to seed. The crop is traditionally never fertilized for fear of lodging, which is very common and severe under irrigation. The effect of fertilizer on green fodder and grain yield, using local variety Baladi-265, was tested using a dressing of 40 N + 40 P/H. Results indicate the advantage of fertilizer in increasing the amount of green fodder, its maximum yields being when fertilized and cut 60 days after sowing. However, it reduces grain yield by 5-6%. Using semi-dwarf varieties, like Numar, Arivat, CM67, Giza 120, the effect of fertilizer on grain yield has also been tested. The average results indicate a positive response in case of the variety Numar, the dressing of 40N + 40PH giving the best yield.

All crop improvement work mentioned previously is carried out at several field crop research stations scattered throughout the most important cropping areas of the country.

Table 2 - Area, Production and Yield - Iraq.

| Ser. No. | Year | Area (000) H. | | | | Production (000) T. | | | | Yield (Kg/H) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North | Middle | South | Total | North | Middle | South | Total | North | Middle | South | Over-all |
| 1. | 68/69 | 423 | 308 | 115 | 845 | 430 | 380 | 154 | 969 | 1016 | 1234 | 1333 | 1141 |
| 2. | 69/70 | 283 | 279 | 111 | 673 | 160 | 379 | 144 | 683 | 566 | 1358 | 1297 | 1015 |
| 3. | 70/71 | 72 | 242 | 82 | 396 | 42 | 304 | 87 | 433 | 584 | 1256 | 1061 | 1094 |
| 4. | 71/72 | 349 | 264 | 112 | 725 | 419 | 387 | 174 | 980 | 1201 | 1466 | 1554 | 1352 |
| 5. | 72/73 | 165 | 215 | 84 | 464 | 84 | 276 | 101 | 461 | 509 | 1284 | 1202 | 996 |
| Average: | | 258 | 262 | 101 | 621 | 227 | 345 | 132 | 704 | 802 | 1317 | 1307 | 1133 |
| % of Total | | 41.5 | 42.2 | 16.3 | 100.0 | 32.2 | 49.0 | 18.8 | 100.0 | 70 | 116 | 115 | 100 |

# BARLEY IMPROVEMENT PROGRAM UNDER RAINFED CONDITIONS IN NORTHERN IRAQ

By

Dr. Abdullah K. Al-Fakhry* and Dr. Abdullah F. Ibrahim**

The Rainfed region of Northern Iraq is characterized by a semi-arid, mostly mediterranean climate. Annual precipitation in the cereal belt of this region, where wheat and barley are the major crops, ranges between 250-500 mm. The area covered by barley in this region is about 40,000 hectares, dominated by one local variety, named black barley, of unknown genetic background. The Research program of barley improvement under rainfed conditions is a part of the dry land farming research program of the Applied Agricultural Research Center, College of Agriculture and Forestry, University of Mosul.

The work on barley in this Center includes the following aspects:

1. Improvement of Local Barley by Mass Selection

The program was started in 1970 with local barley characterized by two-rowed spikes, black husks and soft, smooth awns. This makes it a better feeding-stuff for sheep than other barley varieties. The results of first cycle of selection revealed that the selected material outyielded the unselected barley by 28 percent under low rainfall (237mm) in Hamman Al-Alil and Talafar. The selected strain was also superior in two varietal tests. This strain has been named "Mosul 72". The second cycle of mass selection started in 1976 and one hectare of selected material was seeded this season with the object of further improving the agronomic traits with emphasis on drought resistance and yield.

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2. Barley Introductions

An international collection of 2 - and 6-rowed cultivars is maintained. In the varietal yield trial some of the drought and smut tolerant cultivars were included to compare their yielding ability with the local barley since 1971. In the two successive seasons of 1975 and 1976. Arivat and Numar 67 were found to be superior in their grain yield and tolerated smut disease satisfactorily under natural infection conditions.

3. Performance of Early Barley Mutants Induced from 6-Rowed "Giza 177" Cultivar under Dryland Farming Conditions in Northern Iraq

The material tested herein comprised 5 pure mutation lines in $M_8$-generation which were selected from irradiated seeds of the Egyptian barley 6-rowed cultivar "Giza 177" with gamma rays. These mutations exhibited 20 to 30 days early heading as compared to the mother type and/or other Egyptian barley cultivars. A series of papers dealing with genetic studies on these extreme early mutants, the expression of their agronomic characteristics, cytological behaviour and breeding value has already been published (1, 2, 3, and 4). Besides early heading which was confirmed to be manifest in these mutants through 8 generations, other economic characters have also positively changed. Improved earliness, short stem and high flag leaf area index enable these lines to withstand lodging and tolerate satisfactorily other unfavourable environmental conditions, such as late season attack of disease pathogens including smuts, powdery mildew and leaf spot. Excepting that these early mutations would have a greater capability to tolerate drought when grown in northern Iraq, particularly in seasons with low rainfall, the first propagation of these $M_7$-mutations was done at the College Farm in Hammam Al-Alil and at Talafar in 1975/6 season. A yield trial in which other local and introduced barley cultivars were included, was conducted in both of the above mentioned locations during the following season (1976/77). The mutants started heading on February 26, 1977, while the local and introduced cultivars were still in the tillering stage. Considering the very low rainfall of the present season (90 mm in Talafar and 110 mm in Hammam Al-Alil) it could be safely concluded that these mutations outyield all the tested cultivars. The propagation cycles of these mutations will take place during the next season when their yielding ability will be further tested.

4. Studies on Barley-Legume Hay Mixtures in the Rainfed Areas of Northern Iraq

An experiment was conducted in two locations, Hammam Al-Alil and Talafar in 1974-75 and 1975-76 seasons. The experiment at each location included the following treatment:-

barley; and barley 40 kg N/ha; barley + Vicia dasycarpa; barley + V. narbonensis; and barley + Lathyrus sativus.

The results of the two seasons indicated clearly that nitrogen fertilization considerably increased the green fodder, dry matter yield and protein yield compared to either non-fertilized barley or to the remaining mixture treatments. Moreover, barley-legume mixtures outyielded nonfertilized barley in green fodder, dry matter and protein yield. The highest hay yield was obtained from the barley + V. narbonensis mixture. The suitable stage for cutting barley fodder was between the end of milk ripe stage and early dough stage (i.e. 135 to 150 days from sowing.)

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# BARLEY IMPROVEMENT AND PRODUCTION IN JORDAN

By

Zulkifl Ghosheh*

## Introduction

Agriculture in Jordan is considered the backbone of the national economy. Wheat and barley are the most important crops in terms of land cultivated and total gross income.

Total cultivated land is about one million hectares and both wheat and barley are occupying about 60% of this area. Both area and production fluctuate from year to year depending on rainfall and its distribution as indicated in tables (1) and (2).

Table (1) - Shows the wheat cultivated area, production, and average in the last six years, 1971-1976:

WHEAT:

| Year | Total Area / ha. | Total Prod./ ha. | Average kg/ha |
|---|---|---|---|
| 1971 | 243944 | 168079 | 689 |
| 1972 | 223667 | 211412 | 945 |
| 1973 | 244179 | 50420 | 206 |
| 1974 | 246196 | 244465 | 992 |
| 1975 | 140117 | 61922 | 441 |
| 1976 | 86837 | 64626 | 744 |

Table (2) - Shows the barley cultivated area, production, and average in the last six years, 1971-1976:

BARLEY:

| Year | Total Area/ ha. | Total Prod./ ha. | Average kg/ha |
|---|---|---|---|
| 1971 | 52633 | 26220 | 498 |
| 1972 | 60556 | 34013 | 562 |
| 1973 | 53170 | 5886 | 111 |
| 1974 | 64868 | 40189 | 619 |
| 1975 | 39633 | 13783 | 348 |
| 1976 | 22648 | 16073 | 710 |

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Wheat and barley are traditionally sown during November and December. In some locations, mainly in eastern regions, both are planted earlier during October. On the other hand some farmers in the western regions where rainfall is above 450 mm prefer to plant wheat in late December and early January.

Under Jordan condition barley is harvested one month earlier than wheat. Barley is harvested during May and in some cases in early June where the rainfall is high, and in the meantime the temperature is low.

Climate Conditions and Factors Influencing Barley Production

Barley is grown in areas receiving less rainfall than wheat and other legume crops, and these areas are located in the marginal lands as follows:

| Rainfall | Percentage of area cultivated to barley |
|---|---|
| Less than 200 mm | 18% |
| 201 - 300 mm | 45% |
| 301 - 400 mm | 25% |
| 401 mm and above | 10% |
| Under irrigation | 2% |

Crop Rotations

Because barley has the ability to grow in lower rainfall regions it will continue to occupy most of the marginal land (200-250 mm), and according to this fact the dominant rotation involved in this region is barley fallow which means one crop every two years. On the other hand, in other regions where the rainfall is higher, a limited two-year rotation is practiced (barley-legume rotation). Barley is rarely used in three year rotation (barley-legume-vegetables). Under special situations barley is used in soil reclamation mainly in desert regions where under ground water is pumped and used for irrigation for few years until the soil become suitable for growing vegetables or other crops.

Use of Barley

a) Barley is not usually used for human consumption. Most of barley grown in Jordan is used for animal feeding, mainly for cattle, sheep and goats, and very limited quantities used for poultry feeding industry.

b) All barley varieties grown in Jordan are feeding type, not suitable for malting. All malting barley is imported as malt barley. The average amount imported in the last few years was 300 tons.

Table (3)

Year 1976 - 1977

| Seg.Pop. + Nurseries + Trials | Source | No.of entries | Station Names |
|---|---|---|---|
| **Segregating Population** | | | |
| F2 - Barley | CIMMYT | 435 | Wadi Yabis |
| F3 - Barley | Jordan | 128 | Deir Alla |
| F5 - Barley | W.Germany | 47 | Deir Alla, Irbid, Ramtha |
| F6 - Barley | Jordan | 5 | |
| **Nurseries** | | | |
| Regional Disease Trap Nursery Barley | ICARDA | 123 | Deir Alla |
| Crossing Block Barley | CIMMYT | 237 | Deir Alla |
| Regional Crossing Block Barley | ICARDA | 180 | Irbid |
| Preliminary Observation Nursery Barley | ICARDA | 170 | Ramtha |
| Segregating Population Barley | ICARDA | 105 | Ramtha |
| International Barley Observation Nursery | CIMMYT | 337 | Jubeiha |
| Regional Disease Insect Screening Nursery Barley | ICARDA | 600 | Wadi Yabis |
| Barley Lines | ICARDA | 118 | Deir Alla, Irbid, Ramtha |
| Barley Demonstration | ICARDA | 20 | Deir Alla, Irbid, Ramtha |
| Barley Observation Nursery | ACSAD | 203 | Rabbeh |
| Barley Observation Nursery | FAO Iraq | 28 | Tonabe Farm |
| **Trials** | | | |
| Macroplot Barley Yield Trial | Jordan | 12 | Deir Alla, Irbid, Wadi Dulail Rabbeh, Shoubak and Tonabe. |
| Microplot Barley Varietal Trial | Jordan | 20 | Deir Alla, Irbid, Wadi Dulail Rabbeh, Ramtha and Shoubak. |
| Elite Barley Yield Trial | CIMMYT | 25 | Irbid |
| Regional Barley Yield Trial | ICARDA | 25 | Ramtha |

c) Forage barley: Barley is rarely used as a forage crop except on some dairy farms . Here barley is used with other legume crops mainly vetches as green fodder during winter season. This use is limited to the area where most of the dairy cattle are located.

d) As mentioned before barley is used in soil reclamation in desert regions.

Limitation to Increase Barley Production

Rainfall is considered the main limiting factor for increasing barley production in Jordan. Other factors affecting barley production are:

1) Unavailability of sufficient amount of improved seed varieties to cover most of the barley areas.

2) Unavailability of drought resistant varieties for low rainfall (200 mm of rain).

3) Fertilizers and herbicides are considered an important factor in increasing barley production, but the applications of both are very low for several reasons:

i. High cost of these materials, mainly fertilizers.

ii. Unavailability of these chemicals at the proper time.

iii. Unavailability of application equipment mainly for herbicides, in the absence of knowledge and information about how experience to use chemical weed control.

4) Unavailability of suitable equipment for seed bed preparation, where most of the farmers are using disc or malboard plow. Both plows are not suitable for this type of cultivation. Chesil and sweep beside spring tooth harrow can fit this type of cultivation, mainly in semiarid regions.

5) Rotations: Rotations are among the main factors affecting barley's production especially under low rainfall. Very few farmers are using rotation in their lands. The majority to cultivate their land without following any type of rotations, especially in the marginal lands, however, are practiced in high rainfall regions as a two or three year rotations.

6) Land Fragmentation: this is a crucial problem facing agriculture development and production in Jordan. Land fragmentation prevents the use of suitable equipment. 35% of land holdings are less than one

hectare and 76% of land holding are less than five hectares. Long narrow strips of holdings force the farmers to plow the land in one direction, which results in hard bans affecting the premability of soil in the long run.

7) Soil plowing: Cultivation of soil is badly used in the hilly fields where most of the farmers plow their fields towards the slope thus contributing seriously to soil erosion.

Crop Improvement Efforts

Wheat and barley improvement had started in Jordan in the fifties, when breeding selection and testing of varieties were conducted on a small scale due to shortage of manpower. Recently the work had expanded to cover most of wheat and barley improvement areas. The following list shows the activity of the field crops division in this year, 1976-1977.

i. Breeding Work: Crossing and selection are carried out at four stations (Table 3).

1. Deir Alla ) Jordan Valley
2. Wadi Yabis )
3. Jubeiha Uplands
4. Shoubak Uplands. Summer work breeding

ii. Selection: Selection of promising lines are handled at several stations either for local material or introduce varieties (Table 3).

iii. Testing of Varieties: The testing of varieties are carried out at most of the government stations and sometime in the farmers' fields, as shown in Table 3.

Since wheat is more important than barley in Jordan, most of the work is devoted to wheat improvement. About one third of the cereal improvement effort is devoted to barley. Research workers in winter cereal improvement work and one plant breeder are working together to develop and improve both wheat and barley production.

Since barley is grown under dry condition diseases are not considered a serious problem in Jordan due to the low rainfall in barley areas. Powdery mildew, however, is observed mainly on the lower leaves of barley under high rainfall regions. Leaf rust and black stem rust are observed in some location either under irrigation or as a result of receiving late rains during April and early May.

Some types of insects attack barley in Jordan. The main field insects observed are leaf minor, aphids and thrips. The last two types are noticed in high rainfall regions, and under irrigation in the Jordan valley. The leaf minor is observed in very limited regions mainly in the slopes of mountains that are surrounding the Jordan Valley and mainly under low rainfall.

Principle Varieties

The result of the research work carried out in Jordan at the Agricultural Research and Extension Department, several barley varieties were developed and released and are being used by barley farmers. The main varieties released are spring feeding type. They are:

Arivat: Released in 1958, high yielding early maturing, resistant to lodging and shattering, medium resistant to diseases mainly powdery mildew, medium tall, white kernels, six rowed and occupying about 10% of the total barley area.

Ogalitsu: Released in 1964, suitable for dry regions with about 300 mm of rain, medium tall, resistant to diseases mainly covered smut, lodging and shattering, six rowed variety and occupying about 20% of the total barley area.

Giza 117: Released in 1969 suitable for irrigated area mainly in the desert region, dwarf variety resistant to lodging, white kernels, susceptible to diseases mainly Helminthosporium spp. six rowed barley occupying about 3% of the total barley area.

Deir Alla 106: This variety is considered the first barley variety developed in Jordan by the Field Crops Division from the cross Arivat x Qunnari (local variety) released in 1974. It has a wide adaptation to different climatological zones. It is suitable for irrigated, high and low rainfall areas. The variety produces high yield, and matures early, resist lodging, shattering, and has moderate resistant to diseases. It produces white kernels and occupies about 5% of the total barley area.

Local Varieties: Local varieties still occupy most of the barley area. They are low yielder, susceptible to lodging, shattering and diseases mainly covered smut, mildews and helmenthosporium. The local varieties include both types two and six rowed and are all spring feeding type.

Promising Varieties: According to the information obtained from the trials carried out in Jordan in the last few years several promising barley varieties have shown good characteristics such as yield, early maturity, resistant to lodging and diseases. The promising barley varieties are:

1. Composite 259
2. Line 257/14
3. Plata X SV Mari
4. Obeez 25

# BARLEY PRODUCTION IMPROVEMENT RESEARCH AT THE UNIVERSITY OF JORDAN IN 1975/1976 SEASON

By

Mahmoud Duwayri

Barley is grown in Jordan on an area of about 600,000 dunums. Barley production was estimated to be 40,000 tons in 1974 and 12,000 tons in 1975. However the average yield was 62 kg/dunum in 1974 and 34 kg/dunum in 1975, which is lower than world average.

Barley is important because:

1. Jordan imports large quantities of barley for feeding purposes.

2. Malt barley in Jordan is also imported from foreign countries and there are many indications that there will be more importing of this commodity.

3. Large areas of land that are planted to wheat should be planted to barley instead, since the rainfall in these areas is insufficient to produce an economic wheat crop and a single barley crop requires less water than wheat.

Barley production improvement should receive more attention, since yields can be raised through better technologies. These practices have to be identified so the farmers can use them.

## Objectives

The main objectives of the Barley Improvement project are:-

1. To develop barley varieties which are adapted to the different environmental zones of Jordan and mainly to the areas of low rainfall.

2. To discover the optimum cultural practices which will increase barley yield.

Progress

To meet the above objectives the following experiments were conducted:-

1. Jordan Barley Yield Trial

Twenty five barley varieties or selected lines chosen from the entries grown in 1974/1975 were planted in the Ramthe Agriculture Station on Dec. 6,1975. Each variety was planted in 4 rows 2.5m long and 30cm apart. The varieties were replicated four times in a randomized complete block design. Notes were taken on plant height (CM), heading and maturity dates. The two central rows were shortened to 2m long then harvested, threshed, cleaned and weighed. Data were converted to kg/dunum basis.

2. The Fifth Preliminery Observation Nursery 1975/1976

Entries were received from the Arid Lands Agriculture Development Program of the Ford Foundation, Beirut, Lebanon. These entries were high yielding lines from different programs in many countries in addition to lines selected from CIMMYT nurseries and trials as well as other Internationl nurseries. The main objective of growing this nursery in Jubeiha was to identify high yielding varieties adapted to Jordan.

The nursery consisted of 113 entries. Each entry was planted in 2 rows 2.5m long and 30cm apart. The nursery was planted in Jubeiha on December 24,1975. The plot were fertilized at a rate of 4 kg/dunum of both nitrogen and phosphorous $P_2O_5$.

Data were taken on plant height, heading and maturity dates. Entries were shortened to 2m long rows, harvested, threshed then cleaned, and weighed. Based on their yield performance and other agronomic characteristics and seed characteristics, 28 entries were selected and grown for further selection in Jubeiha, Ramtha Agriculture Station, Rabba & Hisban.

3. Sixth Regional Barley Yield Trial

This experiment was received from the Arid Land Agricultural Development Program, Beirut, Lebanon. The main purpose of this experiment was to identify barley varieties that will do well under the Jordanian conditions.

The trial comprised 25 varieties including a local variety. The varieties included in the trial were selected based on their performance in the different locations. The layout of the trial was a randomized complete block design with four replications.

Each plot consisted of six rows, 2.5m long, with a row to row spacing of 30cm. The trial was planted in the Ramtha Agriculture station, which represents a dry area suitable for barley growing in Jordan.

The soil was fertilized at a rate of 3 kg nitrogen and 3 kg $P_2O_5$ per dunum. The nursery was planted on December 6,1975. The plots were kept weed free by hoeing and hand weeding.

Data were recorded for heading date, plant height and straw and grain yield. The rows were shortened to 2m long and the central four rows were harvested only on May 16, 1976. The weights of the plants for each plot were recorded, then threshed, cleaned and the seeds were weighed.

4. The First Elite Barley Yield Trial (EBYT)

This trial was received from CIMMYT Mexico and consisted of 25 elite varieties. It was planted in the Ramtha Agriculture station on December 6,1975. The layout and Methodology of this trial was similar to the sixth Regional Barley yield trial.

Based on their performance, the top 10 varieties from the above nurseries were selected and then included in a yield nursery to be planted in Jubeiha and Ramtha for further testing.

5. Effect of the Application of Nitrogenous and Phosphorous Fertilizers on Barley Yield

Five rates of each nitrogen and phosphorous were used to test their effect on increasing yield of barley. These rates were 0, 2, 4, 6 & 8 kg/dunum of each nitrogen and phosphorous. The experiments were conducted in Jubeiha, Ramtha and Hisban.

The treatment 2 kg N/dunum was discarded in Jubeiha from the analysis due to the inaccuracy of the data of this treatment. None of the treatments gave significant increases in the yield. However it is clear that 4 kg/dunum of nitrogen produced the highest grain yield in Jubeiha, Hisban and Ramtha. The highest yield of grain as affected by $P_2O_5$ application was obtained when applying 2 kg/dunum in Jubeiha, and Hisban, but 6 kg/dunum in Ramtha. Straw yield as affected by Nitrogen was 391 kg/dunum when applying 2 kg/dunum nitrogen in Jubeiha, and 370 kg/dunum when applying 2 kg $P_2O_5$/dunum.

More detailed experiments have been repeated during the season 1976/1977 in four locations namely Jubeiha, Ramtha, Hisban and Rabba.

6. Segregating Populations

. We obtained more than 500 $F_2$ and segregating populations of barley from CIMMYT and ALAD. These populations were planted in Ramtha and the most promising crosses were identifie for further selection..

## S U M M A R Y

The experiments conducted in 1975/1976 on barley consisted mainly of varietal testing and response to fertilizers in Jubeiha, Hisban and Ramtha Agriculture station. Preliminary varietal testing showed that it is possible to develop barley varieties that are able to resist drought. The testing of barley in the Ramtha station gave a very good indication that in a low rainfall season like the 1975/76 season (where rainfall amounted to 167 mm) a crop could be obtained if the land was planted to barley rather than to wheat.

The fertilizer experiment, showed positive response to both nitrogen and phosphorous application though the results were not significant.

In the 1976/1977 growing season varietal testing on a large scale combined with more detailed studies on fertilizers were carried out. (Table 1).

Table 1. During the 1976/1977 the following Barley Experiments were Conducted in the Different Locations

| Location | Name of Experiment | No of lines or treatments | No rows line | No Replication | date of planting |
|---|---|---|---|---|---|
| Jubeiha | Jordan Barley Yield trial | 35 | 4 | 4 | |
| | Jordan Observation Nursery | 164 | 2 | - | |
| " | Effect of nitrogen on barley | 11 | 5 | 4 | |
| " | Effect of $P_2O_5$ on barley | 11 | 5 | 4 | |
| " | Reginal Preliminary Observation Nursery | 170 | 2 | - | |
| " | Barley Workshop a. Romage barley<br>b. Demonstration lines<br>c. " | 9<br>118<br>106 | 10<br>2<br>2 | -<br>-<br>- | |
| " | Regional Crossing block | 180 | 2 | - | |
| " | Segregating population | 105 | 2 | - | |
| " | Elile Yield Trial (EBYT) | 25 | 2 | - | |
| " | Regional Disease & Insect Screening Nursery (RDISN) | 600 | 1 | - | |
| RAMTHA AGRICULTURE STATION | Jordan Barley Yield Trial | 35 | 4 | 4 | |
| | Regional barley Yield trial | 25 | 6 | 4 | |
| | Regional Prelin Observation Nursery | 170 | 2 | - | |
| Ramtha | Jordan Observation Nursery | 164 | 2 | - | Jan. 9.77 |
| " | Effect of Nitrogen on baney | " | 4 | 4 | " |
| " | Effect of $P_2O_5$ on barley | " | 4 | 4 | " |
| Husban | Effect of nitrogen on barley | " | 4 | 4 | Jan.11,77 |
| | Effect of $P_2O_5$ on barley | " | 4 | 4 | " |
| | Jordan observation nursery | 30 | 2 | - | Jan.12,77 |
| Rabba | Effect of nitrogen on barley | 11 | 4 | 4 | Feb.1, 77 |
| | Effect of $P_2O_5$ on barley | 11 | 4 | 4 | " |
| | Jordan Observation nursery | 30 | 2 | - | |

# BARLEY PRODUCTION IN LEBANON

By

Ali Chaaban*

Because of the limited amount of cultivated land available in the Lebanon other crops like vegetables, fruits and industrial crops that give the farmers high returns are grown on the irrigated areas. Consequently, the cultivated area of barley is small compared with that of wheat and is limited to areas having a rainfall of about 300 mm.

The aim of the Lebanese farmer in growing barley is to produce a sufficient quantity to feed his livestock.

Barley is not used for human consumption in Lebanon, being principally produced for livestock feed. Large quantities of barley (up to 200,000 m. tons) are imported every year for malting and feeding purposes. The farmers therefore have the potential of increasing barley production to cover part of the imported quantities.

The usual price of barley in the Lebanon is 250,000 LL. per metric ton but most farmers feel that to make barley production profitable, this price would have to be doubled.

| | |
|---|---|
| Total area of barley grown | 10,000 ha |
| Average production | 10,000 mt |
| Total area of wheat grown | 70,000 ha |
| Average production | 70,000 mt |

The Agricultural Research Institute at TelAmara is working on the improvement of wheat and barley production under a single program. The work includes breeding, selection and production of new promising varieties and improvement of local cultivation practices. In addition, the Institute cooperates with several International Centers and Organisations (e.g. CIMMYT, FAO and ACSAD). The program is carried out by a staff of eight researchers.

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* Agricultural Research Institute, Tel Amara, Lebanon

Lodging and powdery mildew are the main problems encountered in developing varieties for the coastal and irrigated areas.

Local Baladi (Orge Pays), Roumi, Beecher and Athenais are the principal varieties grown in the Lebanon. Some of the promising new varieties for the future are:

| | |
|---|---|
| Amvat x Athenais | 6 row |
| Atlas x Promesa | 6 row |
| Esperance x Two Row | 2 row |
| Aurore x Esperance | 2 row |

Lebanon - Summary of Crop Statistics

| Group | Area (Ha.) | Production (Tons) |
|---|---|---|
| Cereals* | 88,500 | 93,000 |
| Fruits | 64,500 | 541,000 |
| Vegetables | 31,500 | 346,300 |
| Legume | 17,500 | 28,200 |
| Industrial Crops | 17,500 | 116,250 |
| Total Crops: | 219,500 | 1,124,750 |

* Wheat - 70,000 ha 70,000 tons
Barley - 10,000 ha 10,000 tons

# BARLEY DEVELOPMENT IN OMAN

By

M. Akhtar* and M. H. Al Taie**

Barley is grown by almost all farmers in Oman but on a very limited scale and area during winter as an irrigated crop to feed to cattle as green fodder. For grain purposes it is grown on a limited area to meet only the next year's seed requirement. But there is much scope for increasing the acreage of barley to supplement the feed of poultry, due to intensive development of the poultry scheme in the Sultanate, as well as the water shortage which is now restricting extension of the cultivation of wheat.

Following the establishment of the separate Department of Agriculture in 1970 and later on with the establishment of various Agricultural Research Stations in the Sultanate, the development of barley crop started from the year 1973-74 in colloboration with the FAO Regional Office, CAIRO and ALAD.

## Main Objectives

The main objectives are:

i) Selection of high yielding and disease and pest resistant varieties, both for grain and fodder purpose.

ii) Determination of water requirements.

iii) Determination of fertilizer requirements.

iv) Determination of cultural practices.

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* Field Crop Specialist.

** Director of Agriculture Research.

Work Done in the Past and Results Achieved:

During 1973-74, the 3rd preliminary observation nursery was planned with 53 crosses, out of which 25 with a yield of more than 5000 kg/ha were selected for future use.

During 1974-75, 4 trials on barley were planted, they were:

i) IVth preliminary observation Nursery (100 crosses).

ii) Regional crossing block (104 genotype).

iii) Varietal trial of locally selected material from previous nursery (25 crosses).

iv) Regional yield trial of barley (25 varieties).

From the preliminary observation nursery 11 crosses giving a yield of more than 5000 kg/ha were selected .

Similarly from the Regional crossing block 12 genotypes were selected on the basis of their high yield (more than 5000 kg/ha).

In the Varietal Trial of locally selected material the highest yield of 4416 kg/ha was obtained from Gizeh 68 x 7028 L 26 - 2 L followed by Beecher and Gizeh 68 x 7028 L 26 - 5 L.

In the fifth regional trial of barley L 270/23 and Beecher gave good performances. The line 270/23 yielded 4000 kg/ha, followed by B Beecher which gave the yield of 3444 kg/ha.

During 1975-76 three trials were conducted:

i) 5th FAO Regional Yield Trial (25 vars) repeated due to non availability of 6th Regional Trial.

ii) Varietal Trial of locally selected materials (25 crosses).

iii) Varietal Trial of imported varieties (4 vars).

On the basis of the results of this year as well as the results of the past year the following varieties showed promising results:

L 270/23, Beecher, CC sel Er. 5461, 2758 x Aza, Gizeh 68 x 7028, L26-2L 7028 x Arivat L30 - 2L, 7028 x Arivat L 30 - 3L Arivat X Athenanios Lb4 - 24 and Gizeh 68 x 7028 L 30 - 3L

The average yield of the promising varieties of the last two or three years were:

| Varieties | 75-76 | 74-75 | 73-74 | Average |
|---|---|---|---|---|
| | | Yield KG/HA | (PON) | |
| Line 270/23 | 2759 | 4000 | - | 3379 |
| CC seler 5461 | 3939 | 3500 | 10000 | 5813 |
| 2758 x Aza | 3257 | 3722 | 8666 | 2512 |
| Beecher | 3384 | 4277 | 5333 | 4331: |
| | 3181 | 3444 | - | 3212: |
| 7028 x Arivat L30-2L | 3358 | 3805 | 5333 | 4165 |
| 7028 x Arivat L30-3L | 3535 | 3972 | 6333 | 4613 |
| Arivat x Athenaios LB - 2L | 3737 | 3833 | 6000 | 4098 |
| Gizeh 68 x 7028 L30-3L | 3257 | 4027 | 6000 | 4009 |
| Gizeh 68 x 7028 L26-2L | 2752 | 4416 | 6000 | 4389 |
| Local | 2121 | 2444 | - | 2282 |

out of which the varieties Beecher, line 270/23, CC seler 5461 and 2758 x Aza are being multiplied on a limited scale.

Work in Progress

During 1976-77 the following nurseries and trials have been planted, and the crops harvested, (threshing is under progress).

i) The sixth preliminary observation nursery (170 crosses in two lines of 25 meter length).

ii) The seventh Regional crossing block (180 genotype in two lines of 2.5 meter length).

iii) Varietal Trial of improved varieties (both for grain and green fodder). All the promising varieties mentioned above are being tried with four replications in a plot size of 5m x 4m both for grain and fodder purposes. But for green fodder purposes none have yielded more than Local (28 tons). The highest fodder yield of the improved varieties 2758 x Aza was 27.5 tons/ha.

iv) Nitrogen response trials with improved varieties. Here three varieties Beecher, 2758 x Aza and Arivat x Athenaios LB4 - 2L are being tried at 0, 30, 60, 90, 120 and 150 KGN/ha.

v) Regional Trap Nursery (600 crosses sown in hills 30 cm apart).

Pests and Diseases

No disease of barley has been yet reported within the Sultanate, but the two pests which occur are:

i) Wheat aphids. Rophalosiphum maidis.

ii) Shoot-fly. Atherigona. spp

The aphids are being controlled by application of Dimethoate 40 EC and the work is in progress to evolve the control measures for the shoot-fly.

Weeds i) Wild oat.
ii) Convolvulus avvensis

# BARLEY IMPROVEMENT AND PRODUCTION IN SAUDI ARABIA

By

M. S. Jowanna and I. Baghdadi*

## Introduction

Increasing the production of field food crops especially cereals is one of the most important targets of the present and previous five year agricultural development plan of the Kingdom. The success achieved under the National Wheat Programme during the past few years (1971-1975) directed attention to the possibility of increasing the production of other cereal crops in both directions vertically and horizontally.

The total arable land of the Kingdom is approximately 1000,000 hectares. Wheat, which is the most important winter cereal crop occupies about 83,300 ha. (76,700 ha. of irrigated land and 6000 ha. in rainfed areas), while barley occupies only 15,000 ha. with corresponding production of about 20,000 tons (1.333/ha), which is a relatively low yield. This may be attributed to the following reasons:

1. Most of the cultivated varieties are local low yield/ disease susceptible types.
2. Lack of information on high yielding drought resistant cultivars, moisture and agronomic requirement, especially for rainfed areas.
3. A large portion of the barley acreage is rainfed where amount of rains fluctuate considerably.
4. Barley is also cultivated partially as a forage crop.

The identification of suitable disease resistant/high yielding varieties (HYV's) for both irrigated and rainfed areas, in addition to finding out the proper agronomic requirements/practices for optimizing grain production economically, is now the chief priority.

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Locations and the Corresponding Rainfall Pattern

The main barley locations as well as the corresponding cultivated areas are given in Table 1. Some meteorological information including amount of rains and its seasonal distribution are indicated in Table 2.

Rotation

Wheat-Barley / Fallow or melons-vegetables/ Wheat-Barley.

Sowing - Harvesting Periods (Growing Period)

(a) Irrigated Areas: November-Mid December to March-April with seed rate 120 kg/ha.

(b) Rainfed Areas : October-December (effective germination depends on good precipitation) to March-April with seed rate about 150 kg/ha.

Important Barley Diseases

Rusts. Helminthosporium sp., covered smut.

Uses of Barley and Annual Consumption

In general barley is cultivated for feed purposes either as forage and/or as grain (sheep/goats, horses, etc..). The estimated annual quantity of barley grain consumed in Saudi Arabia amounts to 35,000 tons, of which 1,500 tons are imported.

Limitation to Increasing Barley Production

Irrigation water is considered to be the most important limiting factor for agriculture in the Kingdom. For obvious economic reasons, it is more profitable for farmers in most of the irrigated area to grow vegetables, fruit trees, alfalfa and/or wheat rather than cultivating barley. Hence, rainfed areas may be considered as the only area where barley production/acreage can be increased. This can be achieved in those areas with limited moisture (rainfall) which cannot economically be devoted to the cultivation of other crops, providing that proper agro-

techniques for moisture conservation and suitable early maturing (short growing period), disease resistant HYV's are used.

Barley Testing Programme

The barley testing programme was started a few years ago as a part of the winter cereal improvement programme, with the objective of identifying high yielding/disease resistant varieties for irrigated and rainfed areas. The testing includes varieties/lines that are annually received from regional and international organizations (i.e. FAO, ALAD, CIMMYT, ACSAD, etc..) as well as from some national programmes.

As a result of this testing programme, some promising varieties were identified (namely Giza 121, Beecher, Briggs and L.272/3/4). These varieties performed well locally (about 6.5 ton/ha.) under irrigated conditions as well as in many other countries of the region where they topped the varieties/lines included in the fifth and sixth RBYT.

The following barley yield trials were included in 1976-77 testing programme:

1. Seventh Regional Barley Yield Trial (RBYT).
2. International Elite Barley Yield Trial 1976/77 (IEBYT)
3. Local Barley Yield Trial (LBYT).

Seed Production Programme

Initial steps were taken to secure enough quantities of certified seeds locally. The previously mentioned promising varieties were included in the 1976/77 International Seed Multiplication Programme. A substantial quantity of seeds has been requested from the FAO to accelerate the programme. These HYV's will be released within two years to replace the local varieties presently grown (i.e. Aglana, Arabi Qasem, Madini, etc...).

Table 1: Barley growing Locations and corresponding areas in Saudi Arabia.

| Location | Area in dunum ( 0.1 ha ) |
|---|---|
| Eastern Region | 174 |
| Riyadh | 376 |
| Qassem | 9455 |
| Haiyl | 2132 |
| North Region | 1027 |
| Al-Madina | 991 |
| Mecca | 10854 |
| Asser | 52500 |
| Al-Baha | 45879 |
| Bisha | 10140 |
| Najran | 5224 |
| Jizan | 14091 |
| Total in dunums | 152843 |
| Total in hectares | 15284.3 |

Table 2: Barley growing area in Saudi Arabia; some meteorological data.

| Region /Location | Latit. ° / | Longt. ° / | Altit. m' | Total m.m. | / RAINS seasonal distribution% Winter | Spring | Summer | Autumn |
|---|---|---|---|---|---|---|---|---|
| Eastern Region: | | | | | | | | |
| Hufouf | 25 30 | 49 34 | 160 | 59.2 | 73 | 22 | 0 | 5 |
| Quatif | 26 33 | 50 00 | 5 | 78.6 | 53 | 27 | 0 | 20 |
| Riyadh : | 24 42 | 46 43 | 609 | 100.6 | 45 | 44 | 1 | 10 |
| Qaseem: Buraidah | 26 20 | 43 58 | 625 | 78.4 | .. | .. | .. | .. |
| Unaizah | 26 04 | 43 59 | 650 | 111.1 | 39 | 40 | 0 | 21 |
| Hayil : | 27 31 | 41 44 | 914 | 77.8 | 8 | 22 | 0 | 70 |
| Northern Region: | | | | | | | | |
| Qurayatt | 31 20 | 37 21 | 549 | 52.4 | 27 | 40 | 0 | 33 |
| Tabuk | 28 24 | 36 35 | 774 | 32.0 | 34 | 27 | 0 | 39 |
| Sakaka | 29 58 | 40 12 | 574 | 69.7 | 21 | 30 | 1 | 48 |
| Badana | 31 00 | 40 59 | 660 | 29.2 | 35 | 46 | 0 | 19 |
| Qaisumah | 28 19 | 46 07 | 360 | 44.7 | 67 | 22 | 0 | 11 |
| Al-Madina : | 24 39 | 39 39 | 672 | 34.1 | 36. | 38 | 0 | 26 |
| Mecca : | 21 26 | 39 49 | 280 | 204.8 | 44 | 20 | 5 | 31 |
| Jeddah | 21 30 | 39 12 | 11 | 63.8 | 52 | 15 | 0 | 33 |
| Taif | 21 29 | 40 32 | 1395 | 162.4 | 25 | 25 | 13 | 37 |
| Aseer: Abha | 18 13 | 42 30 | 2190 | 386.9 | 20 | 41 | 28 | 11 |
| Khamis-Mushayt | 18 18 | 42 44 | 1950 | 247.1 | 19 | 40 | 27 | 14 |
| Al-Baha: Balgorashi | 19 51 | 41 34 | 2400 | 346.3 | 34 | 24 | 12 | 30 |
| Bisha : | 20 00 | 42 36 | 1040 | 145.3 | 18 | 53 | 10 | 19 |
| Najran : | 17 29 | 44 09 | 1150 | 43.1 | 53 | 33 | 7 | 7 |
| Jizan : | 17 03 | 42 57 | 4 | 44.6 | 9 | 35 | 13 | 43 |

# BARLEY PRODUCTION AND IMPROVEMENT IN THE SYRIAN ARAB REPUBLIC

By

Issam Naji*

The total area of Syria is 185,000 $Km^2$ and it can be divided into five regions based on annual rainfall:-

| | | |
|---|---|---|
| Greater than 1000 mm | 9,250 $Km^2$ | - 5% |
| 500 mm - 1000 mm | 37,000 $Km^2$ | - 20% |
| 250 mm - 500 mm | 46,000 $Km^2$ | - 25% |
| 100 mm - 250 mm | 74,000 $Km^2$ | - 40% |
| Less than 100 mm | 18,500 $Km^2$ | - 10% |

Only 6% of the estimated area under cultivation (about 6 million hectares) is under irrigation. About 13,888 ha of barley are grown under irrigated conditions and 997,505 ha under a rain-fed regime.

The following table illustrates the production situation for wheat and barley at the present time:-

| | Area (ha) | Yield (kg/ha.) | Production (tons) | Area (ha) | Yield (kg/ha) | Production (ha) |
|---|---|---|---|---|---|---|
| Irrigated | 13,888 | 1,643 | 22,822 | 174,364 | 2,074 | 361,734 |
| Rainfed | 997,505 | 575 | 573,722 | 1,517,903 | 783 | 1,188,327 |

It is apparent from this that the production of wheat is favoured to that of barley under both irrigated and rainfed conditions. The relatively low level of barley production is in part

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due to the fact that seventy percent of the crop is grown in areas with less than 250 mm of rainfall per annum, and only a very small percentage is grown under an annual precipitation of more than 400 mm.

Barley is mainly used as an animal feed and is normally sown between October and November and harvested between May to June. It is mainly the local varieties that are grown, Arabic Black (60%), Arabic White (30%) and others such as Roumy and Arabic Akdar (10%).

Several new promising varieties, which include Arivat and Tricidrit are to be released in the near future.

The most important diseases of barley encountered in Syria are Powdery Mildew and Leaf Rust. These are especially severe problems in wet seasons.

The Breeding Program

Genetic material of a promising nature is introduced by the Field Crops Section from the Ford Foundation, CIMMYT, FAO and other organisations.

This material is evaluated from the point of view of its adaptability and performance under local environment conditions. At present about 300 varieties and lines are being studied in order to select the promising material for testing in the varietal yield trials.

The $F_2$, $F_3$, $F_4$, and $F_5$ segregating populations introduced from these international organisations will hopefully provide segregants combining such desirable characters as high yield capacity, drought tolerance and good disease resistance. These can be used to increase the production possibilities for the barley crop in Syria by replacing the established local varieties in the cropping system.

# BARLEY PRODUCTION IN TURKEY

By

Fikret Demirkan*

## Introduction

Turkish agriculture is dominated by cereals. The total cultivated area is 25 million hectares. About 16 million hectares are sown annually and 8.5 million hectares are fallowed. Winter cereals occupy 12 million hectares each year. Wheat and barley are the most common winter cereals and are grown in the same regions. Wheat occupies 8.5 million hectares with a production average of 13 million tons and barley covers 2.7 million hectares each year. Barley production by years is shown in Table 1.

Table 1. Barley cultivated area, production and yield.

| Year | Area Sown (ha) | Production (ton) | Yield (kg / ha) |
|---|---|---|---|
| 1964-73 (10 years' average) | 2,664.200 | 3,544.500 | 1,331 |
| 1974 | 2,580.000 | 3,330.000 | 1,291 |
| 1975 | 2,600.000 | 4,500.000 | 1,731 |
| 1976 | 2,625.000 | 4,500.000 | 1,714 |

The areas where barley is grown show differences according to climatic and ecological conditions. The planting and harvesting dates vary according to these different conditions in the various regions. In the areas of high plateau where winter barley varieties are grown, sowing is from September to November. Spring sowing in these regions, despite the inadvisability of this practice, is done at the end of February and in March. The harvesting time is from June to August. In the Coastal regions where climatic conditions are favourable, spring habit barley varieties are sown from October to January and harvesting dates are correspondingly from May to July.

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## Climatic Conditions and Factors Influencing Barley Production

Turkey by its geographical position and geological structure has a wide range in elevation, climatic and soil conditions. The barley growing areas are spread almost throughout the country as shown in Figure 1. The areas in these various ecological and growing conditions may be considered as falling into two major groups, the Central Anatolian Plateau and the Coastal Regions.

In the Central Anatolian Plateau where rainfall is limited, winters are moderately cold, and because there is little irrigation, winter varieties mainly wheat and barley, are grown under the fallow-wheat (or barley) rotation sequence. There is no systematic order followed in this rotation. In annually fallowed areas wheat and barley, rarely oats and rye, are either repeatedly sown after one year fallow or replace one another. In a few areas of this region where some irrigation is available, wheat and barley can be rotated with sugar beet or market garden crops and vegetables. In limited areas of the South East, a rotation of lentils and winter cereals is being practiced.

The coastal areas are favoured by adequate rainfall, mild temperatures and, in some areas, the availability of irrigation which allows growth of fall-sown spring barley varieties. Barley mainly rotates with industrial crops such as cotton and tobacco which are the principal crops in regard to area and production for most parts of these regions. In the irrigated areas where intensive agriculture is practiced barley rotates with vegetables and in many places it is also grown amongst the fruit trees of the horticultural areas. However, the general tendency of the farmers in this region is to grow their barley in saline and arid soils and on hillsides.

Areas of barley cultivation are rather intensive in the transitional zones between the Central Plateau and the Coastal plains. These zones have little more rainfall than the Central Plateau, elevation is also high. In this region, where dry farming is practiced and a one year fallow is still adopted, the barley rotates with poppy and sunflower but this rotation is not on a set pattern. Food legumes and forage crops may also be included in the rotational system. In areas within this region where limited irrigation is available, barley and other cereals rotate with sugar beet and vegetables.

• The total growing area,made up from the scattered plains of the mountanous East and the flatter areas of the other mountainous regions, although relatively small, cannot be ignored. The winters here are long and animal husbandry on the open range system is the main farming system followed. Winter cereals are the only crops grown on any scale and a fallow rotation is followed. Almost every year there is a shortage of feed for the animals and so this region has a considerable need for barley cultivation. Besides the winter cereal growing areas of the South East, the arid and relatively hot regions are more important for barley cultivation.

It is still a traditional practice in most areas of Turkey that the small fields or gardens directly around the homestead of the small farms or the villages, which are generally given animal manure, are used for barley growing. The barley produced in these fields is used as green fodder, grain and straw by the farmers for the feeding of the few cattle, sheep and poultry which are kept for their own domestic needs.

The Use of Barley

The main use of barley is for animal feed in Turkey. Up until twenty years ago barley was used for bread and also barley flour was mixed with wheat flour in some mountainous areas. These uses have now been completely replaced by wheat. Over the past few years the brewing industry has expanded and today three percent of the total barley production is used in malting.

Barley when used as a straight feed for cattle, sheep, horses and poultry is used either as whole or rolled grain. In preparation of commercial feeds where additives supplement the food, barley is used in high proportion.

As is well known, barley straw has little animal food value, but it is important as a bulk in animal feeds. It is generally preferred to the other cereal straws because of its light color and thinness. Barley straw also has a use, as do other cereal straws, in the paper industry.

Amongst the farmers it is customary to graze the crop once or twice with sheep whilst it is at the jointing stage. In many places where barley is grown in association with vetch, it is cut as fodder or cut and used in the preparation of silage. There is no specifically recommended barley variety for grazing.

## Limitations to Increasing Barley Production

The barley production areas of Turkey have for a long time shown no signs of expansion. However, the major areas of cultivation of barley in the Central Plateau and transitional zones have always had a lower yield per unit area than the crop on the coastal areas.

Increases in wheat production up to now, have been actively encouraged by the Government because of the increase in population of the country and the associated increase in demand. In connection with this, the official price for wheat is always kept higher than barley and the farmers have always given priority to growing wheat because of their own need. This price differential and the lack of direct encouragement may be the major factors limiting the increase in barley production.

At the moment, the seed multiplication process for the six released and recommended barley varieties has not proved effective and some difficulties have been encountered. Land cultivars besides these released barley varieties are still grown in many areas. In general, barley is not cultivated on the most fertile land, but it is mainly cultivated on arid or hillside areas, and use of fertilizers was uncommon in the past. With the introduction of strong strawed Mexican wheat varieties, fertilization of cereals had become accepted. In the coastal areas and in the irrigated lands barley is now being fertilized. Where industrial crops are cultivated barley is also increasing in importance as a rotational crop.

Besides the other limitations in increasing barley production, a major restraint has been that barley research work has not been handled comprehensively. For a long time, barley research, mainly as breeding, has taken place on a small scale in only a few research institutes and has been unable to show much effect in increasing overall barley production.

## Crop Improvement Efforts

Last year, a National Barley Research Project was prepared and initiated by the Ministry of Agriculture with the aim of increasing yield and improving the quality of barley in Turkey.

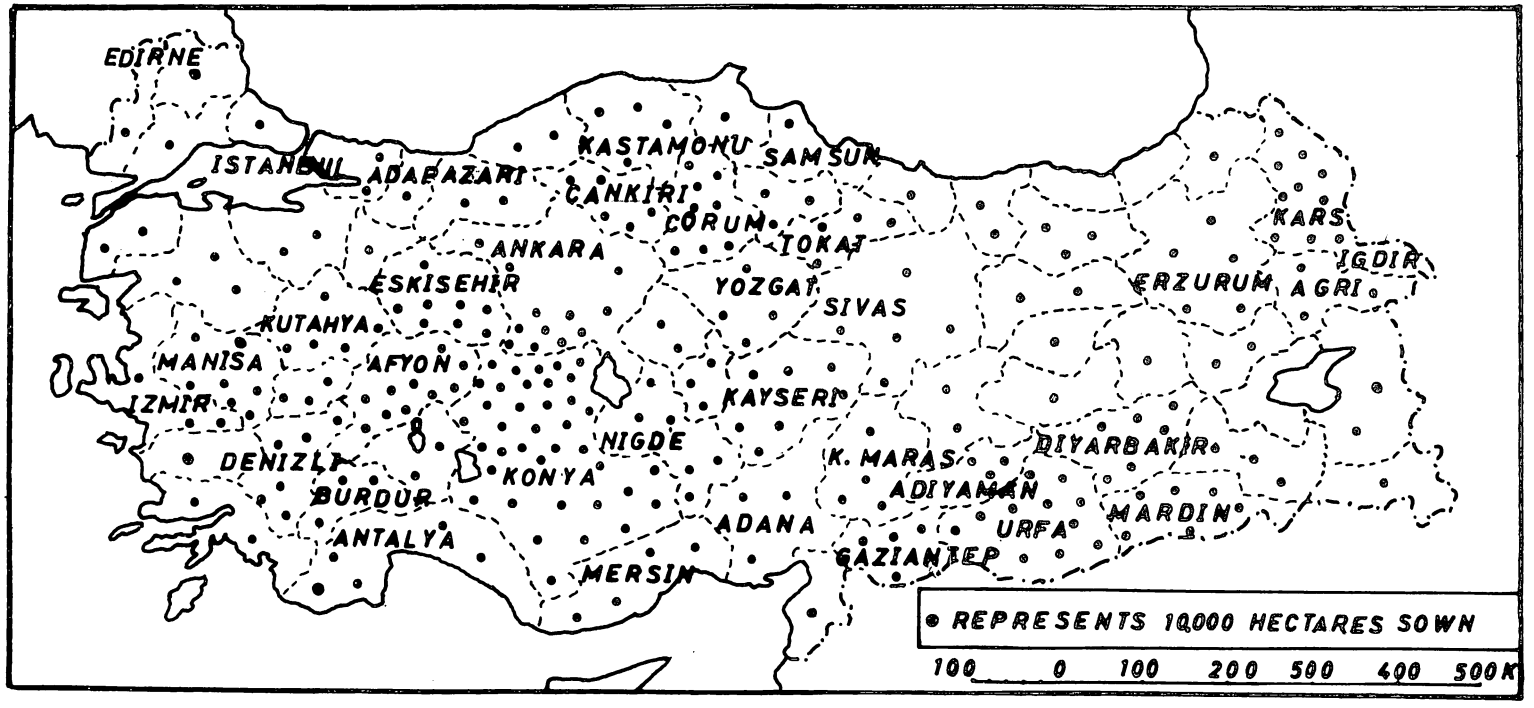
The project calls for multi-disciplinary and cooperative work in breeding, pathology, agronomy, technology, and training aspects on a country wide basis. The project carries out research at twelve research institutes belonging to the Ministry of Agriculture, located in the different regions of the country.

Many introductions from worldwide sources have been screened and tested for many years at several research institutes. The hybridization programmes at Izmir and Eskisehir were also enlarged with the start of the Barley Research Project. Advanced lines obtained at the Izmir Institute are distributed to other stations where spring barley varieties are grown and the material from Eskisehir to stations of the winter areas. A hybridization program will soon be started at the Ankara Institute which represents winter areas. The criteria for improving varieties for the winter areas, are increased straw strength, winter hardiness and drought resistance, responsiveness to fertilizers and improved cultural techniques, and resistance to stem rust, spot blotch, scald and loose smut. The main factors for selection in the coastal areas can be considered to be grain yield, straw strength and resistance to several diseases. (In order of their importance these diseases are powdery mildew, spot blotch, scald, smut and rusts). At the present time, six breeders, two pathologists, and two technologists are working in the barley project. These technical staff have B.Sc. degrees, but need further training.

There are also six wheat breeders assisting on a part time basis. Although the barley project is separated from the wheat project, they are closely related to each other in operation and functions.

There are six released barley varieties being grown in the country. Winter barley Tokak 157/37 is an old variety and occupies 70 percent of the winter barley areas. This is a two row, tall variety which shows good winter hardiness and is also used for malting. A new barley variety Gumhuriyet 50 (also two row) produces yield equal to that of Tokak 157/37. The main variety grown in the coastal areas is a six row barley named Yercil which was released two years ago for the irrigated areas of the Central Plateau and Transitional Zones. Two or three new barley varieties are expected to be released this year.

FIG. 1: DISTRIBUTION OF BARLEY IN TURKEY (1976 DATA)



# BARLEY RESEARCH ACTIVITIES IN THE YEMEN ARAB REPUBLIC

By

M. Mohamed El-Gouri*

## 1. Introduction

The Yemen Arab Republic has a total geographical area of 195,000 $km^2$. It lies between latitude $12^o50'$ to $17^o45'$ north and longitude $42^o40$ to $46^o30'$ East, and altitudes range from 200 - 2,700m. Due to this, Yemen Arab Republic has several different climatical zones. The lowland areas have a typically tropical climate while the high-lands are sub-tropical. Yemeni soils are mostly alkaline. PH ranges between 7.5 - 9.0 (in other words from moderate, high to very high in reaction). The soil fertility condition is as follows:

| | |
|---|---|
| N | - Low to medium |
| $P_2O_5$ | - Low |
| $K_2O$ | - High to very high |

## 2. Barley Cultivation

Barley cultivation is concentrated in the high-land areas with an altitude of 1900-2700 m. The total barley area is about 170,000 ha., and total production is about 200,000 tons. The average yield per hectare is very low due to the continuous growing of local genotypes which are very susceptible to diseases and lodging.

Starting in 1976 a very intensive research programme was initiated on this crop in order to improve its yielding capacity and resistance to various diseases. Great attention was given to the introduction of new lines/varieties for further screening, selecting and testing for adaptability to the various climatical conditions of Yemen.

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* Head of Crop Section, Central Agricultural Research Project Taiz, Yemen Arab Republic.

This extensive programme was carried out in cooperation with the FAO Wheat and Barley Project, CIMMYT and ICARDA. As a result of this work many adaptable, resistant, high yielding varieties and lines were screened.

3. Promising Line Varieties.

Most of the new lines show better performance than the local ones, and some of these lines will replace the local varieties in the near future.

4. Disease

Leaf rust, Helminthosporium leaf spot and powdery mildew are the major diseases prevalent in the country.

5. Growing Period

Barley has two growing periods per year. The first begins during June/July and depends absolutely on rainfall. The second period starts during January/February and in this case barley is sown under irrigation.

6. Area Irrigated/Rainfed

About 10 percent of the area is irrigated. The majority of the area is sown under rainfed conditions in areas with an average rainfall of 400 - 600 mm per annum.

7. Rotation

Cereals are commonly grown after fallow, and trials are in progress to study the best crop rotations.

8. Mechanization

The use of mechanization at the farmers' level is very limited and is, in general, only used for bed preparation and threshing.

9. Seed Rate

The seed rate normally used is 40 - 80 kg/ha.

10. Fertilizers

Fertilizer trials were undertaken to determine the optimum doses, application, form of nitrogen and methods of application. Generally, 30 - 60 kg N, 60 $P_2O_5$ kg and 20 $K_2O$ kg per hectare are recommended for the improved varieties.

11. Seed Production

Pure seed distribution is limited due to lack of seed multiplication and distribution centers. At the moment breeders' and foundation seeds are multiplied under the control of research centers, thus making it very difficult to control seed purification at the farmers' field. Seed multiplication centers should be immediately established to produce pure seeds. Methods of coordination between research institutes and the seed multiplication centers should be sought in order to accelerate the distribution of HYV's in the country on a large scale.

12. Research Stations Engaged in Barley Research

| | Latitude | Longitude | Altitude |
|---|---|---|---|
| 1. Central Agricultural Research Project: | | | |
| a. Ausseifera Station | 13°42' | 44°00 | 1350 m |
| b. Ibb Station | 13°490 | 44°11 | 1950 mm |
| 2. Bilateral Projects: German Yemen Project - Sana'a | 15°23' | 44°3' | 2500 m |

13. Wheat and Barley Research Workers

Mr. Mohyeddin Mohammed Al Gouri:
Head of Cereal Crop Section
Central Agricultural Research Project.

Dr. Elham Talaat,
Wheat Breeder/Agronomist.

Mr. Khaled Nabawi,
U.N.V.

Also joining the staff - Five Technicians under training.

# BARLEY IMPROVEMENT IN PEOPLES DEMOCRATIC REPUBLIC OF YEMEN

By
S.M.Atta and J.S. Bakshi*

This country, on the south west corner of the Arabian peninsular, has a total land area of only 290,000 square kilometres . The terrain is a plateau, partly mountain and partly desert and the total cultivatable area is about 352,000 hectares. The climate is arid and the rainfall irregular, often as low as 250mm over a five year period in most parts of the country. All agriculture therefore depends upon irrigation, and two systems are in use: Firstly speedwater irrigation in which rainfall in the mountains is caught, stored and distributed through canals; and secondly groundwater irrigation. Both methods are very costly . As a result and due to the overall scarcity of moisture the area actually under cultivation seldom exceeds 53,000 hectares. In general winters are mild and so winter cereals are grown on an area of about 10,000 hectares.

Barley is only a minor crop in the country occupying about 1,300 hectares which is 3% of the cultivated area and 18% of the area sown to wheat. Barley is predominantly cultivated in the ancient agricultural area in the extreme west of the country known as the Beha. Though the production of barley may not seem to be highly significant from these figures, it must be remembered that the production of every hectare is vitally important in sustaining the rapidly expanding population of 1.6 million people.

At present barley is used exclusively as a human food. However as development progresses it is likely that there will be increasing demands for feed barleys. Plans are also afoot to build a brewing factory in order to reduce current imports and this will create a considerable demand for malting barley types.

Currently, no improved barley varieties are grown. Barley has received very little research attention and as a consquence most of the varieties grown are local types which form a single complex of varieties. This complex is predominantly of 2 row types, but some 6 row components are also present.

The barley crop usually receives 4-6 irrigations and no fertilisation. Stripe rust and leaf rust are the only two important diseases in Yemen , and

* Ministry of Agriculture, Aden, Peoples Democratic Republic of Yemen.

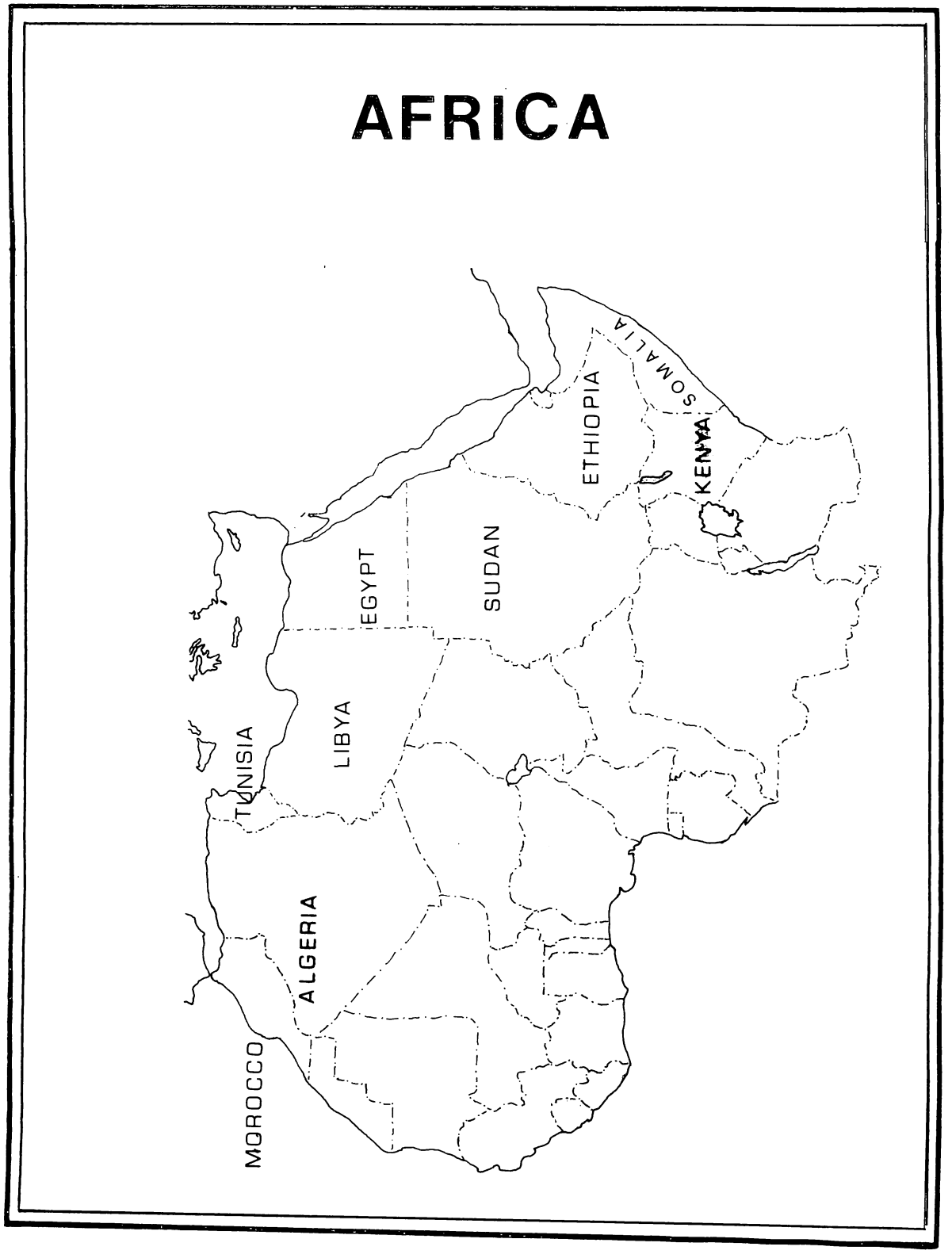
no insect pests have been discovered as yet. Barley is generally planted in October and harvested in late December or January. This procedure effectivelly reduces lodging in local varieties as it provides an escape from leaf rust infection, to which these varieties are highly susceptible, and which may become very severe.

A small research program was instigated in this cropping year and six varieties, five of the 2 row type and one of the 6 row type, were introduced. The main purpose at present is to identity 2 row varieties which can be grown specifically for malt production to supply the brewing plant which will be operational by 1980. Preliminary observations indicate Bonus to be a most promising line, followed by Beecher, Giza 121, Clipper, WI 2197 and the local selections. Local varieties however tend to show an excessive amount of lodging.

Further research efforts in varietal improvement will emphasise combining resistance to lodging and to stripe rust into high yielding 2 row types. Other important assets which will be considered include high temperature tolerance and early maturity.

At planting time temperatures can vary from 15°C to 28°C in the same day. This causes considerable stress to the barley plants and results in reduced stands. Increasing the seed rate has been found to be effective in improving plant stands decimated in this way. For the future, cultivation practices must be improved, fertilisers used and improved varieties grown in order to produce the required yield increases. Experience shows that planting in mid-November rather than at the end of October may result in considerable yield improvement due to the more favourable temperatures and the absence of stripe rust. The development of improved barley for production on saline soils would also give great benefits to the country.

Although it is not intended to undertake an extensive barley breeding program in Yemen , it is hoped that by utilisation of materials made available by international organisations and selection for adaptation to the conditions of the country substantial increases in barley production may be achieved in the future.


AFRICA
SOMALIA
ETHIOPIA
KENYA
SUDAN
EGYPT
LIBYA
TUNISIA
ALGERIA
MOROCCO

# BARLEY PRODUCTION IN KENYA

M.W. Oggema and J.R. Otieno-Sewe *

## Introduction

In the 1976-7 season 30,000 ha of barley were planted 28,000 being grown under contract to Kenya Breweries Ltd. (KBL). The area cultivated with barley has increased dramatically over the past five years (Table Ia), the 1976-7 hectarage being almost double that for 1972-3. During the same period the wheat hectarage has remained almost constant but with small increases in 1975-6 and 1976-7 (Table Ia).

Barley production has likewise increased rapidly over the same period from 22,400 mt in 1972-3 to an estimated 48,000 mt in 1976-7 while wheat has increased from 149,600 mt in 1972-3 to an estimated 170,100 mt in 1976-7 (Table Ib). The average yields for both crops are relatively low at approx. 1400 Kg/ha (Table Ic).

Beer sales have steadily increased over the same period apart from a small drop in 1975 (Table Id) and now amount to approximatley one million half litre bottles per day.

Kenya is now self sufficient in barley and has recently exported 500 tons of feed barley to Tanzania. However 3000 tons of malting barley were imported in 1975 but proved unsuitable for malting on arrival because of low germination and were converted into barley syrup.

## Climatic Conditions and Growing Seasons

Kenya straddles the equator and all the barley (and wheat) is grown within 2° latitude either side of the equator. Day length is therefore practically constant at approximately 12 hrs. per day.

Because of the high elevations at which barley is grown conditions are temperate rather than tropical. Temperatures are largely dependant on altitude and between 2100 and 2400m annual mean minimum temperatures and about 10°C with the coldest recorded temperatures being about 5°C.

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* National Plant Breeder Station, P.B.Njoro, Kenya.

Table 1.

(a) Areas under barley and wheat (ha)

| Year | 1972 | 1973 | 1974 | 1975 | Estimate 1976 |
|---|---|---|---|---|---|
| Barley | 16,200 | 16,200 | 17,500 | 30,000 | 30,000 |
| Wheat | 104,900 | 107,300 | 105,100 | 117,200 | 119,700 |
| All crops cultivated | | | Approximately 12 million | | |

(b) Barley and wheat production (Metric tons)

| Year | 1972 | 1973 | 1974 | 1975 | Estimate 1976 |
|---|---|---|---|---|---|
| Barley | 22,400 | 22,400 | 28,500 | 35,400 | 48,000 |
| Wheat | 149,600 | 137,900 | 161,500 | 175,700 | 170,100 |

(c) National Average Yields (Kg/ha)

| Year | 1972 | 1973 | 1974 | 1975 | Estimate 1976 |
|---|---|---|---|---|---|
| Barley | 1,380 | 1,380 | 1,629 | 1,180 | 1,600 |
| Wheat | 1,426 | 1,285 | 1,537 | 1,499 | 1,421 |

(d) National Beer Sales (hectoliters x 100)

| Year | 1972 | 1973 | 1974 | 1975 | Estimate 1976 |
|---|---|---|---|---|---|
| All brands | 11,131 | 13,834 | 15,693 | 15,276 | 16,909 |

Annual mean maximum temperatures are about 24°C with highest recorded temperatures being about 27°C. At the highest altitudes (2,700-3,000m) the mean minimum temperatures are about 6°C and maximum 20°C. However frosts are occasionally recorded at these altitudes especially between August and October.

Most areas of Kenya experience two rainy seasons - the "long rain" from about mid March to late May and the "short rains" from late October until mid December. However although these are averages there is considerable variation from year to year and at the higher elevations the rainy periods are longer and may almost run into each other. At the lower elevations (2,100 - 2,400m) the crop is grown entirely during the long rains with planting in late February to mid May and harvest in the dry period between the two rainy seasons. Annual rainfall in these areas will be between 400 and 800 mm. At the higher altitudes, (2,500 - 3,000m) where most of the barley is grown this dry period is often absent so that planting is delayed until June-August and harvest occurs in the dry period between the short and long rains i.e. January-March. The annual rainfall in these areas is up to 1200 mm.

About 3,750 ha is grown on the slopes of Mt. Kenya. The mountain causes local variation in the rainfall pattern. On the S.W. side the short rains are more reliable than the long rains and so planting takes place in September with harvest in February/March. On the N.W. slopes the main crop is taken on the long rains and a second crop is frequently possible (though not on the same fields) on the short rains. KBL does not however provide finance for these particular short rain crops.

All the barley in Kenya (Fig. 1) is grown under rainfed conditions. There are no irrigated crops.

## Farming System for Cereal Growing

Many of the large scale farms in the area previously known as the "White Highlands" have been divided and less wheat and barley is grown in these areas than hitherto. That which is grown is usually in a rotation such as three or four years' grass followed by four or five years' arable cropping including barley wheat and maize. Although barley (except for seed) is not often grown in a rotation with maize since malting barley is more reliably obtained at altitudes of 2,300 m or above which are rather too cool for maize.

Much of the wheat and barley is now grown along the Mau Escarpment which was land previously occupied by the Masai and used for grazing cattle. In the last six years large areas have been leased from the Masai by others - frequently not experienced in farming who have used agricultural contractors to carry out all the operations on the crops.

These leasee farmers frequently do not visit the land they have leased and the standards of cultivation and crop hygiene are frequently low. Most of the crops are grown on advances provided by the Wheat Board of Kenya Breweries and since finance is not readily available for other crops continuous wheat or barley growing or alternations between wheat and barley are the rule, rather than the exception. A small amount of oil seed rape is now being included in some areas.

Land adjudication is progressing in this area and more land is now coming into individual or co-operative ownership and is being farmed by the Masai themselves, when hopefully proper rotations can be introduced.

## Use of Barley

Virtually the whole of the barley crop is grown under contract to Kenya Breweries Ltd. as malting barley. The whole crop is bought by KBL and a higher price (shs. 1.45/Kg) is paid for malting barley (i.e. that over 2.4 mm with 95% or more germination and 1.85% nitrogen (dry weight) or below.) Non malting barley fetches shs. 1.05 per Kg. In an average year about 70% of the crop is suitable for malting and 30% is unsuitable. About two thirds of the non-malting barley is used to make barley syrup and the remainder is sold as feed barley.

## Financing and Organisation of Inputs (Fig. 2-3)

In order for the farmer to be sure of a market and a price for his crop he should make a contract with KBL. Any land offered is inspected by a member of the KBL field service and if approved a contract is signed for a specified acreage (usually a minimum of 20 ha). If necessary (and this is usually the case) an agreement can be made to advance money for cultivations and inputs. KBL arranges the opening of a special barley account with a commercial bank and underwrites the bank against any loss. The account is operated by KBL and a limit is set on each account (shs. 1600/ha.) When a farmer requires cultivations or inputs these are arranged in consultation with the KBL field officer for his area. When the work is complete or the inputs have been received,

the farmer signs the invoice confirming that the work has been completed or the inputs received and it is then countersigned by the field officer to certify that the acreage agrees with that on the contract. Spraying and harvesting are usually carried out by contractors and payment is arranged in the same way.

KBL does not buy seed, fertilizer or herbicides in bulk but makes arrangements with suppliers to have available the necessary quantities and which are then purchased individually for each farmer. The field staff not only control the financing of the crop but are available for advice to farmers and keep KBL informed of the state of the crop and estimate the yield each season. Each farmer receives a visit from his field officer once a month. Each field officer covers about 4,000 ha.

When the crop is harvested it is delivered either direct to the Maltings in Nairobi or to one of the two upcountry stores. KBL field staff organize the transport and distribution of the crop to the appropriate store so that a steady supply of barley is available to the Maltings. The farmer pays for the 25 miles of transport from his farm and KBL pay for the rest.

On receipt at any of the intake points the crop is weighed and tested for germination, moisture, screening and % nitrogen and graded as malting or non-malting. If the moisture is above 14.0% it is dried and the farmer charged for doing it. The information on the quality of the crop is sent to the Barley Accountant who calculates the price to be paid for the crop. Any advances plus interest are deducted and the balance is paid to the farmer. (Little, 1976).

The finance and organisation of barley growing is thus controlled by the private sector of the Kenya economy. Wheat in contrast is controlled and financed by the Government through the Ministry of Agriculture and parastatal bodies such as the Wheat Board and the Agricultural Finance Corporation.

The success of the barley growing operation in Kenya is based on the successful operation of Kenya Breweries itself which is able to provide finance and agricultural staff through the sale of beer to an ever increasingly thirsty public, living in a climate conducive to beer drinking. It is also based on the exploitation of improved barley varieties and practices which provide profits and income to both the farmer and the Government and save much valuable foreign exchange through not having to import malt or malting barley. Indeed through crop improvement efforts it should be possible to increase barley production to a level where the export of malt will be possible thus earning foreign exchange.

Fig. 2 Organisation of Barley Production in Kenya

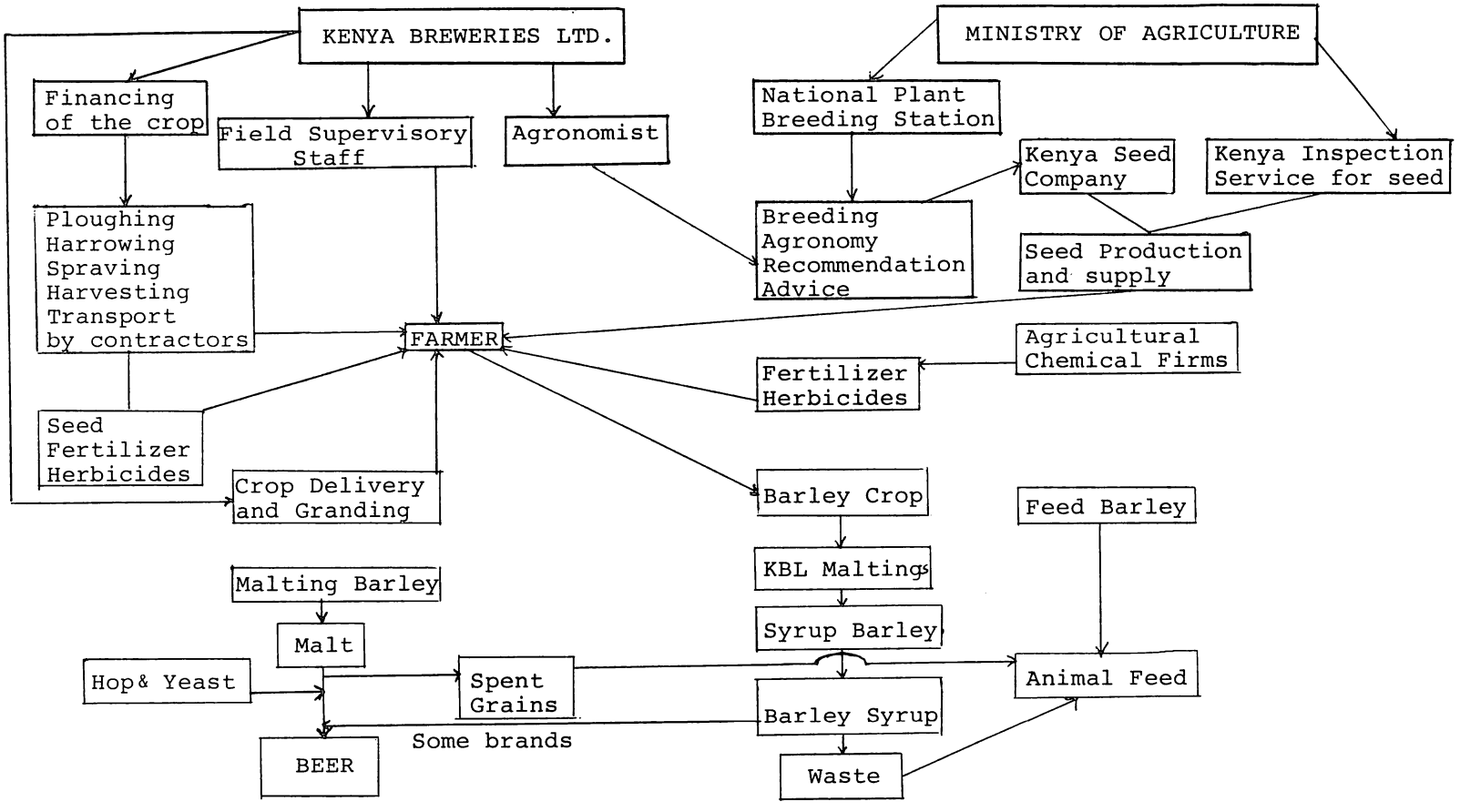
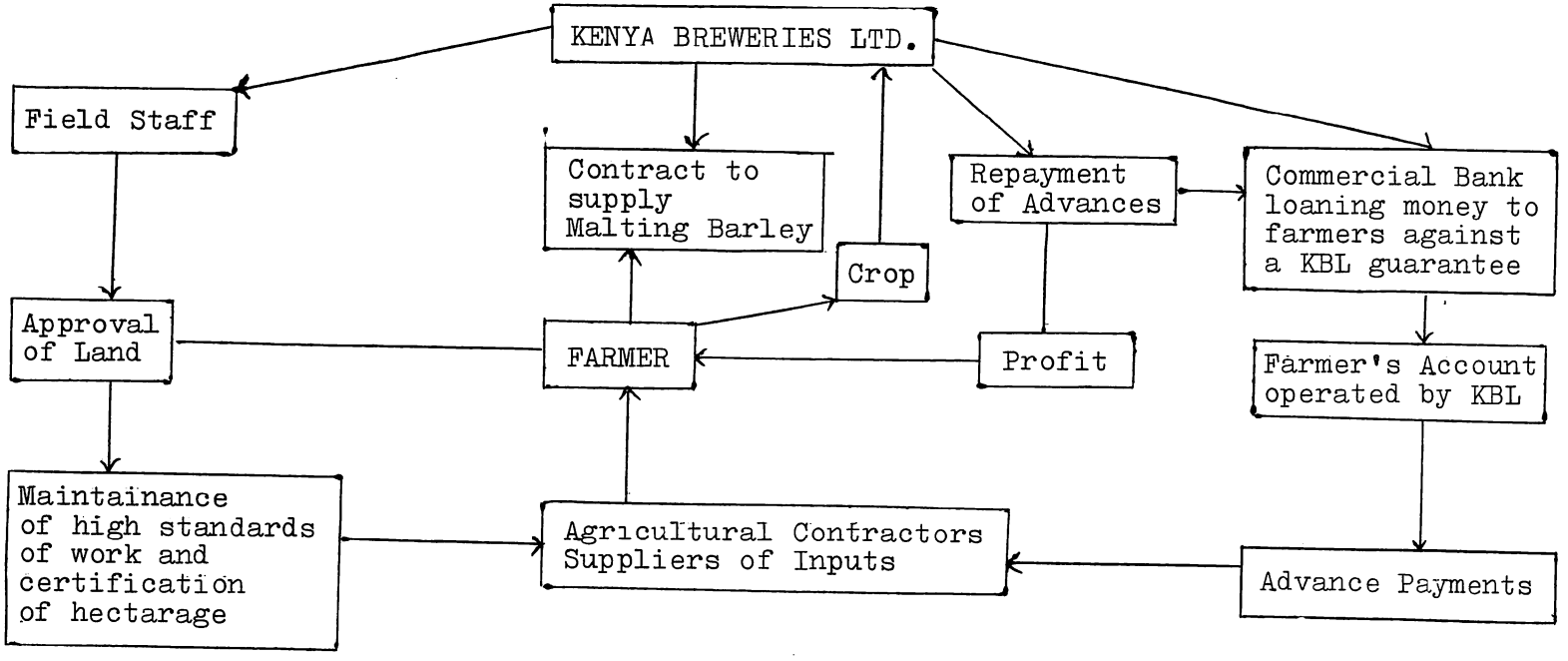


Fig.3 Financing of Barley Growing in Kenya



One possible export market would be Tanzania, but Tanzania Breweries are also interested in growing their own barley and have bought their own 850 ha farm in the southern Highlands near Iringa. The senior author visited Tanzania for three weeks in May 1976 to assess the possibilities of barley growing in Tanzania. The potential is very large and there is plenty of suitable land to reach the Breweries foreseeable demands. However at present there is not sufficient infrastructure in the way of finance, machinery, fertilizer, herbicides and good quality seed for more than about 1,200 ha.

## Limitations to Increasing Barley Production

The cost of production is about 1.25 mt/ha and with average yields at about 1.40 mt/ha there is not a great deal of money on average to be made from barley growing. However some farmers are averaging about 3 mt/ha which is very profitable but equally others are making substantial losses (borne initially at least by KBL). The cost of inputs continues to rise and only by an increase in output/ha can barley growing be made more profitable for the farmer and more economic for KBL. To this end KBL recently appointed an agronomist who jointly with the Ministry of Agriculture runs a research programme (see below) aimed at increasing barley yields.

Barley and wheat are grown in very similar areas and therefore with increasing hectarages of both, they would be competing for the available land. At present there is adequate land available for both but with poor farming practices in some areas some land is becoming unsuitable for production due to infestation with weeds, especially wild oats, and low fertility. At some future date the Government may have to legislate or introduce measures to control wheat and barley hectarages to the proportions they feel are appropriate. This would almost certainly mean a decrease in the barley acreage and so crop improvement efforts aimed at increased yield per hectare are particularly important in barley to maintain the production required by the breweries.

## Crop Improvement Efforts

The National Plant Breeding Station (NPBS) Njoro was set up in 1972 and for 50 years has been breeding and carrying out research on small grain cereal crops, principally wheat. However there has always been some work on barley and to a lesser extent oats and since 1973 the station has also been responsible for work on oil seedcrops.

Up to 1972 the main barley work was the screening of exotic varieties for possible commercial exploiation. This led to the release of Proctor (U.K.) and a selection from Research (Australia) in 1960. From 1966 onwards a wider range of exotic material was tested. This was made possible by a grant from the Rockefeller Foundation and co-operation with F.A.O., USDA and CIMMYT in the exchange of nurseries. This has resulted in the limited release for the 1977/78 season of Amani (Egypt 5 ex Ethiopia). Further promising material is in advanced stages of testing (see below).

In 1972 a local breeding programme was initiated by the Canadian team working at Njoro. Crosses were made principally between Proctor and Research on the one hand and exotic varieties on the other to introduce disease resistance and increase yield while retaining the malting quality of Research and Proctor.

Pedigree selection has been applied to this material for disease resistance and large grain size and $F_5$ bulks were in yield trials in 1976 by 40 - 50%. The most promising crosses are:-

| | |
|---|---|
| KB6 | Research x Briggs |
| KB7 | Research x C63 (B106) |
| KB9 | Research x CN100 DC 23/Fun x $Fun^2$ - Tra II - 11361 - It - 2t B225 |
| KB13 | C63 (B106) x B225 |

Further crosses have been made since 1972 and some of this material will be entering yield trials in 1977/8.

In August 1975 KBL appointed an agronomist to work in cooperation with the staff of NPBS on a joint barley improvement programme. In exchange for facilities at NPBS KBL have bought plot drills and a combine which are on loan to the station, and has provided some recurrent expediture. Negotiations are still underway to finalize an agreement. KBL have also purchased a 350 ha farm at Mau Narok (2800m) to be used largely for experimental purposes. In 1976/7 it was possible to expand the programme and a barley variety trial of 16 entries (including two Triticale varieties) and a fertilizer trial were grown at 11 locations. In addition preliminary trials at three sites, and seed rate, herbicide, fungicide and cultivation trials were successfully completed (see below) and further crosses made.

The wheat and barley improvement projects are therefore closely linked but to some extent independent. The senior research staff engaged in either full or part-time on barley improvement are:-

| | |
|---|---|
| Agronomist KBL | Full time on all aspects. |
| Plant Breeder NPBS | Full time breeder. |
| Assist Plant Breeder NPBS | Part time on introductions and trials. |
| Agronomist NPBS<br>2 Asst. Agron. NPBS | Part time on barley. |
| Pathologist NPBS | Part time on barley. |
| Chemist NPBS | Away on training at present. |
| Chemist KBL | Part time on micromalting tests on new germplasm. |

Dr. G. Kingma (CIMMYT) is based at Njoro and his nursery programme provides invaluable barley germplasm.

## Fertilixer Application

Most soils in Kenya are very deficient in phosphate and both wheat and barley respond economically to added phosphate up to about 75 Kg/js $P_2O_5$. Responses to nitrogen are usually small but in wheat trials there has been an increasing response with continued arable cropping up to about 25 Kg/ha N after four years of cropping. In 10 barley fertilizer trials in 1976 there was very little response to added nitrogen. The present recommendations for barley are between 50 and 75 Kg/ha $P_2O_5$ as triple superphosphate for most areas and about 125 Kg/ha of compound fertilizer (N:P:K) 11.55.0 for areas or fields where a nitrogen response can be expected.

## Weed Problems

Broad leaved weeds are generally not a problem and are adequately controlled with the use of MCPA or CMPP. However grass weeds are becoming increasingly more important and wild oats (*Avena fatua* and *A. sterilis*) are already a very serious problem in many areas. Farmers are being educated to use clean seed, hand rogue light infestations, inspect and clean machinery and carry out timely cultivations. Trials with herbicides have shown that Barnon, WL43425 (Super Barnon) and Avenge are particularly promising for wild oat control in barley under Kenya conditions (Mulamula *et al* 1976b).

*Bromus adoensis* *B. diandrus*, *Setaria verticillata*, *S. pallidifusca*, *Digitaria scalarum* *Pennisetum clandestinum*, and *Lolium perenne* are or are becoming serious problems in some areas and a wide variety of herbicides are being tested for activity against these species. (Mulamula *et al* 1976b).

## Cultivations

Possibly the most important factor limiting barley production in Kenya is correct and timely cultivations. As already mentioned very few farmers have their own machinery and rely on agricultural contractors. This means that cultivations are frequently carried out late and in a hurried and poor way. Trials have been carried out at Njoro and Mau Narok comparing different implements and times of initial cultivations following the previous harvest.

Results at Njoro in 1976 (a very dry season) on barley showed a 39% increase in yield by initiating cultivations five (or seven) months before sowing compared with two months before sowing a grass ley. The implement used had little influence on yield. Similar results had been obtained previously on wheat (Mulamula et al 1976a). The important point is that cultivations should be timed to allow maximum moisture conservation by opening up the soil and allowing rain penetration and controlling weed growth to keep loss of moisture through evapo-transprition to a minimum.

## Diseases

The major disease of barley in Kenya is scald (Rhynchosporium secalis) to which both the current commercially grown varieties (see below) are susceptible. It is most severe in the higher, wetter areas but at least 90% of the crop is infected in most years and infection levels frequently reach 75% or more on well over half the acreage. The yield loss from an infection level of about 80% was 35% in a trial carried out by the NPBS at Mau Narok in 1975 (NPBS Annual Report for 1975) where plots sprayed with dithane were compared with untreated plots.

Spot blotch (Helminthosporium sativum) can be locally severe and has been responsible for crop failures in the past. Neither of the commercially grown varieties has much resistance although Research appears to be slightly more resistant than Proctor.

Yellow rust (Puccinia striiformis) is always a potential threat to barley production and can be devastating on introduced material having little or no resistance. However both Proctor and Research have a very high level of resistance at present. Stem rust P. graminis is generally of little importance in barley (but of major importance in wheat) and brown rust (P. hordei) is similarly rarely of importance, both being favoured by warm conditions not frequently prevalent above 2,500 m where most of the barley crop is grown.

Loose smut (Ustilago nuda) is usually of little importance since the humidity at flowering time is usually too low for infection. However it can occasionally be troublesome and appears to be on the increase, so a close watch is being kept on it.

Control measures are principally by crop hygiene and resistant varieties. The breeding programme is aimed at providing resistance to scald and yellow rust and to other diseases where this is possible. Trials have been carried out for the control of scald using systemic or partially systemic fungicides and thiophanate-methyl (cerconbin), triadimefon (bayleton), tridemorph (calixin) and carbendazim (bavistin) have all shown some activity, the last two being better in combination. Trials are also planned for control of yellow rust using systemic fungicides.

## Pests

In most seasons insect pests are of little importance. However in dry seasons aphids can become a problem but are well controlled using malathion. The seed is routinely dressed with dieldrin which gives adequate control over the soil borne pests e. g. barley bulb fly, leather jackets and wireworms.

## Varieties Grown

The entire hectarage (30,000) is grown to two imported varieties; Proctor from the United Kingdom in 1976/7 occupying 10,000 ha (33%). In 1975/76 Research occupied only 5% of the acreage and although not generally favoured by farmers because of its weak straw its acreage was increased in 1976/7 in order to spread the risk should Proctor for some reason perform poorly. Both Proctor and Research have proved very successful malting barley varieties in their respective countries of origin.

## New Varieties

Proctor and Research have served both the farmer and maltster well for more than 15 years but are relatively low yielding and have poor resistance to scald. One line received in the FAO Barley Screening Nursery in 1971 as Egypt 5 originating from Ethiopia and coded N206 at Njoro has outyielded Proctor by 3% in 24 trials at 11 locations in

in the last four years. Its malting quality still has to be fully assessed but it is likely to be provisionally released and grown on about 160 ha in 1977/8 under the name "Amani" which is Swahili word for peace. Fifty hectares will be grown as seed under contract to the Kenya Seed Co. so that approx. 1600 ha could grown in 1978/9 if it continues to perform satisfactorily and is accepted by KBL as a malting variety. It has much improved resistance to scald compared with Proctor.

Another introduced line looks very promising is B220 originating from France and received as Mammie. It has outyielded Proctor by 21% in 24 trials at 11 sites over four years and appears to have good malting quality. It is at present under multiplication by the NPBS, Njoro and the Kenya Seed Co.

Lines from the local breeding programme could reach farmers about 1980 and on present showing those from crops KB7 (Research x C63) look the most likely to succeed as the first locally bred varieties.

Summary

Barley is grown in Kenya at altitudes of between 2,100 and 3000m within $2^{o}$ latitude either side of the equator. Annual rainfall varies between 400 and 1200 mm per annum. Planting date varies with altitude starting in March at 2100 m and finishing in August at 2,700 m and above. Virtually the entire crop (30,000 ha in 1976/7) is contracted by Kenya Breweries Ltd. (KBL) who also finance farmers and provide an advisory service through their field staff.

The Ministry of Agriculture through the National Breeding Station, Njoro has been involved in small grain cereal research for 50 years. In 1975 a joint research programme for barley was established with KBL. The NPBS programme has resulted in the release of the improved varieties Proctor (ex-U.K.) and Research (ex Australia) which occupy the whole of the barley acreage. Material is now coming forward both introduced and locally bred which is outyielding these varieties by over 30%.

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# BARLEY SITUATION IN ALGERIA

By

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## I. Introduction

About a million hectares are under the system of cereal-fallow rotation in Algeria. This is divided into three major zones which can be defined as follows:

- The coastal plains characterized in general by a good distribution and high amount of rainfall, exceeding 600mm.
- The foot hills and adjacent plains with a rainfall distribution from 400 to 600 mm.
- The high plateau (average elevation of 1000 meters above sea level) where the winter is severe and the rainfall total and distribution is highly variable. The transition into the steppe occurs in the south at about 300mm of rainfall.

## II. Present Situation

Barley is grown mainly in the adjacent foothill and high plateau regions. It occupies the second place in grain production after wheat. On an average about 30% of the cereal area is sown to barley. The production ranges between 500,000 m.tons and 700,000 m.tons. This high variation in production is mainly due to the distribution of rainfall. The area and production of barley in Algeria are presented in Table 1.

Barley production has been declining in recent years and more so since 1973. This has been due to the increased attention given to the high yielding varieties of breadwheat during the past few years, and the increasing demand for bread and breadwheat products.

In the high plateau (the main barley growing region) the varieties Alger 48, Giza 120, Numar and Ager are superior in yield to the local variety Saida 183 (Table 4.)

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The variety Alger 48 was significantly superior to the local variety Saida 183. The potential superiority of Giza 120, Numar and Alger is statistically significant. During 1976 season the winter in Setif was very severe and the variety Alger significantly out-performed all the other varieties.

Barley is grown in the South and South-West cereal areas of Algeria. In the foot hill area and high plateau regions barley is grown more by the small traditional farmers. It is the most important source of animal feed in Algeria in the form of both grain and forage. Barley provides the traditional farmers with an assured income in the dryland areas.

Increasing the animal production is one of the main objectives in the third phase of the Algeria official policy for agricultural development. Consequently, barley is likely to receive more attention in the coming years.

III. Yield and Adaptation

The increase of yield per unit area depends on the crop management and the availability of quality seed and varieties of high yield potential and adaptation.

Saida 183 and Tichedrett (respectively two and six row) are the only two varieties under cultivation. Both of them are selections from natural populations, are multipurpose and more adapted to dry conditions. This adaptation makes them more productive and competitive in dry years with durum and bread wheats.

In general barley has a higher yielding capacity under severe agro-climatic conditions than wheat, but this advantage disappears under good rainfall conditions. Table 2 presents the yield trial results from three different regions. Saida and Setif are located on the high plateau with lower rainfall and severe winters. Alger is a coastal situation with high rainfall, mild winter and is close to sea level.

Lines from many parts of the world were tested in small yield trials, in three different locations: Alger, Saida and Setif in 1975 season and the results of these trials are presented in Table 3 and 4.

A yield trial composed of 19 varieties was grown of the better varieties at Alger. In the coastal plains the French varieties Robur, Ager, Astrix and the Australian line Strain 205 were superior in yield to the local check. Robur was significantly superior in yield to all others.

## IV. Conclusion

Barley in Algeria will continue to be grown as a feed and forage crop. Increasing animal production is one of the main aims of the Algerian Government at present. At the same time Algeria must solve the strategic problem of the cereal grain production. The prime cereal land will continue to be utilised for wheat production, and barley will be grown under harsh dry conditions.

The program is oriented to improve the cultural practices in these low rainfall areas through the introduction of Medicago in the rotation system. This process aims at improving the soil structure, its water holding capacity, reducing the tillage, and to increasing the forage production through medics and barley as the cereal crop in the rotation for both forage and feed grain.

Also the program is aimed at screening introductions of barley to identify varieties of high stable yield for both forages and grain.

Table 1. Average Area, Production and Yield of Barley During the Past Years in Algeria.

| Year | Area 1000 ha. | Production 1000 m.tons | Yield Kg/Ha. | Remarks |
|---|---|---|---|---|
| 1912-1972 | 1,110 | 670 | 603 | |
| 1973 | 590 | 250 | 424 | Very dry season |
| 1974 | 550 | 280 | 509 | Dry winter |
| 1975 | 570 | 456 | 800 | |

Table 2. Comparative Yields of Barley (Saida 183) Breadwheat (Siete Cerros) and Durum (Cocorit 71) During the 1975 Season at Saida, Setif and Alger Experimental Stations

| Station | Altitude m | Rainfall mm | Varieties | Yield kg/ha | C.V. |
|---|---|---|---|---|---|
| Saida | 1025 | 426 | Saida 183 | 535 | 8.5 |
| | | | Siete Cerros | 476 | |
| | | | Cocorit 71 | 362 | |
| Setif | 1081 | 457 | Saida 183 | 341 | 3.6 |
| | | | Siete Cerros | 335 | |
| | | | Cocorit 71 | 249 | |
| Alger | 40 | 657 | Siete Cerros | 800 | 9.0 |
| | | | Cocorit 71 | 650 | |
| | | | Saida 183 | | |

Table 3. Outstanding 6-Row Barley Varieties - 1975 Season - Alger Region

| Varieties | Yields Kg/ha | Height cm | Leaf | Helmin-thosporium | Powdery Mildew |
|---|---|---|---|---|---|
| Robur | 692 | 110 | MR | 2 | 6 |
| Strain 205 | 612 | 120 | S | 8 | 7 |
| Ager | 610 | 125 | MS | 2 | 8 |
| Astrix | 610 | 106 | MR | 2 | 8 |
| Saida | 524 | 135 | MR | 7 | 7 |

LSD at 5% 7.15.

Table 4. Yield in Quintal/ha. of the Outstanding Barley Varieties under Dryland Conditions. Results of the Second Year Yield Trials at Setif and Saida Location, 1975.

| Varieties | Yield in Kg/Ha. | | |
|---|---|---|---|
| | Saida 1975 | Setif 1975 | Setif 1976 |
| Alger 48 | 626 | 426 | 349 |
| Giza 120 | 597 | 400 | 372 |
| Numar | 590 | 414 | 295 |
| Ager | 628 | 381 | 475 |
| Saida 183 | 522 | 360 | 265 |

LSD 5% - Saida 1975: 705
Setif 1975: 692
Setif 1976: 814

# BARLEY IMPROVEMENT IN THE ARAB REPUBLIC OF EGYPT

By

A. A. Mansour*

## Introduction

Barley is considered to be one of the oldest cultivated plants in the Nile Valley, and has been found in Ancient Egyptian remains. It is generally believed that our remote ancestors depended on barley as a food crop more than present day inhabitants. Nowadays, most of the barley production is utilized as a feed for livestock, and is used for human consumption only in the far desert districts. The 2-rowed varieties as well as 6-rowed ones are also used in brewing.

The main barley crop in Egypt is grown under controlled irrigation and covered 43,585 hectares in 1976. It is mainly confined to less fertile and newly reclaimed areas. In addition, barley is produced in about 60-80 hectares along the northern coastal region under a variable and unreliable rainfall, ranging from 80 - 200 mm.

The average grain yield under irrigated conditions was 2.968 tons/ha in 1976. There are no accurate yield data for barley grown under rainfed situations in the coastal areas. However, it is believed that the yield ranges from 0.6 - 0.8 tons/ha if a minimum rainfall of 150 mm is distributed throughout the growing season. About 20 thousand tons, mainly of 2-rowed barley are consumed by the malting industry.

## Barley Breeding and Improvement

From 1921 onwards limited breeding work has been undertaken. It has depended mainly on collections and individual plant selection from local cultivars such as Baladi, Herraoui, Nabawi, and Mariout which were found to be extremely impure. Through

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1921-29 certain barley varieties (about 190 ) were introduced from foreign countries, (i.e. England, Denmark, France, Russia, Abyssinia and other neighbouring countries). During 1935 as a result of intensified work on this material, some varieties such as Baladi 16, Baladi 41 and Baladi 45 were selected from local material. They were not very productive and were susceptible to lodging and fungal diseases, particularly net blotch and rusts. Starting in 1948, the new varieties Giza 68 and Giza 73 were recommended for commercial cultivation besides the variety Baladi 16 because of their better yield potential. Also, attention was directed towards the introduction and testing of the 2-rowed varieties for malting purposes. The varieties Lenta and Balder which proved to be the best, were distributed in 1949.

In 1952, the Barley World Collection (BWC) of 6340 varieties was screened and proved to be of great value to the breeding programme. The main problem in the breeding other than the high yield, was to create varieties resistant to the fungal disease net blotch caused by Helminthosporium teres Sacc. This disease is prevalent in the barley crop grown in the northern part of the Nile Delta where about 60% of the barley area is sown. The estimated annual losses amounted to about 10-15% of the crop and caused a deleterious effect on grain quality.

This BWC together with other old varieties and later entries were tested for several years in the northern Delta regions under epidemic conditions of natural infection. In collaboration with the Plant Pathologists, some sources of resistance were identified with better tolerance than the local varieties. Crossing was subsequently initiated to develop resistant varieties with a high-yielding capacity. As a result, Giza 117 (Baladi 16 x Palestine 10) with moderate resistance to net blotch was released for lower and Middle Egypt in 1959. This variety outyielded both varieties Giza 68 and Giza 73 by 11%. Furthermore, the 6-rowed variety Beecher (Giza 118) which was selected from the BWC and proved a better yielder than Baladi 16 in Upper Egypt was distributed for commercial cultivation starting in 1964. The introduced 2-rowed variety Bonus was also released for malting purposes during 1956 replacing both Lenta and Balder.

Early maturity is one of the important objectives for areas in the coastal regions, where the season is restricted by low rainfall. The early maturing variety Atsel (selected from BWC) was

crossed with Baladi 16. As a result, an early strain, (named Sharawi), which heads one-month earlier than any other varieties grown, proved to be the best adapted variety for drought conditions in this area and was released in 1956.

From 1965 Onwards

Barley production in Egypt must be increased to meet the increasing demand for grain consumption since it is difficult to increase the total area under irrigation (currently about 40 thousand ha). Consequently, it is important to raise production per unit area by the development of better varieties and improved cultural practices.

The continuing exchange of genetic material with international agencies has helped the breeding work to expand and develop new promising varieties.

The following objectives are considered in the Egyptian barley breeding efforts:

- High yielding ability
- Resistance to fungal diseases (i.e. net blotch, leaf rust and powdery mildew)
- Drought resistance
- High protein content
- Short stiffer straw with good response to high N fertilizer rates and resistant to lodging.

More recently Giza 119 (Baladi 16 x Gem) was released to farmers in 1973. The productivity is 32% and 43% higher than that of Giza 117 and Giza 118 respectively. A sister line from the above cross named Giza 121 is now in the first step of seed multiplication and has proved more resistant to net blotch than Giza 119. It will be released in the near future in Lower Egypt where this disease is prevalent. Giza 121, Strain 205 and Line 257/14 are promising strains in Egypt and are considered to have wide adaptation with superior yielding ability, disease resistance and good agronomic characteristics. These strains were tested in 1973/74 at 17 locations throughout the Middle East in the 4th Regional Barley Yield Trial and outyielded the average of the other varieties.

An extensive crossing programme has resulted in the development of new promising lines now in advanced generation.

A summary of the varieties released over the last 40 years is given in Table 1.

The development and release of new barley varieties has contributed towards the increases in the national average yield shown in Table 2.

## Cultural Practices

Many experiments have been conducted to define the optimum cultural measurements of newly released varieties.

The results obtained for the variety Giza 119 indicated that the recommended seeding rate is 100-125 kg/ha depending upon the soil type. The best date of sowing is November all over the country, except in lower Egypt (Delta) where the sowing date is earlier because rainfall at that time may delay the growing season.

As for nitrogen fertilizer rates, 75 kg N/ha is the recommended rate for the variety Giza 119.

## Seed Multiplication and Distribution Programme

The utilization of high yielding varieties of good quality is regarded as a major factor in increasing land productivity. The Ministry of Agriculture adopted an efficient plan for distributing certified seed to all growers. By this plan Breeders' seed, Foundation seed and Registered seed are controlled by the Breeding Section which produces it at the Experimental Station and Government Farms. Certified seed is produced by seed growers on contract under the supervision of the Seed Department. All the seed is properly cleaned, treated with chemicals, certified, sealed in sacks and labelled before distribution.

The objective of this policy is to provide a continuous supply of quality seed of good varieties to renew barley seed once every two years. For this purpose the following areas are planted each year.

| Type of Seed | Area in Ha. |
|---|---|
| 1) Basic Seed (Breeder, Foundation and Registered Seed) | 240 |
| 2) Certified Seed | 2400 |

Further Work in Breeding

Nutritional Value: Breeding for high nutritional values is assuming a great importance and our adapted varieties and other promising lines of barley and spring wheat are now being incorporated in the FAO/SIDA project. The objective in 1975 has been to increase the lysine and protein content. This may solve the problem of under nutrition, especially protein-calorie malnutrition in rural areas.

Salinity: The problem of salt-affected soils also assumes special importance in Egypt both for the Nile alluvial soils and for the newly reclaimed land. The introduction of perennial irrigation without sufficient drainage is responsible for this problem. At present, it is estimated that about one third (800,000 ha) of the total area is salt-affected to different degrees.

A project is being carried out with the objective of identifying those genotypes that may be of value for production under salt-affected conditions. In addition, research on the development of optimum agro-techniques, with special emphasis on water management is being carried out.

Table 1. Pedigree of adapted varieties and year of release.

| Variety | Spike Row No. | Pedigree | Year of Release |
|---|---|---|---|
| Baladi 16 | 6 | Local variety | 1935 |
| Giza 68 and 73 | 6 | Local variety | 1948 |
| Lenta and Balder | 2 | Introduced | 1949 |
| Sahrawi | 6 | (Baladi 16 x Atsel) | 1956 |
| Bonus | 2 | Introduced | 1956 |
| Giza 117 | 6 | (Baladi 16 x Palestine 10) | 1959 |
| Giza 118 | 6 | Introduced = Beecher | 1964 |
| Giza 119 | 6 | (Baladi x Gem) | 1973 |

Table 2. Average Barley Yield in Egypt & Yield Indices 1930 - 1976

| Year | Yield in tons/ha | Index 1930 - 34 = 100 |
|---|---|---|
| 1930 - 34 | 1.790 | 100.0 |
| 1935 - 39 | 2.187 | 122.2 |
| 1940 - 44 | 2.010 | 112.3 |
| 1945 - 49 | 1.875 | 104.8 |
| 1950 - 54 | 2.160 | 120.7 |
| 1955 - 59 | 2.450 | 136.9 |
| 1960 - 64 | 2.773 | 154.9 |
| 1965 - 69 | 2.530 | 141.3 |
| 1970 | 2.525 | 141.1 |
| 1971 | 2.700 | 150.8 |
| 1972 | 2.923 | 163.3 |
| 1973 | 2.850 | 159.2 |
| 1974 | 2.878 | 160.8 |
| 1975 | 2.968 | 165.8 |
| 1976 | 2.968 | 165.8 |

# BARLEY PRODUCTION AND RESEARCH IN ETHIOPIA

By

Hailu Gebre and F.F. Pinto*

## 1. Introduction

The total cultivated land in Ethiopia is about 9.5 million hectares, (about 8.1% of the total area) and is given to the production of cereals, pulses, oilseeds, cotton, sugarcane, coffee and other stimulants, ensete, fruit and vegetables.

Crop production estimates for the major cereal, oil and pulse crops in the agriculturally important areas, obtained by the Ministry of Agriculture and Forestry Development for 1975/76 (1) are presented in Table 1.1.

Cereals occupy over 80% of the area. They are mainly grown by subsistence farmers (average holdings 1.5 ha arable land) under rainfed conditions using traditional methods virtually unaffected by any modernization efforts and hence yields are generally low. Of the total cereal production, it is estimated that about 86% is consumed in the rural areas and 14% (600,000 tons) in the urban areas. Imports of cereals in recent years have been almost exclusively wheat and wheat flour and most of it, roughly 70,000 tons annually, has come in as relief grains.

Barley is an important cereal, occupying about 600,000 ha. (10.7% of the major crop area) and gives a mean yield of 0.93 tons/ha. Its distribution in Ethiopia is indicated in Figure 1. The crop is grown in all Provinces and the percentage distribution, based on the Central Statistical Office estimate (1975) (2), which excludes Eritrea, is shown in Table 1.2.

The most important regions for barley production, are the highlands of Shoa, Arussi, Bale and Begemdir and Semien, which together account for about 75% of the area.

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The great diversity of soil and climatic conditions and the rugged topography lead to a wide variation in sowing periods. The modal growing period in the Central Highlands corresponds with the main rains in summer and extends from mid-June to mid-July sowing to harvesting from November to December. In areas, receiving a bi-modal rainfall, sowings are in mid-March to mid-April with harvesting in August to September. These areas also crop on winter rains from October to February-March. A small winter crop is also often grown (belg crop) in the Central Highlands with supplementary irrigation. The greater part of the barley crop, however, is produced under rainfed conditions.

## 2. Climatic Conditions and Factors Influencing Barley Production

As a generalization, barley is grown at altitudes from 1800 m to 3000 m, where temperate climatic conditions prevail and at least 500 mm of rainfall is received during the crop life, which can range from $3\frac{1}{2}$ to 6 months.

Of the barley growing areas, two broad classes for duration of the rains may be considered. The major class, in the principal producing regions receive over 1000 mm of annual rainfall and the duration of growth is from four to six months. This class may be represented by the Holetta area, for which climatic data (1969 - 75) are presented in Figure 2 (3). It will be noted that the main rains come from mid-June to end-September, with up to 750 mm rainfall during this period. The months of July and August receive high rainfall, during which time a heavy cloud cover prevails and bright sunshine is low, of the order of 2.8 hr/day. Humidity during this period is high, reaching 84% in August. Such conditions result in a prolonged vegetative cycle with a high incidence of foliar diseases. Monthly mean air temperature is low, 12.9°C during crop life, the maximum dropping to 4°C in October and - 0.4°C in November and December. Flowering is in September, with increasing radiation and the grain-filling period is short and limited by the amount of available soil moisture, the severity of the night frosts and in some cases the rapid dessication caused by strong easterly dry winds.

The second class representing about 10% of the total barley area, receives from 500 to 750 mm of annual rainfall, with most of it falling rather erratically from July to early September. This condition is commonly found in the Provinces of Tigre,

Eritrea and Wollo where quick-maturing varieties, taking $3\frac{1}{2}$-4 months are needed. For these areas, soil and moisture conservation techniques are important but adequate drainage is also required as heavy showers can cause serious waterlogging. Varieties developed should have good resistance to drought stresses as well as to foliar diseases.

Crop rotations involving barley also vary, depending mainly on soil fertility and alternative crops available (4). In much of the highlands, even under high rainfall conditions, a fallow is employed. On the Bedi plateau for instance, a barley-fallow rotation is common. On the heavier soils in the Shoa highlands, natural pasture is ploughed, the top-soil collection in heaps and burnt ("guie") and one or two crops of barley grown and followed by horsebeans, after which the land is abandoned for many years until a grass cover is obtained. In the lower areas, as in Yerer Kereyu district, barley follows teff, sorghum or field pea/horsebean and is succeeded by sorghum, chickpea or field pea. In Arussi province, barley is grown in an alternate fallow-crop pattern in some areas and is succeeded by wheat in other areas. In Begemdir province, barley is grown on fallow land or may follow finger millet or field pea and is normally succeeded by field pea. On the red soils in Gojam province it is grown on a 5 to 7 year fallowed land, two to three crops being taken consecutively and succeeded by teff. On the dark loose soils the rotation is fallow-barley-teff.

Agronomic factors influencing barley production have been investigated over many seasons and with special emphasis on malting barley. A great variety of indigenous barley is grown in Ethiopia but mostly of the 6-row or intermediate type and none were considered suitable for malting purposes. High priority was therefore given to the production of malting barley for local substitution of malt, of which some 5000 tons was imported in 1974 by Ethiopia's three commercial breweries. The success of this venture is evident from the fact that imports of malt have currently ceased and local production is now geared to meet the entire needs of the breweries and their anticipated future demands.

The production package for malting barley was developed for three improved varieties in three specific locations, strictly for growing above the 2300 m contour in areas offering a high probability for adequate soil moisture over a total growing season of $4\frac{1}{2}$ months. The package stresses:

(1) the use of pure seed of high germination,

(2) seed dressing with Aldrin to control barley fly,

(3) early sowing at onset of the June rains with a seed rate of 75 to 100 kg/ha (depending on variety) to obtain plant stands of 250 to 320 plants per square metre,

(4) adequate fertilization (depending on area and soil type),

(5) good early weed control,

(6) harvesting at dead ripe stage with special care to avoid breakage and damage to grain,

(7) post-harvest cleaning, grading and storage where required.

At present, the variety Beka is grown in one area (Arussi highlands) using 18/30 NP kg/ha fertilizer and giving a yield of over 2.2 tons/ha. The malting quality is very satisfactory.

## 3. Uses of Barley

Barley is used in Ethiopia for human food, beer production, and for preparing local beverages. About 40% of the total grain produced is used for human food in the form of unleavened bread ("injera"), roasted grain ("kollo") roasted ground flour worked with butter, water and spices ("besso"), and/or pearled, coarse ground flour, then boiled in water and worked with butter ("kinche"). About 3% of the total grains is used for malting for the production of lager and pilsner beer by the St. George Brewery. The greatest use for barley is in the preparation of a local beverage ("tella"), where a small amount of the grain is used as a nucleus malt cake and the rest applied as roasted, coarse ground flour as a main source of starch for yeast in the fermentation process. It may be used pure or mixed with other grains, e.g. maize, sorghum, and millet. A kind of local hops ("gesho") is included for its bitter taste and flavour. Barley is not grown as a forage crop and very little undergrade barley is used for animal feed although the malt residues are.

## 4. Limitations to Increasing Barley Production

The principal limitations so far apply more specifically to the production of food barley. Malting barley enjoys a rather privileged position, and should be considered separately.

Poor Soil Fertility: The Central Highlands are characterized by centuries of intensive cultivation, deforestation and heavy erosion due to excessive rainfall. As a result the fertility of the soil has been considerably reduced and on hillside and sloping fields the topsoil and its organic matter content depleted. It is mainly on such soils that barley is grown. Yields are low, averaging under one ton/hectare.

The traditional practice for improving soil fertility is to fallow the land for one or more years, to adopt rotations with leguminous food crops like chickpea, lentil, field pea and horsebeans and to practice soil burning with fallowing. Such practices have maintained soil fertility reasonably satisfactorily but are certainly not adequate to sustain a market oriented production.

Land tenure: In the past, nearly one third of the entire rural population were tenants, who would have to pay between one-fourth and half of the gross yield as rent to the landlord. In most cases, input costs were borne by the tenant, which for fertilizer, represented a cash outlay of 15-20% of his annual cash income, while still paying a fixed fraction of his gross yield as rent. The system was onorous, extractive and devoid of incentive to produce more than bare subsistence needs. Land reform was therefore vital to involve the tenant in the development process.

The long-awaited land reform was proclaimed by the Government on 4 March, 1975. Briefly, it nationalised all land, abolishing private ownership, the tenancy system and hired farm labour. It placed a limit of 10 hectares per farm family and provided for the establishment of peasant associations on areas of 800 hectares or more with about 100-200 farming family members and for the redistribution of land within the peasant association. This reform should provide prima facie incentives for an increased production.

Fertilizer Use: Much work has been done by FVHC/FAO and the Minimum Package Programme on fertilizer use in the accessable parts of Ethiopia. It was recognised that the marketable surplus of grains would have to come from the smallholders, who would need adequate incentives to improve their production practices and raise yields. In the short term, there would be no alternative to fertilizer as the principal means to increasing production, while improved seed, measures to conserve soil and water resources, pesticides and other inputs would come later. A benefit/

cost ratio of 1.5 for fertilizer was adopted and a general recommendation to use 1 q/ha Diammonium Phosphate, (18/30 H/P, kg/ha) was made. Fertilizer prices have increased steadily but the Government has maintained a subsidized price to smallholders at around US$ 25/quintal.

Whereas, before land reform, there was little incentive to use fertilizer, with land reform this incentive exists, as minimum producer prices for grains have also recently been set to provide a benefit/cost ratio on fertilizer of about 1.5. Estimates of fertilizer use in 1975/76 by the Ministry of Agriculture gives commercial and natural fertilizer as commonly applied to 5.9% and 3.2% respectively of the total area under crop. For barley, 11.8% of the area receives commercial fertilizer while 6.0% receives natural fertilizer (1).

Grain Prices (5). In the past, there were strong fluctuations in grain prices between years as well as within years. This was mainly due to the absence of crop forecasts and a government price policy. The grain trade was regulated by private merchants and dealers. Under such conditions government planning was difficult, the extension service could not advise farmers on crops to plant and the farmer tended to increase production of crops that gave good returns in the previous season--thereby contributing to the price swings.

The new governments' declaration on economic policy in February, 1975, enables it to engage in the wholesale and retail business and exercise strict control on the private sector with regard to supply, prices and distribution of goods. The Government intends to establish the Agricultural Marketing Corporation (AMC) to handle the output of the state farms, grain imports and the growing production from areas of the various package programmes administered by EPID. AMC would over five years become responsible for some 45%of the total wholesale trade of grain, oilseed and pulses and be in a position to exercise a major influence on prices. The Ethiopian Grain Board would also be expanded to include regulation of domestic marketing, improvement of market intelligence services and promotion of market infrastructure improvements.

In early 1976 the government set new wholesale minimum producer prices for the main food crops, which were much higher than in previous years. It, however, did not fix any upper

price limits to protect consumers. The minimum prices for the major cereals were: teff 31-35 EB; wheat 27-31 EB, maize 17-21 EB and barley 20-24 EB/quintal*. It is hoped that the new grain marketing policies will assure stable producer and consumer prices and maintain adequate producer incentives for greater production.

Availability of Inputs. Two major inputs, fertilizer and, to a lesser extent, improved seed have so far been made available to farmers in accessable areas. Input supply for the smallholder on credit terms first became available around 1968-69, through the comprehensive package programmes, (CADU in 1967, WADU in 1969 and several others subsequently). This activity was extended in 1970 to farmers on a national scale through the Minimum Package Programme (MPP) and in 1971 a new agency Extension and Project Implementation Department (EPID) was created within the Ministry of Agriculture to administer the implementation of MPP as well as the comprehensive programmes. The thrusts of the governments' attempts at modernizing peasant agriculture was to come through EPID.

In 1971, there were 112 extension areas, each with a marketing centre from which a total of 4,691 inputs, including 9,460 quintals of fertilizer and 222 quintals of seed was sold to farmers on favourable credit terms. In 1976, there were 351 such centres, with 81,427 input sales for 78,688 quintals of fertilizer and 3,175 quintals of seed. By late 1975, it was estimated that EPID was able to make improved farm inputs available to about 825,000 farmers, about 18% of the total farming population. The estimated demand for fertilizer by small farmers in 1976/77 was 37,500 tons (5).

Although rapid progress has been made over the last five years, it must be noted tnat about 50% of the rural areas are inaccessible and glaring imbalances exist in availability of credit and inputs in different areas. Another problem, with food barley, has been the poor adaptation of improved varieties available for extention use. Local cultivars are often location-specific and have tended to out-yield the improved varieties especially in locations where they have not been specifically tested.

* Prices in Addis Ababa - 1 US$ = 2.07 E Birr.

It can be anticipated that within the government framework of the development plan for the agricultural sector, yet to be formulated for the current period, and with the proper organisation of the peasant associations, that the demand for inputs will increase considerably in future.

The demand for food barley on the markets has always been lower than that for teff and wheat. In view of the increasing demand for these grains and the good possibilities for wheat production in the highlands it is clear that the wheat acreages will increase at the expense of the barley acreages in the future. Increasing barley yields therefore assumes great significance.

The situation with malting barley is clearly different, as production is geared to meet the needs of the malt factory. In the past, Melotti Breweries in Asmara had developed limited facilities for manufacturing malt using mostly imported barley. In view of the security situation in the area, this activity has been reduced. In 1975, a malt house was set up by St. George Brewery in Addis Ababa, with an initial capacity of 3000 tons of barley. It depended on the use of local barley, variety Beka, grown in the Chilalo district, Arussi Province, under a contract arrangement with small farmers administered through the Arussi Rural Development Unit (ARDU) (formerly called Chilalo Agricultural Development Unit, CADU). About 2000 small farmers covering about 2000 ha of land have been involved. ARDU supplies the inputs on credit and gives technical advice; it receives the produce at a guaranteed farm-gate price and arranges to transport, clean and grade the barley at its central station at Kulumsa. The breweries truck the barley into Addis Ababa. The price of cleaned, graded barley delivered at the factory works out at about EB31.50/q and the cost of locally produced malt at about EB 50/q. which represents a considerable saving in material costs and of foreign exchange.

Currently, St. George Brewery have increased their malt capacity to 7000 tons and will also supply malt to the Meta Abo Brewery outside Addis Ababa.

To ensure the supply of good quality malting barley, it may now be necessary for the brewery to be more directly involved in the production aspects.

## 5. Crop Improvement Efforts

The research work on barley improvement since 1967 has been coordinated by the Institute of Agricultural Research (IAR) from its Holetta Research Station, Shoa Province. The effort is progressing on two fronts--the local production of malting barley to meet the needs of the breweries and the development of feed types for utilization in home brewing, human food and livestock feed. The improvement work is conducted in a separate unit from that of wheat in the Department of Field Crops and is at present handled by one barley breeder/coordinator and at least two cooperators within the national task force system based at other locations (6).

Local Collections - In Ethiopia, barley is indigenous and has exceptional diversity of forms. Local cultivars are often a mixture of several types, a sort of composite population, which over long periods of time have become location-specific and are relatively yield stable. Taken out of their adapted environment, however, most cultivars perform poorly. The collection of local cultivars available number about 3300. These have been screened at Holetta or Debre-Zeit and partly screened at other problem locations. Collections are available with the USDA, and are also maintained locally. Seed stocks will in future, also be available through the Ethiopian Genetic Resources Centre in Addis Ababa. The local collection has so far not been studied much in Ethiopia but has proved to be a valuable source of germplasm in the developed world, where studies have identified valuable genes for disease resistance and high protein and lysine content. With the great diversity of ecological regions, soils and other factors and the wide germplasm base available within local cultivars, this collection should provide excellent material for future breeding use, especially in the problem areas.

General Research Problems - The principal problems in the barley improvement work are diseases such as scald, net blotch, spot blotch, loose and covered smuts; pests such as barley fly; climatic and soil conditions such as frost, waterlogging, yield instability and broad adaptation, and weeds. Scald is a major disease in the humid highlands and may reduce grain yields by about 20%. The introduced malting varieties are highly susceptible to the disease. Loose and covered smuts are somewhat serious especially on the malting barley selections.

The most important pest on barley is barley fly (Hylemya arambourgi) which is extensive in the barley producing areas. Local cultivars show some tolerance to the pest. Many traditional barley areas have occasional frost, low soil fertility, waterlogging, and weed (e.g. wild oat )problems. The improvement work focusses on these problems with more emphasis on malting barleys.

Malting Barley Improvement - The work on malting barley research was started at Holetta Research Station, IAR, in 1968 with introductions of more than 100 malting varieties from Europe, Australia, USA, and Kenya. Tests on varietal performance, cultural practices, and identification of suitable malting barley production areas were undertaken and are continuing. Promising varieties were tested in national trials at many locations in the barley growing areas (i.e. as Holetta, Bedi, Sheno, Fitche, Arussi Negelle, Segure, Bekoji, Alemaya, Burie, Amanuel, Gordar, Dabat, and Hawzen). In the last eight years about 63 malting varieties were tested. During this period micro malt tests were obtained through collaboration with overseas laboratories. By 1971 three varieties of good malting quality, namely Beka, Research, and Proctor were identified for the Chilalo Highlands in Arussi province and the Holetta and Sheno Highlands in Shoa province. These three locations are among the major barley growing areas in the country.

Commercial production has only moved forward in the Arussi province over the last three years. Whilst the malt factory and brewery are pleased with the quality of the raw material delivered, certain varietal problems were obvious and needed to be resolved.

The major problems are:

1. The introduced varieties lack resistance/tolerance to post-emergence attack by barley fly, resulting in reduced stands. They have to be seed dressed with Aldrin at present. It would be desirable to have built-in insect resistance or tolerance to the barley fly.

2. Most introduced malting barleys are susceptible to foliar diseases especially scald and net blotch, causing reduced yields mainly through reduction of seed weight. Better resistance to foliar diseases is required.

3. Barley for malting must be of uniform size. This is achieved by screening the harvested seed over a 2.2 mm screen. The variety Beka, is small seeded and gives a screening loss (thins) of 25 to 30%. The "thins" are used for food and local brewing but represent a financial loss to growers and a very significant loss to the maltsters. The variety Kenya Research is better, with about 10 to 15% thins. Varieties developed should have very low screening losses of under 5% thins.

A modest hybridization programme was started in 1968 to incorporate scald resistance into promising introduced malting barleys. A "Holetta Mixed 6R" local cultivar was used as a parent with excellent vigour, good scald resistance, large grain size and fairly wide local adaptation. Six superior two-rowed selections of good malting quality have been identified from that programme and are under test in current national trials. These selections have better tolerance to barley fly, good scald resistance and large, plump fairly uniform grains. They have given trial yields of 5 tons/ha, (compared to 3 tons/h for the introduced varieties) and have shown wide adaptation in barley areas in the country. Regrettably, however, their resistance to loose smut is not as good as that of the introduced parents.

The better varieties are:

4 sels. from Cross EH8B = K.Research x (Holetta Mixed x K.Research)

2 sels. from Cross EH20 = /(Hol.Mixed x Proctor)x (Holetta Mixed x Coast)/ x Proctor

The hybridization work for scald resistance is continuing, with emphasis also on tolerance to frost, water-logged conditions, broad adaptation and yield stability. Specific programmes for locations such as the extensive Bedi plateau, north-east of Addis Ababa, are also being handled.

Food Barley Improvement - The food barley programme is continuing on the same lines as that for the malting barley. Large introductions from overseas have been made since 1967 and over 2600 local collections were screened at Holetta, Bedi, and Sheno. Promising varieties were tested in national trials in many barley growing areas. Results for the last nine years are available. Because of the diverse ecological units in the country, very few varieties of broad adaptation and good yield stability have been

identified. By 1971 the six-rowed varieties Promesa, Beecher, Unitan, and C63 were identified for many locations. Since 1971 more research emphasis was given to the local material which is well adapted to conditions relevant to the traditional way of farming (such as tolerance to frost and waterlogging, fairly successful competition with weeds, fairly good performance under reduced soil fertility, etc..). Some outstanding varieties were identified from this effort. These varieties are IAR/H/81, IAR/H/489, Bedi Black 6R, and Bedi White 6R. One good selection, denoted Composite 29, was also identified from the introduced Composite Cross XXI. This has proved to be widely adapted. On average these varieties give more than 4 tons/ha on experimental plots, and their tolerance to frost is quite satisfactory.

A hybridization programme is followed similar to the malting barleys. The objective in this case, however, is to form a composite cross of the most promising local and introduced cultivars.

It was expected that one large population would be formed which could be specifically screened in the major barley areas to derive improved local populations or varieties of either food, local brewing or malting types.

In 1972, the 107 Genetic Male Sterile Stocks were received from the USA and one entry, Commander 6 (ms 1) was selected for its satisfactory adaptation in the Holetta area. Some 25 promising varieties, (13 local and 12 introduced selections) were included in the breeding programme in 1973 but due to staff changes, this programme was held over and only restarted in early 1976. In the first step of the new programme, the promising varieties and cultivars are hand-crossed on to the male-sterile line, this being done as and when promising stocks are identified. In the $F_2$ and subsequent generations the male-sterile plants are tagged, and those with adequate resistance to foliar and other diseases are retained. All seed on these plants is expected to be naturally crossed and will form the next generation. It is hoped to grow two generations per year and advance the populations in different locations through at least ten generations before specific selections are made.

Currently, there is a proposal to develop high-lysine food barleys. This will be made possible through assistance from FAO/SIDA in training local personnel and providing equipment and materials, based on local cultivars. The programme is to start in 1977.

This leaves one region, namely, the low rainfall areas in the highlands, where much more needs to be done. For these areas, given better soil and water management practices, varieties need to be developed which are early, drought-resistant, with good resistance to foliar diseases like the rusts and spot blotch and with good quality. For this ecology it is hoped that material developed in the Near East Region and at CIMMYT will be useful. So far such material tested in the humid highlands has generally proved very susceptible to scald.

To ensure the continuity and adequate handling of the research work in future, two important issues need to be stressed :

(1) In view of the lack of trained personnel, at least one or two additional senior barley workers would have to be trained, one of whom would specialise in malting barley and the other in population breeding methods.

(2) There is the need to provide adequate laboratory facilities and especially equipment for conducting quality tests, both for malting barley evaluations as well as for food and local brewing. The training of technicians to operate such quality-testing equipment will also need to be provided.

The research effort on both malting and food barleys has obtained some pertinent information on varieties and cultural practices but the extension of the information to farmers has not been satisfactory. There may be many reasons for the slow uptake of findings, but the three most important ones appear to be:

(1) lack of incentive for farmers as the market demand for barley is quite low,

(2) a lack of application of the research and extension departments for a smooth flow of communication, and

(3) a lack of an organized seed multiplication activity in the country.

As a result most of the superior varieties, with the exception of the malting variety Beka, have not reached farmers who thus still depend entirely on their own landraces for seed.

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Table 1.1. Estimates of Corrected Area, Yield and Production for Major Crops in Ethiopia, 1975/76.

| Crop | Area | | Yield | Production |
|---|---|---|---|---|
| | Thousand hectares | % | Quintals Per hect. | Thousand Quintals |
| Teff | 1,720.6 | 30.7 | 6.9 | 11,828.9 |
| Barley | 600.9 | 10.7 | 9.3 | 5,567.8 |
| Wheat | 500.0 | 8.9 | 9.6 | 4,821.7 |
| Maize | 727.6 | 13.0 | 18.0 | 13,106.1 |
| Sorghum | 718.3 | 12.8 | 11.2 | 8,034.2 |
| Millet | 316.5 | 5.7 | 9.8 | 3,112.2 |
| Horse beans | 258.7 | 4.6 | 11.1 | 2,865.7 |
| Chick peas | 197.5 | 3.5 | 5.2 | 1,020.8 |
| Haricot beans | 42.2 | 0.8 | 7.6 | 322.7 |
| Field peas | 107.3 | 1.9 | 3.7 | 400.4 |
| Lentils | 56.2 | 1.0 | 7.6 | 425.2 |
| Flax | 82.2 | 1.5 | 3.4 | 278.9 |
| Neug | 226.3 | 4.0 | 3.3 | 752.5 |
| Sesame | 11.1 | 0.2 | 2.6 | 29.1 |
| Others | 40.6 | 0.7 | 6.3 | 254.9 |
| Total Cropland: | 5,606.0 | 100 | 9.4 | 52,821.1 |

N.B. For private peasant holdings in the agriculturally important areas.

Source: Crop Production Survey, 1975/76, Ministry of Agriculture and Forestry Development, Addis Ababa.

Table 1.2. Percentage of Total Area Under Barley By Provinces, 1974.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Shoa | 29.5 | Gojam | 5.2 | Sidamo | 2.0 | Illubabor | 0.7 |
| Arussi | 26.2 | Wollo | 5.0 | Gemu Gofa | 1.7 | | |
| Bale | 10.0 | Tigre | 4.3 | Keffa | 1.3 | Total = | 100% |
| Begemdir & Semien | 9.2 | Wollega | 3.7 | Hararge | 1.1 | | |

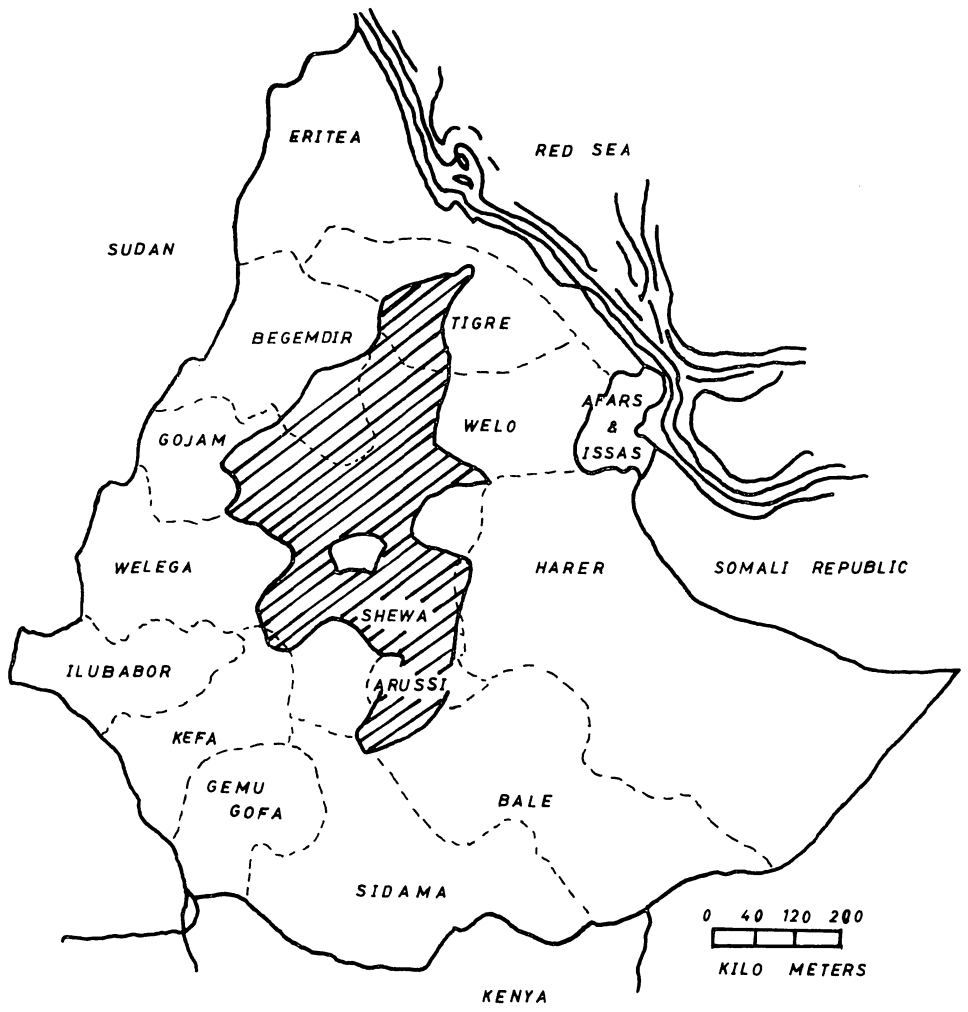



FIG. 1. MAIN AREAS OF BARLEY PRODUCTION IN ETHIOPIA – 1966

SOURCE: STANFORD RESEARCH INSTITUTE PRODUCTION OF GRAINS AND PULSES IN ETHIOPIA, REPORT NO.10, JANUARY 1969

# BARLEY IN LIBYA

By

Mustafa H. El-Shater*

The Libyan Arab Republic has an area of 661,000 ha. being cultivated each year. Barley and wheat are the major cereal crops and occupy about 90% of the cultivated area. They are mostly grown in the rainfed areas. They are also cultivated under irrigation. Barley is the primary crop because it thrives better than wheat under the prevailing conditions in the country. Its production is mainly concentrated in the areas of lesser rainfall in the eastern regions while in the western areas, more barley is grown under irrigation.

Due to the erratic rainfall and distribution, yields of barley fluctuate annually from one area to another as well as from one season to another. In good seasons an average yield of 6 to 10 Quintals** per hectare is harvested. In irrigated areas, the yield average is about 15 to 20 Quintals per hectare.

Barley is mainly used as human food and only about 10% is consumed as animal feed.

## Cultural Practices

1. Date of seeding and harvesting: Seeding in the irrigated areas is done during the months of October and November, while in the rainfed zones, depending on the rain fall it can extend up to the end of December. The crop is harvested during the months of May and June.

2. Rotation: Availability of the water is the main factor determining the crop rotation. Farmers are accustomed to plant either wheat or barley annually or alternating these two crops with each other or to a lesser extent with other crops or leaving the land bare fallow. However, experimental studies have been conducted at the present to investigate the effect of cropping systems on yields of wheat and barley for the irrigated and non-irrigated areas.

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* Agricultural Research Center.

** Quintal = 100 kgs.

| | 1971-1972 | | 1972-1973 | | 1973-1974 | | 1974-1975 | |
|---|---|---|---|---|---|---|---|---|
| | Area (ha) | Production (tons) | Area (ha) | Production (tons) | Area (ha) | Production (tons) | Area (ha) | Production (tons) |
| Irrigated | 25752 | 49968 | 36269 | 72173 | 111356 | 482914 | 140494 | 583050 |
| Rainfed | 138197 | 66427 | 250018 | 132341 | 222712 | 965828 | 280989 | 1334698 |
| Total: | 163949 | 116395 | 286287 | 204514 | 334068 | 1448742 | 421483 | 1917748 |

3. Seeding Rate: Optimum rate of seeding for barley is between 60 and 80 kilogrammes per hectare. Seeds are either broadcasted or drilled in rows 20-30 cm apart.

4. Fertilizer Application: Trials carried out indicated that high yields were possible when 80 kg/ha of nitrogen split into two applications and a top dressing of 90 kilogrammes of phosphorus were added.

Some farmers add 300 kilogrammes of the mixed fertilizer 12:24:12 as a basal dressing at seeding, then they apply 150 kilogrammes of 21% ammonium sulphate as top dressing when plants reach the tillering stage.

Experimental work on fertilizer application in both irrigated and rainfed areas have been planned to find out the most economical use of fertilizer in Libya.

Barley Varieties

Cultivation and production of barley varieties is determined primarily by the prevailing climatic and soil conditions. The main varieties of barley grown in Libya are:

1. Athenais - six rowed barley, introduced from Cyprus in 1952 and released in 1956. Good yielder, most suited for medium fertility soils, early maturing and can be grown on a variety of soils.

2. California Mariout - six rowed barley roughawned, early to midseason and short. It was introduced from the U.S.A. in 1952 and released in 1956. It is susceptible to powdery mildew and not very well adapted for irrigated land.

In addition to the above varieties there are two other varieties bred by the Agricultural Research Center. They are Libya 4 (two-rowed) and Libya 2 (six-rowed) but they are not yet widely distributed.

Barley Diseases and Pests.

Insects do not cause much damage in the fields but the crop is affected by many plant pathogens. Amond the different diseases covered, loose smuts are the most important. Mildew, between the sporium stripe and scald can also cause considerable losses.

Barley improvement in Libya is part of the cereal improvement program carried out at three different experimental stations, representing the three major agro-climatic zones. Obtaining high yield, early maturity and resistance to the prevailing disease are the main objectives of the breeding program.

Large number of introductions are tested each year to find out the best high yielding varieties under the Libyan conditions. The varieties are obtained through the International organizations, FAO, CIMMYT, INRAT and ACSAD. The variety, Beecher, is showing excellent performance and is likely to be released.

Simple and multiple crosses are also made in order to improve different agronomic characteristics and add disease resistance particularly to powdery mildew. There are now a number of promising lines in segregating generations, some of which are being included in the Preliminary yield trials. The new promising lines are:

1. (FAO 18109 x spiti)
2. (FAO 18109 x spiti)
3. (FAO 18109 x Libya 2)
4. FAO 18109 x Libya 2
5. [FAO 18109 x (spiti x C.M)$^{2}$] Fam 224 pl.1
6. [FAO 24393 x (Spiti x C.M)$^{2}$] Fam 295 pl.2

Future Prospects

1. Attention has to be directed to the production of varieties with broad adaptability and draught resistance.

2. Screening for genes that confers resistance to smuts and powdery mildew and incorporating these genes in the high yielding varieties.

3. Agronomic trials have to be conducted to find out the optimum cultural requirements of the promising varieties and lines, such as dates of planting, seed rates, methods of seeding, water and fertilizer requirements with the view to raise the yield per unit area.

4. Increase of qualified and trained personnel to supervise the breeding programs and research studies are needed.

# BARLEY PRODUCTION IN TUNISIA

By

Daaloul, A; Djerbi , M; Ketata, H*
Deghaies, M; Halila, H;**
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## Introduction

Tunisia is an agricultural country where more than 70% of the population earns a living from agriculture. Cereals are among the major crops of Tunisia and cover an area of 1,600,000 ha. This area is distributed in two geographical zones: the Northern region with about 850,000 ha and the Southern region with about 720,000 ha. Three major cereals crops are cultivated in Tunisia. They are durum wheat, bread wheat and barley. The following table summarizes the different areas occupied by each one of these crops.

Table 1. Area Cultivated in 1000 ha.

| Crop | North | South | Total |
|---|---|---|---|
| Durum wheat | 570 | 250 | 820 |
| Bread wheat | 80 | 100 | 180 |
| Barley | 200 | 370 | 570 |

The figures in Table 1. show that barley covers about half (570,000 ha) of the area grown to wheat (1,000,000 ha). However the major part of the area grown to barley is concentrated in the central and southern regions of Tunisia where unfavourable climatic conditions prevail.

Barley is in general sown between the 15th of October and the 15th of December and harvested between the 20th of May and the 15th of June. The average yield of barley remains low compared to wheat: In Table 2 the average yield of wheat and barley differs depending upon the geographical area, and the fact that the low fertility lands are allocated to barley. Wheat receives priority, always being planted on the better lands.

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* from INAT; ** from D. T: office des cereals
*** from INRAT.

Table 2, Average production in tons/ha of the various cereal crops in Area North and South Tunisia

| Crop | | North | South | Average |
|---|---|---|---|---|
| Durum wheat | High-yielding | 1.4 | - | 0.93 |
| | Ordinary | 1.0 | 0.4 | |
| Bread wheat | High-yielding | 1.5 | - | 1.03 |
| | Ordinary | 1.2 | 0.4 | |
| Barley | | 1.2 | 0.5 | 0.75 |

Climatic Conditions and Factors Influencing Barley Production:

In general yields are low but 60% of the area grown to barley is in the central and southern parts of the country where rainfall is below 250 mm/year. Moreover 30% of the area sown to barley has a rainfall that does not exceed 350 mm/year. On the other hand about 4% of the area has a rainfall greater than 450 mm the remaining area sown to barley is in the rainfall zone between 200 and 300 mm. Another important factor to be considered is the fluctuation of rainfall in the south. Although the average is between 200 and 300 mm/year, precipitation of 400 mm is possible in some years, but may not exceed 100 mm in others. This has a strong influence on the area sown to wheat and barley.

It should also be mentioned that barley is usually grown in soils with poor or medium fertility in the North. The main reason being that barley prices are lower than those of wheat.

The prices for winter cereals are 4,500 TD, 6,600 TD and 6.000 TD (ITD = 2.2 US) per quintal of barley, durum and bread wheat respectively.

As for crop rotations, barley grown in the north is used in a 3 or 4 year rotation where it always comes after wheat. This tends to limit its yield. In the central and southern areas, no regular rotation is practiced, Rainfall generally determines which crop is grown.

## Uses of Barley

Grain barley is mainly used for feed (60%) an important fraction is used for human consumption (35%) and only a small portion of the crop is used for malting (5%).

Barley used for food is either ground after being roasted to give "Zamit" or Bsissa", or half ground to make barley bread, "malthouth" or barley soup.

The use of barley for forage is also common. It is then called "Orge en vert" and used for direct grazing or for silage which is gaining more popularity.

## Limitations to Increasing Barley Production

The main limitation to increaseing barley production in Tunisia stems from the relatively low selling price mentioned earlier. This results in the allocation of lands with low fertility to barley.

Furthermore, fertilizers or herbicides are not used as with wheat and this results in lower yields for barley. Efforts to increase cereal production have concentrated on wheat rather than barley. Privileges that are not available to barley are given to wheat. For example; the treatment of foundation and certified seed against smuts, and the free exchange of certified with farmer seed.

## Crop Improvement Efforts

The barley improvement program in Tunisia is still in its youth, work on barley having effectively only started in 1973. The barley program is not independent but is part of the whole Tunisian cereal breeding program. Actually one breeder is in charge of the barley program but the work on disease notations, crossing and selection is carried out by all members of the cereal improvement program.

The objectives of our program are:

1. Developing varieties having high forage and grain yield with a good resistance to the major diseases in Tunisia.

2. Improving the qualities of grain barley to be used for feed or human consumption (high lysine content) and for malting.

3. Adapting varieties to the local conditions (The varieties to be grown in the North should be either short but having good response to fertilizers or tall but having stiff straw. Varieties for the South should be early and drought resistant.)

4. Improving cultural practices for barley production including fertilizer and selective herbicide use. To meet these objectives, several actions were taken:

   (a) Introduction and testing of a larger number of varieties which originate from different international or national programs such as: the Regional Crossing Block, the Preliminary Observation Nursery, etc.....

   (b) Making crosses of local adapted varieties (Martin and Ceres) with other promising varieties having high yield, good type, disease resistance, and good protein content.

   (c) Testing in several locations for yield and other characteristics, the most promising lines retained from the Tunisian breeding nurseries or the introduced collections.

   (d) Carrying out fertilizer and herbicide trials in the main barley growing areas using the actual varieties and the new promising lines in order to define the best rates to recommend to farmers.

Diseases

The most important foliar diseases are the Helminthosporium diseases (stripe, spot and net blotch) which occur in both the southern and northern areas, and powdery mildew, scald and leaf rust important mainly in the north. The spike diseases of economic importance are loose and covered smuts.

Resistance through breeding and selection would be the only practical method to solve the problem of foliar diseases. On the other hand, seed treatment should be economical for covered smut and may be economical in the case of loose smut, at least for foundation seed.

Varieties

The two main varieties grown in Tunisia are Martin and Ceres. They make up about 85% of the barley produced, the remaining portion representing old land soil varieties grown mostly in the South.

From the 3 year test results a number of promising varieties or lines have been selected for yield and disease resistance. Some of these lines are: Gem, Mazorks, Delissa, Kenya, and Cosmos.

In conclusion although, barley is considered as a secondary cereal crop, it is of primary importance for animal feed. Because of the increasing needs of the livestock sector, and in the brewing industry, barley is expected to gain more importance.

# BARLEY RESEARCH AND PRODUCTION IN THE SUDAN

A.G.I. Imam*

Though it is considered to be the second most important winter cereal in the Near East Region, barley production in the Sudan has been restricted in the past to very small irrigated pockets in the Northern Province. The total area of production ranges between 300 - 500 acres annually.

The cultural operations such as land preparation, sowing time, fertilization, irrigation and harvesting are closely in line with those adopted for wheat.

The area under barley production in the Sudan presented in Table (I) remained static from year to year because of a very limited local consumption and because of poor prospects for export.

The area of wheat production, on the other hand, has undergone considerable expansion during the last two decades. This has been related to the adopted policy of diversification and intensification and rising demand for wheat consumption in the Sudan. The increased demand for wheat and wheat products was the result of a marked change in the eating habits of the masses of people who had migrated from the country side to the urban areas for work and better employment prospects. Hence, the remarkable expansion in area of wheat production from less than 40,000 acres in the 1950 to more than 600,000 acres in the 1976/77 season as presented in Table (II).

## Climatic Conditions and Factors Influencing Barley Production

Barley is usually produced under irrigated conditions in the Sudan as a winter cereal. Its time of planting is closely related to that of wheat (November) but the local farmers in the Northern Province sometimes delay barley planting to the third or last week in December.

No rotation is strictly adhered to due to the small and insignificant area used for barley production. The crop is often grown in plots which were previously under legumes or those which had been fallowed for a short-period.

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* Agricultural Research Corporation, Shambat Research Station

The small quantity of barley locally produced in the Sudan is used as feed, forage and also for medical purposes. Small quantities of barley (2000-3000 tons) are annually imported for industrial uses (e.g. malting).

## Limitations to Barley Production in Sudan

The main factors which presently curb the production of barley in the Sudan are related to limited local demand and the dim prospects for exports.

## Crop Improvement Efforts

Although barley improvement research programs were initiated in the late 1950's in conjunction with those for wheat, they were not however given similar or equal priority and had therefore remained partially less-active until early 1971: then, in response to an urgent call by the malting industry, interest in barley improvement was revived and more attention was focussed on producing malting types that would satisfy local requirements and have good economic possibilities of production for export.

The current barley improvement programme includes:

1. Intensive screening, adaptation and selection from a wide base of germplasm obtained from different sources.

2. The setting-up and conducting of several national and regional yield trials.

3. Investigations on barley cultural requirements in Shambat, Hudeiba and Gezira with regard to:
   a. Seed rate.
   b. Optimum time of planting.
   c. Nitrogen fertilization.
   d. Seed production and propagation.

Although the present barley improvement programme is not independent from that of wheat, more attention is now given to barley, more cereal specialists being involved in it. The current programme involves more than one research center and thus in addition to one senior breeder who is in charge, other research specialists in three regional research centres are directly involved in this programme. Moreover, one senior and two junior technical assistants are attached to it in addition to about 10 temporary labourers during the growing season.

## Limitations to Increasing Barley Production

In view of the rising cost of crop production under irrigation, attention has recently been directed towards rain-fed crop production. Part of the barley improvement programme is intended to investigate production possibilities under rainfed conditions. This of course requires more transport and out station facilities than presently available.

## Diseases and Insects

No serious problems of diseases were encountered except in Girba area (near the border with Ethiopia) where leaf and stem rusts were observed in some seasons. Some aphid damage was reported from the different locations where the National tests were conducted. This was checked by chemical spray.

## Principal Varieties Grown

In the traditional areas of farming, in the Northern Province where barley is cultivated under strictly peasant farming conditions, farmers are still persisting in the use of old cultivars which are often mixed, husky, susceptible to lodging and low in yield.

## New Improved Varieties

The improvement research programme for barley culminated in the release of a six-rowed local selection, (Baladi improved No. 46), which displayed a yield of more than 15 tons per acre. The malting prospects for this variety were also reported to be encouraging.

This improved stock is presently under the process of seed increase and progation. It occupied about 3000 acres in the Gezira area during 1976/77 season. Moreover, a score of other promising varieties are currently under test and may be considered for release in the very near future.

Stocks listed for consideration for future release include XV 2240, Giza 121, K71, B55-22 and line 257/14. The performance of XV 2240 under dry farming conditions and possibilities of adaptation is under investigation.

The prospects for future development and expansion of barley production in the Sudan are encouraging. More demand is anticipated from the animal finishing and poultry production sectors. Factors which limit the demand for barley uses as feed may be related to the cost of production under irrigation which gives priority to sorghum because the latter is produced under rainfed conditions. Barley prices have to be relatively closer to those of sorghum for better competition. This may be attained through higher yields under irrigation or comparable yields under dry farming conditions. Part of the programme for barley improvement is therefore directed towards research investigation on adaptation to production under dryland farming conditions in the Sudan.

Table I: Area, Total Production and Average Yield of Barley 1961-1971

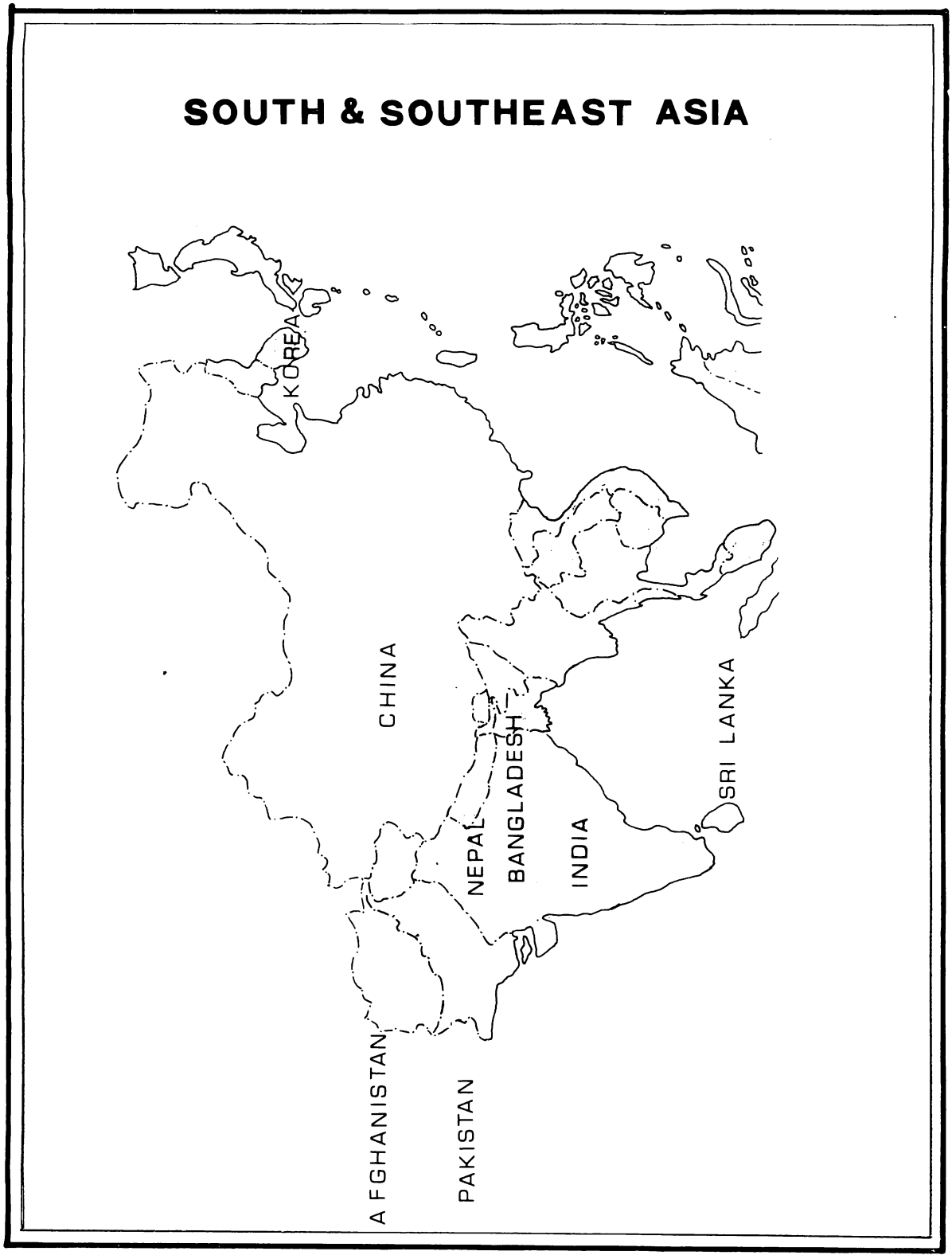
| Year | Area Feddan | Total Production tons | Average Yield ton/Fed |
|---|---|---|---|
| 1961/62 | 416 | 170 | 0.409 |
| 1962/63 | 454 | 130 | 0.288 |
| 1963/64 | 430 | 140 | 0.326 |
| 1964/65 | 391 | 141 | 0.361 |
| 1965/66 | 227 | 102 | 0.449 |
| 1966/67 | 177 | 081 | 0.453 |
| 1967/68 | 167 | 048 | 0.287 |
| 1968/69 | - | - | - |
| 1969/70 | 439 | 160 | 0.364 |
| 1970/71 | 212 | 097 | 0.458 |

Source: Department of Agricultural Economics and Statistics.

Table II: Wheat area and production in the Sudan from 1960 - 1976

| Season | Area (in feddans) | Production (Mt. tons) | Average Production/fed. in tons |
|---|---|---|---|
| 1960 | 38,500 | 24,7oo | 642 |
| 1961 | 39,100 | 26,400 | 675 |
| 1962 | 40,900 | 28,500 | 697 |
| 1963 | 54,000 | 30,900 | 572 |
| 1964 | 55,500 | 36,800 | 663 |
| 1965 | 135,600 | 56,000 | 413 |
| 1966 | 136,500 | 69,000 | 505 |
| 1967 | 172,500 | 78,500 | 455 |
| 1968 | 212,800 | 87,500 | 411 |
| 1969 | 262,500 | 123,200 | 469 |
| 1970 | 290,166 | 115,254 | 397 |
| 1971 | 286,190 | 147,500 | 514 |
| 1972 | 255,000 | 143,000 | 561 |
| 1973 | 248,346 | 152,190 | 613 |
| 1974 | 420,072 | 246,067 | 562 |
| 1975 | 590,507 | 269,264 | 461 |
| 1976 | 713,790 | 254,310 | 370 |

Source: Department of Agricultural Statistics


SOUTH & SOUTHEAST ASIA
KOREA
CHINA
NEPAL
BANGLADESH
INDIA
SRI LANKA
AFGHANISTAN
PAKISTAN

# AFGHANISTAN COUNTRY REPORT

By

M. Osmanzai*

Afghanistan has a total area of about 65 million hectares, of which only a small percentage (12% or 7.8 million ha) is arable. About 50% of this area cannot be cultivated every year due to lack of water, and thus remains fallow.

Crop production is dominated by cereals (Wheat, Corn, Rice and Barley), which occupy about 87% of the area cropped. The remainder is divided between fruits, vegetables and industrial crops.

Barley ranks fourth in production among the cereal crops of Afghanistan, being exceeded by wheat, corn and rice. The average harvested area, during the five-year period from 1972 to 1975 was 325,200 hectares from which the annual production was 368,500 tons. The average yield per hectare was 1.133 tons taking into account both irrigated and rainfed crops.

Barley may be planted in the spring or fall in Afghanistan where winters are not severe. Best yields, however, are obtained, when barley is fall planted. As a result of trials, fall-planted barley has been shown to outyield spring-planted barley by 20%. This fall-planted barley has consistently yielded more than 3.5 tons per hectare.

Barley is not widely used for human consumption, but it is used primarily as livestock feed, especially for working animals. It is the most important feed crop in Afghanistan, and in some cases, it is used for human food. At higher elevations in Afghanistan barley is the only crop grown extensively at the upper limits of agriculture. Where barley is almost exclusively used for human food, naked types are preferred. In these areas some people make special preparation of bread called (Gadulla) out of naked barley and food legumes mixture.

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Afghanistan barleys are remarkable from the stand point of yield, vigor and weak straw, but do not possess much inherent variability. It has been reported that in Northern Afghanistan many species of wild barley are grown, however, there is little diversity of cultivated forms in the country. Little two-rowed barley was found in Afghanistan, and of that found, all was hulled and well adapted to dry land areas. A hull-less four-rowed barley was found in considerable quantities, and some naked six-rowed barleys were also found. Most of the barley found was hulled six-row of a coarse type. It is also reported that the protein content of Afghan barleys range from 8.1 to 12%. This is the usual range for this crop.

On the basis of the seven year plan of Republic of Afghanistan Government some of the area under barley cultivation will be used for other crops which give more net profit under irrigation. The reduction of the area under barley cultivation can be compensated by a 54.2% increase in yield per unit area of land, which implies the yield will be raised from 1.133 tons per hectare to 1.7 tons/ha by 1982. Considering that the yield of grain per unit area is the result of several factors including variety, seed quality, land preparation, seeding operation, water management, chemical fertilizer uses, disease and pests control. Any one of these factors can limit the yield and none of them can alone result in a high yield. The interrelationship of the various factors makes it necessary to consider them collectively.

The main objective of barley improvement in the country is to obtain high yielding varieties adapted to the localities where they will be grown. It is of great importance also to obtain varieties that are able to withstand extreme conditions of cold and drought and that are resistant to pathogenic organisms and insect pests. Desirable milling and malting quality is also a prime consideration in the improvement program.

Barley work has so far been limited to carrying out trials of some international materials, as well as regional barley yield determination. Among the varieties in the Seventh Regional Barley Yield Nursery, conducted at Baghlan, some varieties out-yielded the local variety up to 44%, some of those varieties are: As 54-Tran (Cer-Toll)$^2$ Art. Tol. 1x$B_3$) Vt Pre-Toll, Clipper, CR-115 Por/6-Ly 103C, Giza 68x702B.

However, farmers still grow local varieties, which are mixed and there is no improved variety released to farmers so far. These undesirable mixtures of suitable and unsuitable barley varieties, must be replaced as they decreased average yield of grains, and substituted by new Afghan improved or adaptive introduced varieties.

Recently, more emphasis has been given on the barley improvement program. At present, it includes the following items:

1. Growing of Eighth Regional Barley Yield Nursery at Baghlan.

2. Raising of Segregating Populations at Kabul.

3. Planting Disease and Insect Screening Nurseries at Kabul.

4. Establishment of a Crossing Block at Kabul.

5. Assessment and purification of (30) bulk samples of local barley at Kabul.

6. Planting of a Uniform National Barley Yield Trial in the barley growing provinces. The material included in this experiment has been selected on the basis of performance in the previous years. This experiment has been conducted both under rainfed and irrigated conditions. We are expecting that some of the varieties from this experiment will go to farmers field soon.

The future barley program will consist of :

1. Complete collection, purification, and assessment of local barley from all parts of the country, where barley is grown.

2. Improvement of local varieties by selection for better plant types and testing for yield potential.

3. Hybridization - to develop genetic diversity for selection, and to combine the desirable characters such as stiff straw, disease and insect resistance, particularly yellow rust and aphids.

4. Testing of progenies for selection and yielding potential.

5. Testing of introduced materials and international nurseries.

6. Conducting agronomic studies such as plant management, water management, soil fertility studies, etc.. on promising cultivars.

The need for the search for high yielding barley to meet the targets of increased yields per unit area has now become more urgent. The program is heading in the right direction, new breeding materials and constant work on evaluation could be the key to the future success of barley improvement in Afghanistan.

# BARLEY CULTIVATION AND RESEARCH IN BANGLADESH

By

M. A. Razzaque*

## Introduction

Barley, locally known in Bangladesh as 'paira or zob', is grown as a minor cereal crop and used as food by the poor people. Out of total cultivable area of 11 million hectares, it is grown on only about 25,000 hectares and the production is approximately 17,000 tons. The area under wheat cultivation has substantially expanded from 55,000 hectares in 1965-66 to 150,000 hectares in 1975-76. But during this period, the acreage and production of barley has remained more or less constant (Table 1). The rapid increase of acreage under wheat has been possible by the launching of a massive expansion programme of HYV wheat in 1975-76. In case of barley, no programme has so far been undertaken for its expansion on a large scale.

Table 1. Area, production and yield per hectare of barley for the period of 1966-67 to 1975-76

| Year | Area in Hectare | Production in Tons | Yield in Kg/Ha. |
|---|---|---|---|
| 1966-67 | 22,400 | 15,000 | 684 |
| 1967-68 | 24,400 | 16,000 | 666 |
| 1968-69 | 28,000 | 18,000 | 655 |
| 1969-70 | 29,200 | 19,000 | 666 |
| 1970-71 | 36,800 | 26,000 | 411 |
| 1971-72 | 28,400 | 21,000 | 741 |
| 1972-73 | 25,600 | 16,000 | 636 |
| 1973-74 | 24,000 | 15,000 | 636 |
| 1974-75 | 25,254 | 16,109 | 655 |
| 1975-76 | 25,262 | 16,855 | 684 |

* Senior Scientific Officer, Bangladesh Agricultural Research Institute, Dacca, Bangladesh.

Research for barley improvement was started in Bangladesh after the great Bengal famine in 1942. The varieties being grown here were collected from different parts of India and after necessary testing were released for general cultivation. These varieties are poor yielders and have in course of time become susceptible to diseases.

The normal seeding time of barley is late November and harvesting occurs in late March or early April.

It is grown on comparatively less fertile soil on residual moisture and there is great potential for its expansion to areas where irrigation is a limiting factor for economic cultivation of other winter crops.

Climatic Condition and Factors Influencing Barley Production

Bangladesh, with its vast plain lands, is situated between 20.50°N and 26.50°N latitude and 88.50°E and 92.50°E longitude. It has a sub-tropical climate with an annual precipitation of 210 cm, the maximum being in the month of July (40.89 cm) and the minimum in the month of December (0.50 cm). The precipitation is comparatively low in the western part of the country. The average temperature is 26.00°C with a maximum of 31.76°C and a minimum of 20.01°C. On the other hand, the day length ranges from 10.3 to 13.4 hours with effective sunshine being highest in December (9.4 hours) and lowest in July (4.8 hours).

Barley is grown during the winter months from November to March. There is very little rainfall during the growing period of the crop. The relative humidity varies from 61% to 82%. The temperature, precipitation, day lengths and sunshine periods are given in Table 2.

Barley grows well on loamy or sandy loam soils in the districts of Rajshahi, Pabena, Faridpur, Tangail, Rangpur, Dinajpur, Dacca, Kushtia, Jessore, Mymensingh and Bogra.

It is cultivated most successfully in the gangetic plain where the soil has a better moisture holding capacity and is suitable for dryland cultivation of winter crops. It is generally

grown in double cropped areas following paddy and Jute. Only the marginal lands, where wheat, potato, tobacco and pulses cannot be profitably grown, are used by the farmers for barley cultivation.

Table 2. Temperature, precipitation, day length and sunshine period during the winter months (Barley growing season).

| | November | December | January | February | March |
|---|---|---|---|---|---|
| Temperature $^{o}C$ | | | | | |
| (Maximum) | 29.8 | 27.4 | 26.1 | 30.3 | 34.0 |
| (Minimum) | 16.8 | 12.8 | 8.9 | 14.8 | 16.8 |
| Precipitation (cm) | 3.5 | 0.5 | 1.8 | 3.0 | 4.3 |
| Day length (hours) | 10.5 | 10.3 | 10.5 | 11.1 | 12.0 |
| Sunshine (hours) | 8.4 | 9.4 | 9.2 | 9.0 | 9.2 |

Barley is generally grown as a single crop and occasionally as a mixed crop with lentils, chickpeas, etc..

## Use of Barley

After husking, barley is parched in a pan over fire and then ground to powder. This powder after sieving is locally called 'satu'. It is mixed with molasses and banana and used as a breakfast in the morning or snack in the afternoon.

Almost the entire quantity of barley produced in the country is consumed as 'satu' but the imported stock of about 1,000 tons is used for commercial preparation of barley powder for the children and patients.

Barley is not used as a fodder crop in Bangladesh.

## Limitations to Increasing Barley Production

The main constraints to barley production are:

(i) Poor yield of the existing varieties - high yielding varieties should be evolved and introduced to the growers;

(ii) Difficulty in removing husks of the existing varieties. As a result, the consumers sometimes become disinterested in buying and using barley as a food;

(iii) Competition with other winter crops - such as wheat, potato, tobacco, vegetable, pulses, oilseeds, etc..

(iv) Lack of marketing facilities - there is practically no marketing facility for barley. The price is comparatively low and no price support as in case of paddy and wheat; and

(v) No national programme for seed production and distribution to the growers has been taken up so far.

Varietal Improvement

Germplasm Collection:

In 1972, fifty eight strains were collected from different countries of the world. These formed the initial stock to start a programme for barley improvement.

Breeding:

Systematic research on varietal improvement of barley was initiated in 1973-74. This mainly involved screening of nurseries received from ALAD and CIMMYT. Subsequently, trials were conducted in a number of locations for selections of materials in order to evolve varieties for introduction to the growers within a reasonably short period.

Barley takes longer time to mature in Bangladesh and therefore, maturity is given the primary consideration in making selections under field conditions. The lines or varieties which take more than 115 days to mature are discarded outright. Besides, the following criteria are also taken into consideration in the varietal improvement programme:

(a) High yield;

(b) Resistance to stem and leaf rust and spot blotch diseases;

(c) Drought tolerance; and

(d) Height.

The following experiments are now being conducted:

A. National Programme

1. Introduction and selection
2. Preliminary yield trials
3. Advance yield trials
4. Observational trials

B. International Programme

1. Elite barley yield trial
2. Barley observation nursery
3. Crossing block
4. $F_2$ population

C. Regional Programme

1. Preliminary observation nursery
2. Regional Disease and insect screening nursery
3. Barley yield trial

Disease Situation

Local varieties are mainly grown under dryland conditions. In general, infestation of stem rust on barley is more than that of leaf rust. Other minor diseases such as spot blotch caused by Helminthosporium sativum and other Helminthosporium spp. specially in nursery trials are becoming of major importance. Foot-rot caused by Sclerotium rolfsii also causes appreciable damage at the seeding stage if there is excess of moisture in the field.

Promising materials

A number of promising materials selected on the basis of maturity, yield, disease resistance etc., are now in the advanced yield trials. The names of the materials with their characteristics are given in Table 3.

Prospect of barley cultivation

In the winter season, thousands of hectares of land remain fallow for a period of 3 - 4 months due to lack of irrigation facilities. If suitable drought resistant varieties are developed, these lands may be brought under barley cultivation. Simultaneously,

the possibility for commercial utilization of barley needs to be explored and developed in order to utilize the quantity produced within the country.

Besides, with the increasing population, the gap between production and requirement of food grains will gradually widen and barley may play an important role as an alternate food crop on marginal lands to substantially narrow this gap in Bangladesh.

Table 3. Performance of promising materials (1975-76) along with agronomic characters in irrigated conditions

| Sl. No. | Variety or Cross | Days To Heading | Days To Maturity | Hgt. in Cm. | Disease Reaction | | | Yield In Kg/ha. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Stem Rust | Leaf Rust | Spot Blotch | |
| 1. | CM67-EB487-8-2-15-5 CM67-U-Sask/800 | 75 | 108 | 63 | trs | 0 | 5 | 1911 |
| 2. | SD729-porvenir | 77 | 108 | 58 | trs | 0 | tr | 2434 |
| 3. | CM67-U.Sask.1744 | 78 | 108 | 55 | 5MS | 0 | 10 | 2266 |
| 4. | Minn126-CM67xDs-Apro | 71 | 108 | 48 | 5S | 20S | 10 | 2000 |
| 5. | Minn126-CM67 | 82 | 114 | 64 | 10S | 0 | 10 | 2434 |
| 6. | Gizeh 134-M65-220 | 89 | 121 | 64 | 5S | 0 | 5 | 2222 |
| 7. | Polmolla Blue | 86 | 108 | 73 | 10S | 0 | 5 | 1933 |
| 8. | Beecher | 86 | 115 | 74 | trs | 0 | 10 | 2044 |
| 9. | C103683 | 82 | 112 | 58 | 20S | 0 | 5 | 2550 |

# THE ALL INDIA COORDINATED BARLEY IMPROVEMENT PROJECT AND ITS IMPACT ON PRODUCTION

By

Mahabal Ram* and H. C. Saini**

Barley is an important cereal crop in India, and is extensively used as food. A small portion is used as cattle feed and for malting, brewing and pearling purposes. This crop is grown mainly in the northern Indo-Gangetic plains and adjoining tracts of central India. In the northern Himalayan hills, it is grown up to an altitude of 4000-5000 meters.

Barley occupies about 2.9/million hectares with total production of about 3.15 million tonnes and average productivity about 1075 kgs per hectare (1974-75). The chief barley growing provinces in order of acreage and production are U.P., Rajasthan, Haryana, Punjab and Madhya Pradesh. Other provinces where barley is cultivated in small areas are West Bengal, Himachal Pradesh, Jammu and Kashmir.

Only spring barley is cultivated in this country. Within this type both 6 rowed and 2 rowed varieties exist. In the plains, hulled types are most popular while in the northern hills both hulled and hull-less types exist. Six-rowed barley being more productive than the 2 rowed type, is widely grown in India. The improvement of barley was started in the first decade of this century along with the wheat crop in India. A number of improved barley strains were developed by state departments of Agriculture through pure line selection and hybridization till the mid-sixties and these were recommended for commercial cultivation. Since there was not any coordinating agency at the central or state level to supervise the exchange of research information among scientists, these varieties could remain limited to only local use. Wheat being superior in grain quality and relatively more remunerative in price support than barley, always received priority over barley. On the introduction of dwarf high yielding Mexican wheat varieties in the early

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** S.R.A. Under All India Coordinated Barley Improvement Project.

sixties in India, attention of wheat breeders was completely shifted towards the development of high yielding dwarf wheat varieties and barley was left behind. The result was that wheat area and produce jumped to double within 7 - 8 years of time and India celebrated a wheat revolution in 1968-69.

Realizing that barley forms the staple food of millions of poor and low income groups of people, particularly in dry land areas, ICAR formulated an All India Coordinated Barley Improvement Project in the year 1967-68. The main objective of this project is to develop:

(i) Improved disease and pest resistant barley varieties with better built-in agronomic agronomic attributes making them responsive to growth under moderate fertility conditions in irrigated/rainfed areas in both plains and hills.

(ii) Basic information on plant nutrient requirements for each of the principal soil types where barley is cultivated and with this information formulate suitable recommendations on fertilizer usage, irrigations, seed rate and crop rotation etc.. to permit increased yield per unit area and time.

(iii) Basic information on plant diseases and pests and weed control etc.. to guide barley breeding and production programmes in the country.

(iv) Improved economical methods of tillage operations, planting and weeding, harvesting, etc.. to minimise the cost of production.

Organizational Pattern

The All-India Coordinated Barley Improvement Project is a multi-purpose multi-disciplinary project headed by a project coordinator. There are about nine research centres which are located in different parts of the country depending upon the agro-ecological variability. For this purpose the country has been divided into five agro-climatic zones. These are:

1. The North Western plain zone (Punjab, Haryana, Rajasthan and Western U.P.); a low rainfall moderately dry belt with a longer winter season.

2. The North Eastern plain zone (Eastern U.P., Bihar, West Bengal and Orissa); a high rainfall hot humid belt with a moderate winter season.

3. Central India (Madhaya Pradesh, Southern U.P., Maharashtra and Gujrat); a low rainfall, hot dry belt with a short winter season.

4. Peninsular India (Andhra Pradesh, Karnataka, Tamil Nadu and Kerala); a hot humid, high rainfall in seashore areas and dry belts in plateau regions in the central and northern parts.

5. Himalayan hill valleys (Jammu and Kashmir, Himachal Pradesh, U.P. Hills); a temperate belt with a longer winter season.

Barley research centres located in these regions are:

| | | | |
|---|---|---|---|
| 1. | Durgapura (Rajasthan) | Main Centre | Northern India |
| 2. | Hissar (Haryana) | Sub-Centre | |
| 3. | I.A.R.I. New Delhi | Main Centre | |
| 4. | Kanpur (U.P.) | Main Centre | Eastern India |
| 5. | Pusa (Bihar) | Sub-Centre | |
| 6. | Sabour (Bihar) | Sub-Centre | |
| 7. | Sajoura (H.P.) | Sub-Centre | Northern hill valley |
| 8. | Simla (H.P.) | Sub-Centre | |
| 9. | HAU, Hissar | Headquarter | |

In addition, there are about 100 testing centres where new varieties and agro-techniques are being tested. These testing centres do not receive any financial assistance from ICAR. They are under the control of either the State Government or the State Agricultural Universities.

The headquarters of this project is presently located at the Haryana Agricultural University, Hissar.

This project includes the following disciplines: Breeding, Agronomy, Pathology, Entomology, Physiology and Quality.

Annual Workshop

A barley workshop is organized every year usually in the August-September months to discuss the performance of varieties/ agro-techniques tested in the different trials in the previous season and to finalize the research program for the coming year.

There are about 23 such All-India Crop Improvement Projects operating on various crops in India and the barley project is one of them. Thus, by setting up these projects the Indian Council of Agricultural Research has installed the machinery for integrating research on various problems related to crop improvement. Conducting trials on a large number of cooperative and testing centres located in different agro-climatic ecological zones provides adequate freedom and facilities to the scientists to generate and exchange breeding materials and agro-techniques for the evaluation and screening of varieties before passing them to the farming communities. This opportunity was not available to the scientists before the commencement of the All-India Coordinated Crop Improvement Project System.

Testing Procedures

Here is a brief summary of the various steps involved before a variety of agro-technique is passed on to the cultivators:

Step I. After years of research, scientists develop a new variety at their institutions.

Step II. The new variety developed by the scientists working with the project, Agricultural Universities and Central Research Institutes, is first tested in the departmental trials. If the performance of the new strain if found better than the local check then it is nominated in the forthcoming workshop for testings at national level under the project.

Step III. The new variety is tested at different cooperating research centres spread all over the country for at least three years at two stages under three cropping conditions:

| | |
|---|---|
| Stage I | Initial Evaluation Trials (IET) |
| Stage II | Uniform Varietal Trials (UVT) |

Cropping Conditions

1. Rainfed early sown conditions
2. Irrigated normal sown conditions
3. Irrigated late-sown conditions

Initial Evaluation Trials

This is the first stage of testing of the new entries. The new strains are tested only at a limited number of locations for their uniformity in plant height, duration, adaptability, yield and reaction to diseases and pests. This trial is conducted under uniform fertility conditions. The entries showing poor performance are dropped, moderate ones are retained and only those entries which appear promising are promoted to the uniform varietal trials. Yield and disease resistance are given due consideration for screening of the varieties at this stage.

Uniform Varietal Trials (UVT)

These trials are conducted under wide range of agro-ecological conditions. This includes varietal testing under moderate and low fertility conditions. The main objective of this trial is to discover the response of varieties to fertilizers and water management, date of sowing, and reaction to diseases and pests. Varieties showing better performance are finally selected and proposed for pre-release seed multiplication and for the minikit and district trials.

Step IV Data obtained from the cooperating research centres are analysed and discussed in the annual workshop. Final recommendations are made based on the general acceptance of the scientists participating.

Step V Minikit and District Trials: The varieties showing outstanding performance under UVT are again tested on the farmers fields under so-called Minikit Trials, and on

Government farms as District Trials. In these trials varieties recommended by the workshop for pre-release seed multiplication are tested under farmers conditions. The evaluation of varieties is done by the local extension agencies by judging the reaction of the majority of the farmers in an area. The new variety is recommended for official release by the Central Variety Release Sub-Committee. However, if some state government wants to release a particular variety for its own state, the Indian Council of Agricultural Research raises no objection provided that the workshop has approved it and that the variety in question has been moved for nomination by the Central Ministry of Agriculture, New Delhi.

Achievements:

The achievements made under this project are:

(i) Development of improved varieties for different purposes.

(ii) Disease and pest problems and their control.

(iii) Agronomic advancement.

Development of Improved Barley Varieties

While development of barley varieties with high yield potential and better built-in resistance to the harmful diseases and pests has always been the main goal of barley improvement, attention has been focussed on identifying varieties suited to:

(a) Specific cropping conditions such as:

(i) early sown rainfed conditions
(ii) normal sown irrigated conditions
(iii) late sown on paddy follows

(b) Special purposes such as:

(i) fodder and feed grains
(ii) industrial uses for production of malt, beer and whisky, etc..

(c) Problem soils such as:

(i) Saline sodic soil conditions

## Development of Barley Varieties for Different Cropping Conditions

The bulk of the area under barley is rainfed. Only in a small area in eastern U.P., Bihar and Rajasthan is barley grown under irrigated conditions. Very recently cultivation of late sown barley has been taken up on paddy fallows in eastern India.

Existing varieties were evaluated for their yielding ability, agronomic suitability, reaction to diseases and pests and wider adaptability. On the basis of multilocation testings, about half a dozen varieties were finally screened and recommended for commercial cultivation. The multilocation testing paved the way for wider adaptability and allowed these varieties to become the base materials for further improvement. In addition, about half a dozen varieties produced by hybridization and mutation and suited to meet the local conditions were realised by the State Variety Release Sub-Committees. The details of these varieties have been given in Table 1. Out of these 'Ratna' and 'Jyoti', have been found to be well adapted to the Indo-Gangetic plains both in rainfed and irrigated conditions; RS-6, is suited for production in the low rainfall belts of Central India and 'Himani' and 'Dolma', are suited to the northern Himalayan hill valleys. These varieties yield an average of 15-16 quintal/ha under rainfed low fertility (20N:10K:10PS kg/h) conditions provided good winter rains are received, and 25-30 quintals per hectare under moderate fertility (40N:20P:20K kgs/h) conditions with 1-2 irrigations. The average performance of these varieties in the different parts of the country and under different cropping conditions is given in Tables 4 and 5.

Among the barley varieties released for hills 'Dolma', a hull-less and yellow rust resistant variety has given about 30% higher yield than Kailash (NP109) and is gaining popularity among farmers in the northern hill valleys of Himalaya.

## Development of Semi-dwarf Barley Varieties

Plant type plays an important role in raising the productivity of cereal crops like rice and wheat. Local varieties of barley have similar weaknesses to those found in traditional varieties of rice and wheat. Because lodging in barley limits the productivity per unit area and time, efforts were made to develop semi-dwarf, stiff-strawed lodging resistant barley varieties capable of growth under moderate fertility conditions.

Fortunately, through mutation breeding techniques with the help of Gamma rays, a semi-dwarf stiff strawed barley variety named as RDB-1, was developed from RS-6 (1970) at the Government Agricultural Research Farm Durgapura (Rajasthan), one of the research centres of the All-India Coordinated Barley Improvement Project. Subsequently at IARI, New Delhi, another semi-dwarf line 'DL-70' was developed from a cross BG1 x M5-13. Both dwarf varieties grow without lodging on 50-60 kgs of nitrogen application per ha. and have given grain yields of between 4-5 tonnes per hectare. The average yield potential of semi- dwarf and tall barley varieties is given in Table 1.

Thus development of these semi-dwarf barley varieties have opened new vistas in the barley breeding programme in India and have also demonstrated that the yield of the barley can be substantially raised. However, some limiting factors realised so far with these dwarf varieties are that dwarf plant stature is associated with the poor development of ear length, grain number and grain size (1000 grain weight). As a result, under moderate fertility conditions they have not shown outstanding performance over tall barley varieties. Efforts are therefore being made to:

(i) break the linkage between the plant height and yield component characters through conventional and mutation breeding techniques.

(ii) develop the plant ideo-types suited to rainfed and irrigated moderate fertility conditions separately, based on the information available in case of wheat (Donald 1968 and Asana 1970) and on rice crops (Chandler 1969).

Physiological experiments are being conducted to study the role of plant types, leaf canopy, tillering capacity, ear-sink-size, harvest index and maturing, etc.. in relation to developing an ideal plant ideo-type in case of barley. Preliminary information derived from these experiments has indicated that an ideal plant type for high yield potential is expected to have:

(i) semi-dwarf, thick stiff-culms and compact panicles,

(ii) short, narrow, thick and dark green upright leaves,

(iii) good seedling vigour and synchronized early tillering,

(iv) early maturity and photo-period insensitivity, and

(v) good yield response to moderate fertility conditions.

Gardner et. al.(1966) made comparative studies of three high yielding and three low yielding barley varieties and reported that high yielding varieties had narrow upright leaves while low yielding varieties had wide dropping leaves. These plant characters are not different to those identified in high yielding varieties of wheat and rice.

However, these plant characteristics are only suited to irrigated and moderate to high fertility conditions. Under rainfed conditions the plant has to grow on limited residual moisture and low fertility conditions; the plant ideo-type may thus be a little different, having ability to grow not only under moisture stress conditions but also to conserve moisture obtained from night dews and occasional winter precipitations. The ideal plant type of barley expected to perform well under rainfed condition may have:

(i) semi-dwarf thick-culms with dense panicles,

(ii) short narrow thick dark green dropping leaves,

(iii) good seedling vigour, early tillering ability with development of not more than 2-3 synchronous tillers per plant,

(iv) early maturity,

(v) good root development with deeper penetration in lower soil layers, and

(vi) compact panicles with high spikelet number, high floret fertility and bold seeds.

The concept of a single short strong culm character in wheat may not suit Indian conditions because of the very high seed rate required for such varieties.

Problem Soils:

Screening of Barley Varieties Resistant to Saline-Sodic Soils:

In India, about seven million hectares of arable land are affected with saline-sodic soil conditions found in the Indo-gangetic plains. Among the winter cereals, barley has been found to tolerate a considerable degree of soil salinity and alkalinity. A special coordinated varietal screening trial has been constituted to identify varieties tolerant to such problem soils. On the basis of trials conducted for a number of years at many locations in the country

including those conducted at the Central Soil Salinity Research Institute, Karnal and its sub-station (West Bengal) a few barley varieties such as 'Ratna', 'RS-6', 'DL-3', 'DL-120' and 'K125', have been found to be tolerant to such soils. The average performance of some of these varieties is given in Table 3. Out of these 'Ratna' and 'RS-6' have already been recommended for commercial cultivation. The rest is under pre-release seed multiplication and will be tested in further trials to confirm the tolerance ability to saline sodic soil conditions. Beside these, a large amount of barley germplasm is being tested every year to discover sources of resistance and their use in further barley breeding programme.

## Development of Barley Varieties for Special Purposes

### Fodder and Feed Grain

Barley is largely consumed as food grains and its straw is used as cattle feed in the advanced regions of the country. However, with the gradual increase in the production of wheat, rice and other coarse grains, the preference of people is fast changing toward consuming superior grains. In addition, with a very poor government price support for barley farmers, are loosing interest in growing it.

Recently, a recommendation was made to limit the area under wheat in favour of increasing the productivity of wheat varieties per hectare through genetic and agronomic manipulations. The Ministry of Planning recommended an increase in the area under barley by 2 million hectares to improve the production of green fodder and feed grains needed to boost milk, mutton and egg production in the country. With this reference and also to increase the scope of barley, attention of barley research workers is being diverted towards identifying barley varieties suited to green fodder and feed grain purposes.

Trials were conducted in 75/76 on a group of barley varieties along with standard varieties of oats as checks, to evaluate the production potential of these varieties for green fodder and feed grains. Sowing of the barley and oats varieties was done in the middle of October, with a basal dressing of 40 kgs of nitrogen and 30 kgs of phosphate per hectare. A first cutting of the plants was taken after 70 days for use as green fodder. Immediately the field was irrigated and 40 kgs of nitrogen per hectare was top dressed for regeneration of the ratoons. Thereafter, the crop was allowed to grow and set seeds.

From the experimental findings of these trials, it was found that as regards the green and dry fodder production and nutritive value, barley in general on a par with oats. In fact two barley varieties K-125 and 'Ratna', have performed better than standard oat varieties as regards their green fodder and feed grain production potentials.

It may be concluded from data available that cultivation of barley varieties 'Ratna' and K-125 may be found more economical than oats for green fodder and feed grains production especially since barley grain sells better than oats in the Indian markets due to its utility as human food and as an industrial raw material for the manufacture of malt, beer and whisky. In addition, in a country like India, the occurrance of famine due to accidental floods and droughts commonly affects rice, wheat and millet production. Barley grains may be of great use to the nation in such natural calamities.

Industrial Uses

Brewery and malting industries are not developed in India. As a result a very small portion of total produce is utilized for the preparation of malt, beer and whisky. To meet the requirements of the existing industries in India, a 2-row barley variety Clipper (an introduction from Australia) was released in 1969 for commercial cultivation. This variety was grown by farmers on a commercial scale around Delhi and Haryana. Indian industries did not pay high prices for 2-row barley. In addition, this variety is late in maturity and low yielding compared with the six-row barleys. Farmers were not interested in this variety. Consequently, a number of 2-row barley varieties were developed under the All-India Coordinated Barley Improvement Project to replace Clipper, with early maturity and better in yielding ability. However, it was observed that industries prefer bold seeded barley varieties with 70-75% total extract recovery irrespective of type of barley. Therefore, in a search among existing 6-row barley varieties 'Ratna' and 'Jyoti', were found equally good for industrual uses. 2-row and 6-row barley varieties with bold seeds have been identified for industrial uses. For rapid screening and testing of quality characteristics of new barley varieties a quality testing laboratory has been set up at the Nuclear Research Laboratory IARI, New Delhi. Some of the State Governments are also taking keen interest in developing malting and brewing industries and there is a possibility that in future the industrial uses of barley may be increased many times more.

Protein and lysine contents if some old and recently bred barley varieties show that 'Hiproly' is rich in protein and lysine content. Extensive hybridization involving this variety was conducted to combine its quality characteristics with new improved barley strains. However, efforts are being made both to improve the yield potential of the new lines as well as to develop more semi-dwarf high yielding barley strains rich in protein and lysine. Mass screening of germplasm collected from different places within the country and some introductions received from outside the country has resulted in identification of several lines with high protein and lysine contents.

Barley is a coarse grain because of its husk. However, new barley varieties are superior in protein and lysine content to the high yielding varieties of other important cereal grains such as rice, wheat and corn.

To combine a number of important yield and quality characters and disease and pest resistance together in a single variety is a very tough job and simple breeding procedures such as pedigree or bulk methods of selection may not yield useful results. Therefore, the population breeding approach based on line-tester analysis to identify superior genotypes/crosses and then recycling them in further cross combinations in succeeding generations is being tried in order to develop superior cultivars. In addition, since in Indian markets only bold seeded barley grains are preferred by consumers (without giving much emphasis on other characters) development of composite high yielding and high protein-lysine lines may be also tried to provide nutritive foods to the poor protein hunry masses.

## Diseases and Pest Problems of Barley

Barley in India suffers from many diseases and pests. The most important of them are yellow rust, loose smut, nematodes and aphids. Leaf rust, black rust, net blotch and spot blotch are not very important so far. These minor diseases are either localised or their incidence is so far low.

## Control of Diseases

Yellow rust is a major problem of barley in the north and north-western regions comprising the states of Punjab, Haryana, Rajasthan, Himachal Pradesh, Delhi, U.P. and Bihar. There are

three main races of yellow rust (G19 and 57) prevalent in India. Very little success has been achieved in incorporating race specific resistance. The varieties developed so far possess general resistance. The new barley varieties evolved under the co-ordinated barley project possessing general resistance to yellow rust are Kailash (NP109), Himani, Dolma (DL70), PL56 (Pre-released) and tolerant to yellow rust are BG108 and DL36. Leaf rust and black rust are of minor importance. Leaf rust occurs when crops reach maturity in India. Therefore, little emphasis is being paid on incorporating leaf and black rust resistance into new varieties.

## Control of Barley Pests

Pests cause considerable damage to the barley crop, affecting yield. The Aphid Rhopalosiphum maidis (Fitch) is most important among the barley pests which may cause about 25% damage in some commercially grown varieties. Apart from Aphid, brown wheat mite Petrobia Latens is also becoming a serious pest of barley in rainfed areas.

## Screening of Germplasm Resistant to Diseases and Pests

Success in breeding for disease and pest resistance lies in developing a quick machinery for replacement of varieties. This process is closely linked with quick and better methods of screening the varieties to suit a dynamic selection programme. During the last few years plant pathological and entomological screening nurseries were raised in different parts of the country. The locations or 'Hot-spot ' areas were selected in agro-climatic conditions which favour incidence of barley diseases and pests. The germplasm identified so far from these screening trials possessing resistance to various diseases and pests are detailed below:

## Barley varieties possessing resistance to various diseases and pests.

1. Yellow Rust:

   (a) New Varieties: HBL89, HBL93, HBL99, HBL104, HBL154, HBL163, HBL165, HBL183, HBL180, K730-35.

   (b) Sources of Resistance: Canbrinus, Bige, BHS, 17 Nos. 3438, 3473, 3476, 3843, 3752, BU-9-22, BHS12, Sultan, EB1626, Ahor 131/67, No. 1805, Firebech, Apan 1-147, EI 04, CI 0897, and CS 53/3.

| | | |
|---|---|---|
| 2. | Leaf Rust: | EB 770 |
| 3. | Loose Smut: | Odessa |
| 4. | Nematodes: | Morocco, Moroccain |
| 5. | Aphids: | EB921, Cult.371-1, Cult-9477-3, Cult.9810, Cult.9972. |
| 6. | Stored Grain Pest: | Notch-2 |

However, these barley strains possess only field resistance. Due to limited funds and facilities available, it is very difficult job to undertake rapid collection and screening of the germplasm under controlled conditions.

Screening of barley varieties under field and green house conditions requires both a national and an international approach. Financial and technical cooperation with international agencies is needed to face the challenging problems of barley.

Breeding Policy

Since yellow rust poses the greatest threat to barley, breeding in the past has largely been confined to developing lines possessing race specific resistance. In this approach periodic varietal replacement and varietal zoning is needed. However, farmers in India generally sow their own seeds and are reluctant to make frequent varietal shifts. The incorporation of horizontal resistance is therefore gaining interest among the barley breeders. However, it would be ideal if horizontal and vertical resistance was combined in new barley varieties to the maximum possible, keeping in view the frequency of occurrance of new races and biotypes of yellow rust.

Agronomic Advancement:

Agronomic experiments have been designed to find suitable data on sowing, minimum tillage operations, seed rate, planting methods, economic doses of fertilizer and time and methods of their application for rainfed and irrigated for both timely and late sowing. Barley is usually sown the same time as wheat around middle of November. However, under rainfed conditions, sowing takes place around last week of October to first week of November

when there is good amount of moisture available in the soil but late sowing can be around middle of December in Western India and up to 31st of January in the eastern part of the country.

In irrigated areas 4-5 ploughings with a local plough after a deep ploughing with a soil turning plough are needed. In the rainfed conditions 1-2 ploughings are sufficient to prepare a good tilth. Each ploughing is followed with one or two plankings to conserve moisture.

Seed rate depends upon seed size, nature of variety (semi-dwarf/tall) and methods and time of sowing. Bold seeded varieties need relatively higher seed rates. Similarly in rainfed and late sown conditions, higher seed rate is recommended because of relatively lower tillering ability of the crop. Normal seed rate has been found to be 75 kgs. per hectare for tall varieties. However, higher plant populations can be raised per unit area of semi-dwarf and dwarf varieties due to less shading of the crop. Hence, the general recommendation is to apply the rate of 75 kgs in the irrigated, normal sowing condition and about 80-100 kgs per hectare in rainfed and late sown and saline soil conditions.

Economic fertilizer doses have been worked out for both 6-row and 2-row barley varieties. Optimum doses are 20N: 10P: 10K for rainfed and 40N: 20P: and 20K kgs per hectare for irrigated, timely and late sown crops. Tall barley varieties do not respond beyond 40 kgs of nitrogen application. The normal recommendation for semi-dwarfs is not more than 50-60 kgs of nitrogen per hectare. Response of barley varieties to nitrogen management under different cropping conditions is detailed in tables 4 and 5 respectively.

Two to three light irrigations have been found sufficient to raise a good crop. Where facilities for three irrigations exist, the first irrigation should be given at the crown root stage (21-25 days after sowing), the second at the jointing stage of the crop and third at the flowering stage. Where facilities for only two irrigations exist, the first irrigation should be given at the crown root stage and the second at the boot stage of the crop. However, where only one irrigation is possible a pre-sowing irrigation must be followed by one flood irrigation 35-40 days after sowing when crop has reached to maximum tillering stage.

From data collected so far, it is very clear that new barley varieties have outyielded the best wheat varieties in all the regions including hill zones under both rainfed and late sown conditions. The margin of yield differences ranges from 5 to 10 quintals per hectare.

The results confirm the superiority of barley varieties over wheat under resource constraint conditions.

Comparative Performance of Wheat/Barley/Triticale

Semi-dwarf barley varieties have out-yielded both high yielding wheat and triticale varieties under late sown and limited input conditions. The research results obtained from a number of trials are quite encouraging and indicate the possibility of popularising barley cultivation in rainfed and late sown conditions among farming communities with limited land and input facilities and with the main objective of producing bulk of food grain irrespective of quality of grains, to meet their own family requirements.

Impact of Coordinated Barley Research Production

The All-India Coordinated Barley Improvement Project was started in the year 1967-68. Within 8-9 years about a dozen improved barley varieties and agro-techniques were developed. These developments were passed on to the cultivators for adoption. However, data show that there has been continuous decline in the area, production and per hectare yield of barley in India from 1967-1968 . till 1974-1975.

The main reasons for this decline are:

1. Non-availability of high yielding lodging-resistant barley varieties has been the basic factor behind shifting a sizeable cultivated area from barley to high yielding wheat varieties.

2. Poor price support to barley as compared to that given to wheat and gram reduces farmers preference to grow barley. In this connection, an example of remunerative price support and its immediate impact on farmers to adopt a particular crop is cited here. In the year 1973-74 and 1974-75 when the margin between the price of wheat (@ Rs. 76/q) and barley (@ Rs. 65/q) was very narrow and prices of seed, fertilizers, electricity, fuel, pesticides and labour increased rapidly the cultivation of wheat was

not economical. Therefore in 1973-74 and 1974-75 even in traditional wheat growing area, farmers shifted toward cultivation of barley. A significant increase was observed in the area under barley and the production and yield per hectare.

However, again with revision of wheat price (@ Rs. 105/q plus bonus) favourably in the year 1974-75 coupled with reduction and stabilization of prices of essential inputs, farmers found wheat cultivation to be more rewarding than barley. This is still so because:

1. Barley is being introduced into rainfed saline-alkaline areas and late sown conditions on late paddy fallows and flood plains of Diara Land.

2. Absence of efficient arrangements for production and supply of good quality barley seeds to the cultivators.

3. Due to the poor price support extension agencies took no interest in introducing new barley varieties among farmers.

4. Barley is being largely cultivated on marginal lands without much care.

5. Barley is the only cereal crop which did not receive any assistance in the past in form of breeding materials, funds, technical expertise and new ideas from any international organization and institution.

6. The All-India Coordinated Barley Improvement Project at home is also very poorly funded and equipped with research facilities as compared to other crop research projects.

Maximizing Barley Production in the Country - Future Programmes

1. Modernising Barley Breeding Research: The most important task before the barley research workers is to modernise the barley breeding programme to fill up the research gaps. With this view, the barley breeding programme under the project has been suitably revised to suit the growers and consumers needs and also to fill the gap in our current food production drive. The revised programme aims to develop:

(a) high yielding semi-dwarf, lodging-resistant barley varieties with hull-less amber grain, rich in nutritive value and resistant to major diseases and pests suited to both plains and hill valleys, particularly for dry land and late sown conditions.

(b) high yielding semi-dwarf barley varieties with bold thin husked grains and higher extract recovery for industrial uses.

(c) high yielding semi-dwarf barley varieties for saline-alkaline soil conditions.

(d) dual purpose barley varieties for fodder-cum-feed grain production.

(e) facilities for basic research on genetics and cytogenetics of barley and the resistance mechanusm and mode of infections of major diseases and pests.

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Table 1. Improved Varieties of Barley Developed under the Barley Project

| Name of Variety | Origin | Parentage | Year of release by (CVRC) | Average Yld.Q/ha. | % increase in in yield over (local) | Area of Adaptibility | Special features |
|---|---|---|---|---|---|---|---|
| Tall | | | | Varieties for Plain | | | |
| Ratna | IARI New Delhi | Selection from local material | 1970 | 19.0 | 15 | For rainfed areas in Eastern U.P. and Bihar | Tolerant to saline and alkaline conditions |
| Jyoti | Kanpur (U.P.) | C 251xK12 | 1970 | 30-35 | 6-10 | For irrigated conditions in Punjab, Haryana, Rajasthan and Western U.P. | |
| RS. 6 | Jaipur (Rajasthan) | RS 17xNP 21 | 1970 | 35-38 | 12-18 | For irrigated and rainfed conditions in North M.P. Southern Rajasthan and South U.P. | Tolerant to Saline Alkaline conditions |
| Clipper | Introduction from Australia | - | 1969 | 20-25 | - | For irrigated conditions in Delhi, Haryana and Rajasthan. | Suitable for malting & brewing |
| BG - 25 | HAU, Hissar | C138xCN 170 | 1976 | 25.00 | - | Haryana for irrigated conditions | Resistant to yellow rust normal sowing |
| BG-108 | HAU, Hissar | Kinned x C164 | 1976 | 20.00 | - | Haryana for irrigated conditions | Late sown condition Resistant to yellow rust. |
| | | | | Varieties for Hills | | | |
| Kailash | IARI (Simla) | (EB438xNP100)xNP | 1965 | 20.00 | 16 | Valley of Jammu and Kashmir Himachal Pradesh and U.P. Hills up to 5000 | Resistant to yellow rust. |
| Himani | -do- | (Atlasx54Kailash) x BHS-15-88 | 1974 | 24.00 | 11 Kailash - | Medium to lower hills of H.P. and U.P. | Resistant to yellow rust. |
| Dolma | Bhunter (H.P.) | Selection from USA-115 | 1974 | 22.00 | 3 LSB-3 - | Medium of higher hills of HP. | -do- |

Table 1 (Cont'd)

| Name of Variety | Origin | Parentage | Year of release by (CVRC) | Average yld.Q/ha. | % increase in yield over (local) | Area of adaptability | Special Features |
|---|---|---|---|---|---|---|---|
| | | Released by (SVRC) | | Semi-Dwarf varieties | | | |
| RDB-1 | Rajasthan | mutant of RS-6 | 1971 | 50-60 | | Rajasthan | Semi-dwarf |
| DL-70 | IARI | BGI x M-5-13 | 1974 | 45.0-60.0 | | Punjab | Semi-dwarf |

Pre-release varieties on mass testing under Minikit Trials - BG-25, BG-108, RD-57, RD-103, RD-118, DL-3, DL-36, DL-70, PL-56, and K-125.

CVRC: Central Variety Release Sub-Committee SVRC: State Variety Release Sub-Committee.

Table 2. Impact of price on area and production of Barley

| Year | Year | Barley Area Mill./ha. | Production (Mill./m.t.) | Yield (q/ha) |
|---|---|---|---|---|
| Drought years | 1971-1972 | 2.45 | 2.57 | 1050 |
| " " | 1972-1973 | 2.44 | 2.57 | 971 |
| " " | 1973-1974 | 2.65 | 2.37 | 895 |
| " " | 1974-1975 | 2.93 | 3.15 | 1075 |
| | | Wheat | | |
| Drought Years | 1971-1972 | 19.14 | 23.832 | 1307 |
| " " | 1972-1973 | 19.46 | 26.41 | 1380 |
| " " | 1973-1974 | 18.53 | 21.71 | 1271 |
| " " | 1974-1975 | 18.10 | 24.23 | 1338 |

Sources:

* Estimate of Area and Production of Principal Crops in India (1974-1975).
* Directorate of Economics and Statistics, Ministry of Agriculture Government of India 1976.

Table 3.

Performance of Barley Varieties Under Saline-Sodic Soil Conditions

Location: Central Soil Salinity Research Institute

| Treatment Varieties | Yield kg/ha. | Treatment Nitrogen (kg/ha) | Yield kg/ha |
|---|---|---|---|
| Jyoti | 18.4 | 0 | 9.8 |
| Ratna | 22.6 | 20 | 15.0 |
| DL-70 | 17.7 | 40 | 19.5 |
| Vijaya | 17.9 | 60 | 24.8 |
| Local | 20.6 | 80 | 28.2 |
| S.Emt. | 0.9 | S.Emt. | 1.3 |
| C.D.5% | 1.9 | C.D.5% | 2.6 |

Source: All-India Coordinated Barley Improvement Project - Agronomoc Experiments, 1975-76.

Table 4.

Response of Barley Varieties to Nitrogen Management Under Rainfed Condition

Grain Yield (Q/ha)

| Timely Sown Condition: | | | | | | | | Late Sown Condition: | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | North Western Plain | | North Eastern India | | | Higher hills | | North Eastern Plain | | |
| | Delhi | Hissar | Treatment | Pusa | Maldo | Treatment | Barley | Treatment | Pusa | Kalyana |
| BG49 A | 18.5 | 21.2 | K125 | 22.3 | 27.1 | Himani | 12.7 | K125 | 17.6 | 18.3 |
| DL3 | 20.1 | 22.8 | Vijaya | 21.8 | 27.7 | Dolma | 9.5 | Ratna | 16.4 | 18.4 |
| RD31 | 19.9 | 25.8 | Ratna | 18.7 | 26.7 | BHS24 | 14.5 | DL36 | 17.7 | 16.6 |
| Ratna | 21.2 | 21.8 | Local | 15.0 | 27.0 | HBL29 | 10.4 | Jyoti | 17.2 | 17.3 |
| S.Emt. | 1.3 | 2.0 | S.Emt. | 0.5 | 2.4 | S.Emt. | 1.2 | S.Emt. | 0.4 | 1.5 |
| C.D.5% | N.S. | 4.5 | C.D.5% | 1.1 | N.S. | C.D.5% | 2.7 | C.D.5% | 0.9 | N.S. |
| N(Kg/h) | Average Yield | | N.(kg/ha) | Average yield | | N.(Kg/ha) | Average yield | N.(kg/ha) | Average yield | |
| 0 | 18.3 | 12.9 | 0 | 11.0 | 25.8 | 0 | 8.6 | 0 | 8.9 | 13.6 |
| 20 | 19.8 | 20.0 | 20 | 17.1 | 27.6 | 20 | 10.6 | 20 | 15.8 | 15.9 |
| 40 | 20.1 | 26.6 | 40 | 22.7 | 27.8 | 40 | 12.7 | 40 | 20.8 | 20.0 |
| 60 | 21.4 | 32.1 | 60 | 27.0 | 27.3 | 60 | 15.0 | 60 | 23.1 | 21.0 |
| S.Emt. | 0.9 | 1.2 | S.Emt. | 0.7 | 1.8 | S.Emt. | 1.1 | S.Emt. | 0.6 | 0.7 |
| C.D.5% | 1.9 | 2.5 | C.D.5% | 1.5 | N.S. | C.D.5% | 2.2 | C.D.5% | 1.3 | 1.5 |
| C.V.% | 13.6 | 15.3 | C.V.% | 0.7 | 18.9 | C.V.% | 26.4 | C.V.% | 10.7 | 11.9 |

Source: All-India Coordinated Barley Improvement Project - Agronomic Experiments, 1975-76.

Table 5. Response of Barley Varieties to Nitrogen Management under Irrigated Condition

Grain Yield (Q/ha)

| Timely Sown Conditions | | | | | | Late Sown Conditions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North Western Indian Plain | | | North Eastern Indian Plain | | | North Western Indian Plain | | | North Eastern Indian Plain | | |
| Treatment | Delhi | Durga-pura | Treatment | Kanpur | Madhu-bani | Treatment | Aqra | Durga-pura | Treatment | Kanpur | Pusa |
| DL70 | 45.4 | 35.5 | DL36 | 36.5 | 20.5 | BG108 | 30.7 | 21.3 | BG105 | 20.0 | 15.9 |
| DL88 | 48.2 | 32.1 | DL85 | 38.6 | 24.5 | RD118 | 26.7 | 23.9 | DL48 | 17.5 | 17.5 |
| DL120 | 46.0 | 32.9 | Jyoti | 34.2 | 22.9 | DL3 | 33.2 | 27.6 | DL70 | 16.2 | 18.6 |
| BG108 | 44.3 | 36.7 | K-24 (local) | 33.9 | 19.5 | DL88 | 29.3 | 27.8 | P103 | 19.3 | 19.6 |
| Jyoti | 45.3 | 32.2 | | | | | | | | | |
| S.Emt. | 2.5 | 1.4 | S.Emt. | 3.1 | 1.5 | S.Emt. | 2.7 | 0.8 | S.Emt. | 0.8 | 1.1 |
| C.D.5% | N.S. | 3.1 | C.D.5% | N.S. | 3.4 | C.D.5% | 6.0 | 1.9 | C.D.5% | 1.8 | 2.5 |
| N(Kg/ha) | Average yield | | N(Kg/ha) | Average yield | | N(Kg/ha) | Average yield | | N(Kg/ha) | Average yield | |
| 0 | 40.4 | 22.8 | 0 | 26.2 | 13.0 | 0 | 24.8 | 15.8 | 0 | 8.1 | 9.2 |
| 20 | 45.2 | 35.0 | 20 | 32.9 | 19.0 | 20 | 30.9 | 24.6 | 20 | 16.2 | 16.7 |
| 40 | 48.2 | 38.1 | 40 | 38.6 | 21.4 | 40 | 32.2 | 26.3 | 40 | 22.6 | 21.8 |
| 60 | 49.6 | 39.7 | 60 | 35.4 | 25.9 | 60 | 31.9 | 29.8 | 60 | 26.0 | 23.8 |
| S.Emt. | 1.9 | 1.6 | S.Emt. | 2.5 | 0.6 | S.Emt. | 1.6 | 1.2 | S.Emt. | 0.8 | 0.7 |
| C.D.5% | 3.8 | 3.2 | C.D.5% | 5.1 | 1.2 | C.D.5% | 3.3 | 2.4 | C.D.5% | 1.6 | 1.4 |
| C.V.% | 13.0 | 14.9 | C.V.% | 19.9 | 7.8 | C.V.% | 15.3 | 14.1 | C.V.% | 12.3 | 11.0 |

# BARLEY PRODUCTION IN PAKISTAN

By

M.A.S. Kirmani*

Barley is a crop of minor importance in Pakistan, compared to wheat and rice. It is cultivated in an area of 0.175 million hectares, compared to 6 million hectares under wheat. The production is about 0.19 million metric tons as against 7.75 million metric tons of wheat. The actual area under barley and yearly production for the last six years is given in Table 1.

Table 1.

| Year | Total area in '000' hectares | Total production in '000' metric tons |
|---|---|---|
| 1970-71 | 138.9 | 92.0 |
| 1971-72 | 154.9 | 103.3 |
| 1972-73 | 162.5 | 109.3 |
| 1973-74 | 202.3 | 140.0 |
| 1974-75 | 191.5 | 137.5 |
| 1975-76 | 200.6 | 130.5 |

Total area (Avg. 71-76) = 175.1 thousand hectares. Total production (Avg. 71-76) = 118.8 thousand metric tons.

The average yields are about 678 kg. per hectare while wheat yields are 1290 kg. per hectare.

Barley is cultivated under a wide range of ecological conditions between 24°N to 36°N latitude and from sea level to 1800 meters (a.s.l.). Fifty percent of the area under barley is irrigated, twenty percent is under rainfall of over 500 mm per annum, 10 percent under a range of 200 mm to 500 mm and the remaining 20 percent is grown below 200 mm of rainfall.

* Senior Plant Pathologist,
Cereal Disease Research Institute, Murree, Pakistan.

The distribution, dates of sowing and harvesting and the main varieties in different parts are given in Table 2.

Table 2.

| Area of Cultivation | Date of Sowing | Date of Harvesting | Main Varieties |
|---|---|---|---|
| Punjab | | | |
| Lahore, Multan, Rawalpindi, Sargodha and Bahawalpur | November | April | Type 4 (Reevari) for poor soils and late sowings.<br>Type 5 (Lyallpur) Resists lodging.<br>Suitable for fertile lands. C 141, C 123/1 R 16 and C 121/33. |
| Sind | | | |
| Sukkar, Hyderabad. | October/ November | March (late) | Pusa Barley T.J.-70 |
| N.W.F.P. | | | |
| Peshawat, Malakand D.I.Khan | November | April | Local cultivars C 603 |
| Buluchistan | | | |
| Quetta, Kalat, Sibi. | October/ November | April/ May | Local cultivars. |

All the varieties under cultivation are six row types except Proctor, a two row Barley, imported from United Kingdom and cultivated specially for malting purposes on a small scale. Most of these varieties have been cultivated for more than forty years. Some of the selections introduced since 1970 are:

(1) SD-729 Porvenir.
(2) CM 67 Mara
(3) T.J.-70
(4) Gizeh 134-Apum
(5) Arivat (6
(6) Apum HO 1905
(7) C 603

About 50 percent of the Barley is used as green fodder and feed, and 10 percent for human consumption in the form of beverages and local medicines. In the Punjab it is also used as roasting grains and for making sweetened flour syrup (a substitute diet in hot weather because of its cooling effect).

Over a number of years it has been observed that various diseases attack barley in various regions. The rusts are the most important of these.

Stripe rust is restricted to the Northern foot hill regions of the Punjab and North West Frontier Province (NWFP) which contain about 40 percent of the cropped area. It was very severe in 1973 when head infections caused more than 50 percent damage in the Rawalpindi region of North Pakistan. All the varieties under cultivation are susceptible to stripe rust.

Stem rust is wide spread and almost all the varieties are susceptible. It is more important in the southern region due to the hot and humid conditions. During the last five years about 2-3 percent loss can be estimated due to this disease only.

Covered smut is restricted to the northern regions having low temperatures in the crop growing period. At times more than 20 percent of the crop is found infected with this disease in individual fields, but on average, it is estimated that there is a 1-2 percent loss through this disease alone.

Loose smut is also found in the central plain areas but its incidence is very low.

Other diseases caused by Helminthosporium and Rhyncosporium (scald) are of less significance but do occur in different regions. Damage due to these diseases is negligible. Aphids and Army worm caterpillers are important insect pests and cause damage during rainy and warm conditions.

Barley, being a minor crop, has received little attention for its improvement. Much early effort was confined to classifying the local types being cultivated for centuries in different parts of the country. Better adapted and high yielding types like Type 4 (Reevari) and Type 5 (Lyallpuri) were then introduced to the farmers. The next effort in Barley improvement was made in

1930's when a hybridization program was taken up and crosses like C 141, C 123/L, B 16, C 121/33 and pusa barley were released. Then, in late sixties, efforts were made to make selections from the exotic material received from F.A.O. and other agencies and better adapted high yielding varieties like (1) SD729 Porvenir, (2) CM67-SV Mara, (3) TJ170, (4) Gizeh 134-Apum, (5) Arivat, (6) Apum HC1905, and (7) C603, were selected for introduction after 1970. Presently no vigorous barley improvement program is in progress.

The area under barley has remained limited and has shown an increase of only 62,000 hectares from 1971-76. This low acreage may have been due to the fact that there has been no increase in the requirement of barley for malting and the yield of barley has been about half (678 kg/hectare) that of wheat (1290 kg/hectare). This does not provide any economic incentive for barley cultivation. However barley proves profitable as a green winter-fodder for animal feed as two to three cuttings can be taken per season. This can fetch double the price of a traditional wheat crop particularly in the rainfed areas, but there has been no substantial increase in the demand for green fodder to induce any increase in the area under cultivation.

As has been stated earlier, barley yields are relatively low and provide little attraction for grain purposes. If high yielding, disease resistant and high malting quality varieties are introduced, the export market can be developed. Such varieties can be cultivated more extensively on the marginal lands where barley may perform better than wheat.

# PRESENT STATUS AND PROBLEMS IN BARLEY BREEDING IN THE REPUBLIC OF KOREA

By

C.H. Cho & D.J. Maeng*

## Section 1. Barley Acreage, Production and Use in Korea.

### 1. Acreage:

The total land area of the Republic of Korea is 9,875,769 hectares. Of this only 23% is under cultivation while 77% is occupied by forest and uncultivated land. Of this cultivated land 56% is paddy while 44% is upland. Figure 1 is a summary of the Korean acreage and production of barley and wheat.

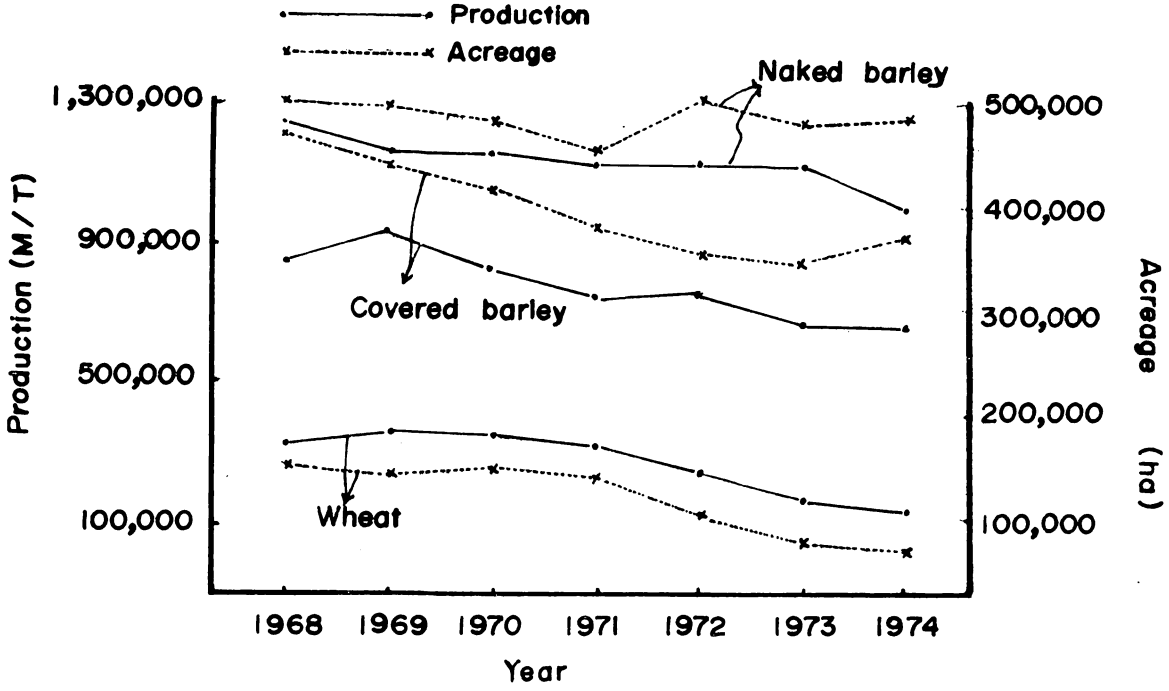



Fig. 1. 1968 to 1974 production of covered barley naked barley and wheat in the R·O·K (Year book of agricultural and forestry statistics)

* Crops Experiment Station, Office of Rural Development, Suweon, Korea.

Over the whole of Korea with the exception of 1974 the acreage of covered barley has declined every year since 1968. (The 1974 covered barley acreage represents a reduction of 21% compared to that of 1968). However, the Korean acreage of naked barley has been erratic, and there appears to be little overall trend in its increase or decrease. The wheat acreage in Korea has consistently and substantially been reduced every year. The 1974 wheat acreage of 66,911 hectares was 57% lower than the 1968 acreage. The average wheat acreage from 1968 to 1974 was 121,344 hectares. Of the total barley acreage 48% is planted under paddy after rice, 33% is cultivated under upland after soybean and 18% is planted as a barley crop or as double cropping of barley-vegetable and barley-industrial crops.

2. Domestic Production and Imports of Barley

Domestic production of barley and wheat shows similar trends to that of their acreage (Figure 1). In the Republic of Korea from 1968 to 1974, the average covered barley production has been 771,097 metric tons, the average naked barley production has been 1,147,263 metric tons, and the average wheat has been 275,582 metric tons. Covered barley accounts for 37%, naked barley for 56% and wheat for 7% of total production of the three crops. Korea imported a total of 3,147,000 metric tons of grain in 1975. Wheat imports were 1,703,000 metric tons while barley imports were 354,000 metric tons. Thus barley imports account for 11% of the total grain imports. From 1968 to 1974, barley imports have varied from none in 1970 and 1971 to imports of 349,607 metric tons in 1973. However, after 1976 barley should not be imported as Korea hopes to accomplish barley self-sufficiency.

3. Use of Barley

Barley and rice are used as the main stays of the Korean diet. In the Korean diet, barley comprises about 20% of the food consumed. Barley consumption has averaged about 53 kilogrammes of barley per person per year during the past ten years. Of the total ROK barley supply in 1975, 75% was used as human food, 1% was used for malting and brewing, 4% was used as animal feed, and 20% remained as stock. In Korea, barley demands for malt

and feed grains are now increasing because of increased brewing demands and animal population.

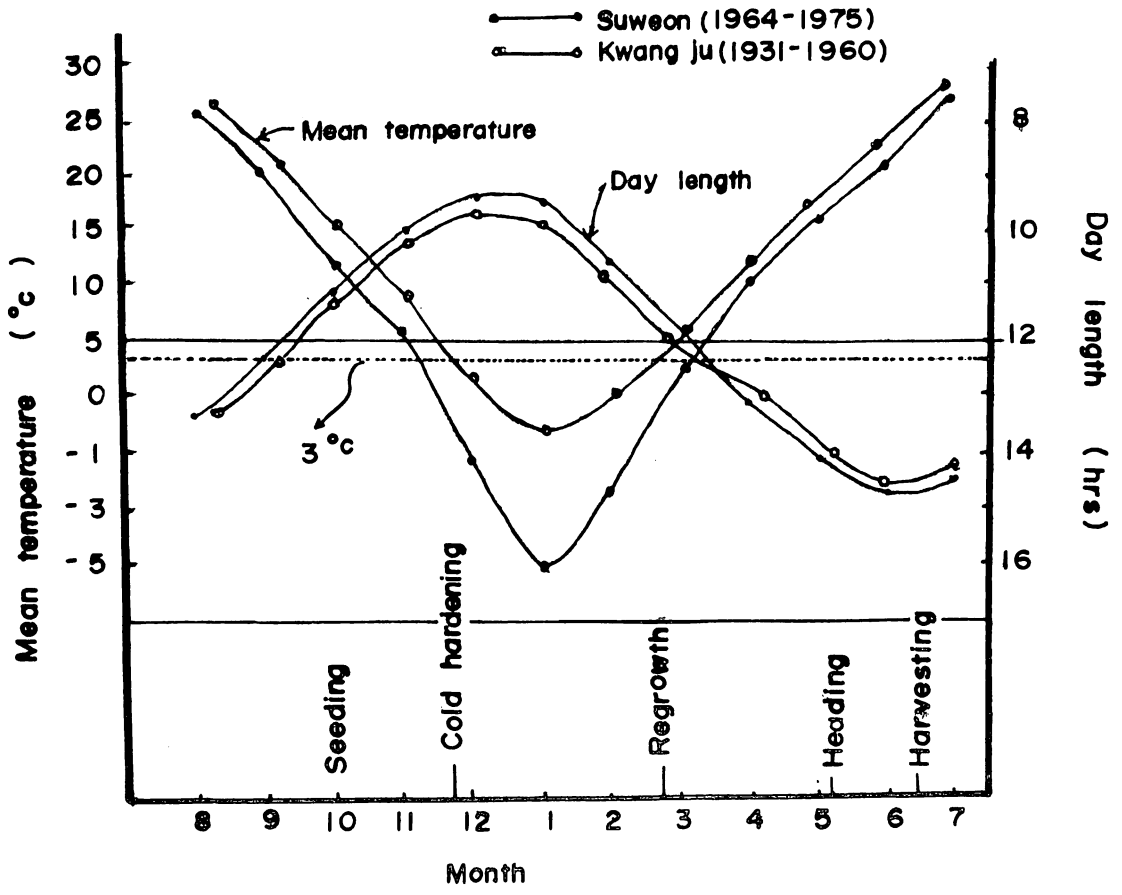



Fig. 2. Mean temperature and day length

Section 2. Environmental Condition and Barley Growth in Korea.

1. Temperature and Day Length

Mean temperature and day length can be explained in conjunction with barley growth as shown in Fig. 2. About 250 days, including 90 days of winter, are required for barley growth. Barley is planted in October and harvested in early June. Having a growing season of 160 days, many of them at low temperatures, causes barley yields to be reduced in Korea. As most Korean barley

varieties are generally seeded during the fall and are of winter habit, they need to be vernalized. In mid- and northern Korea, the temperature remains below 0°C for a long period during the winter months. In this period, barley is retarded and even damaged by the cold. For example, in 1957 there was about a 50% yield loss due to severe cold injury. From March the temperature rises rapidly encouraging the growth of barley. Day-length increases as the temperature rises. The day-length from seeding in October to regrowth in March is short while day-length after April becomes increasingly longer. Day-length at heading time in May is over 14 hours.

2. Precipitation

The average precipitation from 1931 to 1960 was over 1,200 mm in the barley growing regions of Korea. However, this rainfall is concentrated during the summer months. Of the yearly precipitation, about 600 mm falls during the barley growing months of October to June, offering sufficient moisture for barley growth. However, precipitation from March to May is generally irregular. This makes it difficult to maintain favourable soil moisture conditions for barley growth(as shown in Figure 3). When precipitation is below 200 mm upland barley is damaged by drought. When precipitation is over 200 mm paddy barley is injured by wet soil. As shown in Figure 4, the amount of soil erosion is highest from late in June to late in August because of the heavy rainfall. Investigation into soil erosion and the establishment of a soil conservation program is needed.

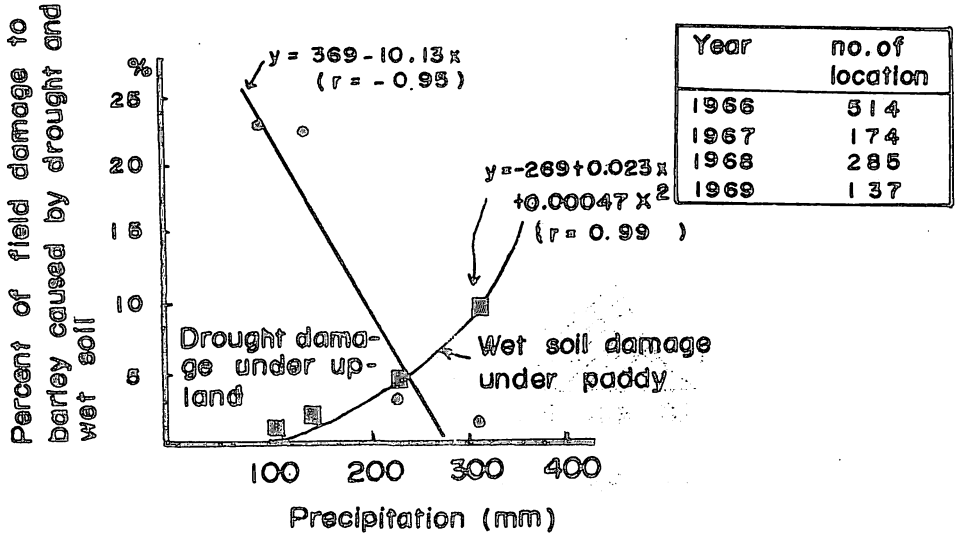



Fig. 3. Field damage to barley caused by drought and wet soil damage(IAS, 1966-1969)

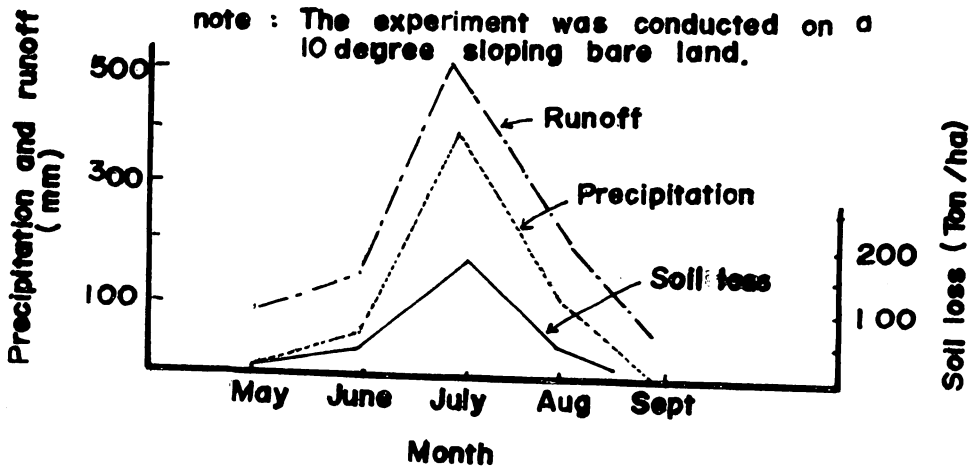



Fig. 4. Monthly drecipitation and soil erosion ( Ins. Agi. Engin. Utl. 1972 ).

3. Soil Conditions and Barley Growth

Barley in Korea is mainly cultivated at an elevation of 100 m or below. Most of the barley produced in Korea, including upland and paddy land, is grown on highly acid soils (Figure 5).

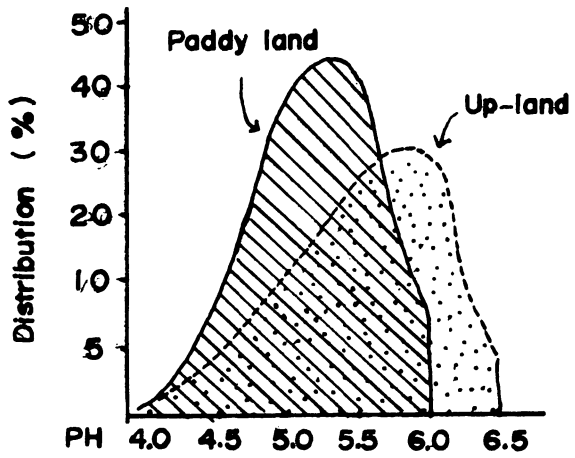



Fig. 5. Soil PH in Korea. (IPE, 1964-1966)

Appreciable quantities of lime applied on these soils increased barley yields by about 24%. This effect is carried over even when the lime is applied to the previous rice crop. The residual effects on barley of lime applied to paddy rice are shown in Figure 6. Appreciable lime applications increased barley yields by 24% and rice yields by 3%. Although appreciable quantities of lime have been applied during the last decade, the pH values of soils have not been altered markedly. This suggests that the applied lime has only neutralized the acidity caused by the nitrogen fertilizer applied during this period. One of the major problems for growing barley in paddy fields is the yield loss caused by wet soil and high water levels.

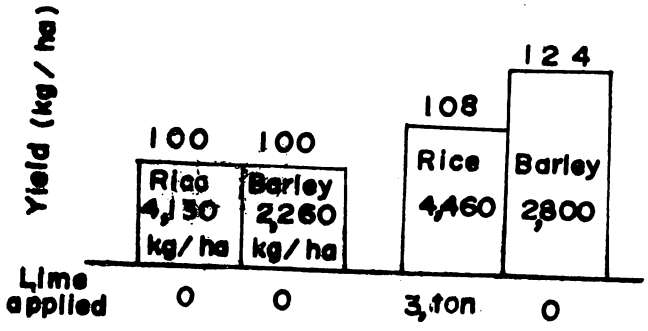



Fig. 6. Residual effects on barley of lime applied to rice (Youngnam CES, 1972)

4. Relation between Weather Conditions and Diseases

In Korea, Barley yields have been decreased on average by 10% due to disease damage. According to the results of a 1972 to 1975 IAS survey, barley stripe, loose smut and scab were the most serious diseases on barley (Figure 7).

Scab caused a barley yield decrease of 50% in 1963. Stripe, another serious barley disease, occurred mainly in the southern areas of Korea. To prevent the occurrance of these diseases, barley researchers are breeding for disease resistance, while farmers are using chemical controls such as vitagiram on barley seeds.

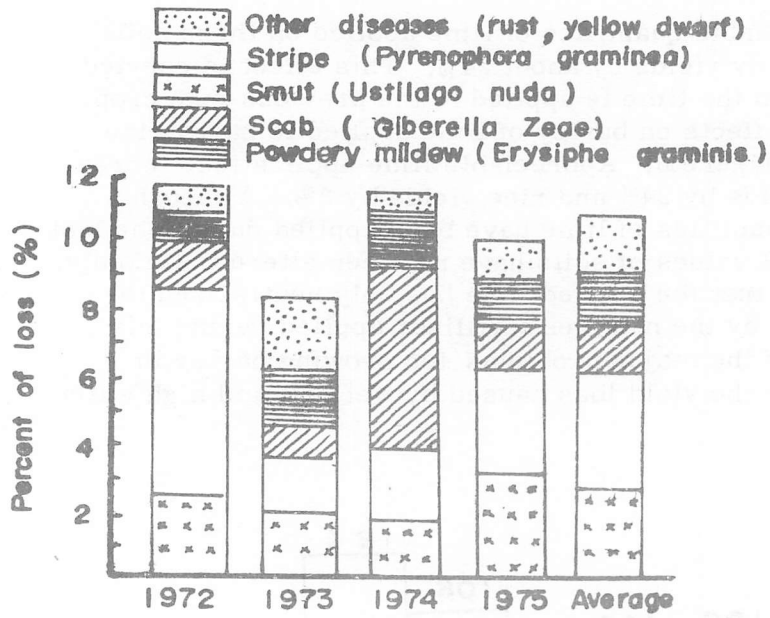



**Fig. 7. Annual yield loss in barley caused by major diseases (IAS, 1975)**

Section 3: Management for Barley Cultivation in Korea.

(A) Cropping System under Paddy Field Conditions

The most common cropping system on paddy fields is to cultivate barley after rice. Before the development of the variety Olbori, barley could only be grown south of the line where the average minimum January temperature is -8°C (Figure 8). Rice yields at north of the Daejon district were substantially reduced when double cropping with barley. This is due to the delayed time of Tongil rice transplanting to allow the barley to mature. However, the production of barley following paddy rice is agronomically possible as far as the Han River with the use of Olbori barley and Chosengtongil rice as shown in Figure 9. An estimated 100,000 additional hectares of paddy fields could be double cropped with barley using improved barley and rice varieties.

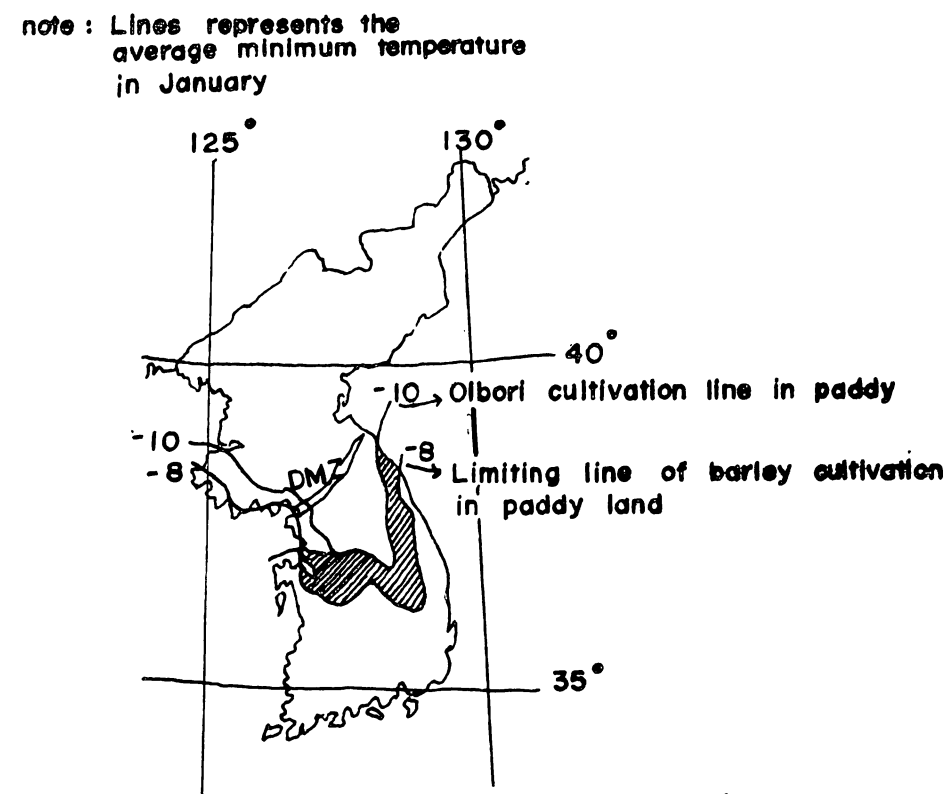



Fig. 8. Limiting lines of barley culture in paddy field (CES, 1974)

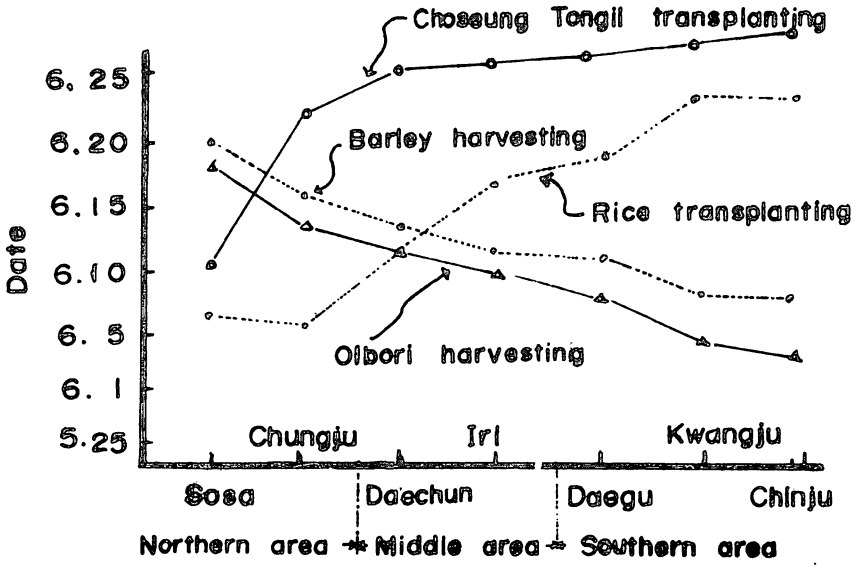



Fig. 9. Over lapping Growth period of barley and rice in paddy (CES, 1974)

(B) Cropping System under Upland Conditions

The most common cropping system in the uplands is to cultivate barley after soybean. As shown in Figure 10, barley soybean double cropping has some limitation due to growth period competition between these two crops. North of the Iri district, no double cropping with soybean is possible. Therefore, barley-soybean rotations are grown only in the central and northern areas of Korea. These peculiar cropping patterns under paddy and upland conditions also place strong emphasis on the earliness of barley.

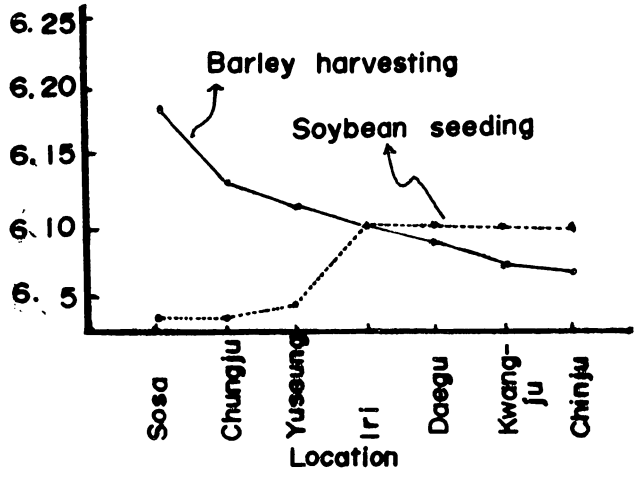



Fig. 10. Over-lapping growth period of barley and soybean in upland (CES, 1974)

Labor competition is one of the most serious constraints for barley production after paddy rice in Korea. The monthly distribution of labor and labor demands for barley and rice production per household in Korea are shown in figure 11. Barley harvesting and rice transplanting during June and July are the greatest competitors followed by rice harvesting and barley seeding in October and November. These problems can be substantially reduced by the mechanization of both barley and rice cultivation. Farm management in Korea is speeding up mechanization. Seeding with a power tiller and a rotatiller has been recently recommended for growing barley after paddy rice. This method reduces the labor requirement by 63% while maintaining the present yield levels (Figure 12).

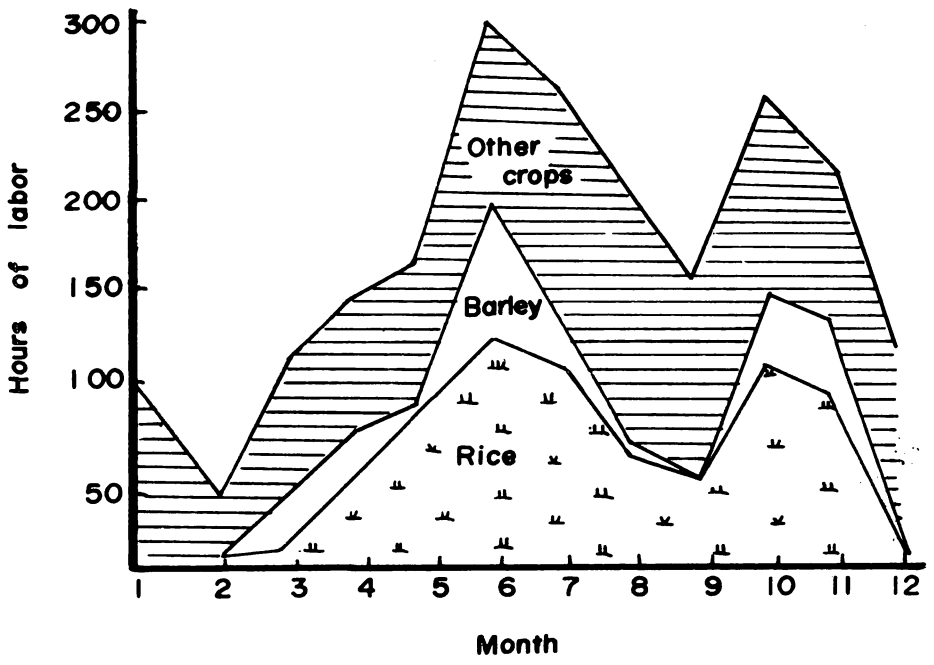



Fig. 11. Farm labor demands in Korea. (CES, 1975)

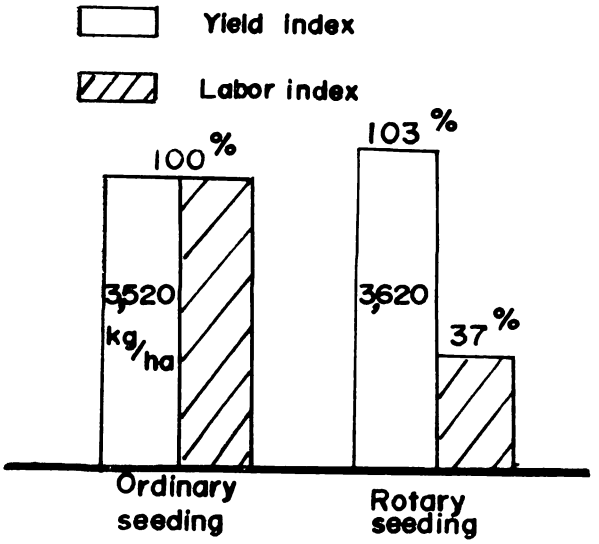



Fig. 12. Effect of rotary seeding (CES, 1974)

Prices received by producers for many agricultural products are set by the government. Farmers have a tendency to cultivate barley for their own use because barley gives a lower economic return than that of rice and soybean. To increase barley production, the government has assisted farmers with the dual price system as presented in Figure 13. Barley production is increased by the practical application of the dual pricing system and by the development of agricucultural techniques. However, in central and northern areas, barley cultivation under paddy is one of the limiting factors for increasing rice production. Farmers will plant barley in paddy fields when they think barley is profitable. Although barley can agronomically be grown after paddy rice, as far north as the Han River, farmers north of Yuseung dislike barley cultivation after paddy rice because of the lower returns than that of a single rice crop as shown in Table 1.

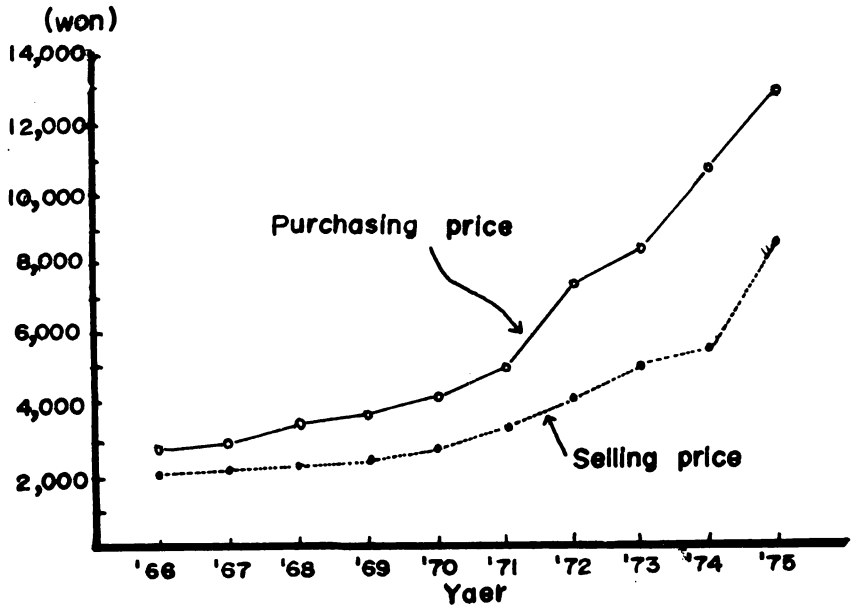



Fig. 13. Barley purchasing and selling prices of goverment (Year book of agricultural and forestry statistics, 1975)

Table 1. Comparing Profits Between a Single Rice Crop and Barley-Rice Double Cropping (CES: 1974.

| Items | Location | | | |
|---|---|---|---|---|
| | Chunchon | Sosa | Chongju | Yuseung |
| Yield reduction of rice by barley-rice double cropping (kg/ha) | 920 | 760 | 970 | 210 |
| Money loss from the reduced yield of rice by barley-rice double cropping (W) | -182,530 | -150,780 | -190,245 | -41,660 |
| Barley yield (kg/ha) | 1,610 | 3,060 | 3,180 | 3,330 |
| Returns from barley produced by barley-rice double cropping (W) | -12,580 | 159,720 | 173,980 | 191,800 |
| Comparison of profits between single rice crop and barley-rice double cropping (W) | -195,110 | 8,940 | -18,470 | 150,140 |

Note: This table was made by a basis of year book of Agricultural and Forestry Statistics in 1975.

Section 4: Breeding Efforts for New Barley Varieties.

1. Earliness

Earliness is the most important breeding goal to an expanded barley acreage in paddy and upland double cropping systems. Earliness will also help to avoid poor grain filling caused by high temperatures in May and June. Heading date is a useful indicator for earliness. Thus, major research emphasis is being placed on studying the physiological factors that control earliness. These factors include growth habit, cold tolerance, and day-length,

temperature responses. In addition studies on the genetics of the heading dates of selected materials have been conducted in order to identify additional valuable genetic sources of earliness. Early varieties are usually low in yield potential and have a low tolerance to cold. This is a great constraint to breeding for earliness. Korean barley researchers hope to solve this matter in the near future. The Crops Experiment Station has developed the new high yielding variety "Kangbori". This is an early and spring habit variety with cold resistance. Varieties such as Kangbori, Olbori, Boanchin and Dongsanpi 49, which are spring habit with cold resistance, are used as crossing materials in breeding the high yielding and early barley varieties.

2. Wet Soil Tolerance Resistance

Barley yields in paddy fields are lower than yields in upland fields. This is caused by excess moisture and wet soil damage resulting from poor drainage in the paddy fields. In order to grow more barley after rice, the selection of wet soil tolerant varieties is a very important breeding objective. Studies on the wet soil tolerance in barley are now being carried out under paddy field conditions at Honam Crops Experiment Station and at wet soil plots at Suwon and Youngnam Crops Experiment Station. Resistant varieties of wet soil tolerance such as Chilbo, Buheung and Kyungnam 89 were selected as being wet soil tolerant. They are now being used as breeding materials for wet soil tolerance.

3. Lodging Resistance

Lodging in Korea is caused by weak culms resulting from drought, an increased culm elongation due to higher temperature after heading, and poorly developed roots. Every year farmers apply more fertilizers to produce higher barley yields, causing the current recommended varieties to lodge and thus lessening their yield potentials. Kangbori is lodging resistant being twice as resistant to lodging in terms of straw breakage strength as the varieties released in the 1960's. Kangbori and Olbori are used as breeding materials for lodging resistance.

4. Disease Resistance

Among the barley diseases, barley stripe, scab, loose smut and powdery mildew are the most serious. Studies on the disease resistance of barley varieties are conducted through

natural and artificial inoculations. All entries in the preliminary and advanced yield trials as well as in the crossing blocks are simultaneously screened in disease plots and the results from this screening are used for selecting lines.

5. Nutrition and Utilization

Adaptive research is needed to improve the nutrition and utilization of barley. Basic research on barley nutritional improvement has substantially enhanced the possibility of improving barley's protein quality and quantity. In Korea barley is utilized as a boiled cereal mixed with rice. In preparing barley with rice, barley needs to be boiled twice as long as rice or soaked in water before cooking. Barley eating quality could be improved by lowering the gelatinization temperature for easy boiling, by having the barley boiled color white, by having a high pearling index, and by having a high protein content. Waxy barley varieties are lower in the amylose content and gelatinization temperature than in those of normal varieties. Because of the desired traits of boiled waxy barley, the Crops Experiment Station started breeding waxy barley varieties for high yield and cold tolerance in 1973. Waxy varieties such as Masankwamaek, Danggomugi, and waxy oderbrucker, are used as breeding materials.

## Section 5: Organization of Barley Research in Korea.

Korean barley research is conducted within the various subdivisions of the Office of Rural Development (Figure 14). The most extensive research program is carried out by the Crops Experiment Station located at Suwon with a branch station located at Mokpo. The Institute of Agricultural Sciences at Suwon conducts studies on barley diseases, insects, and soil problems. Covered barley research is carried out at the Suwon and Youngnam CES. Naked barley research is carried out at the Suwon and Honam CES and the Mokpo Branch Station. Wheat research is conducted at the Suwon and Youngnam CES. Additional experimentation involving regional trials is carried out by the Provisional Office of Rural Development and other divisions within the Office of Rural Development. There is little research work done on barley and wheat at the University level. One private company, Oriental Breweries, has conducted a varietal improvement breeding program in Korea since 1974.

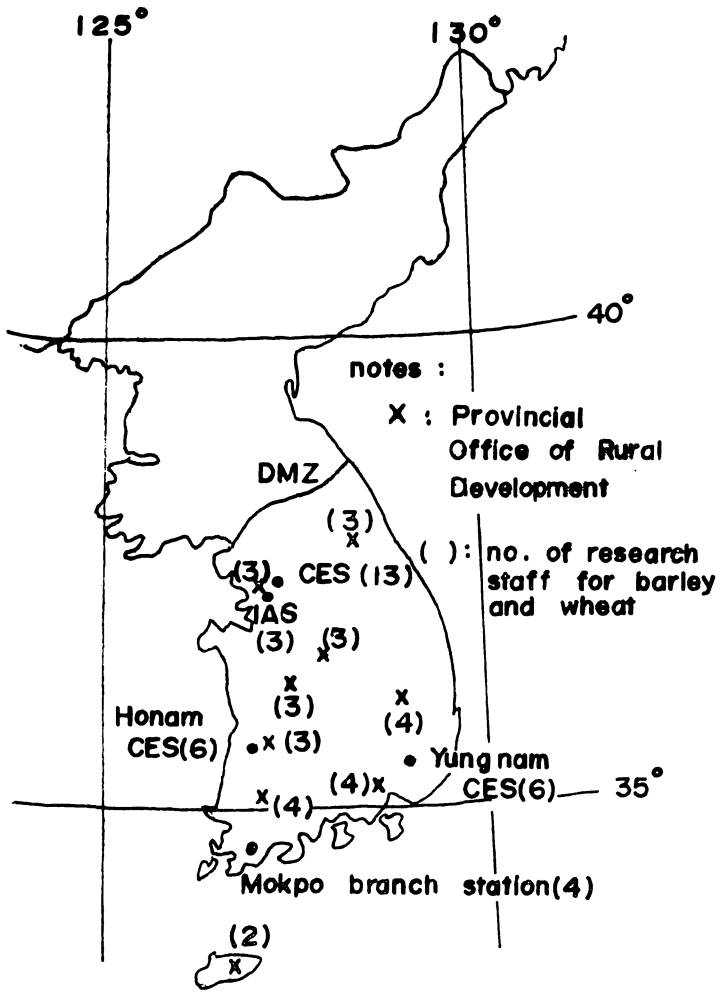



Fig. 14. Research structure of barley and wheat in Korea.

# BARLEY GROWING PROJECT BY THE CEYLON BREWERY LIMITED - SRI LANKA

By

D. Murugesan*

## Brief History

Barley growing was started in Sri Lanka by the Department of Agriculture in 1966. The main aim then was to ascertain whether Barley could be grown successfully, and if so, whether it could be used for fodder purposes in the areas where it is grown.

Subsequently, the Brewery took up this matter in 1967 with the aim of growing Barley for the purpose of malting.

Initially, four varieties of seed were imported, and the preliminary function of the Brewery was to sow seeds once a month to ascertain the best time for sowing of Barley in different parts of the island and to discover how elevation, climatic and soil conditions would affect the growth.

It was established from these trials that the best time to sow Barley is in September, to be harvested in January the following year. It was also found that the varieties of Barley that were used in these trials did not do well at elevations below 4,000 feet.

Subsequently, trials were carried out around Nuwara Eliya area, where the Brewery is situated, and which is 6,200' above sea level, to find out which of the malting varieties would do well.

After several trials it was decided to grow about 50 acres in Nuwara Eliya district and the seeds used were 'Proctor', 'Zephyr' and Julia, which are Two-Row varieties. It was found that Six-Row varieties do not thrive in our climatic conditions and were susceptible to disease.

The 50 acres of Barley that were grown in 1973 and harvested in January 1974 encouraged us to further efforts.

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* The Ceylon Brewery Ltd., Nuwara, Eliya, Sri Lanka.

We then obtained the services of Mr.J.Harold McLaughlin from Canada through the kind courtesy of the Canadian Executive Service Overseas. He was with us for six months to study the crop from September 1974 until February 1975, but unfortunately, unexpected heavy rains in December 1974 ruined the crop due to flooding and diseases.

There was a lull in our efforts during the 1975/76 season in the field of growing of Barley, but we carried out varietal trials using the seeds supplied by the kind courtesy of the Arid Lands Agricultural Development Programme.

During this period we also isolated Clipper Barley as the most promising variety to be used in field trials.

During 1976/77 season we grew Clipper Malting Barley which was harvested in January/February 1977 and produced much better results.

We hope to grow 250 acres in 1977/78 season mainly using Clipper Barley seeds and introduce Research. Our target is to grow at least 1,000 acres of Malting Barley per season. This will meet the requirements of Malting Barley by the two breweries on the island.

Diseases

We have so far encountered only two diseases. They are Helminthosporium gramineum and Rhyncosporium secalis.

Prior to 1976 we had imported seeds that were treated. These treated seeds were found to be susceptible to Helminthosporium gramineum. Furthermore, we found that when seeds were treated and imported, there was a danger of the germination of the seed being affected. Hence, when we used Clipper Barley seed for the 1976/77 season, untreated seeds were obtained and then treated with Panogen (Methyl Mercury dicyandiamide). This proved to be better and we did not have any problem with regard to Helminthosporium gramineum.

Rhynocosporium secalis was experienced on a field scale for the first time during the 1976/77 crop, but this did not adversely affect our crop since it was not wide-spread. We had not come across Rhyncosporium secalis earlier and as such no experiments were carried out against this disease. In the 1977/78 trials

we hope to introduce a few varieties in our varietal trials which might have been made resistant to Rhyncosporium secalis by treatment of seed during this season.

Our main aim will be to continue to try to find a variety in our Varietal Trials that will be resistant to both these diseases, rather than to seek seed treatment in order to reduce production costs.

## Fertilizers

We normally use the following fertilizer levels: 45: 45: 60 NPK.

This is used as a basal dressing and top dressing. The fertilizer has to be controlled, particularly since the barley will be used in brewing, where the nitrogen content will be critical. We normally try to keep the protein content in the barley grown, under 11%.

## Yield

We are not obtaining good results with regard to yield and we have now reached about 0.75 tons per acre whereas our target is in excess of one ton per acre, without exceeding nitrogen levels in the Barley. To this end, we find that the most critical thing is that at the time of filling out of the grains, a reasonable amount of rain which is necessary, does not fall. We have thus decided to advance our sowing time by two weeks for the next season in order to catch the tail end of the Monsoon at the filling out stage.

We normally find that the ear heads appear seven weeks after sowing, milky stage after eleven weeks and the ear heads start filling after 12-13 weeks. It takes about 14 weeks for the ear heads to be filled out fully and as stated above when it does not rain during this period, we find that the ear heads mature too quickly in the tropical sun. In January, the weather is generally very cold at night and dry hot days follow. This we find very suitable for the grains to mature and for the harvesting of the crop.

## Other Problems

Land is not freely available in the area where barley is grown and we depend on Government farms in the area to release land for cultivation. Fortunately for us, in these Government farms, potatoes are grown for seeding purposes and after harvest, the land is allowed to lie fallow for about two years. This land is made available to us along with the equipment available on the farms. Management of the crop becomes more difficult as a result, since we have to deal with officials of the farm. However, these practical difficulties are gradually overcome by frequent conferences.

Apart from this, the crop is generally affected by birds, wild boar and sambhur.

## Scope for Barley in General

Though the Ceylon Brewery Limited is concentrating only in growing of Barley varieties suitable for malting, there is a great deal of scope for Barley growing in general in this country. These are outlined briefly below:

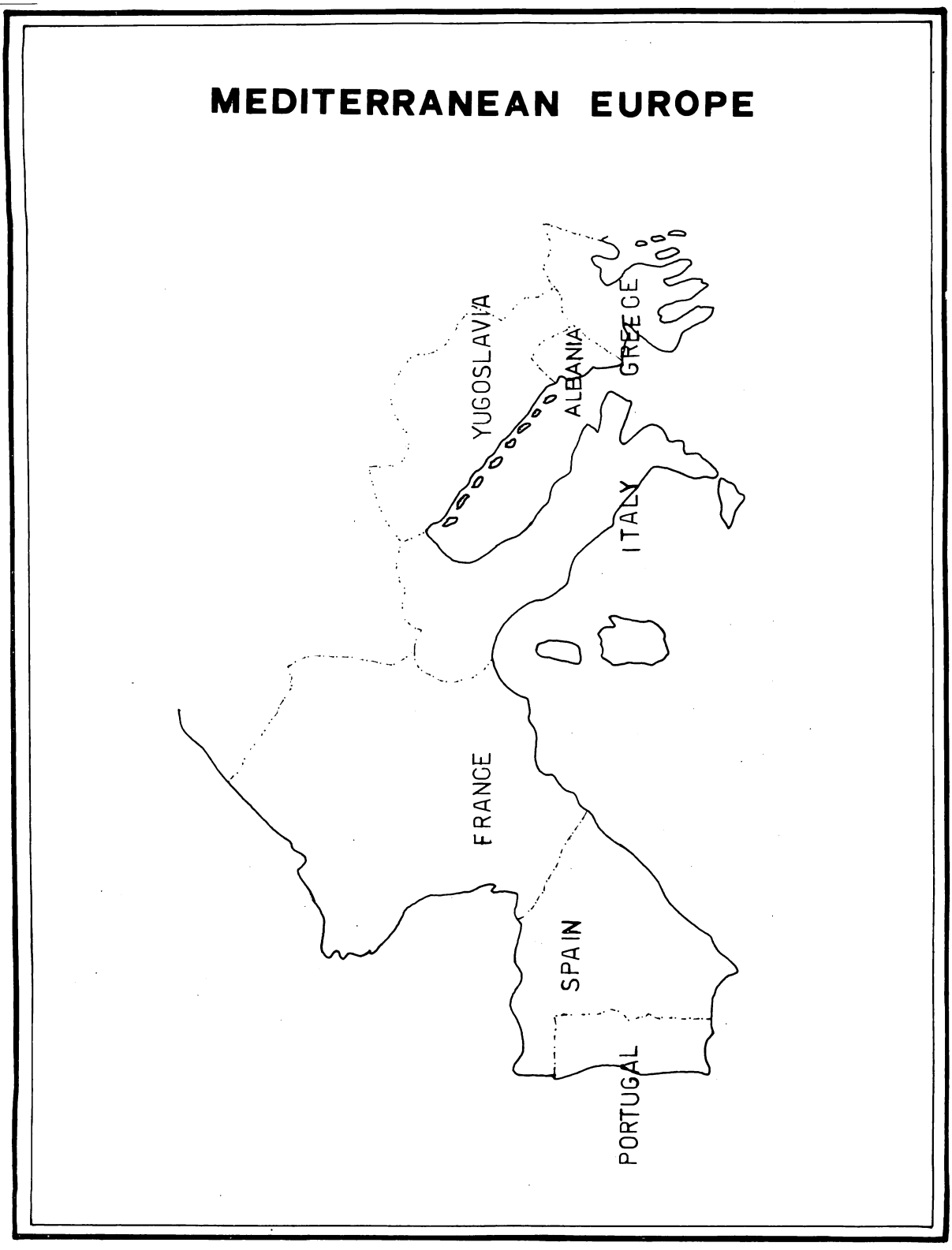
1. Barley could be grown for forage purposes.

2. Malt extract could be obtained from the barley to be supplied to Pharmaceuticals industry, Biscuit manufacturers and Chocolate manufacturers.

3. Production of Malted Milk.

4. Possible substitution of Barley flour for wheat flour which is being imported at the moment. It is found that Barley and wheat flour when mixed, gives better results that wheat flour used by itself.

We have these targets in mind, and in due course, we hope to be able to investigate these further.


MEDITERRANEAN EUROPE
YUGOSLAVIA
ALBANIA
GREECE
ITALY
FRANCE
SPAIN
PORTUGAL

# STATUS OF BARLEY IMPROVEMENT IN THE EUROPEAN MEDITERRANEAN CLIMATE

By

Comenge, Ensenat Jesus*

## Introduction

To speak of the Mediterranean climate conditions would limit us only to some parts of the Iberian Peninsula and the French, Italian and Balkan coasts, however, we would like to put forth the general problem of the coastal countries of the Mediterranean which include Spain, France, Italy, Yugoslavia, Albania and Greece, and also Portugal due to its similarity to many Spanish areas, without forgetting that the penetration of the maritime influence can extend these characteristics to other European countries.

We will speak of the physical environment and of the importance of the growth of barley in these countries in order to obtain a better knowledge of the problems which might have to be faced.

## Physical Environment

The Mediterranean zone is characterized by mild winters (Valencis, an average of 10, 3°C in January) and hot summers (Athens, 27°C in June) which provides in summer the same conditions as in the desert area south of the Mediterranean basin where it is dominated by dry winds (Trade Winds).

Rain normally occurs in autumn, winter and spring, depending on the region, and the rainfall is distributed at sporadic intervals, because of the low number of rainy days per year. (60-65 days per year in the Spanish Mediterranean fringe and even in some parts of this area it is common to have less than twenty days per year). The precipitation is often very heavy and it is possible to receive a higher quantity of rain than the yearly average in only one rain. This climatic condition during the summer is due to the high pressure centralized over the sea which causes a barrier set up against rain and in winter is due to the low pressure coming from the polar front.

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The variability of the climatic phenomenon from year to year is great but it is possible to distinguish different types, depending on the latitude and maritime influence. The isotherm of 9.5°C in January, which comes from Lisbon to Athens, separates two zones.

(I) In the Northern areas the maximum rainfall occurs in spring and autumn. There are cold periods in winter accompanied by strong winds. The dry season in summer persists from 1 to 3 months.

(II) In the Southern areas the winters are mild with rain in December and January. There are droughts lasting 4-5 months in summer and hot desert winds (Siroccos).

The true Mediterranean climate is a transition between the desert climate of the Sahara, lacking in regular rainfall and the Central European climate where the precipitation is almost the same from season to season.

On the other hand, in the Iberian and Balkan peninsulas, as exists also in North Africa, the continental situation and the relief accentuate the contrasts of temperature from winter to summer. In the same way, the distinct exposures create very clear differences throughout the peninsulas, where the western slopes receive more rain than eastern slopes. It is possible to receive 5270 mm of precipitation on the south coast of Yugoslavia (Montenegro), which is the maximum inEurope, while it can be less than 300 mm on the eastern coasts.

The altitude provokes very perceptible climates between very closely situated regions, therefore in the Mediterranean zone it is possible to find a large representation of microclimates. For example, Spain which is typically Mediterranean, includes regions with climates which can be classified as Arid Sub-tropical desert similar to Edfina and Rosella (Egypt), Mersa-Matruh (Libya); areas similar to those of Selemiya and Homs (Syria) or those of litoral and sub-litoral areas of Morocco, Algeria and Tunisia, while there are other zones with climate similar to that of Central Europe (Alsace, Lorraine, Haute Savoie and Low Lands). In general, all of Central Spain has similar climatic characteristics to those of the continental zones of North and West Asiatic Turkey.

The nature of the soil is closely related to the rocky subsoil and the relief of the region. Most of them originate from chalk but others come from granite, slate and gneiss. Concerning the superiority of limestone most of the soil is compact and has a high pH. Fine soils with rocky subsoil are found in mountain areas (litosoles) while the deeper and normally fertile soils (alluvial soil, terra-rossa and rendzinas) are generally found on plains. Light soils with high pH are not very common.

Production Statistics

In table I the total areas dedicated to the growth of barley are shown, as the production in Kg/Ha and the total harvest in each of the Mediterranean countries under study. Although Albania does not appear on this table since detailed statistics were not available, an estimation of a constant production of 10,000 MT for this period and a cultivated surface of 10,000 Ha has been made. These data have been included in the totals of Mediterranean European countries.

From the table the following conclusions can be obtained:

- The cultivated surfaces in the Mediterranean area have increased by 54% in the last ten years (2,500,000 ha.) the most important being the increase in Spain (1,800,000 ha.) and France (425,000 ha.).

- The increased output has been remarkable, especially in Italy, where the yield per hectare has increased by some 1,200 kg followed by France and Greece with an increase of some 800 kg. There has been a total increase in the Mediterranean area of 500 kg/ha (25%).

- The total yield has been increased in all the area by approximately 80%, which is an increase of about 8,500,000 MT.

- In relation to Europe, the production of the Mediterranean area has been maintained around 30%, and with respect to surface area around 36%, which indicates that the increase in surface and production in the rest of Europe has been paralleled.

- The surface of Mediterranean Europe in relation to the world has been estimated from 7% to approximately 10%, while the total production has been increased from 10% to 12%.

The individual increase in productivity, spectacular in some countries are due, in our opinion, to the continual achievement of more profitable and better adapted new varieties.

In the case of Spain, which is without doubt the best case I know, the increase of the surface dedicated to the growth of barley (130% in the period under study, which represents an increase of 243% in the increment total production) has been caused by an agricultural policy tending to increase the growth of cereals for feeding, undertaken by the Spanish Administration in the 1960's. This policy can be summarized as follows:

(a) Establishing the minimum price of guarantee.

(b) Aid to the farmer for purchasing of selected seeds in form of subsidies.

In respect to the former (a) the prices are revised periodically but with the exception of extraordinary years, the farmers have been able to obtain prices superior to the guarantee in the free market.

In the latter (b) now out of use because the aids were created under a system of decreasing the subsidies over time, had as its principal objective (1) to make the farmer accustomed to purchasing good quality seeds at a lower price and (2) to reduce the obsolete varieties which in the hands of the farmers had been mixed amongst themselves for many years and did not have adequate resistance against fungus diseases.

The large increase in production (in kg/ha) in Spain, in my opinion, is to a great extent due to the introduction of better techniques of cultivation, improved mechanization of dryland areas, rational use of fertilizers, and actual allocation of more fertile land to the cultivation of barley. We cannot forget the improvement and the introduction of more productive varieties; however, the difficult climatic characteristics in the areas where barley is grown in Spain make it difficult to replace indigenous varieties. For this reason we can estimate 350,000 ha., now being grown from one local variety (called Albacete) which was selected for areas of about 300 mm of rainfall. The main characteristic of this variety is to produce a very constant yield in the course of time even with marked yearly climatic variations. We cannot, however, expect a spectacular production from it in the years when the climate is more favourable.

International commerce for the European Mediterranean countries are given in table II from which we can deduce the following:

- Exportation of barley in the Mediterranean area is larger than the importation of barley.

- There is a large deficit of barley in Italy.

- The level of exportation of barley from France greatly exceeds the possible shortage of barley in the areas of the Mediterranean countries.

## TABLE 1 : STATISTICAL SUMMARY OF BARLEY PRODUCTION

| | | 1961-65 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | a | 2353 | 2642 | 2818 | 2781 | 2859 | 2953 | 2671 | 2674 | 2799 | 2712 | 2779 |
| | y | 2802 | 2809 | 3504 | 3286 | 3307 | 2752 | 3336 | 3899 | 3912 | 3677 | 3360 |
| | p | 6594 | 7421 | 9874 | 9139 | 9452 | 8126 | 8910 | 10426 | 10948 | 9972 | 9336 |
| Greece | a | 184 | 284 | 351 | 332 | 282 | 342 | 381 | 394 | 412 | 407 | 415 |
| | y | 1349 | 1981 | 2203 | 1418 | 1586 | 2103 | 2049 | 1868 | 2057 | 2292 | 2227 |
| | p | 248 | 563 | 774 | 471 | 448 | 718 | 780 | 736 | 848 | 933 | 924 |
| Italy | a | 203 | 179 | 181 | 175 | 175 | 179 | 185 | 187 | 203 | 224 | 249 |
| | y | 1359 | 1414 | 1632 | 1472 | 1667 | 1755 | 2014 | 2074 | 2255 | 2499 | 2603 |
| | p | 276 | 253 | 295 | 258 | 292 | 315 | 373 | 388 | 458 | 559 | 648 |
| Portugal | a | 125 | 111 | 107 | 135 | 119 | 105 | 112 | 119 | 81 | 94 | 96 |
| | y | 486 | 441 | 689 | 693 | 455 | 514 | 754 | 462 | 700 | 797 | 938 |
| | p | 61 | 49 | 73 | 94 | 54 | 54 | 84 | 55 | 57 | 75 | 90 |
| Spain | a | 1420 | 1338 | 1500 | 1923 | 2110 | 2220 | 2371 | 2519 | 2773 | 3027 | 3262 |
| | y | 1379 | 1499 | 1717 | 1789 | 1881 | 1393 | 2017 | 1730 | 1587 | 1785 | 2063 |
| | p | 1959 | 2006 | 2576 | 3441 | 3969 | 3092 | 4783 | 4358 | 4402 | 5404 | 6728 |
| Yugoslavia | a | 369 | 394 | 343 | 312 | 300 | 280 | 280 | 290 | 328 | 330 | 361 |
| | y | 1509 | 1810 | 1767 | 1442 | 1528 | 1436 | 1657 | 1679 | 2061 | 2406 | 1947 |
| | p | 557 | 713 | 606 | 450 | 459 | 402 | 464 | 487 | 676 | 794 | 703 |
| Mediterranean | a | 4664 | 4958 | 5310 | 5668 | 5955 | 6089 | 6010 | 6193 | 6606 | 6804 | 7172 |
| Europe | y | 2080 | 2221 | 2675 | 2445 | 2506 | 2088 | 2563 | 2657 | 2633 | 2608 | 2570 |
| | p | 9705 | 11015 | 14208 | 13863 | 14678 | 12717 | 15404 | 16460 | 17399 | 17747 | 18439 |
| Europe | a | 12966 | 14701 | 15005 | 15490 | 16175 | 16538 | 16668 | 17103 | 17797 | 18202 | 19038 |
| | y | 2605 | 2662 | 3044 | 2965 | 2990 | 2695 | 3147 | 3218 | 3204 | 3386 | 3056 |
| | p | 33780 | 39574 | 45673 | 45935 | 48365 | 44566 | 52460 | 55041 | 57024 | 61633 | 58187 |
| World | a | 67996 | 70943 | 71877 | 74242 | 77679 | 78247 | 79677 | 84915 | 87854 | 87970 | 91504 |
| | y | 1466 | 1653 | 1664 | 1765 | 1764 | 1783 | 1901 | 1793 | 1928 | 1944 | 1695 |
| | p | 99683 | 117272 | 119602 | 131048 | 137035 | 139551 | 151447 | 152238 | 169417 | 170970 | 155083 |

a = Area Harv., (1.000 ha.) y = Yield., (kg/ha) p = Production. (1.000 MT)

F.A.O.

TABLE 2 : INTERNATIONAL COMMERCE OF BARLEY ( F.A.O. )

| COUNTRIES | Importation | | | Exportation | | |
|---|---|---|---|---|---|---|
| | 1971 .000 MT | 1972 .000 MT | 1973 .000 MT | 1971 .000 MT | 1972 .000 MT | 1973 .000 MT |
| FRANCE | 4 | 14 | 2 | 2715 | 3695 | 4137 |
| GREECE | --- | --- | 100 | 19 | --- | --- |
| ITALY | 1215 | 1248 | 1404 | 5 | 41 | --- |
| PORTUGAL | 117 | 121 | 40 | --- | --- | --- |
| SPAIN | 220 | 7 | 2 | --- | --- | 58 |
| YUGOSLAVIA | 125 | 66 | 40 | 1 | --- | --- |
| TOTAL | 1681 | 1456 | 1588 | 2740 | 3736 | 4195 |

# BARLEY CULTIVATION AND IMPROVEMENT IN GREECE

Elpis A. Skorda*

Barley has been grown in Greece since 3000-4000 B.C. Barley grains, found in excavations have disclosed the remains of a Neolithic race and have been identified as of the six-row type. The oldest authentic records of two-rowed barley have been found in Greek-Roman archives dated about 300 B.C.

In Greece about 1,600,000 hectares of cereal crops are grown (that is 46% of the whole cultivated area). The barley acreage for period 1971-1975 averaged approximately 400,000 hectares (22%) annually, with a yield of about 2200 kg/ha. The annual production of barley covers the whole demand of the country. Out of the 400,000 hectares of barley cultivated (Table I) 90% are estimated to be two-rowed and 10% four-rowed types. Practivally all of the commercial barley is of the covered or hulled type.

Barley has always been an important crop. In ancient times barley was grown largely for human food, but now it is produced mainly for livestock feed, (about 90%) and for malt (about 10%).

The barley crop is scattered all over the country at elevations varying between sea-level to 1500 meters, especially in dryland areas without irrigation. It withstands much of the dry heat of the Greek islands with low to moderate rainfall In all areas where the crop is adapted, barley usually matures early enough to escape serious drought and stem rust attack. Spring drought as well as infection of Helminthosporium spp and Erysiphe graminis, results in uncertain yields. In general, barley is one of the most dependable crops where drought, frost and alkali conditions are to be encountered.

Because barley is an important crop for animal feed an effort has been made to substitute it for wheat in dry areas with soils of poor fertility where it gives higher yields.

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* Plant Breeding Institute
Thessalonika, Greece

Research and development work on barley production has received much emphasis in Greece over the last 10 years. In all areas cultural practices are very satisfactory so that the average yield has increased rapidly over recent years. (Table I) Taking into consideration that barley is grown in arid areas in which no other crop can be grown, the yield obtained is high for the conditions.

## The Current Farming Practices

Most of the barley is planted in the fall and harvested in summer. Only in the northern part of the country, in a small area, is barley sown in late winter or early spring. Usually most of the farmers wait for the fall rain before preparing the land and drilling it, because during the summer rainfall is scarce.

### A. Rotations

Barley is usually sown after wheat and in general follows other small grains.

### B. Tillage Practices

After the wheat harvest in the summer it is common to remove all straw from the field or to burn it. If rainfall occurs during the summer most of the farmers plow their land by tractor; otherwise they plow it in the fall after the first rain, disk it and drill the seed.

### C. Seedbed Preparation and Sowing

The land is often fall plowed in October to early November and disked before the seed is drilled.

### D. Seed Rate and Fertilizer

Fertilizer requirements for barley are lower than for wheat. Barley generally responds to applications of nitrogen and phosphorous and not to potash. On poor soils barley often benefits from top dressing with nitrogen, while in the rather fertile soils this increases the danger of mildew infection and lodging. Higher rates of fertilizer are used for feeding and lower rates for malting types (30 to 60 kg/ha.)

The seed rate varys from 150-200 kg/ha across the country. Because seedbed preparation is generally very good and the seed rate is high, very good stands are generally obtained, which with high tillering, results in very dense crops in which lodging is common. Seed dressing with fungicides and insecticides is common.

E. Date of Sowing

The crop is frequently drilled from the end of October till late January or early February with the later sown seedlings enter the cold winter and suffering from frost. Thus seeding in late fall or in early spring results in reduced yields. Spring and winter varieties are sown in the fall except for the northern part of the country in which spring type varieties are sown from late winter to early spring. Where barley is to be used for forage and for grain it is sown, early in October.

F. Chemical Weed Control

Spraying barley or other grain crops with various formulations of 2, 4-D for weed control has become a wide-spread practice. In most cases in recent years barley has also been sprayed with various chemicals against wild oats.

G. Harvesting

All the barley crop is harvested with a combine, directly when the grain is ripe and dry.

H. Production

Barley in Greece is generally grown for livestock feed, with a small amount for malting.

I. Varieties

Since about 1964, four-rowed barley varieties have largely been replaced by two-rowed types, because of the introduction of more productive two-rowed varieties, resistant to Fritfly.

Most of the barley grown in the country consists of varieties of spring growth habit, sown in the fall. The crop grows under cool winter conditions and then matures in time to escape the warm summer climate. True winter barleys are grown only in the northern part of the country, where they can resist frost damage.

The mean yield of barley in Greece is relatively low, because it is usually grown on marginal land, with shallow soils, and low rainfall. Also, diseases such as mildew, net blotch and stripe cause severe losses in some years.

Research on barley is conducted by the Breeding Institute in the following fields:

1. Varietal improvement for increased yield and quality (Hiproli crosses)

2. Field experiments on the use of fertilizer.

3. Rate and date of sowing.

4. Diseases and insect control.

5. Weed control.

Farmers profit from the results of this research, but the mean yield is difficult to increase mainly because of the dry land conditions under which the crop is grown and the diseases, for which, with the exception of seed dressings, control measures are relatively expensive.

T A B L E I

| Period | Acreage harvested hectare | | | Production 1000 tons | | | Yield per ha/kg | | |
|---|---|---|---|---|---|---|---|---|---|
| | Wheat | Barley | Oats | Wheat | Barley | Oats | Wheat | Barley | Oats |
| 1946-50 | 812800 | 194900 | 134500 | 758 | 179 | 101 | 93 | 92 | 68 |
| 1951-55 | 1006100 | 211000 | 148700 | 1167 | 235 | 146 | 115 | 109 | 98 |
| 1956-60 | 1112800 | 191700 | 138300 | 1613 | 240 | 158 | 144 | 125 | 114 |
| 1961-65 | 1084900 | 194200 | 122300 | 1782 | 284 | 156 | 163 | 145 | 127 |
| 1966-70 | 980300 | 341900 | 101300 | 1809 | 664 | 135 | 185 | 193 | 133 |
| 1971-75 | 916700 | 401800 | 75700 | 1984 | 883 | 108 | 216 | 220 | 143 |
| 1976 | 920000 | 398100 | 70900 | 2351 | 955 | 106 | 256 | 240 | 150 |

# ASPECTS OF GROWING AND BREEDING OF BARLEY IN PORTUGAL

By

M.T. Barradas*

## 1. Aspects of Barley Growing in Portugal

Barley has been grown in Portugal since before the Roman invasion, which began some 300 years B.C.

At present, barley is considered to be a "secondary" cereal and is used mainly for animal feed, malting and brewing. It is also grown, although in small quantities, as a forage crop. When mixed with legume crops it is used for hay and in mixture with oats and rye it can be used as an "early bite" pasture and thereafter cut, after flowering, for animal feed.

Barley is grown, more or less, all over the country except on the coastal NW zone, but the main production area is south of the river Tagus where approximately 80 percent is grown.

Practically all the crop is grown for grain and under dry farming conditions. Only for high quality seed production is it grown after fallow. Due to the mild climatic conditions during the winter in the southern part of the country, practically only spring barley varieties are grown, although they are sown in late autumn/early winter. Barley occupies only 10 percent of the total area sown to winter cereals (Table 1).

It should be stressed that, between 1968/69 and 1972/73 the barley area tended to decrease. However, after the 1973 harvest there has been a continuous trend for this area to increase ; in 1975/76 the barley area was 45 percent higher than in 1973. At the same time there has been an increase in the yield/hectare, which has helped to increase the total production. (Table 2.).

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* Plant Breeding Station, Elvas, Portugal.

Table 1. Average Percentage of Winter Cereals Area (1972-74)

| Crop | Area % |
|---|---|
| Wheat | 50 |
| Rye | 23 |
| Oats | 17 |
| Barley | 10 |

100 = 932 x $10^3$ hectares.

Table 2. Area, Production and Yield of Barley (1973 to 1976)

| Year | Area (Ha) | Production (M/Tons) | Yield (Kg/Ha.) |
|---|---|---|---|
| 1972/1973 | 80,800 | 56,600 | 700 |
| 1973/1974 | 93,500 | 74,500 | 797 |
| 1974/1975 | 102,900 | 126,600 | 1,231 |
| 1975/1976 (1) | 114,000 | 104,000 | 910 |

Source: I.N.E.
(1) Provisional date.

In this period there has been a marked increase in the area of malting barley and a simultaneous decrease in the area of feeding barley. (Fig. 1). At the same time one can see that there has been a continuous and marked increase in the total production of malting barley. (Fig. 2).

This trend is the logical result of the many efforts that have been made in the field of malting barley. These include incentives, improved commercial organization, systems for production of high quality seed, breeding, improved cultivation of soil, proper use of fertilizers (mainly nitrogen) and the use of herbicides.

The system for production of animal feed barley is, on the contrary, quite unprotected. There is no official list of recommended varieties and the farmers find it difficult to acquire sufficient quantities of high quality seed.

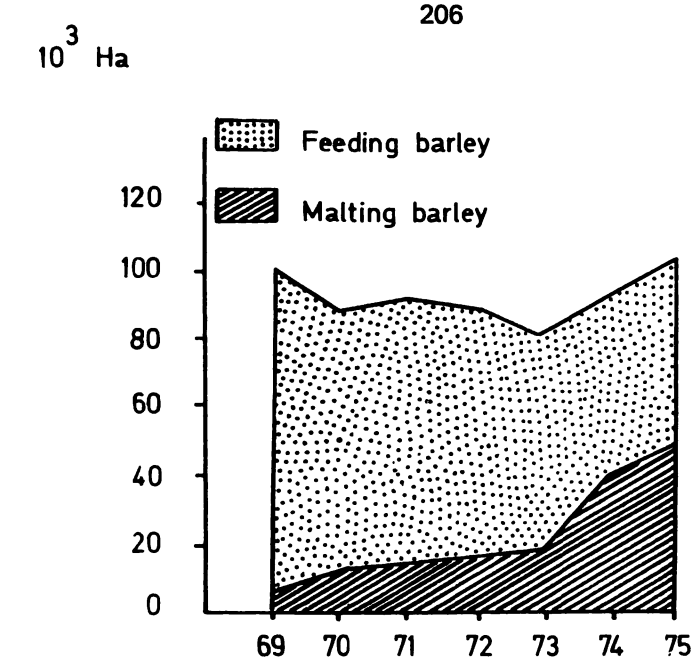



Fig. 1 — Portugal barley area ( 1969 – 1975 )

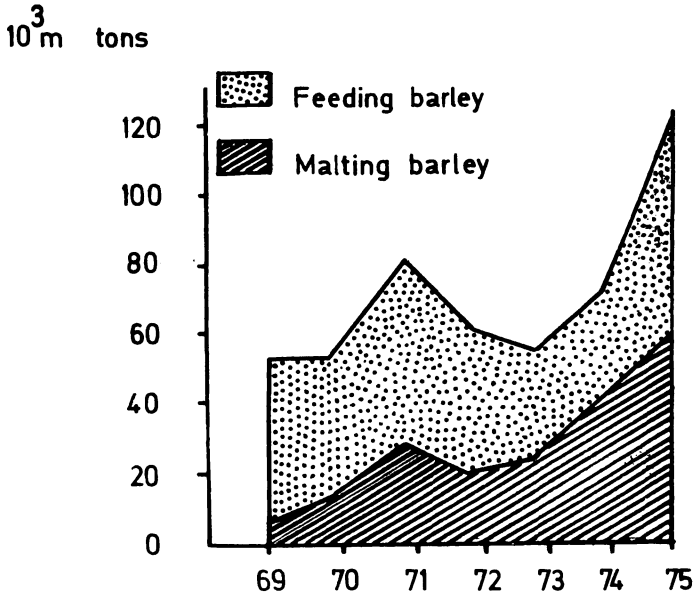



Fig. 2 — Portugal Barley Production ( 1969 – 1975 )

The variations in yield are extreme and are a result of the great irregularity of climatic conditions.

The main negative factors that influence production are:

(i) Excessive rainfall, associated with mild temperatures during November/December/January:
The present high-yielding varieties when growing in soaked soils, humid atmosphere and mild temperatures, have difficulty in emerging, show a high mortality rate, and cross the vegetative phase of their life too rapidly and with little vigour. They, therefore, suffer from strong attacks of the main foliar diseases (Rhynchosporium secalis, Erysiphe graminis, Helminthosporium teres and others), show a weak stand, reduced tillering, small ears and have a short life-cycle. All these problems result in low yields.

(ii) High temperature and atmospheric drought during April and May force the crop to mature and limit the crop season. If the hot weather sets in before grain filling is completed, severe yield reduction occurs due to grain shrivelling and shortening.

The yields are variable but low (average of 880 kg/ha in 1971/75), corresponding to 680 kg/ha for feeding barley and to 1380 kg/ha for malting barley.

From the figures given above, it is not surprising to see that the country is practically self-sufficient as far as malting barley is concerned; however, the production of feed barley shows an enormous deficit. In order to supply the feed grain industry, some 433,000 m. tons are needed (equivalent to ten times the present production of feeding barley).

Until recently the industry used little barley for animal feed and gave little incentive to the farmers to produce feed barley. The industry used to acquire maize in sufficient quantities (locally produced and imported) and therefore used only small quantities of barley, normally purchased at irregular and low prices. However, the present conditions have changed substantially. The production and consumption of animal feeds has risen drastically in the last few years, especially from 1973 onwards. In fact, in 1973, some 1.5 million tons of feed were produced and in 1976 2.3 million tons. This represents an increase of more than 50 percent.

At the same time the maize price in the international market has risen markedly which has had an adverse effect on the economy. It should also be stressed that the local production of maize has been stagnant and has become less capable each year of supplying the portuguese feeding industry.

To face this situation, the industry has changed its strategy in relation to barley and oats and is now pressing several bodies, in order to increase the local production of these two cereals, thus allowing a progressive reduction of imports and of dependence on the international market. The Government has taken, in this line, some incentive measures, such as the increase in price paid to the farmer, for barley and oats. For 1976/77 the following prices have been fixed:

Feed barley - Esc. 5,000$/m. ton. (US$ 128.2/M.T.)
Oats - Esc. 4,000$/m. ton. (US$ 102.6/M.T.)

It should be noted that price of wheat and maize are both Esc. 6,000$/m.ton. (US$ 153.9/M.T.), and the price of malting barley of Esc. 5,400$/m.ton. (US$ 138.5/M.T.).

## 2. Aspects of Barley Breeding in Portugal

The breeding of barley in Portugal has not the same tradition as the breeding of wheat. Moreover, the local varieties are poor as far as yield and other agronomic characteristics are concerned.

The barley breeding programme is centered in the Plant Breeding Station (Estaçao de Melhoramento de Plantas), in Elvas, located in the main cereal growing area. Here a conventional breeding programme is undertaken, using artificial hybridization followed by severe selection associated with yield testing. The procedure adopted is intensive phenotypic selection based on $F_2$ populations. In the first 3-4 generations after crossing the segregating populations are normally manipulated according to the bulk-method principle and the following generations by the pedigree-method. The advanced lines which have showed better performance are included in a country-wide experimental network.

In parallel selection studies are carried out on a large quantity of genotypes received from breeding centers all over the world. The selected lines of the preliminary yield trials run in Elvas are, thereafter, included in the experimental network. On the other hand, some introduced genotypes have proved a good source of parents to be used in our own breeding programme.

Participation in the efforts of the European Brewing Convention has been instrumental in promoting the breeding of barley for malting purposes. Every growing season cooperation on a European basis in the experimental network of the E B C is undertaken.

The severe selection pressure under the edafo-climatic conditions on the recently bred varieties of the European Research Centers has allowed the choice of progressive genotypes. On the other hand, the E B C trials carried out in Portugal included not only the obligatory E B C varieties but also the lines previously selected at Elvas, either introduced or from the national programme. The field results are completed with the analysis of the grain and analysis of micro-malting. In this way it is possible to have, on a scientific basis, the official list of malting barley varieties. At present this includes: Beka (France), Union (Germany) and Delisa (Holland). Possibly in the next season Delisa will be scratched and will be replaced by Carina (Germany) and the list will be increased with the E M P line, CE 7401 (Rika x Beka), which will be named Tibeka.

On the other hand, the genotypes which have shown high yielding capacity and good agronomic characteristics but which are not suitable for the malting industry are selected for feeding purposes.

As far as barley for cattle is concerned, the lines of any origin selected by E M P, are also subject to adaptation trials in the country and those which show a better behaviour than the standard feeding barley Arivat are selected for distribution to farmers.

One should, however, mention that, due to the lack of a system for production of quality seed, of feeding barley varieties, the advances obtained are considerably reduced.

# SOUTH AMERICA



# BARLEY CULTIVATION IN THE ANDEAN REGION OF SOUTH AMERICA

By

Arthur Klatt*

The Andean Region as discussed in this paper will refer to the western part of South America, including the countries of Colombia, Ecuador, Bolivia, Peru and Chile. The region is basically mountainous, dominated by the Andes Mountains which run from Colombia in the north to the southern tip of Chile. The region extends from 12°N in Colombia to 55°S at the southern tip of Chile. The region extends from 12°N in Colombia to 55°S at the southern tip of Chile. The main barley growing region lies between 6°N and approximately 40°S. Elevation varies from sea level to more than 6,500 m, but most of the barley is cultivated in areas with 2,600 - 3,500 m elevation. The average rainfall is generally high but is quite variable from one year to another. Many of the agricultural areas receive more than 1,000 mm per year while others receive only 300 mm; however, this would be the lower limit.

In Colombia, Ecuador, Peru, and Bolivia, barley is grown almost exclusively in the mountain valleys, on the mountain slopes, and on high mountain plateaus. Most of the barley is grown at elevations of 2,800 - 3,500 m, and even as high as 4,000 m in certain areas of Peru and Bolivia. The valleys differ drastically in elevation and environmental conditions; frequently valleys only 20 km apart are completely different in precipitation, temperatures, wind velocities, etc. Because of these extreme variations in environmental conditions, it is difficult to generalize about cultural practices, varieties used, climatic conditions, etc., but an attempt will be made to do so.

In southeastern Peru and western Bolivia there is a high mountain plateau commonly referred to as the Altiplano. This area has an elevation ranging from 3,800 to 4,500 m above sea level and

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it is actually a large plateau situated between two chains of the Andes. The rainfall in the Altiplano ranges from 650 mm in the north to less than 300 mm in the south. The area is subject to frost essentially 12 months of the year but two months are generally considered frost free (January and February). Barley is an important crop of the Altiplano, being grown for grain and for forage. The basic needs in this area are very early varieties and/or frost tolerant varieties which can escape or tolerate the frost. The barley is generally seeded in the spring (September-October) and must flower in January or February when there are less chances of frost. Physiological maturity must be achieved by mid to late March because frost can occur at this time.

In Chile, cultural conditions are quite different because nearly all of the barley is grown on the coastal plain and is either irrigated or is grown under good rainfall conditions. In many respects, the climatic conditions in Chile are more typical of those in Argentina and Uruguay than of the inter-mountain area. However, Chile has a common problem with those of the Andean Region; i.e. the problem of similar diseases.

Throughout the Andean Region the farming practices are quite primitive, except in Chile. In the four northern countries the cultural practices generally used would be considered traditional; the wooden plow is still used quite extensively. The farms are basically small with the average farm size being 2-3 hectares and few holdings would exceed 20 hectares. On the small farms (minifundios), mechanization is very limited and most of the work is done by hand or by animal power. Very little use is made of fertilizers, herbicides, insecticides, certified seed, credit, and other inputs. The typical farmer would be considered a subsistence farmer, growing several crops to reduce his risk and provide food for his family and a small amount of produce for selling.

In Chile, agriculture would be considered quite modern if compared to the other countries. Chilean farmers have utilized advanced cultural practices for many years because of aggressive research and extension programs and the larger holdings of individual farmers. However, in the last few years the situation has stagnated and agricultural production has been affected.

The Andean Region has approximately 475,000 ha. of barley (See Table 1) and produces 490,000 tons of barley per year. Of the total barley area, 455,000 ha are grown for grain and 20,000 ha are grown for forage purposes. A relatively large area in the Altiplano of Bolivia is devoted to barley for pasture or forage purposes, but the exact data are unavailable. Peru and Bolivia have the largest areas under barley cultivation (Table 1), but Peru and Chile are the largest producers. The four northern countries have an average production per hectare of 900 kgs. while Chile has an average production of 2,350 kgs. per hectare. These production figures reflect the technology being employed in the various countries and are also a function of the topography and climatic conditions of the countries.

In contrast, the total wheat area in the Andean Region is 1,025,000 ha.; however, 70% of this area is in Chile. Average wheat production is approximately one ton per hectare in the four northern countries and is 1.6 tons per hectare in Chile. The yield figures for wheat and barley are very similar, indicating that essentially the same technology is used on both crops. However, these data are interesting because in the four northern countries and especially in Ecuador and Peru, barley is frequently grown where wheat cannot be grown, such as in the higher elevations (above 3000 m) where wheat would be frequently affected by frost. Due to barley's early maturity, it escapes the frost and is used extensively in rotation with potatoes at these high elevations.

In regard to trade in barley, the region as a whole imports slightly over 200,000 tons per year. Colombia and Peru are the biggest importers, and they purchase approximately 90,000 and 80,000 tons respectively. Bolivia imports about 20,000 tons annually and Ecuador 15,000 tons. (Nearly all of the imported barley is used for malting purposes and very little is utilized for human or animal consumption). Chile annually exports about 30,000 tons of malting barley and is trying to increase this amount because of the favorable price for malting barley. Current Colombia is purchasing a sizeable amount of barley from Chile to help meet its malting requirements and this regional trade may increase in the future.

Barley is used for various purposes and in various manners within the region. Colombia utilizes 80% of its production for malting purposes and Chile uses 60%, while Ecuador malts 30% of its production and Bolivia and Peru utilize 10-15%. In Ecuador and Peru,

a large percentage of the barley produced (50-60%) is used directly as human food in various preparations such as barley soups, non-alcoholic sweet drinks from barley, a sweet snack for children, popped barley, etc. In Bolivia, Colombia, and Chile, 10% or less of the national production is used as human food. However, in Bolivia, these data do not include the Altiplano region where barley is cultivated quite extensively and constitutes one of the staple food crops of that region. Bolivia is the only country in the region that utilizes a large percentage (50-60%) of its national production for animal feed. Chile feeds 30% of its barley to animals while the other 3 countries feed 10% or less. If we look at the region as a whole, approximately 40% of the barley is used for malting purposes, 30% is used directly as human food, 25% for animal feed, and 5% for other purposes. The figures are estimated and are subject to error, but represent the best available data.

In regard to cultural practices used on barley, the situation is quite variable from one country to another. In Chile and Colombia, most of the barley is grown under high or medium fertility levels, while in Ecuador, Peru, and Bolivia, the majority of the barley is grown under low fertility levels. Chile is the only country that irrigates a sizeable percentage of its barley (30%), while Peru and Colombia irrigate only 10% of their barley area and the other countries little or none. In all cases, the main barley production is under rainfed conditions, generally with 500 mm or more of precipitation per crop cycle. Bolivia is the exception and its barley area generally receives less than 450 mm per crop cycle and in some areas as little as 250 mm.

The entire region utilizes spring barleys exclusively with the exception of Chile which has 10% of its area under winter types. About 90% of the area in Chile and Colombia is seeded with improved varieties; in contrast, Peru and Bolivia utilize local cultivars on 95% of the area. In Ecuador, 60% of the area is seeded with local cultivars and 40% to improved varieties, and the area devoted to improved varieties is increasing. Peru has initiated an intensive barley breeding program and new, improved varieties should be adopted by the farmers in the near future. Also, in Bolivia, two new varieties have been identified and will be released to the farmers in the near future; however, adoption will be quite slow due to various complicating factors.

Filsberck Union is one of the improved varieties in Ecuador, Chile, Bolivia and Peru. Chevalier is grown in Peru and Bolivia and Magnif 105 is very promising in Peru. European varieties dominate in Chile, while Colombia and Ecuador generally grow improved varieties developed by their research programs. Peru will probably release 4 lines (numbered selections) in the near future. Ecuador is planning to release Duchicela, INIAP Precoz, and Dorada distica, and Bolivia will release San Benito 76, Promesa SB-76, and Hipana. Chile will release Laufen in the near future and Colombia is contemplating the release of a selection of Funza, a variety originally developed in Colombia.

Various rotations are practiced in association with barley. Barley after barley (continuous) and barley after fallow are the most commonly employed. Barley after wheat rotation is not widely used in any of the countries. In Chile and Bolivia a sizeable percentage of the barley is grown in rotation with other crops.

The disease situation is quite complicated and varies from country to country. In 1975, a new race of stripe rust started in Colombia (near Bogota) and by 1976 had spread to the northern boundary of Ecuador. By 1977, the new race had spread south throughout Ecuador and had reached the northern boundary of Peru. The future dispersal of this new stripe rust race will be watched closely to see if it continues southward into Peru and Bolivia. The new race (commonly identified as a sub-race of Race-24) eliminated all of the commercial malting varieties in Colombia and Ecuador. The only improved variety which is resistant is the Variety Dorada in Ecuador and this is a variety used for human consumption. Therefore, the main disease problem in Colombia and Ecuador is stripe rust and aggressive programs are seeking resistance to this new race.

Helminthosporium is a major disease in all the countries and is probably the number one disease in Bolivia and Peru. Stem rust is an important disease in Peru and Bolivia but does not cause appreciable losses in Ecuador, Chile, or Colombia. Another race of stripe rust causes some losses in Chile and Bolivia but is of secondary importance.

Rhynchosporium secalis or scald is a disease of primary importance in all of the countries of the region. Scald is the most important disease in Chile and is the second most important in Ecuador. Leaf rust is a serious problem only in Peru and there, only in certain areas. Loose smut occurs in all countries but the

losses are not considered to be serious. Barley Yellow Dwarf Virus (BYDV), transmitted by aphids, causes serious losses in some years in Chile. Occasionally, BYDV causes important losses in northern Ecuador and Southern Colombia, while in the other countries it is of little consequence.

In summary, stripe rust in Ecuador and Colombia is the only disease which is causing heavy losses in yield potential. Helminthosporium and scald are endemic and frequently cause appreciable losses in all of the countries. The other diseases are secondary and seldom cause severe losses except in certain areas.

Insects are not a serious problem every year on barley in the region, but aphids are occasionally a pest in all of the countries. In Chile, Ecuador, and Colombia the aphids serve as the vector for BYDV which can cause severe losses under ideal conditions. In Bolivia and Peru the aphid is basically a sucking insect which causes damage to the plants at nearly any stage. The aphids can be easily controlled with one of several insecticides, but unfortunately the chemicals are expensive and control is seldom practiced or is practiced too late to offset damage. Storage insects are of minor importance in the region but some countries have a small problem with certain grain weevils.

In Ecuador, Bolivia and Chile the barley improvement program is associated with the wheat improvement program. Independent barley improvement programs exist in Colombia and Peru. The three previous countries have 2 or 3 scientists working in the barley program. Peru has 4-scientists, and Colombia has 11.

All of the barley improvement programs are attempting to incorporate better disease resistance and lodging resistance into their new varieties. All of the countries except Chile are looking for earliness, while Chile is actually looking for later types which are better adapted to their conditions. Drought tolerance is a priority only in Peru and Bolivia. In the Peruvian program, the scientists are looking for types with frost resistance (not winterhardiness) and types which are more tolerant to hail for the Altiplano. With the new stripe rust race, the Ecuadorian and Colombian programs are giving number one priority to identifying types with resistance to this race. Since there is a strong possibility that the new race will continue to move southward, the Peruvian and Bolivian programs must shift their emphasis quickly in order to identify lines with resistance before the present varieties are eliminated.

In Chile and Colombia there is a lot of emphasis on improving malting quality. Chile is primarily interested in quality because of its export potential while Colombia is giving it a great deal of attention because it is a large consumer of barley for malt. In Peru there is a program to improve the malting quality of barley and also a program to improve the quality of barley used for human consumption. Major emphasis for human consumption is to find naked types with large seeds and higher protein content.

In general, the cultural practices employed in the cultivation of barley are the main factors limiting barley production throughout the region. The farms are basically small, unmechanized, and the farmers have limited access to money with which to purchase inputs. Another major factor in limiting production has been the lack of production or extension programs to demonstrate the new technology. Because of this, a large proportion of the small farmers in the sierra are unaware of the attributes of new technological practices such as better seedbed preparation, fertilizers, herbicides, certified seed, etc.

Throughout the region, weeds are a serious factor limiting yields and very little use is made of herbicides. Seedbed preparation is frequently poor resulting in poor stands and frequently augmenting the weed population. Little use is made of fertilizers and in some countries the price is so high that its use is actually discouraged. In general, improved varieties are not being used to the extent that they should be and greater emphasis must be given to developing better varieties for the farmers.

In summary, the Andean Region has an average barley production of slightly less than one ton per hectare. New higher yielding varieties are needed in certain countries to replace the low yielding local cultivars and varieties with resistance to the new stripe rust race must also be identified. CIMMYT will assist in these breeding programs and will encourage the exchange of breeding materials within the region to facilitate the rapid identification of better adapted types. However, before production can be increased significantly, there must be an improvement in the cultural practices employed in barley cultivation. All of the

countries need to initiate aggressive production and extension programs to demonstrate the attributes of the more advanced technological practices to the small farmers. CIMMYT will assist in identifying the most important inputs required in various areas and will assist in the implementation of the production programs. Every effort will be made to encourage the respective governments to give agricultural development its necessary priority and encourage them to embark on extension programs directed to the farmers.

TABLE 1

BARLEY AND WHEAT AREA AND PRODUCTION IN THE COUNTRIES OF THE ANDEAN REGION

| COUNTRY | BARLEY AREA (HA) | | BARLEY PRODUCTION (Tons) | WHEAT AREA (HA) | WHEAT PRODUCTION (Tons) |
|---|---|---|---|---|---|
| | GRAIN | FORAGE | | | |
| Colombia | 60,000 | 0 | 70,000 | 50,000 | 45,000 |
| Ecuador | 70,000 | 1,000 | 65,000 | 60,000 | 70,000 |
| Peru | 170,000 | 10,000 | 155,000 | 140,000 | 135,000 |
| Bolivia | 100,000 | n.a. | 70,000 | 75,000 | 70,000 |
| Chile | 55,000 | 10,000 | 130,000 | 700,000 | 1,100,000 |

n.a. = Data not Available

# SUMMARY TABLES....

# SUMMARY TABLES

## AFGHANISTAN

Area:

| | |
|---|---|
| Total Arable Land | 7,844,000 hectares |
| Total Area Sown to Barley | 325,200 |
| Total Area Sown to Wheat | 2,440,000 |

Production:

| | |
|---|---|
| Total Barley | 368,500 metric tons |
| Total Wheat | 2,677,500 |

Yield:

| | |
|---|---|
| Barley | 1,133 kg/ha |
| Wheat | 1,097 |

Uses of Barley:

| | |
|---|---|
| Human Food | 5% |
| Animal Feed | 95% |

It is estimated that 70% of the barley is grown in areas with less than 400 mm rainfall and the remaining 30% is grown under irrigation.

Normal sowing: Varies - depending upon elevation.

Normal harvest: May to August.

Main commercial varieties: Mostly local cultivars.

Main diseases: Powdery mildew, scald, Helminthosporium, stem rust.

Main insect: Aphids.

Barley is part of the wheat improvement work. There are currently 11 researchers associated indirectly with Barley.

## ALGERIA

### Area:

| | |
|---|---|
| Total Arable Land | 6,240,000 hectares |
| Total Area Sown to Barley | 750,000 |
| Total Area Sown to Wheat | 2,200,000 |

### Production:

| | |
|---|---|
| Total Barley | 500,000 metric tons |
| Total Wheat | 1,300,000 |

### Yield:

| | |
|---|---|
| Barley | 667 kg/ha |
| Wheat | 591 |

### Uses of Barley:

| | |
|---|---|
| Human Food | 10% |
| Animal Feed | 90% |

Approximately 95% of the barley is sown in rainfall areas with less than 400 mm of rainfall.

Normal sowing: October to November.

Normal harvest: May to June

Main commercial varieties and % area: Saida 183, 70%, Tichedrett 30%.

New promising lines: Zemyr (2 rows), Rubus (6 rows), Berenice (2 rows).

Major diseases: Helminthosporium, leaf rust, yellow rust.

Barley improvement work is included with wheat improvement work.

It is estimated that approximately 20,000 hectares of barley is harvested for hay.

## BANGLADESH

| | |
|---|---|
| **Area:** | |
| Total Arable Land | 11,000,000 hectares |
| Total Area Sown to Barley | 25,000 |
| Total Area Sown to Wheat | 150,000 |
| **Production:** | |
| Total Barley | 17,000 metric tons |
| Total Wheat | 215,000 |
| **Yield:** | |
| Barley | 684 kg/ha |
| Wheat | 1,433 |
| **Uses of Barley:** | |
| Human Food | 100% |

Barley is sown in areas which have residual moisture only, and rarely do winter rains occur.

Normal sowing is late November.

Normal harvest: March or early April.

Main commercial varieties and % area: Local cultivars 100%.

Promising Lines: SD729-Porvenir, CM67-U Sask. 1744, Minn. 126-CM67, Gizeh 134-M65-220.

Main diseases: Helminthosporium, stem rust, leaf rust, loose smut.

Insects are not a serious problem.

The barley program work is included with the wheat program.

Barley is commonly consumed as "satu" by the rural people.

Dehusked barley is fried, ground and mixed with molasses or bananas and served for breakfast or as afternoon snacks.

## CYPRUS

| | |
|---|---|
| **Area:** | |
| Total Arable Land | 365,000 hectares |
| Total Area Sown to Barley | 70,000 |
| Total Area Sown to Wheat | 80,000 |
| **Production:** | |
| Total Barley | 81,000 metric tons |
| Total Wheat | 81,000 |
| **Yield:** | |
| Barley | 1,157 kg/ha |
| Wheat | 1,013 |
| **Uses of Barley:** | |
| Animal Feed | 100% |

The majority of the barley (70%) is grown in the 300 to 400 mm rainfall areas.

Normal sowing: November.

Normal harvest: May to June.

Main commercial varieties and % area: Athenais 90%, Attiki 10%.

Main diseases: Leaf rust, Helminthosporium, powdery mildew, Loose smut.

Main insects: Leaf minor and Aphids.

Barley research is included with the wheat improvement work.

There are 16 winter cereal research people.

In Cyprus about 15,000 ha. of barley are used for grazing and 2,000 ha. are made into hay.

EGYPT

Area:

| | |
|---|---|
| Total Arable Land | 2,720,000 hectares |
| Total Area Sown to Barley | 43,000 |
| Total Area Sown to Wheat | 576,000 |

Production:

| | |
|---|---|
| Total Barley | 129,000 metric tons |
| Total Wheat | 1,984,000 |

Yield:

| | |
|---|---|
| Barley | 2,968 kg/ha |
| Wheat | 3,447 |

Uses of Barley:

| | |
|---|---|
| Human Food | See note. |
| Animal Feed | 80% |
| Malting | 20% |

All of the above acreage is grown under irrigation.

Normal sowing date: November.

Normal harvest date: April - May.

Main commercial varieties and % area: Giza 119 80%, Bonus 20%.

New promising lines: Giza 121, under multiplication.

Main diseases: Helminthosporium, leaf rust, powdery mildew.

Main insects: Aphids.

The barley program is separate from the wheat improvement work. There are about 13 workers directly involved with the barley improvement work.

Note: Along the coastal area another 65,000 hectares can be estimated to be sown depending upon rainfall. In this area the rainfall will vary from 7.5 to 20.0 cm and yields are estimated at 560 kg/hectare. This production is used for human consumption especially by bedouines.

ETHIOPIA

Area:

| | |
|---|---|
| Total Arable Land | 13,000,000 hectares |
| Total Area Sown to Barley | 600,900 |
| Total Area Sown to Wheat | 500,000 |

Production:

| | |
|---|---|
| Total Barley | 556,780 metric tons |
| Total Wheat | 482,170 |

Yield:

| | |
|---|---|
| Barley | 930 kg/ha |
| Wheat | 960 |

Uses of Barley:

| | |
|---|---|
| Human food | 40% |
| Malting | 3% |
| Other | 57% |

The majority of the barley is grown in areas with rainfall in excess of 400 mm.

Normal sowing date: Mid-June to July.

Normal harvest date: November to December.

Main commercial varieties and % area: Local cultivars 97%, Bekaa 3%.

Newpromising lines: IAR/H/485, Bedi White (6 rows), Bedi Black (6 rows), several selection crosses involving local varieties.

Main diseases are scald, Helminthosporium and leaf rust.

Main insect problem: Barley fly.

Barley improvement work is independent from wheat research and currently three people are assigned to work on barley.

The majority of use of barley at the farm level is in the form of beverage preparation.

FRANCE

Area:

| | |
|---|---|
| Total Arable Land | 17,027,000 hectares |
| Total Area Sown to Barley | 2,717,000 |
| Total Area Sown to Wheat | 4,117,000 |

Production:

| | |
|---|---|
| Total Barley | 10,012,000 metric tons |
| Total Wheat | 18,906,000 |

Yield:

| | |
|---|---|
| Barley | 3,686 kg/ha |
| Wheat | 4,592 |

Barley is used for animal feed and malting.

Substantial quantities are exported.

## GREECE

Area:

| | |
|---|---|
| Total Arable Land | 2,780,000 hectares |
| Total Area Sown to Barley | 398,100 |
| Total Area Sown to Wheat | 920,000 |

Production:

| | |
|---|---|
| Total Barley | 950,000 metric tons |
| Total Wheat | 2,351,000 |

Yield:

| | |
|---|---|
| Barley | 240 kg/ha |
| Wheat | 256 |

Uses of Barley:

| | |
|---|---|
| Animal Feed | 90% |
| Malting | 10% |

Majority of the barley is in the low to moderate rainfall areas.

Normal sowing dates varies from October to January-February.

Normal harvest date: June.

Main commercial varieties are: Bekaa 50%, Locala 16%, Elasson 12%, Rivale 12%, Attiki 3%.

New promising lines: T-880828, T-89029-5-1.

Major diseases are: Helminthosporium, powdery mildew and leaf rust.

The main insect problem is frit fly.

Barley improvement is included from the wheat program currently.

The use of barley has shifted from human use to animal feed in recent years. The winter barleys are grown in the northern areas.

Barley is sown from sea level to 1,500 meters elevation.

INDIA

Area:

| | |
|---|---|
| Total Arable Land | 160,610,000 hectares |
| Total Area Sown to Barley | 2,930,700 |
| Total Area Sown to Wheat | 18,107,500 |

Production:

| | |
|---|---|
| Total Barley | 3,150,000 metric tons |
| Total Wheat | 24,235,000 |

Yield:

| | |
|---|---|
| Barley | 1,075 kg/ha |
| Wheat | 1,338 |

Uses of Barley:

| | |
|---|---|
| Human Food | 94% |
| Animal Feed | 1% |
| Malting | 4% |
| Other | 1% |

About 50% of the barley is grown in areas with less than 400 mm of rainfall and the other 50% is grown in the 400-500 mm rainfall zone.

Normal planting: October-November.

Normal harvest: April

Main varieties: Ratna, Jyoti, RS-6, Himani, Dolma and local cultivars.

New promising varieties: DL3, DL36, DL70, BG25, BG108, RD31, RD57, RD103, K125, PL56.

Main diseases: yellow rust, Helminthosporium loose smut, leaf rust.

Main insect: Aphids.

Barley improvement is an independent research program. There are about 70 active research workers in barley.

In India short maturity or earliness is very important.

IRAN

Area:

| | |
|---|---|
| Total Arable Land | 15,580,000 hectares |
| Total Area Sown to Barley | 1,500,000 |
| Total Area Sown to Wheat | 5-6 million |

Production:

| | |
|---|---|
| Total Barley | 1.5 million M.T. |
| Total Wheat | 6.2 million M.T. |

Yield:

| | |
|---|---|
| Barley | 1.0 T/H |
| Wheat | 1.0 T/H |

Uses of Barley:

| | |
|---|---|
| Human Food | 5% |
| Animal Feed | 90% |
| Malting | 5% |

About two-thirds of the barley crop is sown under low rainfall situations and one third is irrigated.

Normal sowing: variable with elevation.

Normal harvest: May to August.

Main diseases: Helminthosporium, yellow rust, powdery mildew, loose smut.

Barley improvement is part of the wheat improvement program. One researcher is directly assigned to barley research.

IRAQ

Area:

| | |
|---|---|
| Total Arable Land | 7,500,000 hectares |
| Total Area Sown to Barley | 545,000 |
| Total Area Sown to Wheat | 1,439,000 |

Production:

| | |
|---|---|
| Total Barley | 618,000 metric tons |
| Total Wheat | 1,396,000 |

Yield:

| | |
|---|---|
| Barley | 1,116 kg/ha |
| Wheat | 955 |

Uses of Barley:

| | |
|---|---|
| Human Food | Small |
| Animal Feed | 95% |
| Malting | 5% |

About 42% of the barley is sown in rainfall areas below 400 mm and about 58% is sown in irrigated conditions.

Normal sowing: November to December.

Normal harvest date: May

Main varieties and % area: Black local cultivar 25%, white local cultivar 10%, Arrivat 10%, Numar 4%.

New promising lines: Giza 121, Prior, Clipper.

Main diseases: Helminthosporium, loose smut, covered smut.

Main insects: Aphids, stink bug.

Barley is included with wheat improvement work and there are 15 researchers involved indirectly and directly.

In Iraq about 165,000 hectares of barley are grazed and then allowed to mature for grain production.

ITALY

Area:

| | |
|---|---|
| Total Arable Land | 9,290,000 hectares |
| Total Area Sown to Barley | 224,000 |
| Total Area Sown to Wheat | 3,712,000 |

Production:

| | |
|---|---|
| Total Barley | 559,000 metric tons |
| Total Wheat | 9,695,000 |

Yield:

| | |
|---|---|
| Barley | 2,499 kg/ha |
| Wheat | 2,612 |

JORDAN

Area:

| | |
|---|---|
| Total Arable Land | 1,132,000 hectares |
| Total Area Sown to Barley | 50,000 |
| Total Area Sown to Wheat | 200,000 |

Production:

| | |
|---|---|
| Total Barley | 35,000 metric tons |
| Total Wheat | 135,000 |

Yield:

| | |
|---|---|
| Barley | 700 kg/ha |
| Wheat | 675 |

Uses of Barley:

| | |
|---|---|
| Animal Feed | 100% |

Approximately 25% of the barley is grown in areas with 300 to 400 mm of rainfall and 65% in areas with less than 300 mm.

Normal sowing: November to December.

Normal harvest: May.

Main commercial varieties: Baladi 70%, Ogalitsu 15% , Arrivat 10%, Deir Alla 106 5%.

New promising lines: Composit 259, Line 257/14, Plata x Sv. Mari.

Main diseases: Covered smut, powdery mildew, leaf rust, Helminthosporium.

Main insect: Aphids, leaf miner.

Barley research is included with the wheat improvement program. There are 4 researchers involved.

KENYA

Area:

| | |
|---|---|
| Total Arable Land | 19 million ha. |
| Total Area Sown to Barley | 30,000 |
| Total Area Sown to Wheat | 120,000 |

Production:

| | |
|---|---|
| Total Barley | 48,000 metric tons |
| Total Wheat | 170,000 |

Yield:

| | |
|---|---|
| Barley | 1,600 kg/ha |
| Wheat | 1,400 |

Uses of Barley:

| | |
|---|---|
| Human Food | |
| Animal Feed | 30% |
| Malting | 70% |

Barley is grown at higher elevations and 90% of area will be in rainfall areas with more than 800-1,900 mm.

Normal sowing: Late date - March to August.

Normal harvest date: July to February.

Main commercial varieties and % area: Proctor 75%, Research 25%.

New Promising Lines: Egypt 5(B206), Mammie (B220).

Main diseases: Scald, Helminthosporium, yellow rust, stem rust.

Main insect: Aphids.

Barley improvement work is included with wheat research. In total there are 14 researchers who work part time on barley.

In Kenya barley is contract grown by the farmers in most cases. This accounts for the high percentage used in malting.

## KOREA, REPUBLIC OF

Area:

| | |
|---|---|
| Total Arable Land | 2,241,000 hectares |
| Total Area Sown to Barley | 730,972 |
| Total Area Sown to Wheat | 74,648 |

Production:

| | |
|---|---|
| Total Barley | 1,575,880 metric tons |
| Total Wheat | 165,404 |

Yield:

| | |
|---|---|
| Barley | 2,156 kg/ha |
| Wheat | 2,216 |

Uses of Barley

| | |
|---|---|
| Human Food | 75% |
| Animal Feed | 4% |
| Malting | 3% |
| Other (stocks) | 18% |

Barley is grown as a winter crop and often double cropped with rice or soybean.

All of the barley is grown in areas with rainfall in excess of 500 mm.

Normal sowing: October.

Normal Harvest: June.

Main varieties and % area: Kangbori 25%, Sedohadaka 22%, Olbroi 15%, Backdong 13%, New Promising lines: Bunong, Sukae 180, SB71107

Main diseases: Helminthosporium (stripe), loose smut, powdery mildew, scab (Fusarium).

Main insect: Aphids.

Barley improvement is included with wheat research. In total about 27 researchers are associated.

Barley has traditionally supplied about 20% of the Korean food needs. The production of hulled barley has been declining but naked barley remains constant. The estimated average annual loss in yield due to diseases in about 11 percent. There is now an increasing demand for barley in the malting and animal feed industry.

LEBANON

Area:

| | |
|---|---|
| Total Arable Land | 220,000 hectares |
| Total Area Sown to Barley | 10,000 |
| Total Area Sown to Wheat | 70,000 |

Production:

| | |
|---|---|
| Total Barley | 10,000 metric tons |
| Total Wheat | 70,000 |

Yield:

| | |
|---|---|
| Barley | 1,000 kg/ha |
| Wheat | 1,000 |

Uses of Barley:

| | |
|---|---|
| Animal Feed | 60% |
| Malting | 40% |

Barley is grown almost exclusively in the low rainfall areas.

About 40% is grown in the 300 to 400 mm zone, 50% in areas below 300 mm rainfall and 10% is irrigated.

Main varieties and % area: Orge Paye 25, (Baladi 25) 50%, Roumy 30%, Beecher 15%, Athenais 5%.

New promising lines: Arrivat x Athenais (6 row), Atlas x Promesa (6 row) Esperance x Two Row (2 row) Aurore x Esperance (2 row).

Main diseases: powdery mildew, leaf rust, loose smut, Helminthosporium.

Insects: Aphids, stink bug.

Barley is part of the wheat improvement program and there are four researchers currently working.

## LIBYA ARAB REPUBLIC

Area:

| | |
|---|---|
| Total Arable Land | 2,377,000 hectares |
| Total Area Sown to Barley | 600,000 |
| Total Area Sown to Wheat | 115,000 |

Production:

| | |
|---|---|
| Total Barley | 172,489 metric tons |
| Total Wheat | 70,000 |

Yield:

| | |
|---|---|
| Barley | 610 kg/ha |
| Wheat | 609 |

Uses of Barley:

| | |
|---|---|
| Human Food | 90% |
| Animal Feed | 10% |

The majority of the barley (85%) is grown under low rainfall situations of less than 300 mm. The remainder is grown under irrigation.

Normal sowing - October to November.

Normal harvest - May to June

Main commercial varieties: Athenais, California Mariout, Beecher, Local Cultivars.

New promising lines: Libya 4 (2 row), Libya 2 (6 row).

Main diseases: covered smut, loose smut, powdery mildew, Helminthosporium, scald.

The barley program is included with the wheat improvement work.

MOROCCO

Area:

| | |
|---|---|
| Total Arable Land | 7,400,000 hectares |
| Total Area sown to Barley | 2,000,000 |
| Total Area sown to Wheat | 1,900,000 |

Production:

| | |
|---|---|
| Total Barley | 2,050,000 metric tons |
| Total Wheat | 1,900,000 |

Yield:

| | |
|---|---|
| Barley | 1,025 kg/ha |
| Wheat | 1,000 |

Uses of Barley:

| | |
|---|---|
| Human Food | 60% |
| Animal Feed | 38% |
| Other | 2% |

Most barley grown in areas with less than 400 mm of rainfall.

Normal sowing date: November and December.

Normal harvest date: May-June.

Main commercial varieties and % area: Locals 99%, Rabat 071, 895 et 89, 1%.

New Varieties: 42 at 905 (Arig 8).

Main diseases: Helminthosporium, leaf rust, powdery mildew, loose smut.

Main insect problem: Hessian Fly.

Barley research is included with wheat improvement and two people are assigned to barley research.

NEPAL

Area:

| | |
|---|---|
| Total Arable Land | 1,980,000 hectares |
| Total Area Sown to Barley | 26,000 |
| Total Area Sown to Wheat | 330,000 |

Production:

| | |
|---|---|
| Total Barley | 25,000 metric tons |
| Total Wheat | 390,000 |

Yield:

| | |
|---|---|
| Barley | 962 kg/ha |
| Wheat | 1,182 |

Uses of Barley:

| | |
|---|---|
| Human Food | 80% |
| Animal Feed | 10% |
| Malting | 10% |

Barley is grown on residual moisture at lower elevations. At high elevations rainfall is variable during the crop season.

Normal sowing date: October-November.

Normal harvest date: April-May

Main varieties: Local cultivars

New Primising Lines: Bonus, CI-10448 (6 row), HBL 56 (6 row) Galt (6 row).

Main disease: Yellow rust, Helminthosporium, Powdery mildew.

Main insects: Aphids.

In Nepal barley is a separate research program.

At very high elevations (4,000 meters), Barley is sown in April and harvested in October.

## SULTANATE OF OMAN

### Area

| | |
|---|---|
| Total Arable Land | 36,000 hectares |
| Total area sown to Barley | 600 |

### Production:

| | |
|---|---|
| Total Barley | 900 metric tons |

### Yield:

| | |
|---|---|
| Barley | 1,500 kg/ha |

### Uses of Barley

| | |
|---|---|
| Human Food | 5% |
| Animal Fodder | 90% |
| Seed | 5% |

Barley is grown at elevations between 11 to 500 meters and only under irrigated conditions.

Normal sowing: Late November to early December.

Normal harvest: Mid-April to May for grain production
Late February to early March for green fodder

Main commercial variety: Local

Main diseases: None

Main insects: Shoot Fly and Aphids

Improvement work is undertaken by the field crops section and 5 researchers are engaged on working with barley on a part time basis.

## PAKISTAN

### Area:

| | |
|---|---|
| Total Arable Land | 19,385,000 hectares |
| Total Area Sown to Barley | 175,100 |
| Total Area Sown to Wheat | 6,113,000 |

### Production:

| | |
|---|---|
| Total Barley | 118,800 metric tons |
| Total Wheat | 7,629,000 |

### Yield:

| | |
|---|---|
| Barley | 678 kg/ha |
| Wheat | 1,290 kg/ha |

### Uses of Barley:

| | |
|---|---|
| Human Food | 50% |
| Animal Feed | 40% |
| Malting | 10% |

Most of the barley is grown in the plains on residual moisture with few winter rains. In the mountains it is depended upon winter rains and at very high elevations barley is grown as a summer crop.

Normal sowing: November.

Normal harvest: April

Main varieties: Local cultivars

Main diseases: yellow rust, Helminthosporium spp. smuts, powdery mildew.

Main insect: Aphids.

Barley research is carried out by the wheat research group.

In the high elevations barley is sown in the spring and harvested in the fall.

## PORTUGAL

Area:

| | |
|---|---|
| Total Arable Land | 4,130,000 hectares |
| Total Area Sown to Barley | 104,000 |
| Total Area Sown to Wheat | 500,000 |

Production:

| | |
|---|---|
| Total Barley | 91,000 metric tons |
| Total Wheat | 630,000 |

Yield:

| | |
|---|---|
| Barley | 875 kg/ha |
| Wheat | 1,260 |

Uses of Barley:

| | |
|---|---|
| Animal Feed | 40% |
| Malting | 60% |

The majority of barley is grown in southern Portugal under rainfall conditions in excess of 400 mm.

Normal sowing date: November early December.

Normal harvesting: May to June.

Main commercial varieties and % area: Local cultivars 53%, Beka 29%, Union 7%, Arrivat 5%, Clermont 3%, Delisa 2%, Lima Monteiro 1%.

New promising lines: Ribeka, Carina and Ceres.

Major disease: Scald, Helminthosporium, powdery mildew.

Main insects: Aphids.

Barley improvement is part of the wheat improvement work about 11 people working in some capacity part-time.

Although figures are unavailable some barley is sown for animal grazing and hay.

## SAUDI ARABIA

Area:

| | |
|---|---|
| Total Arable Land | 1 million hectares |
| Total Area Sown to Barley | 15,000 |
| Total Area Sown to Wheat | 83,300 |

Production:

| | |
|---|---|
| Total Barley | 20,000 metric tons |
| Total Wheat | 120,000 |

Yield:

| | |
|---|---|
| Barley | 1,333 kg/ha |
| Wheat | 1,500 |

Uses of Barley:

| | |
|---|---|
| Human Food | 15% |
| Animal Feed | 85% |

About 90% of the barley is grown in rainfall areas of less than 400 mm rainfall.

Normal sowing - November to December.

Normal harvest - April.

Main varieties - Local cultivars

Main diseases: Helminthosporium, stem rust.

Barley research is part of the wheat improvement work.

SPAIN

Area:

| | |
|---|---|
| Total Arable Land | 20,885,200 hectares |
| Total Area Sown to Barley | 3,262,000 |
| Total Area Sown to Wheat | 2,863,000 |

Production:

| | |
|---|---|
| Total Barley | 6,728,000 metric tons |
| Total Wheat | 4,354,000 |

Yield:

| | |
|---|---|
| Barley | 2,063 kg/ha. |
| Wheat | 1,521 |

Uses of Barley:

| | |
|---|---|
| Animal Feed | 80% |
| Malting | 20% |

About 60% of the barley is grown in areas with rainfall in excess of 400 mm.

Normal sowing date - mixed October to January.

Normal harvest date - June to July

Main commercial varieties and % area: Albacete 15%, Hatif de Grignon 10%, Pallas, Monlon.

Primising lines - Alicia, Begona, C-213-15, C-214-1.

Major diseases: Helminthosporium, powdery mildew, loose smut.

Main insect: Frit Fly, aphids.

Barley improvement work is independent of wheat research.

Spain exports substantial quantities of barley in some years up to 50,000 tons.

SRI LANKA

Barley is a new crop to Sri Lanka and the acreage is still very small. Experiments are continuing and hopefully about 100 hectares will be grown in 1977-78. Yields run about 2.5 tons per hectare. The area where barley does best is at 3,000 meters. The varieties which look promising are Proctor, Zephyr,Julia and Clipper.

SUDAN

Area:

| | |
|---|---|
| Total Arable Land | 7,450,000 hectares |
| Total Area Sown to Barley | 100 |
| Total Area Sown to Wheat | 300,000 |

Production:

| | |
|---|---|
| Total Barley | 150 metric tons |
| Total Wheat | 264,000 |

Yield:

| | |
|---|---|
| Barley | 458 kg/ha |
| Wheat | 880 |

Most barley is grown under irrigation.

Normal sowing November some in December.

Normal Harvest.

Commercial Varieties - Baladi improved 46.

Promising Varieties - Giza 121, K71, B55-22
Line 257/14

Main Disease - Very few - rarely leaf and stem rust.

Main Insect - Aphids

Barley is used mainly for feed.

## SYRIAN ARAB REPUBLIC

Area:

| | |
|---|---|
| Total Arable Land | 5,546,000 hectares |
| Total Area Sown to Barley | 1,011,393 |
| Total Area Sown to Wheat | 1,692,267 |

Production:

| | |
|---|---|
| Total Barley | 596,544 metric tons |
| Total Wheat | 1,550,000 |

Yield:

| | |
|---|---|
| Barley | 590 kg/ha |
| Wheat | 917 |

Uses of Barley:

| | |
|---|---|
| Animal Feed | 100% |

Barley is grown mostly in the low rainfall areas. Seventy percent of the acreage is sown in areas of less than 300 mm. rainfall, and 20% in the 300 to 400 mm rainfall zones.

Normal sowing date: October to November.

Normal harvest date: May to June.

Main varieties: Arabic Black Local 60%, Arabic White 30%.

New promising varieties: Arivat, Tricidrit.

Main disease: powdery mildew, leaf rust.

Main insect problems: Stink bug, aphids.

Barley research is included with the wheat work. Currently one researcher is assigned to work directly on barley.

In dry years barley acreage is sold for grazing.

## TANZANIA

| | |
|---|---|
| **Area:** | |
| Total Arable Land | 15,192,000 hectares |
| Total Area Sown to Barley | 3,300 |
| Total Area Sown to Wheat | 40,000 |
| **Production:** | |
| Total Barley | 4,000 metric tons |
| Total Wheat | 4,280 |
| **Yield:** | |
| Barley | |
| Wheat | 1,071 kg/ha |
| **Uses of Barley:** | |
| Human Food | 1% |
| Malting | 99% |

Barley is grown in the 300 to 400 mm rainfall zone.

Normal sowing ; March

Normal harvest : July

Main varieties: Proctor 50%, Research 50%.

New promising lines: A number of Kenya selections look promising.

Main diseases: Helminthosporium, scald, leaf rust, powdery mildew,

Main insect: Army worm.

There are two part-time barley research workers.

Barley is contract grown by farmers for malting purposes.

All figures above for barley are estimated.

TUNISIA

Area:

| | |
|---|---|
| Total Arable Land | 4,510,000 hectares |
| Total Area Sown to Barley | 570,000 |
| Total Area Sown to Wheat | 1,214,000 |

Production:

| | |
|---|---|
| Total Barley | 330,000 metric tons |
| Total Wheat | 1,150,000 |

Yield:

| | |
|---|---|
| Barley | 755 kg/ha |
| Wheat | 947 |

Uses of Barley:

| | |
|---|---|
| Human Food | 35% |
| Animal Feed | 60% |
| Malting | 5% |

It is estimated that 80% of the barley is sown in areas with an annual rainfall of less than 300 mm.

Normal sowing: October to November.

Normal harvest: May to June.

Main commercial varieties: Local cultivars, 40%, Martin, Ceres.

New promising lines: Gem, Mazorka, A16, Kenya.

Main Diseases: Helminthosporium, smuts, powdery mildew, leaf rust.

The barley work is included with the wheat improvement work. Currently, two researchers are involved.

## TURKEY

### Area:

| | |
|---|---|
| Total Arable Land | 25,543,000 hectares |
| Total Area Sown to Barley | 2,625,000 |
| Total Area Sown to Wheat | 8,500,000 |

### Production:

| | |
|---|---|
| Total Barley | 4,500,000 metric tons |
| Total Wheat | 13,000,000 |

### Yield:

| | |
|---|---|
| Barley | 1,714 kg/ha |
| Wheat | 1,529 |

### Uses of Barley:

| | |
|---|---|
| Human Food | 2% |
| Animal Feed | 95% |
| Malting | 3% |

About 70% of the barley is grown in areas with less than 400 mm of rainfall.

Normal sowing: September to December for winter barleys, March for spring barleys.

Normal harvest: July.

Main varieties and % area: Kokak 157/37 50%, Zafer 160 20%, Yesilkoy 387 5%, Gem 15%, Gumhuriyet 50 5%, and Yercil 5%.

Main diseases: Powdery mildew, Helminthosporium, scald, covered smut, stem rust, leaf rust.

Main insects: Frit fly, saw fly, stink bug.

Barley is an independent program and currently about 9 researchers are involved.

## YEMEN ARAB REPUBLIC

| | |
|---|---|
| **Area:** | |
| Total Arable Land | 1,200,000 hectares |
| Total Area Sown to Barley | 78,000 |
| Total Area Sown to Wheat | 50,000 |
| **Production:** | |
| Total Barley | 80,000 metric tons |
| Total Wheat | 52,000 |
| **Yield:** | |
| Barley | 1,176 kg/ha |
| Wheat | 1,183 |
| **Uses of Barley:** | |
| Human Food | 80% |
| Animal Feed | 20% |

About 50% of the barley is grown in the 400-500 mm rainfall areas and the remainder in the 300-400 mm zones. A small area about 10% is irrigated.

Normal sowing - two seasons - mid-June and February.

Normal harvest - November and May

Main varieties - All local cultivars - Sakha 60%, Aswad 30%, Bekur 8%, Habib 2%.

Promising lines - Giza 121, Giza 12o, Por x Lar - Pak. Arivat x Local Db.

Main diseases - Leaf rust, Helminthosporium spp., powdery mildew.

Main insect - Aphids, saw fly.

Barley is included in the general research program and currently there are three research workers with wheat and barley.

Due to elevational differences two main crop seasons occur and most of the barley is sown at elevations from 1900 - 2700 m.

## YEMEN, PEOPLES DEMOCRATIC REPUBLIC

| | |
|---|---|
| Area: | |
| Total Arable Land | 352,000 hectares |
| Total Area Sown to Barley | 1,300 |
| Total Area Sown to Wheat | 7,000 |
| Production: | |
| Total Barley | 1,750 metric tons |
| Total Wheat | 14,000 |
| Yield: | |
| Barley | 1.3 tons/ha |
| Wheat | 2.0 |
| Uses of Barley: | |
| Human Food | 100% |
| Animal Feed | |

Most of the barley is grown with Ground water irrigation.

Normal sowing date - October.

Normal harvest date - January.

Main varieties - All local cultivars

Main diseases - Yellow rust, Leaf rust.

The barley work is included with wheat research. At present three researchers are associated with the barley work.

## YUGOSLAVIA

### Area:

| | |
|---|---|
| Total Arable Land | 7,381,000 hectares |
| Total Area Sown to Barley | 330,000 |
| Total Area Sown to Wheat | 1,843,000 |

### Production:

| | |
|---|---|
| Total Barley | 754,000 metric tons |
| Total Wheat | 6,283,000 |

### Yield:

| | |
|---|---|
| Barley | 2,406 kg/ha |
| Wheat | 3,409 |

## APPENDIX I - LIST OF PARTICIPANTS

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APPENDIX II

PROGRAM
OF THE FOURTH REGIONAL WINTER CEREAL WORKSHOP - BARLEY
AMMAN, JORDAN
APRIL 24 - 28, 1977

| | |
|---|---|
| Sunday, April 24th | Location - University of Jordan |
| 08.00 - 09.00 | Registration - Gymnasium |
| 09.00 - 10.30 | OPENING SESSION - Samir Raffai Auditorium |
| | Introduction - S.Qasem |
| | Welcome Address and Conference Opening. His Excellency The Crown Prince. |
| | Keynote Address - World Food Situation. R.G.Anderson. |
| | Vote of Thanks. |
| 10.30 - 11.00 | C o f f e e B r e a k |
| 11.00 - 13.00 | SESSION 2 - Gymnasium |
| | Chairman - K.Finley |
| | Reporters - M.Duwayri<br>R. Grey |
| | Status of Barley Improvement Around The World. R.F.Eslick |
| | Barley Production, Utilization and Research In The Afro-Asian Region. J.P.Srivastava |
| | Status of Barley Improvement In The European Mediterranean Climate. E.J.Comenge. |
| | Barley Improvement in Australia and its Potential Contribution to the Mediterranean Region. |
| | D.H.B. Sparrow |
| 13.00 - 14.30 | L u n c h B r e a k |

14.30 - 17.00 SESSION 3

Chairman - Z. Ghosheh

Reporters - L. Hachemi
A. Klatt

The Agronomic Uniqueness of Barley,
B. C. Wright.

Agro-Climatological Environments and Barley Production,
P. Bronzi.

Farmers and Markets: Is Barley The Answer ?
D. Winkelmann

Factors Affecting Farmers' Adoption of New Production Technology,
C. K. Mann

16.30 - 17.00 C o f f e e B r e a k

17.00 - 18.30 SESSION 4

Chairman - E. E. Saari

Reporters - E. Ghobrial
R. Little

Brief Review of Country Reports:

| | |
|---|---|
| 1. Afghanistan | M. Osmanzai |
| 2. Algeria | L. Hachemi |
| 3. Bangladesh | A. Razzaque |
| 4. Cyprus | A. Hadjichristodoulou |
| 5. Egypt | A. A. Mansour |
| 6. Ethiopia | H. Gebre |
| 7. Greece | E. A. Skorda |
| 8. India | M. Ram |

20.00 Dinner - Hosted By The Ministry of Agriculture
At Mojamaa Al-Naqabat.

Monday, April 25th

| | | |
|---|---|---|
| 08.00 - 10.30 | SESSION 5 | |
| | Chairman - E.E. Saari | |
| | Reporters - M.H. El-Shater<br>G. Varughese | |
| | Brief Review of Country Reports (Continued) | |
| | 1. Iran | B. Sadri |
| | 2. Iraq | S. Bekou |
| | 3. Jordan | Z. Ghosheh |
| | 4. Kenya | M. W. Oggema |
| | 5. Korea | C. H. Cho (Read by J. M. Prescott) |
| | 6. Lebanon | A. Chaaban |
| | 7. Libyan Arab Republic | M. H. El-Shater |
| | 8. Morocco | |
| | 9. Nepal | B. M. Mathema |
| | 10. Pakistan | M. A. S. Kirmani |
| | 11. Portugal | M. T. Barradas |
| 10.30 - 11.00 | Coffee Break | |
| 11.00 - 13.00 | SESSION 5 (Continued) | |
| | 1. Saudi Arabia | M. S. Jowanna and I. Baghdadi |
| | 2. Somalia Dem. Rep. | A. Guled |
| | 3. Spain | J. Comenge Ensenat |
| | 4. Sri Lanka | D. Murugesan |
| | 5. Sudan | A. O. I. Imam |
| | 6. Sultanate of Oman | M. Akhtar |
| | 7. Syrian Arab Republic | I. Naji |
| | 8. Tunisia | A. Daaloul |
| | 9. Turkey | F. Demirkan |
| | 10. Yemen Arab Republic | M. Mohamed El-Gouri |
| | 11. Peoples' Dem. Rep. of Yemen | S. Mohsin Atta and J. S. Bakshi |
| | 12. Andean Region, South America | A. Klatt |
| | 13. University of Jordan | M. Duwayri |
| 13.00 - 14.30 | Lunch Break | |

14.30 - 16.30 SESSION 6

Chairman - R. Melville

Reporters - M.W. Oggema
W.L. Pelton

International Barley Programs and Nursery Systems.

The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)
L.R. Morsi and J.A. Quhaiwi

International Maize and Wheat Improvement Center. (CIMMYT)
R.G. Anderson

Food and Agricultural Organization of the United Nations (FAO)
Y.Y. Klaimi

The International Center for Agricultural Research in the Dry Areas (ICARDA)
H.S. Darling

Oregon State University, International Nursery Program.
W.L. McCuistion

International Winter Wheat Performance Nursery.
K.D. Wilhelmi and V.A. Johnson.

16.30 - 17.00 Coffee Break

17.00 - 18.30 SESSION 6 (Continued)

Montana State University/AID - Barley Research Program.
L.P. Carter

Identifying and Cataloguing of Disease Resistant Barley Germplasm and The International Rust Nursery.
J.G. Moseman

The Svalof Barley Breeding Program.
A. Hagberg.

Off-Season Winter Cereal Nursery Facilities in Kenya.
G. Kingma

Varietal and Germplasm Development at Washington State University.
R.A. Nilan, A.J. Lejeune and C.E. Muir.

20.00 Dinner - Hosted by the University of Jordan At The University Campus.

Tuesday, April 26th

06.30 - 18.30 Field Trip - Z. Ghosheh and M. Duwayri.

Amman - Jarash - Ramtha - Irbid - Deir Allah - Dead Sea - Amman.

Wednesday, April 27th

08.30 - 10.30 SESSION 7

Chairman - J.M. Poehlman

Reporters - I. Baghdadi
R. Habgood

Obtaining Greater Progress in Barley Breeding.
D.C. Rasmusson.

Male Sterile Facilitated Recurrent Selection Advantages and Disadvantages.
R.F. Eslick

Male Sterile Facilitated Recurrent Selection and Happy Homes
R.T. Ramage

Breeding for Wide Adaptability and Superior Agronomic Types.
E. Rodriguez Campos (Read by H. Nasr)

10.30 - 11.00 Coffee Break

11.00 - 13.00 SESSION 8

Chairman - A.K.Al-Fakhry

Reporters - M.Akhtar
G.Jenkins

Winter Barley Breeding and The Exploration of Spring x Winter Hybrids.
G.Jenkins

Breeding for Short Duration Barley.
E.I.Kivi.

Implications of Barley Breeding for Food and Feed Quality
C.W.Newman

The Potential of Utilizing Genes for Improved Quality in Barley for Food and Feed.
L.Munck.

13.00 - 14.30 L u n c h B r e a k

14.30 - 17.00 SESSION 9

Chairman - F.Khoury

Reporters - M.R.Omar
H.Nasr

Aspects of Improving Agronomic Practices to Maximize Barley Yields in the Region.
A.Hadjichristodoulou.

Possible Characteristics of Drought Tolerant Barley.
H.Ferguson

Weed Control in Wheat and Barley in the Middle East.
A.R.Saghir

Cultural and Weed Control Practices for Barley Production in North Africa.
W.L. Nelson.

Barley in The Ley Farming System
J.B.Doolette.

Effect of Clipping on Forage, Hay and Grain Production from Barley, Wheat and Triticale.
E.A.Skorda

Seed Quality and Production - A Vital Link to National Barley Production Programs
J.E.Douglas

17.00 - 17.30 Coffee Break

17.30 - 18.30 Sunset Concert - The Royal Jordanian Army Band.

Thursday, April 28th

08.30 - 10.30 SESSION 10

Chairman - J.M.Prescott

Reporters - R.M.Djerbi
A.H.Kamel

Barley Diseases in the Near East
T.A.Hak and E.Ghobrial

Barley Diseases and Their Surveillance in the Region.
E.E.Saari and J.M.Prescott

Utilizing Recurrent Selection Populations for Disease Resistance in Barley.
E.L.Sharp and H.E.Bockelman.

USDA Barley Germplasm Collection Program - Classification and Availability to the National Programs.
J.G.Moseman and J.C.Craddock

10.30 - 11.00 Coffee Break

11.00 - 13.00 SESSION 11

Chairman - O. L. Brough

Reporters - N. Kathkuda
W. L. McCuistion

1. Concluding Remarks

   a) Crop Improvement
   A. Hagberg

   b) Cultural Practices
   R. J. Nilan

   c) Plant Protection
   E. E. Saari

   d) International Programs and Nurseries
   J. P. Srivastava

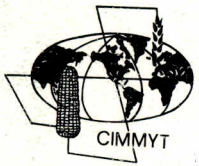
   e) Economic Policies, Seed Production and Transfer of Technology
   S. Barghouti

   f) General Conclusions of the Workshop
   R. G. Anderson

2. Closing Remarks
   S. Qasem

3. Appreciation
   L. P. Carter




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1978